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Towards an Inclusive Digital Cultural Heritage: Frameworks for Representation and Sustainability

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ABSTRACT:
The digitisation of cultural heritage (CH) offers significant opportunities for preservation, maintenance, and promotion. However, it also presents challenges in terms of representation and the exhibition of content, particularly for the cultural heritage of minorities. This situation can lead to reduced participation and inclusion of minority groups, creating inequitable representations of diverse values in digitisation efforts and increasing the risk of misuse of digital CH. Existing academic frameworks often inadequately address digitization needs and diverse stakeholder perspectives. There is a need for adaptive frameworks that integrate various values and narratives relevant to digital and multicultural heritage management. The paper emphasizes the need for a more inclusive and collaborative approach to cultural heritage digitization. The proposed Quadruple Helix Ecosystem Framework provides a comprehensive model to guide the development of innovative and sustainable digital heritage initiatives where diverse stakeholders work together to preserve, interpret, and present cultural heritage in the digital age.

Keywords: *cultural heritage, digitalization, stakeholders, minorities*

1. Introduction

The evolution of theoretical models in cultural heritage (CH) management reflects a growing emphasis on inclusivity, participation, and long-term sustainability. This shift has been propelled by internal sectoral transformations, evolving policy frameworks, and the increasing integration of digital infrastructures (Smith, 2006; Giaccardi, 2012). Recent scholarship has positioned co-creation as a critical methodology for overcoming the limitations of expert-driven, hierarchical approaches. Through collaborative practices that involve communities, institutions, and public agencies, co-creation supports cultural democracy and equity—values that resonate with sustainable development goals, particularly those related to social inclusion and cultural resilience (UNESCO, 2015; Bonacchi & Mazel, 2021).

Despite the growing embrace of participatory strategies, a conceptual gap remains: the lack of a comprehensive model capable of accounting for the diverse, shifting, and often contested roles of stakeholders in the digitization of cultural heritage. This is particularly relevant within sustainability discourse, which increasingly demands heritage systems that are not only economically and environmentally sustainable but also socially embedded and participatory (Auclair & Fairclough, 2015; Labadi & Logan, 2016).

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However, claims of participation often obscure underlying asymmetries—particularly the tendency of institutional actors to shape the terms and limits of engagement. A more integrated framework is needed, one that not only reconfigures stakeholder participation but critically examines who holds decision-making power, whose contributions are amplified or side-lined, and how digital publics are constituted. Such a framework must reframe cultural heritage not as a neutral space of access, but as a field of technological, ecological, and socio-political entanglements. In this context, digital heritage is not merely an archival function but part of a living system requiring adaptive governance and inclusive, power-aware stewardship (Faro Convention, 2005; Parry, 2007).

The first phase of this research seeks to establish a nuanced understanding of stakeholder dynamics in cultural heritage digitization through a triangulated analytical approach. It begins with an analysis of European and international policy documents to examine how stakeholder participation is structured and incentivized at institutional levels—often under normative assumptions of consensus and inclusion. This is followed by a review of academic literature to trace how conceptualizations of engagement have evolved, including growing critiques of tokenism and co-option. Finally, the analysis turns to empirical case studies, with particular attention to projects involving indigenous and minority communities, to identify where participatory ambitions align—or fail to align—with the realities of practice. Across these layers, attention is paid not only to modes of inclusion but also to exclusions: whose authority is legitimized, who gets visibility in digital platforms, and which narratives remain peripheral. By synthesizing insights from policy, theory, and practice, this phase supports a more reflexive and socially accountable approach to cultural heritage digitization.

2. Political Shifts in Cultural Heritage Policy: Changing Roles of Stakeholders

The analysis of policy documents revealed that the relationship between stakeholders and heritage has evolved significantly over time, reflecting broader changes in how heritage itself is defined, valued and managed. The early era of cultural heritage conservation, spanning the late 19th and early 20th centuries, was defined by a strong focus on preserving the material and aesthetic qualities of historic monuments and buildings (Glendinning, 2013; Muñoz Viñas, 2005). This approach prioritized the physical preservation of tangible heritage as a static and timeless legacy, often disconnected from its social and political contexts (Waterton & Watson, 2015). The period saw the gradual formation of an international conservation movement, driven by a shared belief in the universal value of cultural heritage and the need for systematic approaches to its preservation (Smith, 2006). This evolving professional framework laid the groundwork for the first international agreements on heritage conservation, marking a crucial step toward establishing global standards for heritage protection. This traditional approach, however, faced mounting criticism for its narrow focus.

The period from the 1960s to the 1990s was marked by a profound transformation in the field of heritage conservation, driven by significant political, social and intellectual shifts (Harrison, 2013). This era challenged the materialist and expert-dominated approaches of earlier decades, emphasizing the dynamic and contested nature of heritage (Avrami et al., 2019). Conservation practices began to incorporate a broader

range of values, reflecting the diverse ways in which communities ascribe meaning to heritage (Howard, 2003; Ashworth & Graham, 2005). Movements advocating for civil rights, decolonization, and social justice challenged traditional power structures and emphasized the need for inclusive and participatory approaches to decision-making across all sectors, including heritage conservation. The Nara Document on Authenticity (1994) reflected the values turn, addressing the Eurocentric biases that had dominated earlier conservation frameworks. Developed as part of the World Heritage framework, the Nara Document emphasized the importance of understanding authenticity within its cultural context, recognizing that different societies and traditions ascribe value to heritage in diverse ways. This shift acknowledged that heritage is not merely a static artefact of the past but a living construct tied to the identities, experiences, and aspirations of contemporary communities (Fairclough et al., 2008; Harvey, 2008). By involving stakeholders in the decision-making process, the field sought to democratize heritage management and ensure that diverse voices were represented. Since the 1990s, heritage conservation has evolved beyond its traditional focus on material preservation and the intrinsic value of historic sites (Harrison, 2013; Lähdesmäki et al., 2020). By embracing this expanded perspective, the field has redefined its goals, methodologies, and stakeholder relationships, aligning closely with European Commission's New European Agenda for Culture (2018), which emphasizes the role of cultural heritage in fostering societal cohesion and sustainability. The evolution toward heritage as a societal instrument has been influenced by global trends, including increasing urbanization, climate change, and social inequalities. The UNESCO Historic Urban Landscape Recommendation (2011) exemplifies this shift, advocating for embedding heritage within urban planning and sustainable development strategies. This recommendation aligns with the European Commission's Recommendation on a Common European Data Space for Cultural Heritage (2021), which calls for the integration of digital technologies to make heritage accessible and relevant in urban and social contexts. Such approaches underscore heritage's role in fostering resilient and sustainable cities, addressing issues such as housing, mobility, and climate adaptation (UNESCO, 2011; European Commission, 2021). This era is characterized by a strong emphasis on stakeholder engagement and co-creation (Chitty & Smith, 2019; Ludwig, 2016). Heritage conservation has moved away from an expert-dominated model to embrace collaborative processes involving diverse actors, including local communities, private sector partners, NGOs, and government agencies (Fredheim, 2018). For example, community-led initiatives in post-conflict regions, such as Bosnia and Rwanda, demonstrate how heritage can be a powerful tool for reconciliation and healing, enabling communities to rebuild their identities through shared narratives (Walters et al., 2017). The instrumental turn has fundamentally expanded heritage's scope to address pressing global challenges, particularly climate change and accelerating urbanization (Fouseki et al., 2020). Research demonstrates that existing buildings contribute approximately 40% of global energy consumption and carbon emissions, positioning their adaptive reuse and conservation as crucial components of sustainability strategies (Foster & Kreinin, 2020). The European Green Deal and the Digital Decade (2021-2030) frameworks have catalyzed innovative approaches to energy-efficient digital infrastructures supporting heritage preservation and urban resilience. As climate-related threats intensify and urban populations expand, heritage sites face unprecedented risks

requiring innovative adaptation strategies. Contemporary research together with the key policy documents demonstrates the critical intersection between heritage conservation and climate resilience planning (DeSilvey & Harrison, 2020). The recognition of heritage as a vital resource for environmental sustainability has catalyzed transformative interdisciplinary collaborations among conservation professionals, urban planners, environmental scientists, and policymakers (Messenger & Smith, 2022; Richards et al., 2019). Economic valuation has become another key aspect of the instrumental turn (Throsby & Rizzo, 2019; Vecco & Srakar, 2018). The Creative Europe Programme and the R&I Framework Programmes (especially H2020 and Horizon Europe) have underscored the role of heritage in driving economic growth, fostering tourism, and generating employment. However, this emphasis on economic benefits has sparked debates about the commodification of heritage and its impact on authenticity and social equity (Guttormsen & Swensen, 2016; Lähdesmäki et al., 2020). While heritage tourism can generate significant revenue, it may also contribute to gentrification and the displacement of local communities, highlighting the need for ethical and inclusive approaches to heritage management (Gravari-Barbas et al., 2017; Zhu, 2021). Urban regeneration initiatives particularly exemplify these challenges, necessitating careful negotiation between historic fabric conservation and contemporary development demands (Bandarin & van Oers, 2015; Pereira Roders & van Oers, 2019).

In conclusions, cultural heritage conservation has shifted from a static, expert-driven practice to a dynamic, inclusive process aligned with sustainability goals. This transformation reflects a growing recognition of heritage as a living resource that contributes to social equity, climate resilience, and urban sustainability. By embracing diverse values, engaging stakeholders, and integrating heritage into broader policy frameworks, contemporary conservation supports both cultural continuity and future-oriented development.

3. Stakeholder Engagement Frameworks in Cultural Heritage Management

In the realm of cultural heritage management, the evolution toward participatory approaches has led to the development of various stakeholder engagement frameworks. While these theoretical frameworks were developed independently, they collectively demonstrate a significant evolution from expert-cantered to participatory approaches. These frameworks not only accommodate a wide range of participants but also foster deeper collaboration and shared responsibility. The **Living Heritage Approach** (Poulios, 2014) and **peoples-based conservation** (Sully, 2013) both reposition power toward heritage communities, though they diverge in their temporal orientation. Living Heritage assumes a continuous, often ancestral relationship between communities and heritage, while peoples-based conservation allows values to emerge dynamically from present-day contexts. Both challenge traditional value-based paradigms, but only the latter explicitly prioritizes social welfare over material preservation. **Conservation 3.0** (Gustafsson, 2019) and the **Heritage-as-vector** model (Janssen et al., 2017) reframe heritage in terms of strategic utility—be it for regional development or spatial transformation. They introduce economic and planning logics that broaden the stakeholder base to include policymakers, developers, and creative industries. While these models expand participation structurally,

they risk relegating community voice to a means rather than an end, particularly when heritage becomes instrumentalized. In contrast, the **Memory Ecosystem Model** (Burkey, 2022) builds from the affordances of digital media to construct a participatory memory space. It fosters dialogic rather than directive relationships between institutions and communities, emphasizing co-authorship over representation. This model resonates with the **Voices of Culture Stakeholder Model** (2015), which aims to systematize participatory governance but does so more from an institutional policy standpoint than through lived, iterative practices of memory creation. More recent contributions like the **Assessment Framework for Youth Digital Participation** (Zhang et al., 2024) and the **Conservation Management Planning Framework** (Cuncha Fereira et al., 2024) introduce procedural precision to participatory work. The former brings statistical and analytical tools into the assessment of youth engagement, reflecting an effort to operationalize participation in measurable terms. The latter offers a values-based planning process grounded in risk assessment, condition analysis, and policy design, but does not directly interrogate power asymmetries or issues of representation. What becomes clear across these models is that while they converge on the importance of stakeholder inclusion, they diverge on fundamental questions: Who defines heritage? Who benefits from its preservation? How is authority negotiated across digital and physical domains? A critical mapping of these frameworks highlights both productive complementarities and areas where conceptual overlaps may obscure meaningful differences. For practitioners, this synthesis offers more than a menu of options—it provides a navigational tool for selecting or combining frameworks based on the specific political, technological, and community dynamics of a given heritage context.

Our review of recent literature reveals three conceptual gaps that continue to shape and constrain cultural heritage management. First, conflicting interpretations and value ascriptions reflect an ongoing struggle to reconcile expert-led approaches with pluralistic stakeholder perspectives. This is evident in discussions around living heritage and values-based conservation (Poulios, 2014; Cunha Ferreira et al., 2024), where the dynamic and socially embedded nature of heritage challenges static preservation models. Second, ambiguity in foundational terminology—such as authenticity, integrity and participation—persists across academic and professional discourses (Sully, 2013; Gustafsson, 2019), undermining coherence in both theory and application. Third, while participatory practices are increasingly emphasized, the literature highlights a continued lack of integrated frameworks that meaningfully combine technical expertise with community input, particularly in emerging digital and youth-oriented initiatives (Zhang et al., 2024; Burkey, 2022). These gaps are not just theoretical. They carry significant implications for the sustainability of heritage management. Without clearer definitions, shared value frameworks and genuinely inclusive processes, heritage practices risk becoming extractive, exclusionary or detached from the evolving social and environmental conditions in which they operate.

In addition, the review highlights critical stakeholder-related gaps that continue to affect the inclusivity and effectiveness of cultural heritage management. Ambiguity around stakeholder roles often results in "fragmented collaboration, blurred lines of responsibility and diminished accountability, limiting the potential for genuine co-creation in heritage processes"(Voices of Culture, 2015). Unequal access to digital tools and

infrastructure further restricts participation, particularly among those lacking the skills or resources to engage with increasingly digital forms of heritage work (Burkey, 2022). At the same time, many heritage initiatives continue to overlook the perspectives and contributions of marginalized groups, leading to practices that reflect dominant cultural narratives while excluding alternative voices (Zhang et al., 2024). These challenges are more than operational inefficiencies—they expose structural inequalities that shape who is heard, who is visible and who ultimately benefits from heritage initiatives. Yet they also offer a pathway toward more inclusive and sustainable frameworks. Addressing these gaps means refining participation models to clarify roles, remove technological barriers and deliberately integrate diverse viewpoints, thereby advancing heritage practices that are not only more equitable but more representative of the communities they aim to serve. Furthermore, the absence of digitization-specific frameworks presents a significant structural weakness in current heritage management approaches. While traditional models offer valuable guidance for conservation, interpretation and stakeholder engagement, they often treat digitization as a peripheral or purely technical concern rather than a core component of heritage work. This marginal positioning leads to inconsistent implementation of digital initiatives, as institutions lack structured approaches to navigate the complex decision-making, evaluation and stakeholder coordination required in digital transformation efforts (Burkey, 2022; Zhang et al., 2024). The tendency to rely on general principles or narrow technical standards fails to address how digitization intersects with broader cultural, institutional and social dimensions of heritage practice. This gap limits the potential for digitization to be strategically embedded within heritage institutions' long-term goals, resulting in fragmented practices and missed opportunities for inclusive digital engagement. At the same time, it offers an important opportunity to develop targeted frameworks that build on existing heritage management knowledge while addressing the specific demands of digitization. Doing so would not only improve institutional capacity to manage digital projects but also ensure that digital heritage practices are more coherent, adaptive and reflective of contemporary heritage realities.

The COVID-19 pandemic exposed the fragility of traditional access to culture and accelerated the digitization of the heritage sector. As physical spaces closed, digital technologies became critical for maintaining public access to cultural resources and educational content (World Intellectual Property Organization, 2022). Institutions rapidly expanded their digital offerings, including immersive exhibitions, virtual tours, and online archives (Nohrer et al., 2021; Giannini et al., 2022). In many cases, these shifts reshaped not only outreach strategies but also institutional structures and partnerships, positioning digital infrastructures as central to long-term cultural sustainability. Yet the transition has been uneven. While digital solutions enabled new forms of engagement, they also revealed and deepened existing structural inequalities (Samaroudi et al., 2020; Volanakis et al., 2024). Communities already facing marginalization—particularly in rural, minority, or economically disadvantaged settings—were often excluded from these new digital spaces due to limited connectivity, low digital literacy, or lack of localized content (Mihelj et al., 2019; Higgins et al., 2023; Conti, 2025). The very technologies intended to democratize access have, in some cases, reproduced or even intensified cultural exclusion. These developments point to a fundamental sustainability challenge. Beyond technical infrastructure and innovation, sustainable digitization depends on equitable participation

and long-term inclusion. The lack of coordination among key stakeholders—government bodies, academic institutions, industry actors, and civil society—has limited the sector's ability to respond holistically. As the literature notes, sustainability in digital heritage requires more than digitization; it demands the design of participatory systems that support cultural continuity, social justice, and collaborative stewardship (Giaccardi, 2012; Parry et al., 2018). This chapter argues that the sustainability of digital cultural heritage cannot be reduced to technological preservation or institutional resilience. It must also address the social conditions under which digital engagement is possible. Without systemic attention to access, representation, and cross-sectoral cooperation, digitization risks becoming an exclusionary practice rather than an enabling one. The next section establishes the empirical ground for the analysis of stakeholder engagement in cultural heritage digitization projects.

4. Methodology

This study uses a multi-source qualitative approach to examine stakeholder engagement in cultural heritage digitization. Given the complexity of interactions between institutional, academic, community, and technical actors, a case study-based design is particularly suited to capturing diverse models of participation (Yin, 2018). Case studies allow for the investigation of processes as they unfold in specific contexts, offering insight into both structure and practice—especially important in digital heritage, where outcomes are often shaped by informal collaboration and evolving technologies (Flyvbjerg, 2006). The first Phase of the research combines three types of analysis: policy review, literature analysis, and empirical examination of 40 digitization projects. The policy layer maps how stakeholder roles are framed by institutions such as UNESCO and the European Commission. The academic layer traces how engagement has been theorized in heritage and digital studies (Giaccardi, 2012; Waterton & Smith, 2010). The empirical layer focuses on how engagement is enacted in practice, with close attention to initiatives involving minority and indigenous communities. This triangulated structure ensures analytical depth and allows comparison between intended models and actual implementation.

4.1 Stakeholder Engagement in Practice: Empirical Patterns from 40 Case Studies

The empirical study is based on a structured process of collecting case studies to examine how different stakeholders are involved in cultural heritage digitization. A total of 40 case studies were identified, with a targeted inclusion of at least 10 initiatives involving indigenous or minority communities. The selection process was governed by clearly defined inclusion criteria. Eligible projects had to focus specifically on cultural heritage digitization, encompassing a range of materials such as historical artefacts, manuscripts, architectural heritage, and audio-visual records. Each project was required to demonstrate substantive use of digital technology—such as 3D scanning, AI-assisted restoration, metadata structuring, or virtual/augmented reality—for purposes of preservation or public access. Furthermore, comprehensive documentation and evidence of identifiable stakeholder involvement were mandatory for inclusion. Data collection drew from five principal categories of sources. Academic databases, including Google Scholar, ResearchGate, CORE, and JSTOR, formed the foundation of the search. These

were supplemented by institutional and governmental reports from organizations such as UNESCO, Europeana, and national heritage authorities. Project documentation from major museum and heritage institutions—including the British Museum, the Smithsonian Digitization Program, and the Digital Public Library of America—was also reviewed. Proceedings from relevant conferences, particularly the Digital Heritage International Congress and ICOMOS events, contributed further material. Finally, reports produced by NGOs and community organizations, especially those representing indigenous and minority groups, were included to ensure a wider representational scope. For each selected case, key data were recorded using a standardized template. The empirical scope is deliberately wide, encompassing projects that employ a range of technological tools—from 3D modelling and virtual reconstructions to oral history documentation and community-managed digital archives. Geographical representation spans multiple regions, with a noticeable cluster in Cyprus, Canada and the United States, complemented by cases from Australia, Italy and a range of other countries. While the sample is not statistically representative of the full global landscape of heritage digitization, it is analytically generative. The cases were selected to capture variation in institutional settings, funding sources, community involvement, and technological choices. This enables a grounded examination of stakeholder dynamics that goes beyond normative expectations or policy rhetoric. By concentrating on how engagement operates in actual project settings, this chapter lays the foundation for tracing patterns, inconsistencies and emerging models in stakeholder collaboration.

A clear majority of projects (65%) focus on 3D and digital reconstruction, reflecting the field's strong investment in spatial preservation. These initiatives frequently target architectural sites, artefacts and archaeological remains, underscoring a sustainability logic focused on long-term digital surrogates for fragile or endangered physical heritage. Archive and collection-focused projects account for 17.5%, followed by documentation initiatives (10%), with oral history, virtual exhibitions and other formats appearing only occasionally. Technology use shows a marked preference for immersive and spatial tools. VR/AR features in 77% of projects, indicating a shift toward audience engagement through interactive environments. Photogrammetry and 3D scanning appear in 45%, often combined with VR to create integrated preservation and storytelling workflows. The coupling of these technologies supports sustainable access, allowing institutions and communities to maintain and share digital cultural assets beyond physical or geographical limitations. Digital archives and AI-driven analysis tools are present in approximately one-quarter of the projects, pointing to growing interest in scalable, data-intensive infrastructures. Though less frequent, audio-visual recording and GIS mapping technologies remain vital for site-specific or narrative-rich documentation efforts. These findings highlight a growing convergence around immersive, preservation-oriented technologies that serve both engagement and sustainability aims. Technological integration is evident across the sample, with 16 projects employing two tools and 12 relying on a single technology. More complex configurations—featuring three or four technologies—appear in 8 and 4 projects respectively. This distribution reflects the layered demands of cultural heritage digitization, where documentation, preservation, and presentation often require distinct yet complementary tools. The most frequent pairing—Photogrammetry or 3D Scanning with Virtual or Augmented Reality—appears in 7 projects, offering both

precision in capture and immersive user engagement. Standalone VR/AR implementations and combinations with digital archives or databases follow, each present in 5 cases. These patterns point to a growing preference for integrated technological strategies that support both sustainable preservation and broader accessibility.

Stakeholders were grouped into seven categories: academic, community, government, technical, museum, funding, and NGO. Government bodies are the most frequently involved (17.5%), followed by museums and indigenous communities (12.5% each). Public and grassroots participation remains low (5%), raising concerns about long-term sustainability, particularly in terms of local ownership and relevance. Stakeholder roles concentrate on research (47.5%) and technical implementation (42.5%), with limited involvement in content provision, funding, engagement, or project management. This narrow distribution suggests that while technical and academic capacities are well represented, broader stakeholder integration—crucial for cultural, financial, and operational sustainability—remains underdeveloped in many projects. Academic involvement remains prominent and beneficial, but broader stakeholder inclusion—particularly of communities, businesses, and government bodies—is needed to increase project relevance and long-term impact. Projects focused on indigenous and minority heritage offer stronger models of community participation, where collaborative practices are embedded in both design and implementation. These approaches not only strengthen cultural representation but also support more sustainable management of digital heritage by aligning preservation efforts with community-defined priorities.

4.2 Comparative Analysis of Stakeholder Engagement in Cultural Heritage Digitization

This chapter presents a comparative analysis of stakeholder engagement patterns across two categories of cultural heritage digitization projects: those focused on indigenous and minority heritage, and those addressing broader or mainstream heritage contexts. The findings reveal significant differences in how various stakeholders participate in these projects, reflecting contrasting approaches to governance, collaboration, and sustainability in digitization practices. Academic institutions emerge as the most consistently engaged stakeholders in both categories, with nearly identical levels of participation—68.4% in indigenous/minority-focused projects and 66.7% in other cases. This uniformity highlights the central role of academia in providing research expertise, project coordination, and technological capacity across the field, regardless of cultural context. However, other stakeholder categories show marked variation. Community involvement is a defining feature of indigenous and minority heritage projects, with 68.4% of such cases involving active participation from community members. In contrast, only 4.8% of mainstream projects show similar levels of engagement. This disparity—over 60 percentage points—underscores the extent to which community collaboration is embedded in projects concerning marginalized or underrepresented groups. Such engagement is not only a reflection of participatory intent but also a condition of legitimacy and ethical practice in these settings. Museum involvement also follows this pattern. It is significantly higher in indigenous and minority heritage projects, appearing in 52.6% of cases compared to 14.3% in other projects. This suggests that institutions with curatorial and interpretive expertise are more commonly mobilized in projects that require deeper contextualization,

negotiation of representation, or co-curation with communities. Technical stakeholder participation is similarly more prominent in indigenous and minority cases, with engagement rates of 42.1% compared to 23.8% in broader projects. This may indicate more complex technological demands, such as the need for advanced 3D modelling, immersive environments, or culturally sensitive data structures. It may also reflect stronger emphasis on digital longevity and access, particularly in contexts where physical heritage is at risk or where community-controlled platforms are a goal. Government participation, while somewhat more evenly distributed, also shows a higher presence in indigenous/minority projects (47.4%) than in mainstream ones (33.3%). This suggests greater public-sector commitment to inclusive heritage practices, possibly influenced by policy frameworks that prioritize diversity, reconciliation, or regional development. Taken together, these patterns point to distinct models of stakeholder engagement. Indigenous and minority heritage digitization projects tend to adopt more inclusive, multi-actor strategies that involve communities, public institutions, and technical experts alongside academic partners. In contrast, mainstream projects more often rely on narrower institutional networks, with limited direct community input.

5. Limitations and further research

The article approaches digitization largely as a socio-technical process, without fully addressing how exclusion from infrastructure, digital literacy, and language access shapes who gets represented—downplaying structural inequalities in digital heritage work. As a direction for further research, future studies could examine how structural barriers—such as limited digital infrastructure, language exclusion, and uneven digital literacy—affect who is able to engage in digital heritage initiatives. This would require focused inquiry into underrepresented groups' access to and control over digital tools, as well as the socio-political conditions that shape these disparities. Such research could offer a more grounded understanding of digital inclusion beyond participation metrics. While the case study approach provides valuable insight into stakeholder dynamics during active project phases, it does not account for what happens once external funding ends. The article lacks a longitudinal perspective, leaving unclear whether participatory models sustain community engagement, digital access, or archival relevance over time. Future work should trace the post-project trajectories of digital heritage initiatives, examining the durability of community-led versus institution-led models. This includes investigating the maintenance, accessibility, and local relevance of digital archives after project completion, offering a clearer view of what sustainable participation looks like beyond funding cycles.

6. Conclusions

The empirical analysis demonstrates that long-term sustainability in cultural heritage digitization cannot be achieved solely through technological innovation or institutional leadership. While the field shows a clear investment in immersive technologies—particularly the combined use of 3D scanning and VR/AR—these tools are often deployed in contexts where stakeholder engagement remains narrowly defined. Most projects rely heavily on academic and technical actors, with minimal involvement

from communities, grassroots organizations, or non-institutional partners. Research and technical implementation dominate, accounting for nearly 90% of recorded stakeholder activities, while roles related to content curation, funding, engagement, and project management remain underrepresented. This narrow distribution reflects a gap in collaborative governance and raises concerns about institutional resilience. This pattern risks reinforcing hierarchical models of heritage management and limits the potential for projects to remain relevant, adaptable, and socially grounded over time.

In contrast, initiatives involving indigenous and minority communities present alternative models of sustainability. These projects embed community participation from the outset, ensuring that digital heritage outputs reflect local priorities, cultural values, and knowledge systems. Such integration supports cultural sustainability by promoting continuity between digital representation and community identity. To move toward more sustainable digital heritage systems, broader stakeholder integration is necessary—not only as a matter of representation but as a strategy for institutional resilience. Expanding stakeholder diversity, especially by including grassroots organizations and public actors, is essential to building inclusive and socially sustainable digitization practices that can endure beyond initial project cycles.

The comparative findings highlight that sustainability in digital cultural heritage cannot be achieved through technological innovation alone. Long-term relevance depends on inclusive engagement structures that involve a diverse range of stakeholders, particularly communities directly connected to the heritage being digitized. Projects that prioritize community participation tend to foster stronger cultural continuity, institutional resilience, and shared ownership. Academic institutions play a key coordinating role across different project types, but their contribution to sustainability is shaped by how effectively they support broader collaboration.

However, achieving equitable participation is not merely a matter of including more actors—it requires confronting the institutional barriers that often inhibit co-stewardship. Academic and governmental structures may resist redistributing authority, especially when accountability, funding control, or expert-driven models are at stake. These forms of resistance can undercut even well-intentioned participatory strategies, limiting the depth and durability of collaboration. Future research should examine how these barriers operate in practice and what forms of institutional change are necessary to support more balanced, long-term partnerships with communities. Understanding and addressing these constraints is essential for building truly sustainable and inclusive digital heritage systems.

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