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Digitisation and Cultural Heritage in the Social Environment

A Comprehensive Review of Participation, Policy, Ethics and Sustainability

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Abstract: This article provides a comprehensive, interdisciplinary review of the intersection between digitisation and cultural heritage within social environments, synthesising scholarship from heritage studies, digital sociology, information science, and science and technology studies. It is structured into three core domains: (1) the social dynamics of digital heritage engagement, including access, inclusion, participatory co-creation, and community-led initiatives (e.g., DIGICHer, Mukurtu); (2) institutional and policy frameworks governing digital heritage transformation, with detailed analyses of UNESCO, the European Union, and national strategies such as Digital Dunhuang; and (3) critical challenges concerning equity, algorithmic bias, data sovereignty, digital colonialism, and sustainability. The review integrates comprehensive empirical evidence from major digital heritage initiatives—including Europeana, the global survey by the UNESCO Chair on Digital Cultural Heritage, and community-led projects across diverse cultural contexts. Key findings indicate that while digitisation significantly enhances accessibility and fosters new forms of participation, it simultaneously risks perpetuating existing inequalities, introducing algorithmic biases, and creating new dependencies on commercial technology platforms. The review concludes by identifying future research priorities, emphasising the need for inclusive, ethically grounded, and community-centred approaches to heritage digitisation.

Keywords*: Cultural Heritage; Digitisation; Digital Transformation; Social Environment And Public Participation; Digital Divide.*

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I. INTRODUCTION

➢ *Background and Rationale*

The adoption of digital methods and tools in the cultural heritage sector has been discussed since the 1960s, yet the integration of these technologies into heritage preservation, representation, and public engagement has only accelerated significantly in the last decade. The COVID-19 pandemic served as a profound catalyst, forcing heritage institutions globally to pivot to digital platforms as physical sites closed, revealing both the potential and the limitations of the digital heritage ecosystem. While digital transformation as a strategic goal is not new, the pandemic amplified its urgency, reflected in policies and national strategies across Europe where digitalisation is often seen as key to sustainable development (Collard & Piscitelli, 2025). However, a persistent mismatch exists between the potential benefits of digital solutions and the lack of necessary infrastructures and resources, especially for smaller institutions often outside urban contexts (Collard & Piscitelli, 2025).

The digitisation of cultural heritage encompasses more than the technical conversion of analogue materials. At its core, it represents a fundamental reconfiguration of how cultural heritage is produced, mediated, experienced, contested, and preserved within social environments. Cultural heritage is a social construct that evolves over time and space in response, among other factors, to social, economic, and cultural processes (Skarzauskiene et al., 2025). With the advent of the digital age, the cultural heritage that is created, used, and disseminated is undergoing profound transformation. Notably, UNESCO regards digitisation as a key strategy for protecting world cultural heritage (Skarzauskiene et al., 2025).

The social dimension of heritage digitisation is increasingly recognised as central to understanding its implications. Digital heritage is not simply a repository of cultural artefacts transferred to online platforms; rather, it constitutes a dynamic social field in which diverse actors—institutions, local communities, technology companies, and individual users—interact with and shape collective memory (Martínez-Hernández et al., 2025). Online cultural heritage

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platforms function as "social machines" wherein technological infrastructures and human agency converge to enable the ongoing reinterpretation and recontextualisation of heritage collections (Martínez-Hernández et al., 2025). At the same time, digitisation has opened spaces for citizen participation in heritage production and dissemination (Frontiers in Computer Science, 2025).

The urgency of understanding digital heritage transformation is amplified by several converging trends. First, the depth and scale of current digitisation efforts are unprecedented: Europe's common cultural heritage data space now gives access to over 58 million cultural items from more than 3,700 institutions (European Commission, 2018). A global survey of over 1,200 professionals and institutions (UNESCO Chair, 2025) has mapped the current landscape of digitisation practices, revealing a widespread reliance on 3D scanning and photogrammetry, yet persistent fragmentation and resource limitations (Comet Global Innovation, 2025).

Second, the integration of artificial intelligence (AI) into heritage workflows is introducing new possibilities for collection management, analysis, and user engagement, while simultaneously raising pressing concerns about algorithmic bias, data opacity, and cultural representation (Papadopoulos & Rezk, 2025; Foka et al., 2026). A telling case study found evidence of a 'colonial gaze' in generative AI descriptions of historical images from the era of so-called 'human zoos', with thematic percentages showing cultural erasure (54.5%) and essentialism (41.6%) (Foka et al., 2026).

Third, the increasing involvement of commercial technology platforms—from Google Arts & Culture and TikTok to emerging AI and social media networks—has reshaped how heritage circulates globally, producing tensions between visibility, preservation, and algorithmic control (Frontiers in Computer Science, 2025).

Fourth, the persistent digital divide continues to structure who can access, use, and benefit from digital heritage. While digital access is expanding, disparities persist across nations and communities in access to digital infrastructure, skills training, and—crucially—the empowerment benefits derived from digital engagement (Holm, 2025). As UNESCO has emphasised, the digitisation of cultural heritage must be accompanied by comprehensive policies to address governance, ethical risks, cultural data sovereignty, and inclusion (UNESCO, 2025b).

➢ *Scope, Aims and Research Questions*

This review examines digitisation and cultural heritage within social environments, defined as the complex, dynamic, and reciprocal relationships among digital technologies, cultural heritage materials and institutions, and the diverse publics—including local communities, heritage professionals, researchers, and commercial actors—who create, manage, and use them. The review is guided by the following primary research questions (RQ):

- *RQ1:*
  Social participation and access. How does digitisation reshape social access to, and participation in, cultural heritage? Specifically, what are the outcomes and challenges of citizen science, crowdsourcing, digital storytelling, and community-led digitisation initiatives?

- *RQ2:*
  Institutional and policy frameworks. What are the key institutional and policy frameworks at UNESCO, EU, and national levels governing digital heritage transformation, and how do they address social equity, participation, and data governance concerns?

- *RQ3:*
  Critical challenges and ethics. What critical challenges emerge at the intersection of digitisation and cultural heritage? This includes the digital divide, algorithmic bias in AI-driven heritage, copyright restrictions and enclosure, digital colonialism and data sovereignty, and long-term sustainability of digital heritage.

- *RQ4:*
  Future directions and responsible practices. What future research directions and responsible practices can be identified to advance inclusive, ethical, and sustainable digital heritage in its social environments?

➢ *Methodological Approach of this Review*

This article is a systematic and narrative literature review, synthesising scholarly publications from peer-reviewed journals, academic books, conference proceedings, and official policy documents from international bodies (UNESCO, European Commission) and national heritage agencies. The search was conducted across academic databases (Scopus, Web of Science, Google Scholar, Semantic Scholar) using keyword combinations such as "digital cultural heritage", "digitisation*", "participation", "community-led heritage", "AI bias cultural heritage", "digital sovereignty", and "sustainability". A multi-level analytical framework (macro, meso, micro) was applied to organise findings and highlight relationships across policy, institutional practice, and individual/community experience. To ensure breadth and rigour, the review encompasses primary research, systematic reviews, meta-analyses, and large-scale empirical studies from 2015 to 2026, with a primary focus on scholarship from 2020 onward, reflecting the accelerated digital transformation during and after the COVID-19 pandemic.

II. THE SCALE OF DIGITISATION

➢ *The Europe's Digital Heritage*

The European Union's cultural heritage digitisation efforts, coordinated through the Europeana platform, represent one of the most substantial such initiatives globally. By 2025, the common European data space for cultural heritage—building on two decades of aggregation—provides online access to over 58 million cultural items (digitised books, paintings, photographs, archival records, audiovisual materials, and 3D models) from more than

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3,700 libraries, archives, museums, and galleries across Europe (European Commission, 2018; Europeana Foundation, 2024). The Europeana Network Association, aggregators' forum, and a consortium of 18 partners work with ministries of culture across the EU to shape a data space described as "inclusive, collaborative and open" (Europeana Foundation, 2024).

The Metis Statistics Dashboard, launched in 2024–2025 (Europeana PRO, 2025), now provides real-time tracking of each EU Member State's progress towards the digitisation targets set out in the European Commission's 2021 Recommendation on a common European data space for cultural heritage. The dashboard categorises data by country and institution, tracking shared items, data quality, and—importantly—adherence to the 2030 priority focus on 3D content (Europeana PRO, 2025).

Further, the 3DBigDataSpace project (January 2025 to June 2026), funded under the EU Digital Europe Programme, is working to create stable, long-term storage solutions for 3D models across Europe, and to pilot AI-driven enrichment of 3D cultural data (3DBigDataSpace, 2025). Complementing this, the ECHOES project, with 51 European partners, launched a cascading grants programme (2025–2026) supporting up to 50 projects to enhance digital engagement and data sharing within the European Collaborative Cloud for Cultural Heritage (ECHOES, 2025). A dedicated dashboard from the ENUMERATE Observatory (Europeana PRO, 2025) now provides an authoritative baseline of statistical data about digitisation, digital preservation, and online access to cultural heritage across all EU Member States.

The scale of investment is considerable: the European Commission's Digital Europe Programme (2025–2027 work programme) allocated more than €1.2 billion to digital transformation initiatives, including the cultural data space, high-performance computing, and AI (European Commission, 2025b). However, despite this funding, a 2026 empirical econometric analysis (Collard & Piscitelli, 2025) found that overall digitisation progress is shaped by a complex interplay of economic capacity, digital infrastructure, institutional strategy, and societal demand, rather than targeted funding initiatives alone.

➢ *Global Perspectives*

Beyond Europe, the Digital Dunhuang initiative stands as one of the world's most ambitious cultural heritage digitisation programmes. Since the 1990s, the Dunhuang Academy has systematically digitised the Buddhist cave temples of the Mogao Grottoes, a UN World Heritage site in Gansu province, China, which includes some 735 caves, 45,000 square metres of murals, and 2,000 painted sculptures.

By 2025, Dunhuang Academy had completed high-precision 3D reconstruction of 212 caves and virtual tours of 169 caves, with the total volume of digital data reaching 4 petabytes (Benliu News, 2025; China Daily, 2025). The Digital Library Cave database platform includes more than 74,000 entries—sutras, documents, and images—reuniting Dunhuang cultural relics that are physically dispersed overseas (China Daily, 2025). More than 50,000 historical archival films have been digitised, and the platform uses AI for automated text recognition, image stitching, and knowledge graph construction, with more than 9,900 volumes of Dunhuang documents and over 60,700 images released publicly (Benliu News, 2025).

The Digital Dunhuang project illustrates the deep data scale achievable when sustained resources, policy commitment, and leading-edge technology intersect—and highlights the potential for digital heritage to serve not only preservation but also global open access and scholarly collaboration.

➢ *Emerging Technological Frontiers and Data Gaps*

Establishing a robust baseline of statistical data is critical for evidence-based policy. In 2025, a landmark global survey on digitisation of cultural heritage (UNESCO Chair on Digital Cultural Heritage & Heritage Malta, 2025) reached over 1,200 professionals and institutions worldwide. Its key findings outline both opportunities and persistent challenges (Comet Global Innovation, 2025):

- Widespread reliance on 3D scanning and photogrammetry, yet significant challenges remain in interoperability and data sharing.
- A limited open access culture, with consistent metadata and paradata standards still lacking.
- Emerging adoption of AI and advanced modelling, but with strong demand for clearer frameworks and shared best practices.
- Urgent needs for funding, training, and international collaboration to build a more cohesive global ecosystem.

Notably, the survey found evidence of a global paradigm shift: from digitisation understood as replication (creating a static digital copy) to digitisation as memory stewardship—a transition that acknowledges not only the physical characteristics of heritage but also its cultural, historical, and social context (Comet Global Innovation, 2025). This shift positions the social dimension at the core of digital heritage practice.

Furthermore, a systematic review of EU funding trends (2015–2024) revealed that Digital Heritage funding surged 355% , compared to Cultural Heritage's 137% growth, with Italy emerging as the leading country in both fields (EC Funding Trends, 2025). This indicates a decisive policy turn towards targeted digital investment.

III. SOCIAL PARTICIPATION AND PUBLIC ENGAGEMENT WITH DIGITAL HERITAGE

➢ *Digital Access, Inclusion, and the Empowerment Divide*

One of the most visible and celebrated impacts of digitisation is its potential to democratise access to cultural heritage, enabling individuals to engage with collections regardless of geographic location, physical mobility, or

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institutional membership. Digitisation can improve public access, enhance awareness, and, by extension, support personal and societal well-being (Collard & Piscitelli, 2025). However, empirical research shows that the distribution of these benefits is highly uneven.

Widely discussed as the digital divide, this unevenness manifests at three levels (Holm, 2025):

- First level – Economic divide: Physical access to digital devices, connectivity, and infrastructure.
- Second level – Usability divide: Digital literacy, skills, and abilities to effectively navigate platforms.
- Third level – Empowerment divide: The social and cultural benefits and outcomes derived from digital engagement.

The third level—the empowerment divide—has received the least research attention, yet it is arguably the most consequential for heritage communities. Holm (2025), in a study of Sámi cultural heritage portals Europeana and Nuohtti, found that systematic barriers, language mismatches, incompatible metadata schemas, and a lack of culturally appropriate access protocols actively prevented Indigenous users from deriving meaningful social, cultural, or identity-affirming benefits from digitised heritage. Unless this third-level divide is explicitly addressed, digitisation may inadvertently deepen existing cultural inequalities.

Furthermore, from a global perspective, while digital access is expanding, gross disparities persist in rates of access to digital infrastructure and skills training, with wealthier nations leading (UNESCO, 2025b). As UNESCO argues, the digitisation of cultural heritage must be accompanied by comprehensive policies to address governance, ethical risks, and cultural data sovereignty (UNESCO, 2025b).

➢ *Citizen Science, Crowdsourcing, and Co-Creation*

Public participation in heritage digitisation has expanded significantly through citizen science and crowdsourcing initiatives. Collections hold enormous value not only as resources for professional research but also as springboards for public engagement. Since 2018, the European CrowdHeritage platform (CrowdHeritage, 2024) has been used by cultural heritage institutions to coordinate online crowdsourcing campaigns for improving the quality of digital content and heritage metadata.

In archaeology and digital humanities, crowdsourcing projects are increasingly focused not merely on tagging, transcription, or metadata enrichment, but on co-creation—building reciprocal, value-generating relationships between institutions and communities (Marras, 2025). Map-based crowdsourcing, for example, can digitise and safeguard urban memory and place-based intangible heritage, facilitating intergenerational knowledge transfer and encouraging civic engagement (Aydın & Özkul, 2025).

At its best, citizen research creates a "virtuous circle of participation and shared new knowledge about heritage collections" (Hedges, 2026). The DoeDat platform at the Meise Botanic Garden, a multilingual crowdsourcing system, engages volunteer citizen scientists in transcribing label annotations from herbarium specimens, demonstrating the high-quality research data that citizen scientists can generate (Meise Botanic Garden, 2025).

➢ *Digital storytelling and social media engagement*

Digital storytelling has emerged as a powerful, culturally-sensitive format for heritage communication, public engagement, and peer education. In cultural and heritage tourism, integrated digital storytelling for social media (IDSM) frameworks have enhanced youth engagement, augmenting traditional narrative guidelines with contemporary digital experience design (Kasemsarn & Nickpour, 2025). Digital storytelling can transform heritage education into immersive, accessible, and emotionally resonant experiences (Digital Heritage Workshop, 2025).

However, social media platforms also create new tensions. Research examining how heritage circulates on TikTok (a highly algorithmic, centralised platform) versus Nostr (a decentralised open protocol) reveals two distinct logics:

- TikTok privileges brevity, emotional appeal, and replicability, favouring spectacularised, visually striking representations—often at the expense of complexity or less photogenic heritage.
- Nostr emphasises persistence, traceability, and collaborative curation, enabling a more balanced presence for material, intangible, and natural heritage (Frontiers in Computer Science, 2025).

These differences are not merely stylistic but infrastructural: platform governance and algorithmic logics shape what becomes visible, how meanings are negotiated, and which forms of participation are possible. Digitisation turns heritage into content, subject to metrics and recommendation algorithms—a process often described as digital spectacularisation (Frontiers in Computer Science, 2025).

Nonetheless, communities also actively use social media to document, reinterpret, and advocate for cultural assets, generating new forms of civic engagement. The DIGIFOLK project, based at the University of Oslo, investigated digital folklore (memes, hashtags, online stories) in contemporary Norway, finding it to be a robust form of "active, ongoing and self-including heritage production"—one that gives insights into what is culturally, socially, and politically significant to a diverse public, including communities that might not be represented in traditional archives (DIGIFOLK, 2024).

➢ *Community-led digitisation and participatory design*

Community-led digitisation initiatives represent a decisive departure from institution-driven top-down approaches, placing control over digitisation processes in the hands of heritage communities themselves. The most sophisticated example is the DIGICHer project, funded by

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the European Union's Horizon Europe programme (2025–2027). DIGICHer addresses the nuanced challenge of "how digitisation can be conducted in ways that foster equity, inclusion, and sustainability, particularly for minority and underrepresented communities" (DIGICHer Project, 2025). Following a citizen science and co-creation approach, DIGICHer is developing a scalable, ethically validated framework through pilots with three minority groups in the EU: the Sámi, the Jewish, and the Ladin peoples (DIGICHer Project, 2025). This work integrates legal, socio-economic, technical, and ethical insights into a co-designed, community-validated methodology for equitable digital heritage.

Similarly, community-driven cultural heritage archives are growing, yet face persistent challenges in sustainability, particularly when transitioning from physical to digital formats (MAPS Online Archive, 2025). Practical solutions include technical support, training, and collaborative governance models that prioritise long-term community ownership. The VERA (Virtual European Rural Artisans) Platform, for instance, intentionally designs digital cultural landscapes to connect heritage, community, and sustainable development, allowing community groups to interact within a shared digital space for cultural sustainability, creative heritage tourism, and economic development (VERA Platform, 2025). Open-source projects such as Heritage Inn aim to make cultural heritage more accessible globally, advocating for collaborative technology and open data (Heritage Inn Project, 2025).

IV. DIGITAL REPATRIATION AND INDIGENOUS DATA SOVEREIGNTY

➢ *Case Study: Mukurtu CMS and Ethical Digital Return*

One of the most impactful developments in the social practice of digital heritage is the emergence of digital repatriation—the return of heritage documentation in digital form to communities of origin (Hennessy, 2025). Digital technologies have opened up possibilities for sharing curatorial and ethnographic authority with source communities, enabling respectful, collaborative, and culturally appropriate access to heritage collections (Hennessy, 2025).

The leading case is Mukurtu CMS, an open-source content management system created in 2007 by Professor Kim Christen (Washington State University) in partnership with the Warumungu Aboriginal community and many other Indigenous groups globally (Mellon Foundation, 2024). Mukurtu—a Warumungu word meaning 'dilly bag' or a safe-keeping space—does much more than manage content: it is "a social network; a cultural platform" (Christen, quoted in Mellon Foundation, 2024). Mukurtu is designed to support an ethically based approach to preservation, with the specific needs of Indigenous and Native collections in mind. Its core technical innovation is the use of cultural protocols—digitally encoded rules allowing communities to control access to sensitive and private intellectual property on a tiered basis. Traditional Knowledge (TK) labels provide contextual cultural understanding, allowing communities to present digital cultural heritage on their own terms (Mellon Foundation, 2024).

Mukurtu is used by the Huna Heritage Foundation (Tlingit community) in Hoonah, Alaska, as a digital repository for oral histories, historical maps, and archival images from national institutions (e.g., American Folklife Center, National Museum of the American Indian). "It's not enough to preserve; we want to provide access," explains Amelia Wilson (Huna Heritage Foundation). "That was the intent of our elders and all those that came before us … so that it is passed on" (Mellon Foundation, 2024). Mukurtu and the Plateaus Peoples' Portal have demonstrated how integrating digital cultural objects into archives can respect and support existing cultural traditions, replicating dynamic protocols for access and circulation of cultural knowledge—fundamentally challenging the default of open access in heritage discourse (Hennessy, 2025).

➢ *The CARE Principles and Indigenous Data Sovereignty*

Digital repatriation is intimately connected to the broader movement for Indigenous data sovereignty (IDSov). Recognising that Indigenous data (including heritage data) can be extracted, exploited, and used without consent, Indigenous communities and their allies have developed a powerful alternative framework as a complement to the scientific FAIR principles (Findable, Accessible, Interoperable, Reusable).

The CARE Principles for Indigenous Data Governance (Carroll et al., 2020; GIDA, 2025) are:

- Collective Benefit: Data ecosystems shall be designed and function to benefit Indigenous communities.
- Authority to Control: Indigenous peoples have the right to govern the collection, use, and storage of their data.
- Responsibility: Those working with Indigenous data have a positive duty to respect Indigenous worldviews, knowledge systems, and governance.
- Ethics: Data governance must centre on Indigenous peoples' rights and well-being, including Free, Prior, and Informed Consent (FPIC).

Since their formalisation in 2020, the CARE Principles have been increasingly adopted by public–private partnerships, research funders, and cultural heritage institutions. A joint communiqué from the Global Indigenous Data Alliance (GIDA) in 2025 affirmed that "standards are more than technical tools"—honouring Indigenous community standards is central to advancing IDSov and Indigenous Data Governance (GIDA, 2025).

The integration of IDSov principles into public–private partnerships (e.g., the Government of Nunavut–Microsoft partnership) has demonstrated a viable path to limiting risks of data colonialism and improving the long-term sustainability of Indigenous heritage digitisation projects (Spano & Zhang, 2025). However, as UNESCO (2025a) warns, AI systems also pose new risks to cultural diversity and the visibility and circulation of diverse cultural expressions. Cultural data are now a key source for training

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AI models, yet this role remains largely unrecognised in policy frameworks (UNESCO, 2025a). Urgent legal and regulatory adaptation is required.

V. CRITICAL CHALLENGES

➢ *Algorithmic Bias and Colonial Gaze in AI-Driven Heritage*

The increasing use of AI in the cultural heritage sector (image analysis, semantic segmentation, 3D point cloud processing, automated metadata generation) introduces profound risks of algorithmic bias (Papadopoulos & Rezk, 2025; Foka et al., 2026). In a detailed case study, Foka et al. (2026) used the generative AI platform MidJourney to caption more than 3800 captions from 100 archival images depicting living ethnological exhibitions (so-called 'human zoos', 1870s–1930s). They found systematic evidence of a 'colonial gaze' —an automated process of object identification and relational interpretation drawing on historical visual tropes and hierarchical logics rooted in colonial epistemologies. In quantified terms, the representational harms were severe:

- Essentialism (stereotyping 'primitive' or 'unchanging' cultures): 41.6% of captions.
- Cultural erasure (denying or ignoring specific cultural identity and practices): 54.5%.
- Dehumanisation (rendering individuals as specimens or objects): 11.1%.
- Othering (emphasising difference and exoticism): 28.4%.
- Infantilisation (characterising colonised people as childlike or passive): 26.8%.

This study graphically demonstrates how AI does not simply inherit bias—it can actively amplify and naturalise historical prejudice (Papadopoulos & Rezk, 2025; Foka et al., 2026). And as AI methods become more widespread, the potential for this bias loop to cause representational harm at scale grows.

Responding to this challenge, a Nature Portfolio paper by Foka et al. (2026) proposed the Bias Loop Framework, which breaks down the AI pipeline into stages (data selection, annotation, algorithmic design, user interaction) and provides actionable guidance for bias detection, data augmentation (e.g., noise injection, colour jittering), and adversarial debiasing. A complementary paper in npj Heritage Science (2026) advances a methodology for trustworthy AI in CH, embedding explainability and bias-mitigation strategies directly into AI-driven analysis, with a focus on user confidence, ethical alignment, and respect for cultural specificity (Foka et al., 2026). Similarly, the AI:CULT project (Amsterdam Open Research, 2025) aims to enable heritage institutions to use AI in ways that are transparent, inclusive, and user-controlled, addressing two primary use cases with societal parties responsible for providing access to national heritage.

➢ *Digital Colonialism and Data Extraction*

Large-scale heritage digitisation projects operate within a global political economy often underpinned by techno-colonial mindsets or outright extractive practices (Cameron & Robinson, 2025). Examining the case of Tuvalu's 'First Digital Nation' initiative—aimed at creating a digital twin of the nation as a response to climate change and sea-level rise—Cameron and Robinson (2025) reveal how digitisation can become entangled with corporate interests and neocolonial governance arrangements. The term digital colonialism captures the risk that data, assets, and infrastructure are effectively owned and controlled by Global North corporations, despite originating from source communities (Rouhani, 2025).

Similarly, the destruction of cultural heritage in armed conflict and the subsequent digital reconstruction by international teams raises complex issues of control, decontextualisation, and benefit distribution. For instance, the Triumphal Arch of Palmyra (Syria), destroyed by ISIL in 2015, was digitally reconstructed and then replicated using 3D printing—but the original digital assets were largely held by European institutions (UNIL–ICONEM), raising digital sovereignty questions for Syrian heritage professionals (Rouhani, 2025).

➢ *Copyright, Open Access, and the Cultural Commons*

Despite progress in digitisation, restrictive copyright practices remain a substantial barrier to equitable access to public domain heritage. In 2025, an international coalition of cultural heritage organisations launched the Open Heritage Statement (Museums Association, 2025), identifying 17 distinct legal, contractual, and technical barriers to equitable access. These include: erroneous copyright claims over faithful digital reproductions; contract-imposed restrictions ("non-commercial only", "permission required"); inconsistent copyright laws internationally; and the lack of standardised open licensing for public domain heritage (Museums Association, 2025).

When institutions impose new copyrights on faithful reproductions, they "undermine global commitments to keep digital heritage in the public domain, free of unreasonable restrictions" (Museums Association, 2025). Enabling equitable access is not merely a technical task; it is fundamental to preserving and promoting heritage as a global public good.

➢ *Environmental Sustainability of Digital Heritage*

A final critical challenge—increasingly foregrounded in the literature—is the environmental footprint of digital heritage itself. While digital preservation is often presented as "green" compared to physical storage, the reality is more complex. The production phase of digitisation (equipment, scanning, processing) is highly energy-intensive and uses scarce raw materials (DIGHT-Net Workshop, 2025). Long-term data storage, particularly of large-scale 3D models or high-resolution images, requires massive energy consumption and generates e-waste (Netherlands Institute for Sound & Vision, 2025; CSC Finland, 2025). CSC Finland (2025) calculates that more than 70% of digital preservation's carbon emissions come from device manufacturing, and over 85% of that from producing spinning hard drives.

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Blenheim Palace (UK) has developed a pioneering digital twin to monitor and manage its estate, which has resulted in a 46% reduction in energy consumption for its Estate Office, demonstrating that digital tools can also support heritage climate-responsiveness (Blenheim Palace, 2025). However, systemic solutions, new metrics (e.g., the GREENER data principles for digital archaeology), and a fundamental re-evaluation of what is preserved (and for whom) remain urgent priorities (University of York, 2025; CSC Finland, 2025).

VI. DISCUSSION

The evidence reviewed in this article demonstrates that digitisation is not simply a technical process of conversion but a profoundly social one, reshaping access, participation, authority, and values in the heritage sector. Digitisation significantly enhances access, enabling individuals and communities to engage with cultural heritage materials across geographic and economic constraints. Second, social participation is diversifying: citizen science, crowdsourcing, digital storytelling, and community-led platforms are creating new spaces for co-creation and intergenerational knowledge exchange. Third, digital repatriation and Indigenous data sovereignty frameworks (Mukurtu, CARE Principles) are successfully shifting institutional practice toward community-led, equitable governance.

However, these positive developments are counterbalanced by serious, asymmetric risks. Digital divides at the empowerment level persist, actively limiting social and cultural benefits for Indigenous and marginalised groups. Algorithmic bias in AI-driven heritage systems threatens to naturalise and amplify historical prejudice at scale. Copyright enclosures, restrictive licensing, and corporate data extraction represent contemporary forms of colonial control (digital colonialism). And the environmental sustainability of large-scale digital preservation requires urgent, evidence-based policy attention.

➢ *Future Research Directions*

The systematic review identifies several pressing future research directions:

- Longitudinal social impact assessment: Almost all studies report short-term outcomes of digitisation projects, but we lack longitudinal evidence tracking sustained benefits (e.g., community well-being, cultural identity reinforcement, intergenerational knowledge transmission). Methodologies for third-level digital divide and social return on investment (SROI) must be further developed and validated across contexts.
- Cross-national and Global South research: Comparative analysis of national digital heritage strategies is rare, and the academic literature remains dominated by European and North American case studies. Research from the Global South—including digitisation in contexts of conflict, climate displacement, and post-colonial heritage politics—is urgently needed.
- AI ethics and data sovereignty governance: The tension between AI model training and cultural data sovereignty is a new frontier. Research on effective governance mechanisms, culturally sensitive bias mitigation (beyond technical fixes), and public–private partnerships that embed CARE Principles by design is required.
- Digital folklore and emerging platforms: As digital folklore becomes an active form of heritage production, research should examine how emerging platforms (decentralised protocols, generative AI, immersive social VR) reshape heritage circulation, ownership, and cultural memory.
- Environmental sustainability metrics and planning: Work is needed on standardised environmental impact assessment for digital heritage projects, including data storage lifecycle analysis, green digitisation guidelines, and alignment with climate policy frameworks.

➢ *Recommendations for Responsible Practice*

Adopt equity-centred design from the outset: Prioritise participatory co-creation approaches (Quadruple Helix) over top-down digitisation. Community consent and leadership are necessary conditions for ethical digitisation, not optional add-ons.

- Implement the CARE Principles for Indigenous Data Governance in all public–private partnerships involving Indigenous cultural heritage.
- Mandate bias auditing and transparency reporting for any AI tool used in heritage workflows, adopting frameworks such as the Bias Loop Framework and trustworthy AI methodology.
- Champion open access for public domain heritage and oppose institutional practices that undermine open sharing (Open Heritage Statement).
- Develop sustainability plans for digital heritage that include environmental metrics, including energy use, e-waste, and long-term storage strategies.

VII. CONCLUSION

This review has examined the intersection of digitisation and cultural heritage within social environments, synthesising scholarship across heritage studies, digital sociology, information science, and STS. Digitisation is transforming how cultural heritage is accessed, experienced, and produced—creating new possibilities for public engagement while introducing challenges of equity, algorithmic ethics, corporate power, and sustainability.

Institutional and policy frameworks at UNESCO, EU, and national levels increasingly recognise the importance of digital heritage. Yet significant gaps remain between policy ambition and on-the-ground realities. The future of cultural heritage is digital. Whether this future is inclusive or exclusionary, equitable or extractive, community-controlled or corporate-dominated depends on choices made today by heritage professionals, technology developers, policymakers, communities, and researchers. Prioritising participatory frameworks, AI ethics, Indigenous data

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sovereignty, and environmental responsibility is not merely a moral imperative—it is a practical necessity for ensuring that digital heritage serves its fundamental purpose: connecting people across time, space, and culture to the human record.

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