

Digitalisation of Cultural Heritage and the Economics of Cultural Tourism: Transforming Preservation into Opportunity

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Abstract. The digitalisation of cultural heritage represents one of the most significant transformations in contemporary cultural policy and tourism economics. This paper examines the intersection of digital technologies—including 3D scanning, virtual and augmented reality, artificial intelligence, and blockchain—with the preservation, accessibility, and economic valorisation of cultural heritage. Drawing on case studies from major institutions such as the Louvre, the British Museum, and innovative projects like Rome's Circo Massimo Experience, we analyse how digitalisation creates economic value across the complete tourist journey: from pre-visit inspiration through on-site enhancement to post-visit engagement. The paper addresses the fundamental tension between heritage as a preservation cost and heritage as an economic opportunity, arguing that digital technologies offer solutions that simultaneously increase revenue, expand accessibility, and reduce physical strain on fragile sites. However, significant challenges remain, including the digital divide, technological obsolescence, questions of authenticity, and ethical considerations regarding ownership and representation. We conclude with a framework of principles for responsible digital heritage development and recommendations for cultural institutions seeking to navigate this transformation.

Keywords: Digital Heritage, Cultural Tourism, Virtual Reality, Augmented Reality, Museum Economics, Heritage Preservation, Overtourism.

1 Introduction

Cultural heritage—encompassing tangible assets such as buildings, monuments, and artifacts; intangible traditions including music, dance, and crafts; and natural landscapes of cultural significance—faces an unprecedented paradox in the twenty-first century. On one hand, global interest in heritage has never been higher, with cultural tourism representing approximately 40% of all international tourism and generating an estimated \$1.5 trillion annually worldwide (UNWTO, 2023). On the other hand, this success threatens the very assets that generate it: overtourism erodes ancient stones,

human breath degrades fragile frescoes, and the concentration of visitors overwhelms local communities (Koens et al., 2018).

Into this paradox enters digitalisation—the conversion of physical and intangible cultural assets into digital formats and the use of digital technologies to enhance their accessibility, preservation, and economic value. What began in the 1990s with basic museum websites has evolved into a sophisticated ecosystem of 3D scanning, virtual reality (VR), augmented reality (AR), artificial intelligence (AI), and blockchain technologies (Parry, 2019). The COVID-19 pandemic dramatically accelerated this transformation: institutions that had invested in digital infrastructure found themselves reaching millions of remote visitors while those without digital strategies faced existential threats (NEMO, 2020).

This paper addresses a central question: How can digitalisation transform cultural heritage from a preservation cost into an economic opportunity—without compromising its authenticity or social mission? We examine this question through four lenses: the technological toolkit available to heritage institutions; the economic models enabled by digitalisation; real-world case studies demonstrating success and failure; and the challenges and ethical considerations that must guide responsible implementation.

2 Defining the Landscape: Cultural Heritage and Cultural Tourism

2.1 The Scope of Cultural Heritage

UNESCO's Convention Concerning the Protection of the World Cultural and Natural Heritage (1972) established the foundational framework for understanding cultural heritage as a shared human inheritance requiring protection and transmission to future generations. Contemporary definitions have expanded beyond monumental architecture to encompass three interconnected categories: tangible heritage (buildings, artifacts, manuscripts), intangible heritage (traditions, languages, performing arts), and natural heritage with cultural significance (UNESCO, 2003).

This expanded definition has profound implications for digitalisation strategies. While early digital heritage projects focused on scanning objects and monuments, contemporary approaches must also capture and transmit intangible practices—a significantly more complex technical and ethical challenge (Giaccardi, 2012).

2.2 The Economics of Cultural Tourism

Cultural tourism—travel motivated by interest in historical sites, museums, festivals, local traditions, and gastronomy—constitutes the largest segment of global tourism (Richards, 2018). Economic impact occurs across three levels: direct revenue (ticket sales, tours, merchandise); indirect revenue (spending at hotels, restaurants, and transport serving tourists); and induced revenue (employment, taxes, and multiplier effects throughout local economies) (Throsby, 2010).

Research consistently demonstrates that cultural tourists represent premium customers. Studies across multiple markets indicate that culturally motivated travelers spend 38% more than average tourists and stay 22% longer at destinations (European Commission, 2017). This premium positioning creates strong economic incentives for destinations to develop and market cultural assets—while simultaneously creating pressures that threaten their preservation.

2.3 The Overtourism Crisis

The economic success of cultural tourism has generated a crisis of overtourism at major heritage sites. Venice receives approximately 30 million visitors annually while sustaining a resident population of only 50,000; the resulting transformation of housing stock into tourist accommodation, congestion of public spaces, and strain on infrastructure has prompted resident protests and municipal restrictions on visitor numbers (Seraphin et al., 2018). Similar dynamics affect Dubrovnik, Barcelona, Amsterdam, and numerous other destinations where the carrying capacity of heritage sites has been exceeded.

The physical impact on heritage assets compounds social pressures. The Sistine Chapel limits visitors because human respiration raises humidity levels that damage Michelangelo's frescoes; foot traffic on the Acropolis measurably erodes ancient marble; touch transfers acids and oils that degrade surfaces over time (Cassar, 2009). These effects create a fundamental economic tension: restricting access protects heritage but reduces the revenue required for its maintenance.

3 The Digital Heritage Toolkit

3.1 Capture Technologies: Creating Digital Twins

The foundation of digital heritage is the creation of accurate digital representations of physical assets. Two primary technologies dominate this domain: LIDAR (Light Detection and Ranging) scanning and photogrammetry.

LIDAR scanning uses laser pulses to measure distances with millimeter precision, generating "point clouds" of millions of measurements that can be processed into detailed 3D models. The Cathedral of Cologne, for example, was documented with over one billion measurement points, creating a comprehensive digital twin suitable for conservation planning, virtual experiences, and scholarly analysis (Murphy et al., 2013). Photogrammetry achieves similar results through computational analysis of overlapping photographs, offering lower equipment costs but requiring greater processing power and expertise (Remondino, 2011).

The economic significance of digital twins extends beyond preservation. Once created, these assets can be deployed across multiple revenue-generating applications: virtual tours, educational programs, merchandise, video games, and architectural planning. The marginal cost of each additional use approaches zero, fundamentally altering the economics of heritage documentation.

3.2 Experience Technologies: Virtual, Augmented, and Mixed Reality

Virtual Reality (VR) creates fully immersive digital environments that transport users to locations they cannot physically visit—whether due to distance, disability, cost, or the impossibility of time travel. Contemporary VR can reconstruct the Roman Forum as it appeared in 100 CE or permit exploration of a pharaoh's tomb without risk to fragile paintings (Champion, 2011).

Augmented Reality (AR) overlays digital content onto physical reality, typically through smartphone screens or specialized glasses. Unlike VR, AR keeps users physically present at heritage sites while enhancing their understanding through reconstructions, animations, and contextual information. The key advantage of AR is accessibility: most visitors already carry the necessary hardware in their pockets (Bekele et al., 2018).

Mixed Reality (MR) represents an emerging synthesis in which digital objects interact with physical space—a holographic guide who walks beside visitors, points at actual artifacts, and responds to questions. Technologies such as Microsoft's HoloLens and Apple's Vision Pro are advancing this capability, suggesting futures in which the distinction between physical and digital experience becomes increasingly blurred (Milgram & Kishino, 1994).

3.3 Platform Technologies: Digital Infrastructure

Behind individual experiences lies essential digital infrastructure. Google Arts & Culture has partnered with over 2,500 museums worldwide, providing free access to high-resolution images and virtual tours that have attracted billions of views (Proctor, 2011). Europeana aggregates over 50 million cultural heritage items from European collections into a searchable digital repository (Purday, 2009). Individual institutions develop mobile applications that personalize visit experiences through location-aware content delivery.

These platforms serve multiple economic functions: marketing heritage to global audiences; reducing barriers to access; generating data on visitor interests and behaviors; and, increasingly, enabling direct monetization through ticketed virtual experiences and e-commerce integration.

3.4 Intelligence Technologies: Artificial Intelligence and Machine Learning

Artificial intelligence is quietly revolutionizing heritage work across multiple domains. Machine learning algorithms can catalog and tag collections in hours rather than years, identify patterns in archaeological data invisible to human researchers, and predict conservation needs before deterioration becomes critical (Fiorucci et al., 2020).

For tourism applications, AI enables real-time language translation that eliminates barriers for international visitors, personalized tour recommendations based on visitor interests and behaviors, and crowd management algorithms that optimize visitor flow to reduce congestion while maximizing capacity. Generative AI is beginning to create

customized interpretive content tailored to individual knowledge levels and interests (Sylaiou et al., 2010).

3.5 Ownership Technologies: Blockchain and NFTs

The most controversial addition to the digital heritage toolkit involves blockchain technology and non-fungible tokens (NFTs). Blockchain provides immutable records of ownership and provenance, potentially addressing persistent problems of art forgery and theft (Whitaker, 2019). NFTs create unique digital certificates that can be bought and sold, enabling new fundraising mechanisms for heritage institutions.

The Uffizi Gallery's sale of an NFT of Michelangelo's Doni Tondo for €140,000 demonstrated the fundraising potential, though critics have questioned whether buyers receive meaningful value and have raised concerns about the environmental impact of blockchain technology (Franceschet et al., 2021). The underlying concepts of digital ownership and authenticity verification, however, offer legitimate applications in heritage contexts that may outlast current controversies.

4 Economic Value Creation Through Digitalisation

4.1 The Tourist Journey Framework

Understanding digital heritage economics requires analyzing the complete tourist journey rather than focusing solely on the physical visit. Contemporary frameworks identify five stages at which digitalisation creates value: dreaming (discovering destinations), planning (research and booking), experiencing (the visit itself), remembering (sharing and reflection), and returning (loyalty and repeat engagement) (Neuhöfer et al., 2014).

This framework reveals that the economic impact of digitalisation extends far beyond virtual admission tickets. Digital content shapes destination choices, enhances on-site spending, extends post-visit engagement, and builds long-term relationships that generate repeat visits and advocacy.

4.2 Pre-Visit Value: Inspiration and Marketing

Early skeptics feared that putting collections online would reduce physical visits—why travel to Paris if you can view the Mona Lisa on your screen? Research has consistently disproven this substitution hypothesis. Studies by the Smithsonian Institution found that virtual visitors were 67% more likely to plan in-person visits than non-virtual audiences; digital exposure stimulates rather than satisfies the desire for authentic experience (Smithsonian Institution, 2019).

Digital content functions as a powerful marketing engine. User-generated content on social media provides free advertising worth millions in equivalent paid reach; influencer partnerships amplify messages to targeted demographics; and search engine optimization ensures heritage sites appear when potential tourists research destinations

(Kirářová & Pavličeka, 2015). The "long tail" economics of digital distribution also enable niche marketing: an institution can reach the 10,000 people worldwide specifically interested in Etruscan pottery rather than relying solely on mass marketing to general audiences.

4.3 On-Site Value: Enhancement and Monetization

Once visitors arrive, digital technologies enhance experiences in ways that command premium pricing. AR guide applications offering reconstructions and contextual content typically sell for €15-30 above standard admission—a significant revenue increment with minimal marginal cost after initial development (Jung et al., 2016).

Gamification strategies using quest-based exploration increase visitor dwell time, which correlates directly with spending in cafés, restaurants, and gift shops. The concept of "phygital" experience—seamlessly blending physical and digital elements—represents best practice in contemporary heritage interpretation (Pallud & Straub, 2014).

Digital crowd management offers economic benefits that extend beyond direct revenue. Real-time visitor tracking enables timed entry systems that eliminate queues while actually increasing daily capacity; the Anne Frank House pioneered this approach with notable success (Russo et al., 2010). Location-aware applications can nudge visitors toward under-utilized areas, distributing economic benefits more evenly across destinations and reducing wear on popular sites.

4.4 Post-Visit and Remote Revenue

The visit is not the conclusion of economic engagement but the beginning of an ongoing relationship. User-generated content transforms visitors into marketers; digital souvenirs and personalized content extend the revenue moment; email and social media maintain engagement that generates repeat visits and referrals (Neuhofer et al., 2014).

Entirely new revenue streams emerge from remote monetization. Virtual tours can be ticketed at €5-20 for premium experiences, reaching global audiences without geographic or capacity limitations. Educational programs for schools generate revenue while building future generations of visitors. Corporate events held in virtual heritage venues represent an emerging market segment. The National Theatre's "NT Live" broadcasts, which project live performances to 2,500 venues in 65 countries, demonstrate the scale achievable through digital distribution (Barker, 2013).

4.5 The Immersive Experience Model

Perhaps the most radical economic innovation involves immersive experiences that require no original artworks whatsoever. The "Van Gogh: The Immersive Experience" charges €30-40 per ticket, has attracted millions of visitors globally, and travels to multiple cities simultaneously—all without displaying a single authentic Van Gogh painting. Production costs are substantial but fixed, while insurance, security, and climate control expenses that burden traditional exhibitions are eliminated (Bradburne, 2021).

Critics characterize such experiences as "cultural fast food"—entertainment masquerading as education. Defenders argue that immersive experiences introduce new audiences to art, generate revenue that supports traditional institutions, and represent legitimate creative expression in their own right. Regardless of aesthetic judgment, the economic model is undeniably successful and is being replicated for Monet, Klimt, Kahlo, and other artists.

4.6 Cost Savings: The Other Side of Economics

Digital economics encompasses cost reduction as well as revenue generation. Digital twins enable restoration teams to simulate interventions before touching fragile originals, reducing expensive errors. Structural monitoring through embedded sensors predicts problems before they become crises requiring emergency intervention. Scholars can study digital copies rather than handling vulnerable objects, extending the lifespan of originals (Stylianidis & Remondino, 2016).

Disaster recovery represents perhaps the most dramatic cost savings. When Notre-Dame de Paris burned in April 2019, existing 3D documentation—including scans created by the late art historian Andrew Tallon and detailed models developed for the video game *Assassin's Creed Unity*—proved invaluable for reconstruction planning. The availability of comprehensive digital records has significantly accelerated the reconstruction timeline and reduced associated costs (Lowenthal, 2019).

5 Case Studies

5.1 The Louvre: Digital Strategy at Scale

The Louvre Museum exemplifies digital strategy at institutional scale. With approximately 10 million physical visitors annually (pre-pandemic), the museum faces chronic overcrowding, particularly around iconic works such as the Mona Lisa. The Louvre's response combines free online access—functioning as marketing rather than direct revenue source—with premium on-site experiences including the Nintendo 3DS audio guide and partnerships with technology companies (Louvre, 2021).

The museum's 2018 appearance in Beyoncé and Jay-Z's music video "Apeshit" demonstrated the power of cultural partnerships: the video accumulated over 150 million views, reaching audiences who might never visit a museum website. This strategy reflects an understanding that digital heritage success often depends more on cultural relevance than technological sophistication.

5.2 Circo Massimo Experience: Creating Value from Absence

Rome's Circo Massimo Experience represents a particularly innovative approach to digital heritage economics. The Circus Maximus was ancient Rome's largest entertainment venue, accommodating 250,000 spectators for chariot races—but today the site is

an empty field with virtually no visible remains. Prior to digitalisation, the site attracted few visitors and generated no revenue.

In 2019, the municipality launched an AR experience using head-mounted displays that reconstruct the Circus in its imperial splendor. Visitors wearing the devices see chariot races, cheering crowds, and the emperor presiding from his box—experiences entirely impossible through traditional interpretation. Tickets priced at €12 generate estimated annual revenue of €2-3 million from what was previously a free, empty space (Sovrintendenza Capitolina, 2020). The project demonstrates that digital technology can literally create economic value from archaeological absence.

5.3 The British Museum: Open Access as Strategy

The British Museum pursues a philosophically distinct approach centered on open access. The museum makes 4.5 million collection records available online without charge, partners with Sketchfab to distribute 3D models freely, and links extensively with Wikipedia to maximize discoverability. Crowdsourcing initiatives engage volunteers in transcription and cataloging projects (British Museum, 2022).

The economic logic is indirect: widespread public engagement justifies government funding, stimulates charitable donations, and builds global audiences who eventually visit in person. This model may be viable primarily for institutions with significant public funding and established brand recognition, but it demonstrates that digital economics need not rely on direct monetization.

5.4 Small Museum Innovation

Digital success does not require massive budgets. The Museum of English Rural Life in Reading, UK, achieved viral fame through witty Twitter posts—particularly an image of a large sheep that garnered over 100,000 retweets. Physical visitor numbers doubled following the social media success, demonstrating that personality and creativity can outweigh technological sophistication (Museum of English Rural Life, 2019).

The Rijksmuseum's "Rijksstudio" platform allows users to download high-resolution images from the collection and create their own artworks, which can then be shared or printed. The initiative generated 30 million visits and transformed passive viewers into active participants engaged with the collection (Verwayen et al., 2011).

6 Challenges and Ethical Considerations

6.1 The Digital Divide

Digital heritage democratizes access for those with technology while potentially excluding those without. Approximately 2.7 billion people worldwide lack internet access; elderly visitors often struggle with application interfaces; high-tech requirements

can alienate audiences seeking contemplative experiences (International Telecommunication Union, 2022). There is risk of creating two-tier heritage access in which premium digital experiences are available only to the technologically privileged.

Particularly concerning are cases where Western institutions digitize heritage from the Global South without ensuring that local communities benefit from or control the resulting digital assets. Digital colonialism—the extraction of cultural value through technological means—represents a genuine ethical risk requiring careful attention to ownership, access, and benefit-sharing (Christen, 2015).

6.2 Technological Sustainability

Physical heritage can endure for millennia; digital heritage may become inaccessible within years. The average website requires redesign every 2-3 years; mobile applications require constant updates to remain compatible with evolving operating systems; VR platforms lack standardization, meaning experiences created for one system may not function on another (Deegan & Tanner, 2006).

The question is not merely whether institutions can digitize their heritage but whether they can maintain those digital assets indefinitely. This requires ongoing investment in technological infrastructure, format migration, and digital preservation expertise—costs rarely included in initial project budgets. As the Digital Preservation Coalition has noted, "digital preservation is not an event but a process" (Digital Preservation Coalition, 2021).

6.3 Authenticity and the Aura of the Original

Walter Benjamin's influential 1936 essay "The Work of Art in the Age of Mechanical Reproduction" argued that reproductions lack the "aura" of original objects—a quality derived from uniqueness, historical testimony, and presence in time and space (Benjamin, 1968). Digital reproduction intensifies this philosophical challenge: if a virtual visitor can examine every brushstroke of a painting in higher resolution than physical museum viewing permits, what exactly is lost?

Research suggests audiences understand and value physical and digital experiences differently rather than as substitutes (Parry, 2007). However, the risk of "Disneyfication"—heritage transformed into entertainment spectacle—concerns scholars and practitioners who fear that digital enhancement may trivialize or distort historical meaning (Hewison, 1987). Transparency about what is original and what is reconstruction appears essential for maintaining public trust.

6.4 Expertise and Institutional Capacity

Implementing digital heritage strategies requires expertise that cultural institutions traditionally lack. Competition with private-sector employers for digital talent is intense; training existing staff is slow and expensive; outsourcing creates dependency on vendors who may not understand cultural values or institutional missions (Malde et al., 2019).

Small museums are particularly vulnerable: they have the most to gain from digital reach but the least capacity to implement sophisticated strategies. Addressing this gap requires investment in training programs, shared service models, and accessible tools that lower technical barriers to participation.

6.5 Ethical Considerations

Profound ethical questions attend digital heritage development. When institutions digitize Indigenous sacred objects, who owns the resulting data and who controls its distribution? When visitor applications track movement and behavior, are privacy boundaries being crossed? When algorithms personalize experiences, whose histories are centered and whose are marginalized? When commercial imperatives drive content decisions, how is public educational mission protected?

These questions have no universal answers, but they demand explicit consideration in project design rather than treatment as afterthoughts. The principle that technology is never neutral must inform all stages of digital heritage development (Winner, 1980).

7 Future Directions

Technological trajectories suggest several developments likely to reshape digital heritage economics in coming years. Lightweight AR glasses from Apple, Meta, and competitors will make augmented experiences ubiquitous, eliminating the friction of smartphone-based applications. AI-generated personalized guides will adapt content to individual knowledge levels, interests, and learning styles. Real-time language translation will eliminate barriers for international visitors. Haptic technologies may eventually enable visitors to feel the texture of artifacts they cannot touch (Burdea & Coiffet, 2003).

Longer-term speculations point toward more radical transformations. The "Metaverse"—persistent virtual environments in which social and economic activity occurs—could support fully virtual heritage economies in which geography becomes irrelevant. AI reconstruction from fragmentary evidence may eventually visualize complete ancient cities. And recognition is growing that born-digital culture—early websites, video games, digital art—constitutes heritage requiring preservation in its own right (Lusenet, 2007).

8 Conclusions and Recommendations

Digitalisation of cultural heritage represents a fundamental transformation in the economics of cultural tourism—one that offers solutions to the tension between access and preservation while creating new revenue streams, expanding global audiences, and enhancing visitor experiences. The evidence reviewed in this paper supports several conclusions:

First, digital exposure stimulates rather than substitutes for physical visits. Institutions should approach digital content as marketing investment rather than competitive threat.

Second, economic value creation occurs across the complete tourist journey, not only during physical visits. Strategy should address pre-visit inspiration, on-site enhancement, and post-visit engagement as integrated elements of visitor relationship management.

Third, digital success does not require massive budgets. Creativity, personality, and cultural relevance often outweigh technological sophistication. Small institutions can achieve disproportionate impact through strategic use of social media and partnerships with major platforms.

Fourth, significant challenges require attention. The digital divide, technological sustainability, authenticity questions, expertise gaps, and ethical considerations are not barriers to dismiss but problems to solve through thoughtful design and ongoing commitment.

Based on this analysis, we recommend that cultural heritage institutions adopt a framework of six principles for digital development:

- Complementarity: Digital should enhance, not replace, physical experience
- Inclusivity: Design for the widest possible access, including those with disabilities and limited technology
- Sustainability: Plan and budget for long-term maintenance of digital assets
- Authenticity: Be transparent about what is original and what is reconstruction
- Ethics: Engage communities, respect rights, and embed ethical consideration in design
- Experimentation: Test, learn, and iterate rather than seeking perfection before launch.

The transformation of cultural heritage through digitalisation is not a question of whether but how. The institutions that thrive will be those that embrace digital possibilities while remaining faithful to their missions of preservation, education, and public service.

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Received: January 21, 2026

Reviewed: February 26, 2026

Finally Accepted: March 15, 2026