

Reimagining the Museum Experience: A Systematic Review of Digital Transformation's Function in Enhancing Visitor Behaviour, Institutional Marketing, and Heritage Accessibility

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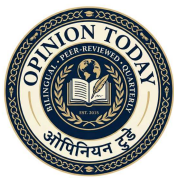
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Abstract

This systematic review investigates the transformative effect of digital technologies on the global museum sector with respect to visitor behaviour, institutional marketing, and heritage accessibility. It synthesizes interdisciplinary literature on digitisation, immersive technologies, and organisational change to understand the ways in which museums are changing from object-centred repositories to dynamic, audience-oriented spaces of knowledge. The review highlights that while emerging technologies like augmented reality (AR), virtual reality (VR), artificial intelligence (AI), and Internet of Things (IoT) systems have a promising role in visitor engagement, learning outcomes, and experiential satisfaction, there is a significant gap between the potential of technology and institutional preparedness. The findings demonstrate that successful digital transformation depends not only on the technological infrastructure but also on the organisational capacity, policy frameworks and user-centred design. The COVID-19 pandemic is singled out as a major accelerator that redefined digital strategies, cementing the relevance of hybrid engagement models. It also highlights the increasing importance of data-driven decision-making, open data ecosystems and digital marketing to reach audiences and enhance museum sustainability. The review places these insights in the Indian context, highlighting national efforts such as digital cataloguing and virtual museum platforms, but also challenges including infrastructural gaps, digital illiteracy, and policy fragmentation. The paper presents an integrative conceptual framework connecting technology, visitor experience, governance, organisational change and heritage valuation. It ends by emphasizing major research gaps, including digital equity, long-term sustainability, and Global South perspectives, and indicates future directions for scholarship and practice.

Keywords: Digital transformation; Museum digitisation; Visitor engagement; Cultural heritage; Heritage accessibility



1. Introduction

1.1 Background and Context

Museums have traditionally played a role as custodians of collective memory, preserving and interpreting objects that link societies with their cultural, historical and artistic past. For much of the twentieth century these institutions acted as relatively static repositories, where physical proximity to collections defined visitor engagement and curatorial authority was largely uncontested (Stow, 2011). But with the digital revolution, the museum's role has been fundamentally redefined from object-centred preservation to knowledge-oriented exchange, with collections as platforms for learning, interaction and community participation (Li, 2024a).

In scholarly literature, this transformation is conceptualised by three interrelated processes: digitisation, digitalisation, and digital transformation. The conversion of physical artefacts into digital formats is called digitisation. The use of digital resources in institutional processes is referred to as digitalisation. In contrast, digital transformation is a broader socio-technical shift that involves organisational restructuring, workforce development and cultural change (Liao et al., 2020). Importantly, research has indicated a shift from technology-centric approaches toward more human-centered perspectives, emphasizing digital skills, changing job roles, and institutional adaptability (Liao et al., 2020).

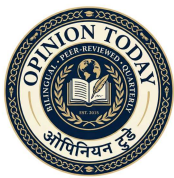
The use of digital technologies in museums has developed only slowly. Liu (2023) proposes a four-stage model from early adoption of ICT to advanced immersive environments with artificial intelligence (AI). Such technological advances particularly augmented reality (AR), virtual reality (VR) and Internet of Things (IoT) systems have greatly improved visitor engagement, interactivity and experiential learning (Innocente et al., 2023; Li et al., 2024b). The COVID-19 pandemic further accelerated this transformation as museums turned to digital platforms to engage audiences while physical museums were closed (Samaroudi et al., 2020; Noehrer et al., 2021).

Technological innovation is not the only reason for the digital transformation of museums but also a consequence of policy frameworks and global socio-technical developments. Governments, especially in Europe (Booth et al., 2021; Stow, 2011), have framed the call for digitisation as a democratic imperative to improve public access to cultural heritage. Meanwhile, the evolution of smart tourism, such as AI-based analytics, IoT-based monitoring, and integrated digital platforms, provides useful models for better management of visitors and service provisioning in museums (Radjapova & Najmiddinov, 2025).

From a broader heritage management perspective, there is a paradigm shift from preservation-focused approaches to more participatory, community-oriented, and sustainability-driven models of cultural heritage governance (Castor, 2026). This shift underscores the need to align technological innovation with social inclusion, cultural authenticity, and equitable access. In India, the national-level programmes like the National Mission on Monuments and Antiquities (NMA) and JATAN Virtual Museum Builder have led to extensive digitisation and virtual displays and better public access. But there are still problems to address, such as digital inequality and a lack of technical skills and policy coherence. The challenges these issues pose underscore the need for a more integrated and strategic approach for digital transformation in the museum sector.

1.2 Problem Statement and Rationale

In spite of the rising amount of research on digital transformation in museums, the field is still very fragmented. Research is focused on a specific application of technology (e.g., AR adoption, IoT based visitor tracking), or on a specific institutional concern (e.g., marketing communication, open data policy), with no attempt to connect across various strands. While there are many specialised studies that examine digital transformation technologies and their functions in museum exhibits, the



connections between technology and application contexts are under-researched (Li et al. 2024b). Lu et al. (2023) then found that amount of research on technology and museum visitor experiences has increased exponentially, but there is little evidence of consistency in theories, models, and frameworks over time. They have identified theoretical stagnation in the face of empirical growth, and this suggests the need to make the many disparate strands more cohesive and unified in an analytical framework. Likewise, Yang et al. (2025) pointed out that the technology applications, platform developments, and user experience evaluations for digitizing museums in China are making considerable progress, but there is still a lack of systematic research summarizing the overall research status, achievements, and hotspots, especially linking regional practices with global developments.

1.3 Scope and Delimitations

The review has been conducted through published, peer-reviewed research and post-graduate dissertations from 2011 to 2024 and literature up to 2026 has been included as a supporting reference. The fifteen core studies make up the main analytical corpus and are mostly set in the institutional framework in Europe, using various qualitative and quantitative methods. This geographical focus makes it impractical to draw more general conclusions, but allows all the evidence to be interpreted in the context of digital transformation in established museum systems in the Global South. Recent additions from Chinese (Yang et al., 2025) and multi-continental (Castor, 2026) contexts help to partially redress this geographic imbalance.

2. Review Methodology

2.1 Search Strategy and Database Selection

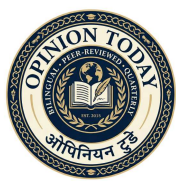
The literature search was carried out in four main academic databases, namely Scopus, Web of Science, Google Scholar and the Social Science Research Network (SSRN). Search terms included combinations of “museum digitisation”, “digital transformation”, “cultural heritage technology”, “visitor engagement”, “augmented reality museum”, “museum marketing”, “open data museum” and “heritage accessibility”. Boolean operators were employed to filter the queries. To be included in the studies, they had to be published in English, be about digital transformation in the museum or cultural heritage sector, and be published between 2011 and 2024. We excluded opinion pieces, conference abstracts without full text and studies solely on the digitisation of archaeological fieldwork without a museum management dimension.

2.2 Study Selection Process

The database searches generated a first pool of ninety-two potentially relevant papers. Following the removal of duplicates and screening titles and abstracts for relevance, forty-three studies proceeded to full text screening. Fifteen studies were chosen for in-depth thematic analysis because of their direct relevance to the research questions, methodological rigor and thematic diversity. The final corpus consists of six journal articles, one dissertation, one book chapter, and seven other works.

2.3 Data Extraction and Thematic Analysis Framework

Data were extracted from each study using a structured coding template, including the author(s), year, title, methodology, geographical context, focus area, key findings, theoretical framework, limitations, and suggestions for future research. Thematic analysis was conducted using a deductive-inductive approach: initial themes were identified from the research



questions (technology, visitor behaviour, organisational impact, policy, heritage valuation) and further themes were inductively derived during the coding process (post-pandemic adaptation, digital equity).

Table 1: Conceptual Distinction Between Digitisation, Digitalisation, and Digital Transformation in the Museum Sector

Concept	No. of Studies (WoS)	Main Topics	Core Features	Temporal Span
Digitisation	879	3D technologies, cultural heritage, digital libraries, digital museums	Collections digitised as resources	1997–2021
Digitalisation	229	3D technologies, cultural heritage, digitisation processes	Streamlined as digital processes	1997–2020
Digital Transformation	21	Digital skills, job profiles, workforce development	Revolutions and socio-technical transitions	2004–2021
Datafication	1	Data literacy, critical pedagogy, remix methods	Behaviours and actions datafied	2020

3. Thematic Review of Literature

3.1 Digitisation of Museum Collections: Drivers, Processes, and Preservation Challenges

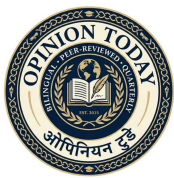
3.1.1 Evolution from analogue to digital: Historical trajectory

The digitisation of museum collections has experienced a major conceptual change. This shift from a time when digitisation was seen as a special project with external funding to one where it was embedded as a core institutional activity was traced by Stow (2011). Early work focused on the creation of digital surrogates that could be stored without the threat of repeated physical handling. As the internet became more accessible and government policies pushed for public access, the scope grew to include metadata enrichment, online cataloguing and interactive collection portals.

This trajectory is part of a broader shift in the museum's self-conception. Where once there had been the primary duty of physical preservation of objects, institutions increasingly recognised a parallel duty to make their holdings intellectually accessible. In 2009 the Swedish government's national digitisation strategy in Scandinavia established electronic access to and digital preservation of cultural collections as a democratic principle (Stow, 2011). Similarly, similar directives appeared throughout the European Union, dispersing digitisation as a reorientation of the museum's social contract. A similar trend was observed by Yang et al. (2025) in the Chinese context. In the past ten years, Chinese museums have been accelerating their digital reform, focusing on technological integration, from simple digital management systems and information gathering to online exhibitions, virtual tours and immersive technologies.

3.1.2 Motivations and drivers for digitisation

Three key reasons for digitisation are consistently identified in the literature reviewed. The first is the imperative of access: making collections available beyond the constraints of geography and opening hours. The second is about preventive



conservation where digital surrogates reduce the need for physical handling of fragile artefacts (Stow, 2011). The third is about how knowledge is produced and disseminated, because digitised collections can be cross-referenced, analysed computationally and integrated into educational curricula in ways that physical objects cannot facilitate.

However, Stow (2011) noted a troubling disconnect between motivations expressed in policy documents and actual digitisation practices observed in museums. Many institutions did not have formal digitisation strategies, but rather activities were pursued on an ad hoc basis, driven by available funding. Li (2024a) highlighted that museums' awareness of the need to cater to digitally informed audiences was accelerated during the COVID-19 pandemic, but the adaptation was often reactive rather than strategically planned.

3.1.3 Digital preservation challenges and long-term sustainability

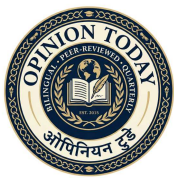
In the literature, a frequent theme is the long-term sustainability of digital collections. Technological obsolescence is a primary threat to the longevity of digitised material (Stow, 2011; Hou, Kenderdine, Picca, Egloff and Adamou, 2022). Without continued investment in data migration and format conversion, digital records created today may become inaccessible in a generation. This challenge is further compounded by questions of equity: institutions in lower-income settings may not have the financial and technical capacity to sustain digital infrastructure, thus reproducing existing inequalities also at the digital level. Castor (2026) reaffirmed this, noting that unequal benefits resulting from digital heritage infrastructure continue to be a major gap across continents and that the long-term sustainability of participatory digital models are inadequately studied.

3.2.1 Sensor-based visitor monitoring and ambient intelligence

The concept of ambient intelligence and Internet of Things (IoT) monitoring systems has greatly increased the ability to precisely, continuously and objectively analyse visitors' behaviour. The CoME project (Angeloni and Tonelli, 2021), for instance, used six RGB-D cameras, spread out over four floors of the Civic Museums of the Palazzo Buonaccorsi, to detect and track some 6,200 visitors over a 55-day period. Likewise, Jiang et al. (2022) designed a commodity Wi-Fi based framework that can accurately count the number of visitors up to 95% in multi-area contactless counting. Moreover, Pierdicca et al. (2019) reported that visitors' interest mostly lasted a few minutes (median about two minutes per room) and found that an increasing number of smart tourism technologies are being introduced at the international level within the framework of a comprehensive smart tourism ecosystem. For example, Radjapova and Najmiddinov (2025) reported implementing over 2,000 IoT sensors throughout Barcelona to monitor tourist flows, public transport usage and visitor activities, and using a central management system to control tourist influx. Similarly, Singapore's Smart Nation initiative relies on AI and IoT solutions to analyse tourist flow in real-time, enabling better management of resources. In summary, these examples show the potential and capabilities of data-driven and sensor-based solutions to assist museums and tourist destinations in creating evidence-based visitor management strategies.

3.2.2 Augmented reality adoption in museums: From TAM to UTAUT

Augmented reality has emerged as one of the most actively researched technologies for museum visitor engagement. The Technology Acceptance Model (TAM) has been the most commonly used theory to explain the process of AR adoption, and it was initially developed by Davis (1989). Khalil et al. (2023) polled 316 attendees at the Atelier des Lumières in Paris at the immersive exhibitions and came up with 2 new constructs that build upon TAM: user satisfaction and social mimetism.. Trunfio, De Lucia, Campana, and Magnelli (2021) conducted a large-scale survey of 739 visitors at the Pacis Museum in



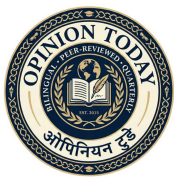
Rome, providing evidence that AR and VR significantly enhanced visitor experiences. Lu et al. (2023) contextualised these findings within their evolutionary framework, noting that while TAM has been the most frequently utilised theoretical lens in studies on smart museum technology, most applications have modified the original model with extended variables, reflecting the field's recognition that standard TAM constructs inadequately capture the richness of heritage visitor experiences.

A significant theoretical advancement has been made by Wang et al. (2025), who extended the Unified Theory of Acceptance and Use of Technology (UTAUT) framework specifically for AR wayfinding systems in open historic districts. Using structural equation modelling with 516 valid responses, they found that effort expectancy exerted a stronger positive influence on behavioural intention than performance expectancy—a notable departure from both conventional UTAUT predictions and museum-based studies where performance expectancy typically predominates. This “ease-of-use preference” indicates that in open, experience-driven cultural heritage environments, visitors prioritise operational simplicity over functional capability. Furthermore, their analysis revealed that perceived interactivity influences behavioural intention both directly and indirectly through perceived pleasure, while social influence and perceived risk affect intention exclusively through perceived trust as a complete mediating variable. Wang et al. (2025) proposed an implementation pathway of “technical ease of use – content gamification – trust-oriented management” that offers practical guidance for AR deployment in heritage contexts.

Building on this line of research, Zhang, Papp-Váry, and Szabó (2025) employed the Stimulus–Organism–Response (SOR) model to explore how digital technologies influence World Heritage visitor satisfaction and visitor intentions to recommend the sites to others in the coastal cities of China. With 402 participants in eight cities, they applied structural equation modelling to show that VR and AR technologies act as external stimuli that boost the levels of digital participation and perceived authenticity (organism-level mediators), which, in turn, promotes satisfaction and recommendation behaviours (response outcomes). Their research builds on Cultural Authenticity Theory to show how digital tools can relate to cultural stories, and their suggestions highlight the need for culturally responsive, participatory digital strategies to enhance the sustainability of heritage tourism.

Table 2: Comparative Summary of Technology Acceptance Studies in Museum and Heritage AR Contexts

Study	Year	Framework	Sample	Context	Country	Key Finding
Khalil et al.	2023	TAM (extended)	n = 316	Immersive art exhibitions	France	User satisfaction and social mimetism extend TAM
Trunfio et al.	2021	IPA + Cluster Analysis	n = 739	Heritage museum AR/VR	Italy	AR/VR significantly enhance visitor experience and satisfaction
Li, Tu et al.	2024	TAM (extended)	n = N/A	Wearable AR in museums	China	Visual appeal and tech readiness drive AR acceptance
Xu et al.	2025	TAM (modified)	n = N/A	Archaeological AR site	China	Innovativeness predicts AR attitude; discomfort deters it



Wang et al.	2025	UTAUT (extended)	n = 516	AR wayfinding in historic districts	China	Effort expectancy > performance expectancy; trust mediates risk/social influence
Zhang et al.	2025	SOR framework	n = 402	World Heritage Sites	China	Digital participation and perceived authenticity mediate satisfaction and recommendations
Xing & Sun	2025	TAM	n = 155	AR & virtual exhibitions	UK	AR positive for engagement; resources moderate impact
Deng et al.	2025	Fit-Viability Model	n = 316	Virtual reality museums	China	Dual pathway: visit-tech fit → hedonic experience → engagement

3.2.3 Immersive technologies: Virtual reality and extended reality (XR)

In addition to AR, extended reality (XR) has been the focus of increasing scholarly interest. A literature review, based on PRISMA methodology, of sixty-five works has been carried out by Innovative Cultural Ambient Assisted Living through Head Mounted Display and CAVE Systems in Heritage Contexts (2023), which divided heritage applications into the following categories: education, entertainment, edutainment, touristic guidance, accessibility, visitor profiling, and management. Deng, Zhang and Jiang (2025) developed a fit-viability model in which they showed that the fit-technology dimension could affect the hedonic experience, which then would affect engagement.

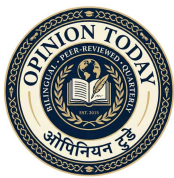
Yang et al. (2025) gave some useful details about the use of immersive technology in the context of the Chinese museum industry. Their review revealed the use of VR technology to build virtual simulation systems for experiencing and experiencing cultural artefacts including chime bells, ceramic restoration platforms and interactive agricultural tool displays. They also pointed out that AR applications have grown from simple mobile guides to interactive applications that also include augmented projection, tactile sensing, and multimodal technology. In addition, mixed reality (MR) has started to appear as a means of integrating virtual and real content in shared spaces, and holographic projection and interactive games have enhanced the modes of presentation in the exhibitions. The researchers' conclusion on immersive technologies and interactive experiences as the main research topic in Chinese museum digitisation highlights the growing convergence of the world on experiences and technology-based heritage engagement.

3.3 Digital Platforms and Organisational Transformation

3.3.1 Impact of digital platforms on museum organisational structure

The effect of digital transformation on the organisation. The case study carried out at the Civic Museums of Treviso showed that, although the creation of a digital platform was implemented to modernise the management of the museum, organisational transformation did not follow as expected. This is evidence that adoption is not enough to trigger structural change, when institutions are not yet ready (including staff capacity, management buy-in, and cultural receptivity).

This observation was given conceptual substance by Liao et al. (2020) who described the process of digitisation as the conversion of resources, digitalisation as process optimisation, and digital transformation as a real socio-technical shift. Their analysis of the literature indicates that there is very little specific work on digital transformation compared to the vast amount of literature on digitisation, pointing to the fact that the sector has been primarily technical and has not paid much



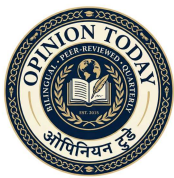
attention to the deeper organisational and human aspects that are needed if digital transformation is to happen. This concern from the visitor experience point of view was echoed by Lu et al. (2023), who noted that the volume of research on technology and museum visitor experiences has been growing exponentially, yet there was little consistency around the theoretical frameworks used, and this dearth of theory-building in the broader field of creating the conceptual foundation for genuinely transformative institutional practice is not unique to museum studies.

3.3.2 International best practices in digital tourism management

The comparative study of Radjapova and Najmiddinov (2025) provides useful information about the role of national-level digital strategies in the context of heritage tourism institutions. Their study identified examples of how Singapore has introduced AI-powered tourist flow analysis, a unified digital access platform (SingPass), Dubai has rolled out more than 120 integrated services via the app “Dubai Now” with AI personalisation features, and Barcelona has introduced a tourism system with nearly 2000 IoT sensors to manage tourist flows, including AI-powered personalised recommendations, and Estonia has digital identity services via its e-Residency programme. The study, however, also revealed key challenges that face the emerging markets of tourism in Uzbekistan: lack of technical infrastructure, lack of qualified digital staff, lack of integration of digital platforms, and lack of legal frameworks. The museum sector faces similar challenges including infrastructure inequality, skills gaps, platform fragmentation and regulatory gaps, all of which can be directly transferable to museums.

Table 3: International Best Practices in Digital Systems for Tourism and Heritage Management

Country	Key Digital Systems	Technologies Deployed	Relevance for Museums
Singapore	Smart Nation initiative; STB Smart Travel Recommender; SingPass unified access	AI, IoT, VR/AR, real-time analytics	Model for AI-driven visitor flow management and personalised museum guides
UAE (Dubai)	Smart Dubai; Dubai Now app (120+ services); Dubai360 VR	AI, VR, biometric recognition, facial ID	VR/AR virtual tours for heritage sites; integrated digital service ecosystems
Spain (Barcelona)	Smart Tourism City; 2,000+ IoT sensors; QR geolocation; Turisme de Barcelona app	IoT, QR codes, geolocation, digital maps	Sensor-based crowd management; multilingual heritage interpretation
Estonia	e-Residency; digital advisory services; statistical surveillance system	Digital identity, chatbots, real-time statistics	Digital-first governance model; data-driven policy for cultural institutions



3.4 Open Data Ecosystems and Cultural Policy Frameworks

The comparative case study of art museum open data ecosystems was undertaken by Booth, and Ogundipe (2021), who looked at three mid-sized art museums in Europe. They found that museums are very sensitive to their contexts, and they change their open data policies accordingly, depending on network signals. Museums, however, failed to be very effective in communicating with their users, leaving the informational interdependence that is essential for functioning ecosystems at bay. Policy and national financial incentives proved to be catalysts for openness, but institutional conditions were limiting progress. Borda and Bowen (2025) suggested that the idea of global digital citizenship can provide a framework for considering the role of museums in a participatory innovation and digital equity.

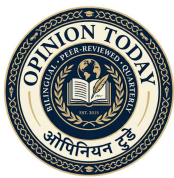
Castor (2026) continued this discussion by highlighting the need for robust policies that incorporate equity and sustainability considerations in the context of heritage management. The review illustrated through case studies from Africa, Asia Pacific, Europe and Latin America that four key dimensions of an effective heritage management programme are: digitalisation and technological innovation; genuine community involvement and participatory governance; a comprehensive policy programme that incorporates equity and sustainability; and adaptive management that embraces uncertainty and complexity. A multi-dimensional view contributes to the comprehension of the position of museum open data and digital policies in the context of a broader governance structure that takes into consideration various cultural, economic and institutional contexts.

3.5 Museum Marketing Strategies in the Digital and Post-Pandemic Era

COVID-19 significantly affected museum marketing strategies, driving the use of digital communication and engaging an audience. De et al. (2022) conducted a study of 2,392 social media posts from the most visited art museums in Spain, which revealed the pandemic as a turning point in digital communication management. Their research demonstrated the growing role of online media in sustaining audience engagement when there is limited face-to-face access. Additionally, Gherheş, et al. (2025) found that younger, more educated visitors showed greater openness to the virtual museum's activities, indicating that the effectiveness of the use of digital tools for engaging visitors depends on the demographics. In a similar way, Samaroudi et al. (2020) found that in the period of lockdowns, the heritage institutions responded in various ways and this was due to the differences in their capacities, priorities and IT readiness. All of these studies collectively show the pandemic's impact on digital transformation in museums and how visitor engagement and marketing strategies have been changed.

3.6 Cultural Heritage Valuation and Socio-Economic Impact

Sánchez Royo (2011) used two approaches, contingent valuation and choice experiment to estimate the value of Fallas festival in Valencia. Ozdemir and Zonah (2025) explored how smart technologies work in conjunction with heritage interpretation within the context of four major museums in Europe, and they concluded that smart technologies were in line with sustainability goals. As digital transformation is not only a technical challenge but also a cultural and political one, Li (2024a) argued that there is a tension between the commodification of the cultural product and the potential of digital tools in driving genuine engagement. This more empirical perspective was brought by Zhang et al. (2025) who conducted a survey at the 402 touristic destinations of the Chinese coastal World Heritage Sites, showing that the use of digital engagement tools like VR and AR increase the perceived authenticity of the site and improves the satisfaction of the tourist, therefore resulting in positive behaviors regarding the site recommendation. The researchers conclude that "promoting culturally appropriate narratives with digital technology does not reduce, but enhances, perceived heritage value..



3.7 Accessibility, Inclusion, and the Digital Divide

There is an increasing set of scholarships on equity dimensions. Eardley et al. (2022) challenged the assumptions of museums based on the visual, and called for inclusive, multisensory design. Clini, Nespeca, Ferretti, Galazzi and Bernacchia (2025) showed that 3-D printed tactile replicas can make the archaeological collections accessible to blind and low vision visitors. Suıçmez et al. (2025) examined the impact of AI tools in museum applications on accessibility in six countries and stated that the museum sector needs to develop specific ethical frameworks and inclusive governance models for effective implementation of AI.

3.8 Changing Heritage: Design, Interpretation, and Contemporary Perspectives

The concept of heritage is increasingly discussed in terms of a dynamic and socially produced process. Hou et al. (2022) analysed the digitisation of ICH, and most of the digital tools available are still based on the object-centric approach, which lacks the ephemeral and embodied aspects of living traditions. The work of Caciara, et al. (2023) showed an integrated approach for the digitisation of an Art Nouveau museum in Romania, using both 3D photogrammetry and laser scanning and the creation of virtual tours. Castor (2026) was one of the most major reframes of this discourse, making the case for a shift in heritage management from preservation-based to what many scholars would call “living heritage” processes, which combine current cultural expression with understandings of history. The review concluded that there is no one-size-fits-all solution to effective heritage management and that a paradigm shift towards weaving together community agency, indigenous governance and technological innovations with climate adaptation is a research and practice frontier.

4. Critical Synthesis and Discussion

4.1 Cross-Cutting Themes and Convergences

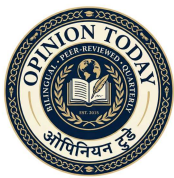
There are several overarching themes that arise from the thematic analysis. The most striking is the universality of the access imperative, irrespective of whether the subject is digitisation, visitor monitoring, the uptake of AR, open data or heritage valuation, the discourse is consistently about closing gaps between collections and publics.

The second recurring theme is that of the potential of technologies and organizational readiness. The Treviso case explained that platform adoption did not lead to change; Noehrer et al. (2021) explained that preparedness is a pre-condition for being ready during a pandemic; Booth et al. (2021) showed that institutional conditions are a hindrance to progress; and Radjapova and Najmiddinov (2025) reported on how the uneven infrastructure, skills shortages and platform fragmentation were constraining digital tourism development in emerging markets. This was further echoed at micro level, Liao et al. (2020) found that although literature on digitisation was extensive, literature on genuine digital transformation was relatively scarce, indicating that the industry has been very much preoccupied with the technical aspects of digitisation and not particularly deepening the organisational aspects required for a sustained transformation.

Third, COVID-19 is a disruptive moment across several research strands, with a push towards trends that are continuing and an irreversible shift in the relationship between museums and the digital world.

The thematic analysis throws up a number of general themes. The most obvious is the access imperative, from digitisation to visitor monitoring, AR to open data, heritage valuation to heritage protection, the conversation always focuses on eliminating divides between collections and publics.

The recurring theme is between technology and organisation. The Treviso case, however, provided a particularly interesting insight into the relative roles of effort expectancy and performance expectancy in the adoption of AR technologies in heritage tourism settings. Their study shows that ease of use becomes the more significant factor in determining



technology acceptance in experiential and non-utilitarian settings, whereas UTAUT theory assumes that perceived usefulness is more significant. For museums in the process of considering digital innovation, this distinction has a significant impact. Institutions would be more effective in focusing on the intuitive design of the interface and streamlined interaction methods, including one-button access, as well as the elements of the games that would help maintain the interest of visitors. In addition to these design elements, intentional efforts to build trust and to communicate risks clearly are important for mitigating visitor concerns around new technologies.

The focus on adoption, Lu et al. (2023) bring in a useful longitudinal lens to help to understand the process of digital transformation over time in heritage institutions. They have captured the developmental nature of technological change in this sector in their Four-Stage Model (from ICT Incubation to Smart Technology Adoption to ICT Transformation to Futuristic Innovation). The literature available today indicates that a significant portion of the museums now exist in the middle, between the Stages III and IV, where a combination of established digital practices and artificial intelligence, extended reality and predictive analytics are becoming more common. This evolutionary schema also contributes to understanding the differential adoption rates and across institutions that have different geographical, financial and organizational situations.

The results of the three studies (Zhang et al., 2025; Castor, 2026; and Yang et al., 2025) point to a bigger picture: digital transformation in a heritage context is not a solely technical business. Perceived authenticity is found to mediate between digital features and visitor satisfaction, making it important to ensure that technology does not supplant cultural meaning but rather reinforces it, especially in this regard (Zhang et al., 2025). In Castor (2026), the authors highlight the need to place community engagement at the very heart of the digital heritage process, and view the process of digitisation not as a mere process of modernisation but as a kind of democratic engagement. Overall, these research findings have confirmed that sustainable digital transformation requires a careful balance between technology and upholding cultural values, local identities and the meaningful engagement of communities in the process of shaping heritage narratives.

Table 4: Thematic Synthesis Matrix – Cross-Cutting Themes Across Reviewed Studies

Theme	Description	Key Sources	Implications
Access Imperative	Universal drive to democratise cultural heritage through digital channels	Stow (2011); Booth et al. (2021); Ozdemir & Zonah (2025)	Foundation for all digital transformation efforts
Technology-Readiness Gap	Persistent disconnect between available tools and institutional capacity to adopt them	Noehrer et al. (2021); Liao et al. (2020); Radjapova & Najmiddinov (2025)	Investment in skills and governance is as critical as technology
Pandemic Acceleration	COVID-19 forced rapid digital adoption and permanently altered museum-audience relations	Samaroudi et al. (2020); De las Heras-Pedrosa et al. (2022); Gherheş et al. (2025)	Hybrid physical-digital models are now essential

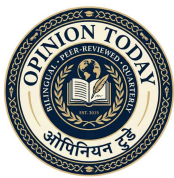


Ease-of-Use Preference	Visitors in heritage contexts prioritise simplicity over performance	Wang et al. (2025); Khalil et al. (2023)	UX design and frictionless interfaces drive AR adoption
Trust as Gatekeeper	Perceived trust mediates the effects of social influence and risk on adoption	Wang et al. (2025); Booth et al. (2021)	Authoritative content and transparent data policies build user confidence
Evolutionary Trajectory	Research and technology evolving through four identifiable stages	Lu et al. (2023); Yang et al. (2025)	Institutions must assess their position on the maturity curve
Cultural Authenticity	Digital tools must enhance rather than diminish perceived heritage value	Zhang et al. (2025); Castor (2026); Li (2024a)	Culturally sensitive design is essential for sustainable engagement
From Digitisation to Transformation	Research shifting from technology-centric to people-centric concerns	Liao et al. (2020); Park (2021); Castor (2026)	Organisational culture and workforce development are key enablers

4.2 Methodological Observations

Qualitative case studies predominate the literature reviewed, and examine to focus on a single institution or small set of museums. There are limited quantitative large-scale studies available, such as Wang et al., (2025), 516 respondents, and Khalil et al., (2023), 316 respondents, Trunfio et al., (2021), 739 respondents, Zhang et al., (2025), 402 respondents and Deng et al., (2025), 316 respondents. There are no noticeable longitudinal designs. The evidence base in the contexts of Europe and East Asia is limited; perspectives from the Global South are sorely needed, some of which Castor (2026) has begun to offer in a multi-continental approach.

Lu et al. (2023) contributed greatly to this methodological study by outlining how data collection methods in technology-museum visitor experience research have developed over time. They found that traditional approaches (questionnaires, semi-structured interviews, and participant observation) were still common, but also found more innovative approaches such as eye tracking, netnography, shadowing, and personal meaning mapping. The recent development of physiological measurement techniques, in addition to self-report methods, indicates a maturing of the methodological repertoire of the field that future work should be developed upon.



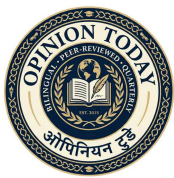
4.3 Theoretical Frameworks Employed

Table 5: Theoretical Frameworks Applied in the Reviewed Literature

Framework	Application Context	Representative Studies	Contribution
Technology Acceptance Model (TAM)	AR adoption in museums	Khalil et al. (2023); Li et al. (2024c); Xu et al. (2025)	Identified social mimetism and satisfaction as TAM extensions
UTAUT (Extended)	AR wayfinding in open historic districts	Wang et al. (2025)	Demonstrated effort > performance expectancy; trust mediates risk/social influence
Stimulus–Organism–Response (SOR)	Digital engagement at World Heritage Sites	Zhang et al. (2025)	Digital features → authenticity & participation → satisfaction & recommendations
Deming Cycle (PDCA)	Visitor monitoring as continuous improvement	Angeloni et al. (2021)	Positioned visitor analytics as iterative quality management
Open Data Ecosystem Theory	Museum open data policy comparison	Booth et al. (2021)	Revealed communication gaps in museum–user relationships
Fit-Viability Model	Virtual museum engagement	Deng et al. (2025)	Dual-pathway model linking tech fit and destination fit to engagement
Actor-Network Theory	Collections management systems	Park (2021)	Foregrounded agency of data and technology in institutional networks
Contingent Valuation	Intangible heritage assessment	Sánchez Royo (2011)	Quantified public valuation of cultural heritage benefits
Socio-Technical Systems	Scientometric mapping of the field	Liao et al. (2020)	Distinguished digitisation, digitalisation, and transformation as layers
Four Stage Model of Evolution	Technology–museum visitor experience research	Lu et al. (2023)	Mapped evolution from ICT Incubation to Futuristic Innovation across 122 studies

4.4 Gaps and Limitations in the Existing Evidence Base

The methodological limitations, there are substantive limitations of interest. The idea of digital equity and the digital divide is underdeveloped; most studies make the assumption of a digitally literate audience (Eardley et al., 2022; Borda and Bowen, 2025). The discussion of intellectual property and ethical concerns of online collections are brief. The sustainability of digital



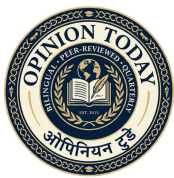
infrastructure is under-theorised at a long-term level. Additionally, Radjapova and Najmiddinov (2025) revealed that the legal aspects of digital tourism are lacking at the national level and pose a cross-national challenge that needs to be addressed by policy. Castor (2026) highlighted three key gaps in the existing literature: Underrepresentation of contexts from the global south, lack of integration of climate adaptation in heritage strategies, and lack of equitable access to and distribution of digital infrastructure benefits.

5. Proposed Conceptual Framework

Table 6: Integrative Conceptual Framework for Museum Digital Transformation

Dimension	Core Components	Key Enabling Factors	Supporting Evidence
(a) Technological Infrastructure	Digitisation equipment, IoT sensors, AR/VR platforms, AI tools, cloud computing	Investment in hardware/software; interoperability standards; platform integration	Li et al. (2024b); Radjapova & Najmiddinov (2025); Jiang et al. (2022); Yang et al. (2025)
(b) Visitor Experience & Engagement	Satisfaction, behavioural engagement, learning outcomes, accessibility, hybrid interactions	Intuitive UX design; ease of use; gamification; perceived interactivity and pleasure	Wang et al. (2025); Trunfio et al. (2021); Deng et al. (2025); Zhang et al. (2025); Lu et al. (2023)
(c) Organisational Capacity & Change Management	Staff competencies, governance structures, leadership commitment, cultural openness	Digital skills training; workforce development; entrepreneurial mindsets	Liao et al. (2020); Noehrer et al. (2021); Park (2021)
(d) Policy & Governance	Government directives, EU open data policies, funding incentives, copyright frameworks, legal norms	Regulatory reform; digital tourism legislation; transparent privacy policies	Booth et al. (2021); Stow (2011); Radjapova & Najmiddinov (2025); Castor (2026)
(e) Heritage Valuation & Socio-Economic Impact	Cultural value assessment, visitor metrics, community identity, sustainability outcomes	Contingent valuation methods; mixed-methods impact assessment; stakeholder engagement	Sánchez Royo (2011); Ozdemir & Zonah (2025); Li (2024a); Zhang et al. (2025)

These five dimensions are interrelated and mutually supporting. Valuable data are gathered from enhanced visitor experiences that will inform organisational decision-making processes and feed into technological infrastructure. Policy frameworks can either help or hinder the adoption of digital innovations, and heritage valuation offers an economic, social and cultural rationale for continued investment into digital transformation initiatives. The framework builds on the results of Wang et al. (2025), found a critical pathway between the ease of use of the technology, content gamification and



trust-based management for visitor interaction with the digital technology. It also builds on the work of Liao et al. (2020) who stated that beyond simply advancing from digitisation to digitalisation as steps in digital transformation, there is a need to strive for a more comprehensive shift in socio-technical change. Moreover, Lu et al.'s (2023) evolutionary model provides concrete levels of technology–visitor interactions – a progression of degree of maturity, which are characterized as a growth in the degree of integration and engagement. Finally, the framework is supported by empirical evidence from Zhang et al. (2025) who found culturally sensitive digital approaches can increase perceived authenticity, increase visitor satisfaction and lead to positive visitor behaviours. These insights can be used together to build a solid understanding of the multi-faceted dimensions of digital transformation in museums and cultural heritage institutions.

6. Implications for Theory, Practice, and Future Scholarship

6.1 Theoretical Contributions and Emerging Directions

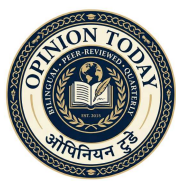
This thematic synthesis provides a few theoretical contributions. First, the integrative conceptual framework brings together the diverse strands of the literature by linking together the technological, experiential, organisational, policy and valuation dimensions. Second, there is temporal and conceptual depth from the incorporation of Lu et al. (2023) Four Stage Model and Liao et al. (2020) conceptual stratification. Third, the Wang et al., (2025) UTAUT extension and Zhang et al., (2025) SOR framework illustrates how multiple theoretical perspectives can complement each other, with adoption-focused and experience-focused views on heritage. The Indian heritage sector is a space of huge size and institutional variety that is highly suitable to these frameworks.

6.2 Future Research Directions

The results of this review reveal some significant issues that require continued research. First, there is a high absence of long-term studies exploring the long-term effects and sustainability of digital transformation projects in the field of museums and heritage. Much of the existing research focuses on providing cross sectional information, which hinders understanding of the development of digital strategies over time, and how they can impact on organisational performance, visitor engagement, and cultural preservation outcomes. Second, digital equity is under-explored, with regards to access to digital heritage resources for underserved, marginalised and digitally disadvantaged people. Future research should explore the potential for technological innovation that could lead to cultural participation and less culture gap.

Third, there is a need to increase the focus on the legal, ethical and governance aspects of digital transformation, such as copyright protection, intellectual property rights, data privacy and the ethical impact of new technologies. Fourth, comparative studies between museums in the South and in any other region are still restricted. While Castor (2026) has taken an important step by analyzing digital transformation from multiple continents, more work is required to examine how various socio-economic, political and cultural contexts affect the process and outcomes of digital transformation. Finally, the use of artificial intelligence, machine learning and advanced analytics for managing museums, predicting visitors' behaviours, and informing curatorial decisions is still in a nascent stage and is ripe for further research.

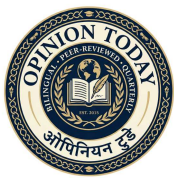
Furthermore, Liao et al. (2020) found that while there is a lot of research into digitisation, there is still not much research that concentrates on full digital transformation. This indicates that museums are not yet fully aware of the changes in the organisation, management and culture that are necessary if they are to optimally exploit the transformative power of digital technologies. Moreover, Lu et al. (2023) pointed out the lack of theoretical integration in the field, as evidenced by the rapidly expanding body of empirical research without corresponding theoretical integration. Therefore, there is still a lack of a unified conceptualization of digital transformation and analytical language to discuss it in the context of museum



environments. In order to overcome these restrictions, some research directions are suggested. Spanning both quantitative data on visitors and qualitative analysis of institutional practices, mixed methods should be used in future research to gain a deeper understanding of digital transformation processes. The multi-continental perspective introduced by Castor (2026) should be extended to cross-national comparative research on the impact of various policy contexts, governance systems and cultural settings. In addition, research needs to build and test an integrated digital transformation level model for museums based on the conceptual model proposed in this study and the Four-Stage Model of Evolution by Lu et al. (2023). The future impact of new technologies such as AI personalisation systems, blockchain applications in tracking provenance, and extended reality (XR) environments should be explored in more detail. The technology developed in Chinese museums, as summarized by Yang et al. (2025), could be explored in such studies. Furthermore, future studies should explore the suitability of the extended UTAUT model suggested by Wang et al. (2025), focusing on how the perceived interactivity, enjoyment, and trust factors affect the adoption of technology in museum settings. Likewise, the replication of Stimulus–Organism–Response (SOR) model in different heritage situations would improve understanding of visitors' experiences and behavioural reactions. Last but not least, comparative studies should examine the potential of international practices described by Radjapova and Najmiddinov (2025) in Singapore, Dubai, Barcelona and Estonia to be applied in the institution's contexts to reinforce the museum governance processes, digital innovation strategies and visitor management.

7. Conclusion

The aim of this systematic review was to bring together the results of fifteen key studies and a wider body of literature to form a complete picture of the global museum sector digital transformation. The analysis identifies that digital technologies offer significant potential to enhance visitors' experiences, extend access, and create new forms of cultural value. Achieving this promise, however, requires transformational change in organizational culture, organizational capacities, organizational governance, and policy contexts as well. The study by Wang et al. (2025) that effort expectancy is more important to technology adoption than performance expectancy in heritage tourism raises the question of what factors should be considered in designing a technology that is to be accepted by the user. Liao et al. (2020) three conceptual levels of digitisation, digitalisation and digital transformation offer a helpful guide to positions in the digital journey and more transitions to come. The comparative study of international digital tourism conducted by Radjapova and Najmiddinov (2025) provides tangible examples and shows the structural issues that heritage institutions and new tourism markets face. The Four Stage Model of Evolution (FMoE) of Lu et al. (2023) provides a temporal lens to situate individual institutions and research agendas within the wider process of technological and conceptual maturation. The decadal review of Chinese museum digitisation by Yang et al. (2025) adds further granular, region-specific evidence which will add weight to the core corpus, which is largely European and multi-national. The results of Zhang et al. (2025) on digital engagement towards WH sites based on SOR framework give an empirical proof of the argument that digital tools can positively contribute to perceived cultural authenticity rather than harming it. Castor's (2026) global systematic review of cultural memory and heritage management puts the entire discussion in a wider paradigm shift from preservation-based to community-based, memory-centred heritage practice. The integrative conceptual framework presented in this review, which links technological infrastructure, the visitor experience, organisational capacity, policy governance, and heritage valuation, is a first step towards bridging the theoretical gap identified in the literature. It's designed not only as an analytical framework for future research but also as a strategic compass for museum professionals who are facing a complex and contested landscape of digital change and ultimately transformation.



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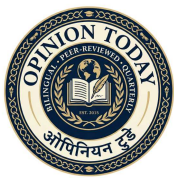
Rashmi Ayyagari: Conceptualization, Data curation, Writing original draft, review & editing. **Dr Vandana Tomar:** Supervision.

Competing Interest Declaration

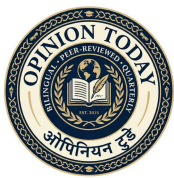
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