

A Digital Transformation Framework for Sustainable Heritage Tourism: Challenges, Issues, and Implications for Local Communities

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ABSTRACT

Digital technologies promise heritage destinations better visitor information, booking, and flow management, yet heritage sites also carry conservation obligations, resident populations, and small and informal operators whose interests a visitor-centred digitalization agenda does not automatically serve. This paper reports a structured review, involving search strings covering four thematic clusters that were run in various databases; records were screened at title/abstract and full-text stages, bibliographic details and DOIs were verified against publisher records, and thirty studies were retained and synthesised. The review makes three contributions. First, it proposes a four-layer framework (digital infrastructure and access; visitor-facing digital services; heritage documentation, preservation, and cultural sustainability; and community governance, inclusion, and digital literacy) anchored in stakeholder, social exchange, digital-divide, and technology-acceptance theory. Second, an analysis shows that community-level challenges (digital divide, overtourism amplification, small-operator exclusion, cultural commodification, data governance, and institutional fragmentation) are frequently identified but rarely paired with a tested mitigation. Third, the paper highlights the implications, which are drawn separately for residents, small and informal operators, destination managers, and policymakers, and a phased implementation roadmap is proposed to sequence infrastructure, visitor-service, heritage-preservation, and community-governance investments. The paper concludes that digital transformation in heritage tourism is therefore framed as a governance and equity problem, with community inclusion treated as a structural design requirement.

Keywords: digital transformation; sustainable heritage tourism; smart tourism destination; community-based tourism; digital divide

INTRODUCTION

Heritage destinations, including historic city centres, UNESCO World Heritage Sites, and culturally significant districts, occupy a distinctive position within the broader digital transformation of tourism. Like any destination, they are targets for the visitor-facing digital services that have reshaped how tourists search for information, book activities, and navigate a destination [1], [2]. Unlike many destinations, however, heritage

sites also carry conservation obligations to tangible and intangible cultural assets, host resident populations whose daily lives are affected by visitor volume, and depend heavily on small, often informal, local operators like family-run restaurants, homestays, and independent guides whose digital capacity often lags behind that of larger, more established attractions [3], [4]. Digital transformation initiatives designed primarily around visitor experience and destination competitiveness can therefore have effects on heritage communities that a purely technology-adoption framing does not capture.

This paper proposes a digital transformation framework for sustainable heritage tourism that treats these community-level effects as a structural design concern rather than a secondary consideration. Digital transformation research in tourism has matured considerably, producing systematic reviews of digitalization's role in sustainable tourism development [5], conceptual frameworks for digital transformation at destination and municipal scale [6], [2], and extensive documentation of specific technologies such as visitor-flow monitoring [7], augmented and virtual reality heritage experiences [8], mobile applications for senior and other tourist segments [9]. In parallel, a distinct literature documents the digital divide facing small tourism operators and residents in destination communities [3], [10], [11], [12]. This paper's contribution is to bring these strands together into a single framework specific to heritage tourism, and to use that framework to organize a systematic discussion of the challenges, issues, and community-level implications that heritage-destination digital transformation raises.

Building on this rationale, the review pursues three objectives: to synthesize digital-transformation, smart-destination, heritage-management, and community-based tourism literature into a single framework applicable to heritage destinations specifically; to identify the principal challenges and issues that digital transformation raises for the communities which are residents, small and informal operators, and heritage stakeholders living in and around heritage destinations; and to draw out implications for residents, operators, destination managers and policymakers, and researchers, culminating in a phased roadmap for implementation. These objectives are addressed through three research questions. RQ1 asks what the core functional layers of a digital transformation framework for heritage tourism should be. RQ2 asks what challenges and issues digital transformation raises specifically for the communities and areas surrounding heritage destinations, as distinct from tourists or destination-competitiveness outcomes. RQ3 asks what the practical implications of these challenges are for the different stakeholder groups involved, and how implementation should be sequenced.

The remainder of the paper is organized as follows. Section 2 describes the review methodology. Section 3 sets out the conceptual foundations distinguishing digitization, digitalization, and digital transformation, and reviews existing general-purpose digital transformation and smart-destination frameworks. Section 4 presents the proposed four-layer digital transformation framework for sustainable heritage tourism. Section 5 discusses the challenges and issues this framework surfaces for local communities. Section 6 draws out implications for each stakeholder group, and Section 7 proposes a phased implementation roadmap. Section 8 concludes.

METHODOLOGY

Review Design

This paper adopts a narrative review methodology to synthesize existing knowledge and develop a conceptual framework. A narrative design allows articles from different sources to be read on their own terms and then integrated conceptually. The review nonetheless follows a structured, five-stage procedure, summarized in Figure 1 and described in the following subsections.

Search Strategy

Keyword searches were carried out iteratively across four thematic clusters corresponding to the paper's conceptual scope: (i) tourism information systems and technology-acceptance research (e.g., “web-based tourism information system,” “technology acceptance model tourism website”); (ii) digital transformation and smart-destination frameworks (e.g., “digital transformation tourism framework,” “smart tourism destination,” “digital transformation framework smart municipality”); (iii) heritage-site visitor management and digitization (e.g., “overtourism visitor carrying capacity technology,” “digital heritage preservation UNESCO,”

“augmented reality heritage tourism”); and (iv) community-based tourism, digital divide, and stakeholder governance (e.g., “digital divide small tourism enterprises,” “stakeholder collaboration heritage management,” “community-based tourism digital platform”). Approximately fifteen distinct search queries were run across these clusters against various databases and digital libraries.

Inclusion and Exclusion Criteria

A source was included if it was (a) a peer-reviewed journal article or peer-reviewed conference proceeding, (b) published in English, (c) substantively concerned with at least one of the four thematic clusters above, and (d) traceable to a verifiable digital object identifier (DOI) or equivalent persistent publisher record. Sources were excluded if they were non-peer-reviewed web content, opinion or trade-press commentary, or if a verifiable DOI or persistent publisher identifier could not be located.

Screening, Selection, and Coding Procedure

Candidate records surfaced by the search strategy were screened in three passes, illustrated in Figure 1. First, titles and abstracts were screened against the inclusion and exclusion criteria above. Second, the full text of surviving records was obtained and read, and each source's bibliographic details (authors, year, journal or venue, volume, and pages) and DOI were cross-checked against the publisher's own record; sources whose bibliographic details could not be confirmed this way were dropped. Third, each retained source was coded against the four thematic clusters used to structure the search, with several sources coded against more than one cluster where their content spanned multiple clusters. This process yielded the thirty sources synthesized in this paper.

Synthesis Procedure

Coded sources were synthesized in two stages. First, sources from thematic clusters (i) and (ii) were used to construct the four-layer digital transformation framework presented in Section 4, with each layer populated by the subset of sources whose content corresponded to that layer's function. Second, sources from thematic clusters (iii) and (iv), together with sources from clusters (i) and (ii) that documented a community or resident-facing effect, were used to derive the six-part challenges taxonomy presented in Section 5. This two-stage synthesis procedure is what links the conceptual framework (Section 4) to the community-level discussion (Section 5) that this paper treats as its central contribution.

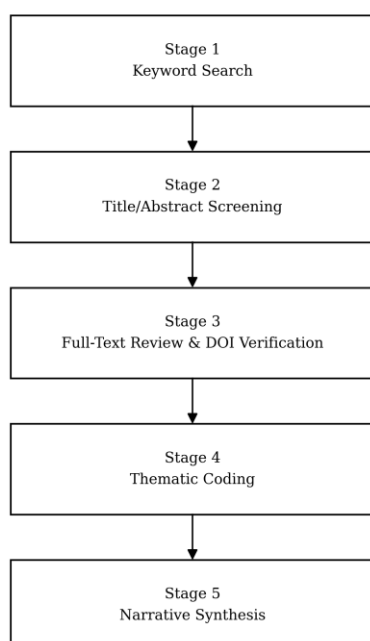


Figure 1. Five-stage review procedure, from keyword search to narrative synthesis.

CONCEPTUAL FOUNDATIONS

From Digitalization to Digital Transformation

The digital-transformation literature distinguishes digitization (converting analogue information into digital form), digitalization (using digital technologies to change existing processes), and digital transformation (a more fundamental, often strategic and organizational, reconfiguration enabled by digital technology) [5]. Applied to heritage tourism, digitization corresponds to activities such as creating digital catalogues of heritage assets; digitalization corresponds to putting existing information and booking processes online, the pattern seen in most single-destination tourism information system case studies [13], [14], [15]; and digital transformation corresponds to a more structural shift in how a destination is planned, governed, and experienced, the level at which visitor-flow monitoring, data-driven heritage conservation, and community digital-inclusion policy operate together [6], [7]. Much of the existing tourism-system literature operates at the digitalization level; this paper argues that sustainable heritage tourism requires engaging the transformation level, particularly regarding community governance.

Existing Digital Transformation and Smart-Destination Frameworks

Several general-purpose digital transformation frameworks exist outside the heritage context and offer useful structural precedents. Van der Hoogen et al. [6] propose a digital transformation framework for smart municipalities structured around smart governance, smart environment, and smart living dimensions, developed and tested with local government stakeholders in South Africa. Wu et al. [2], reviewing 278 studies on digital tourism and smart development, identify five key trajectories, including the deepening application of digital technologies in tourism and the integration of the digital and tourism real economies. El Archi et al. [16] map the bibliometric landscape of digital technologies specifically for sustainable tourism destinations. These frameworks are valuable but are not heritage-specific: none foregrounds the conservation obligations, resident populations, or small-operator inclusion concerns that distinguish heritage destinations from tourism destinations generally, a gap this paper's proposed framework addresses directly.

PROPOSED FRAMEWORK: FOUR LAYERS

Building on the conceptual foundations above, this paper proposes a four-layer digital transformation framework for sustainable heritage tourism. Table 1 summarizes the layers, their core functions, and representative supporting literature; each layer is discussed in turn below.

Table 1. A four-layer digital transformation framework for sustainable heritage tourism.

Layer	Core Function	Representative Literature
1. Digital infrastructure and access	Connectivity, device access, and baseline digital literacy across residents, operators, and visitors	[10], [17], [12]
2. Visitor-facing digital services	Information search, booking, wayfinding, and visitor-flow/carrying-capacity management	[13], [14], [15], [9], [7]
3. Heritage documentation and cultural sustainability	Digital cataloguing, immersive (AR/VR) presentation, and data-informed conservation of tangible and intangible heritage	[18], [8], [19]
4. Community governance, inclusion, and digital literacy	Stakeholder coordination, self-service operator participation, and resident/operator digital-inclusion support	[3], [20], [11], [4], [21], [22]

Layer 1: Digital Infrastructure and Access

The foundation of any heritage-destination digital transformation is reliable connectivity and baseline digital literacy not only for tourists, but for residents and small operators. Geohansa et al. [10], studying a smart tourism village in Indonesia, found that unstable internet infrastructure and low digital literacy, particularly among elderly residents, were the most consistently cited barriers to fuller digital participation. Marsdenia [17] similarly documents that moderate digital-literacy levels among rural business operators were a key success factor in sustaining tourism-related digitalization through a period of economic disruption. Without this layer, investment in visitor-facing services or heritage documentation risks benefiting only the already digitally engaged segments of a destination's population.

Layer 2: Visitor-Facing Digital Services

This layer covers the functions most system-development case studies address: centralized information search, booking, and content management [13], [14], [15]. It also extends to a function heritage destinations specifically need, and that conventional tourism-system case studies typically omit: visitor-flow and carrying-capacity monitoring. Zubiaga et al. [7], working within the Smart Heritage City project, developed an IoT- and GIS-based visitor-flow monitoring toolkit for historic centres to help managers act before tourism carrying capacity is exceeded and overtourism sets in. Ramos-Soler et al. [9] show that mobile applications designed with specific visitor segments in mind, which, in their case, senior tourists at World Heritage Sites, measurably improve the visitor experience, illustrating that visitor-facing digital services should be evaluated for inclusivity across the visitor population, not only for functional completeness.

Layer 3: Heritage Documentation, Preservation, and Cultural Sustainability

Digital technologies also serve a conservation and cultural-sustainability function distinct from visitor service. Jiang and Phoong [19], in a ten-year review of digitalization-and-tourism research, find that digital platforms have been linked to improved cultural-heritage awareness and documentation when designed with that purpose in mind. Han et al. [8] demonstrate, through a tourist-experience model developed from focus-group research, that augmented reality applications in urban heritage tourism can deepen visitor engagement with heritage content beyond what static information provision achieves. Gretzel et al.'s [18] foundational account of smart tourism situates this documentation-and-presentation function within a broader vision of ICT-enabled destinations that integrate information, culture, and stakeholder participation rather than treating heritage content as a static add-on to a booking platform.

Layer 4: Community Governance, Inclusion, and Digital Literacy

The fourth layer is where this framework diverges most from general-purpose smart-destination models, and is the layer this paper's subsequent discussion of challenges (Section 5) engages with most directly. Maquera et al. [4] argue that community-based digital tourism platforms should be designed explicitly for local-operator inclusion and heritage preservation as core objectives, not incidental effects of a visitor-facing platform. Abdul Samad et al. [3] and Dangi and Petrick [20] each document, from different angles, qualitative interviews with homestay operators and a governance-justice framework for community-based tourism, respectively, showing that digital and institutional inclusion cannot be assumed to follow automatically from platform deployment. Snis et al. [22] and Reta and Beldados [21], studying stakeholder collaboration in heritage-town and heritage-city contexts respectively, both find that the governance and coordination mechanisms linking government, heritage-conservation bodies, tourism operators, and residents are as consequential for outcomes as the technology itself.

Challenges and Issues for Local Communities

This section organizes the principal challenges and issues raised in the reviewed literature, framed specifically around their implications for the communities and areas surrounding heritage destinations rather than for destination competitiveness or visitor experience alone.

Digital Divide and Unequal Access

The most consistently documented issue is unequal digital access and literacy across residents, small operators, and tourists. Geohansa et al. [10] find that elderly and otherwise less digitally engaged residents in a tourism village were effectively excluded from digital participation without direct assistance, while younger residents carried a disproportionate, often unfunded, burden of digital promotion work. Abdul Samad et al. [3] similarly document substantial variation in digital-technology perception and usage among homestay operators. Zaidan [12], analysing ICT usage among tourism SMEs in Dubai, and Lama et al. [11], analysing e-tourism adoption barriers among small tourism enterprises in Nepal, both find that infrastructure, resource, and awareness constraints, not attitude alone, limit small-operator digital participation, indicating that digital-divide barriers are structural as much as behavioural.

Overtourism, Visitor Pressure, and Carrying Capacity

A second, less obvious challenge is that visitor-facing digital services, if deployed without a carrying-capacity management function, can accelerate the very overtourism pressures that threaten heritage-site sustainability and resident quality of life. Bertocchi et al. [23], modelling tourism carrying capacity in Venice, document the tension between growing visitor demand which digital marketing and booking platforms tend to amplify and the physical and social capacity of a historic centre to absorb it. Zubiaga et al.'s [7] visitor-flow monitoring toolkit exists precisely because destination managers need a digital counterweight to the demand-generating effect of digital visibility. Whether visitors and operators actually adopt these digital services in the first place is itself explained by established technology-acceptance constructs, perceived usefulness and perceived ease of use [24], which Herrero and San Martín [25] confirm apply directly to tourists' willingness to use accommodation and destination websites for information search and online booking. Beyond adoption, usability evaluation of these services using validated instruments such as the System Usability Scale [26], structured user-acceptance testing [27], and tourism-specific usability metrics [28] remains inconsistently applied across the single-destination case studies reviewed here, even though functional testing alone does not establish whether a service is easy or satisfying to use. A digital transformation framework that invests in visitor-facing promotion and booking (Layer 2) without a corresponding carrying-capacity monitoring function risks worsening, rather than mitigating, this pressure.

Economic Displacement and Small-Operator Exclusion

Centralized digital platforms, even when well-intentioned, can reproduce or worsen existing economic asymmetries between large, established operators and small or informal ones. Maquera et al. [4] and Dangi and Petrick [20] both raise this concern explicitly: a platform that lists attractions and operators without a self-service mechanism for small or informal operators to register and manage their own presence leaves them dependent on centralized administration, which in practice tends to under-represent them relative to already well-known sites. Li and Guan [29], studying the influence of digital transformation on the business performance of small tourism enterprises in China, find that the performance benefits of digitalization are not evenly realized and depend heavily on the enterprise's existing digital capacity, reinforcing rather than levelling pre-existing advantages absent targeted support.

Cultural Commodification and Authenticity Risks

Digital presentation of heritage content carries its own risk: that heritage is packaged for visitor consumption in ways that residents and heritage-conservation stakeholders do not recognize as authentic or that flatten cultural or historical complexity into a marketable narrative. While the augmented- and virtual-reality heritage-experience literature emphasizes visitor engagement gains [8], it says comparatively little about resident or heritage-authority sign-off on how heritage content is digitally represented. This is a gap this review surfaces rather than resolves: none of the reviewed digital heritage-documentation or immersive-experience studies [18], [8], [19] report a formal resident- or heritage-authority review mechanism for digital content, suggesting this is an area requiring dedicated governance attention within Layer 3 and Layer 4 of the proposed framework.

Data Governance, Privacy, and Surveillance Concerns

Visitor-flow monitoring and other data-driven management tools (Layer 2) necessarily involve collecting data about where people are and when, raising governance questions about who controls this data, how long it is retained, and whether monitoring technology deployed for visitor management could extend, deliberately or not, into monitoring residents. None of the visitor-flow-monitoring literature reviewed here [7] addresses resident data-privacy safeguards explicitly, and this paper's framework treats data-governance policy as a necessary, currently under-specified, component of Layer 2 and Layer 4 implementation.

Institutional Fragmentation and Governance Gaps

Underlying each of the challenges above is a common governance problem: digital transformation in heritage tourism typically involves multiple, loosely coordinated actors municipal or district government, heritage-conservation authorities, tourism boards, individual operators, and residents without a single body responsible for coordinating across them. Reta and Beldados [21], studying cultural heritage tourism in Gondar City, Ethiopia, identify governance-based, norm-based, and mutuality-based forms of stakeholder collaboration as distinct and not always mutually reinforcing mechanisms. Snis et al. [22] describe the practical difficulty of “becoming a smart old town” as fundamentally a stakeholder-collaboration and cultural-heritage management challenge rather than a technology-procurement one. Van der Hoogen et al.'s [6] smart-municipality framework, developed outside the heritage context, similarly finds that digital transformation success depends heavily on smart-governance dimensions rather than on infrastructure alone.

IMPLICATIONS

For Residents and Local Communities

Digital-literacy support should be extended to residents, not only tourists or operators, with particular attention to elderly and otherwise less digitally engaged groups identified as most at risk of exclusion [10]. Resident data-privacy safeguards should be an explicit, stated design requirement for any visitor-flow-monitoring or carrying-capacity technology deployed in or near residential areas, rather than an afterthought addressed once a system is already operating. Resident input mechanisms on how heritage content is digitally represented (Layer 3) should also be considered alongside visitor-experience design, to guard against the commodification concerns residents themselves are best placed to identify. Finally, whether resident attitudes toward tourism shift following digital transformation is itself measurable using established instruments such as the Tourism Impact Attitude Scale [30], rather than requiring new instrument development for every destination.

For Small and Informal Operators

Self-service registration and listing management, rather than administrator-only content management, should be evaluated as a design option to reduce the operator-exclusion risk documented by Maquera et al. [4] and Dangi and Petrick [22]. This structural change on its own, however, is unlikely to be sufficient: digital-capacity support in the form of training and resourcing should accompany platform deployment, since Li and Guan [29] and Zaidan [12] both find that digitalization's benefits are conditional on existing operator capacity rather than automatic, meaning that access to a platform without the capacity to use it effectively is unlikely to close the gap it is meant to address.

For Destination Managers and Policymakers

Visitor-facing promotional and booking investment (Layer 2) should be paired with carrying-capacity monitoring investment, not sequenced after visitor growth becomes a problem, given the demand-amplifying effect digital visibility can have [25], [7]. Alongside this, a named, cross-stakeholder coordination body or mechanism, spanning heritage conservation, tourism management, and community representation, should be established before major platform investment, informed by the governance-fragmentation findings of Reta and Beldados [23] and Snis et al. [24]. Sequencing coordination ahead of investment, rather than treating it as a

downstream implementation detail, is what this paper's framework suggests separates heritage destinations that realize digital transformation's community-facing benefits from those that realize only its visitor-facing ones.

TOWARD IMPLEMENTATION: A PHASED ROADMAP

Because the four layers depend on each other, this paper proposes a phased implementation sequence. Phase 1 establishes baseline digital infrastructure and literacy support (Layer 1) across residents, operators, and destination-management staff, addressing the access barriers identified as the most fundamental constraint in the community-based tourism literature [3], [10]. Phase 2 develops visitor-facing services with carrying-capacity monitoring built in from the outset, rather than added retrospectively (Layer 2), informed by the Venice and Smart Heritage City precedents [23], [7]. Phase 3 develops heritage documentation and digital presentation capability with an explicit resident/heritage-authority review step (Layer 3). Phase 4 formalizes cross-stakeholder governance arrangements and self-service operator participation mechanisms (Layer 4), which this review's synthesis treats as the layer least well addressed by existing single-destination case studies and the one most directly responsible for whether digital transformation's benefits reach the full heritage community rather than only its most visible or best-resourced participants.

CONCLUSION

This paper proposed a four-layer digital transformation framework for sustainable heritage tourism, digital infrastructure and access, visitor-facing digital services, heritage documentation and cultural sustainability, and community governance, inclusion, and digital literacy, synthesized from thirty peer-reviewed sources across tourism-system development, smart-destination and digital-transformation research, heritage visitor-management studies, and community-based tourism literature. Reviewing the literature through the lens of this framework surfaces a consistent pattern: technical and visitor-facing dimensions of heritage-destination digital transformation are comparatively well studied, while the community-facing dimension, such as digital-divide barriers, overtourism pressure, small-operator exclusion, cultural commodification risk, data governance, and institutional fragmentation, is less consistently addressed and less consistently resolved. Treating community inclusion as a structural design requirement of digital transformation, rather than an optional or secondary consideration layered on afterward, is this paper's central recommendation for researchers, destination managers, and policymakers engaging with heritage tourism digitalization going forward.

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