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Overlay or scaffold? The continuity assumption in smart tourism ecosystem theory and the post-conflict blind spot

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Abstract

Theories of the smart tourism ecosystem rest on a premise that has rarely needed stating: a destination is already in place. Its layered models locate technology and data above a territory, a population and a heritage stock treated as given, and crises are analysed through the concept of resilience, that is, of return to an earlier state. Destinations recovering from war do not meet this premise, and in some of them the digital record of a monument now exists before the monument has been rebuilt. This article asks whether the field can describe the formation of a smart ecosystem under such discontinuity rather than its recovery from disturbance. We approach it indirectly, by examining whether the three literatures that hold the elements of such a description (smart tourism ecosystems, digital cultural heritage and post-conflict tourism) have interacted, analysing 2,074 Scopus-indexed publications at four levels against validated null models. Interaction is nearly absent: no shared keywords, no shared documents where about 119 would be expected by chance ($P \approx 10^{-71}$), twelve shared authors among 5,804 and a Cross-Domain Integration Index of 0.015. The few terms connecting the post-conflict literature to the digital field belong to the vocabulary of resilience. Link prediction places the most probable point of contact at the intersection of post-conflict and smart tourism research, a result that holds across eleven specifications and in a Lens.org replication. We describe the premise, trace its consequences and outline a scaffold model in which digital infrastructure precedes physical reconstruction.

Keywords: smart tourism ecosystems; continuity assumption; post-conflict tourism; digital cultural heritage; literature-based discovery; scaffold model

1. Introduction

Models of the smart tourism ecosystem generally begin with a destination that is already in place. The foundational model of Gretzel et al. (2015) describes smart tourism through three components, smart destinations, smart business ecosystems and smart experiences, served by three layers of data collection, exchange and processing; in each case the components rest on an existing base, a territory with transport and accommodation, a population that lives and works there, and a stock of heritage that can be recorded, interpreted and marketed. Later ecosystem models (Boes et al. 2016; Buhalis 2020; Koo et al. 2025) refined the layers and widened the set of stakeholders, but retained the base. The premise has seldom been stated, probably because few of the destinations on which the theory was developed gave any reason to question it. We refer to it here as the continuity premise: smartness is understood as an addition to a destination whose physical, demographic and cultural foundations are present and stable.

A related pattern can be seen in how the field has treated crisis. Pandemics, natural disasters and terrorism entered smart tourism research largely through the vocabulary of resilience (Hall et al. 2017; Gretzel et al. 2020; Prayag 2023). In this vocabulary a system is disturbed, absorbs the shock, adapts and returns to a functioning state, and digital tools are valued for helping it return sooner. Resilience is, in this sense, a way of thinking about disturbance. It presupposes an earlier state to which a system can return and a system that persists through the shock; it is less well suited to situations in which a system has to be formed anew.

Destinations recovering from war are such situations. Territory may be contested, mined or occupied; populations are displaced and return only in part; heritage is partly destroyed and, in places, survives only in the memory of those who left; institutions are being rebuilt rather than improved. The full-scale war against Ukraine has damaged or destroyed 540 cultural sites verified by UNESCO, and the recovery needs of the culture and tourism sector have been

estimated at USD 10.5 billion over the coming decade (World Bank 2025). The order of the layers has also changed in practice: since 2022, digital records of Ukrainian monuments produced through citizen scanning, laser survey and volunteer archiving have in a number of cases come to exist before, and to be more complete than, the monuments themselves. In such a setting smartness is not an addition to a standing destination; it is closer to a scaffold around which the destination is rebuilt. The theory currently offers no concept or model for this situation.

Whether smart tourism ecosystem theory can account for the formation of an ecosystem under discontinuity, as distinct from its recovery from disturbance, is the question this article addresses. A direct answer, in the form of a model tested against evidence, is not yet available; the destinations concerned are still at war. An indirect answer is possible: one can ask whether the field possesses the intellectual materials from which such a model could be assembled, and whether its structure shows any movement in that direction. The materials appear to exist, but in three separate literatures. Research on smart tourism ecosystems provides the architecture; research on digital cultural heritage provides instruments that have already reversed the order of the layers in practice (Boboc et al. 2022; Rodríguez-Garcia et al. 2024); research on post-conflict tourism provides an understanding of how destinations return after war (Causevic and Lynch 2011; Reddy et al. 2020; Boyd et al. 2023). A few contributions sit at their intersection (Neglia et al. 2024; Ivanov and De Marchi 2025; Chukut et al. 2025), and bibliometric reviews have mapped each literature separately (Madzík et al. 2023; Vlase and Lähdesmäki 2023; Kumar et al. 2024; Li et al. 2025). We have not found a study that examines whether the three have interacted, or that measures the distance between them against a statistical benchmark.

This review undertakes that examination. It works in an inferential rather than a purely descriptive mode, drawing on three research traditions in which the relevant questions have already been formalised: literature-based discovery, the statistical validation of co-occurrence

networks and the measurement of interdisciplinarity (Section 2.6). Treating the three literatures as complementary but disjoint in Swanson's sense, we ask three questions. RQ1: what intellectual structure does the combined field form, and through which terms is the post-conflict literature connected to the digital literatures? RQ2: how integrated are the three domains at the levels of keywords, documents, authors and venues, compared with what chance alone would produce? RQ3: if a model of ecosystem formation were to be developed, which intersection does the structure of the field identify as the most probable starting point? The evidence, we will suggest, describes a field with a single conceptual channel for conflict, resilience, and none for formation; a field whose structure is favourable to the missing model but unlikely to produce it unaided; and a point of departure that is already occupied, mainly by practitioners and national scholarship in the countries concerned. Fig. 1 summarises the logic of the study.

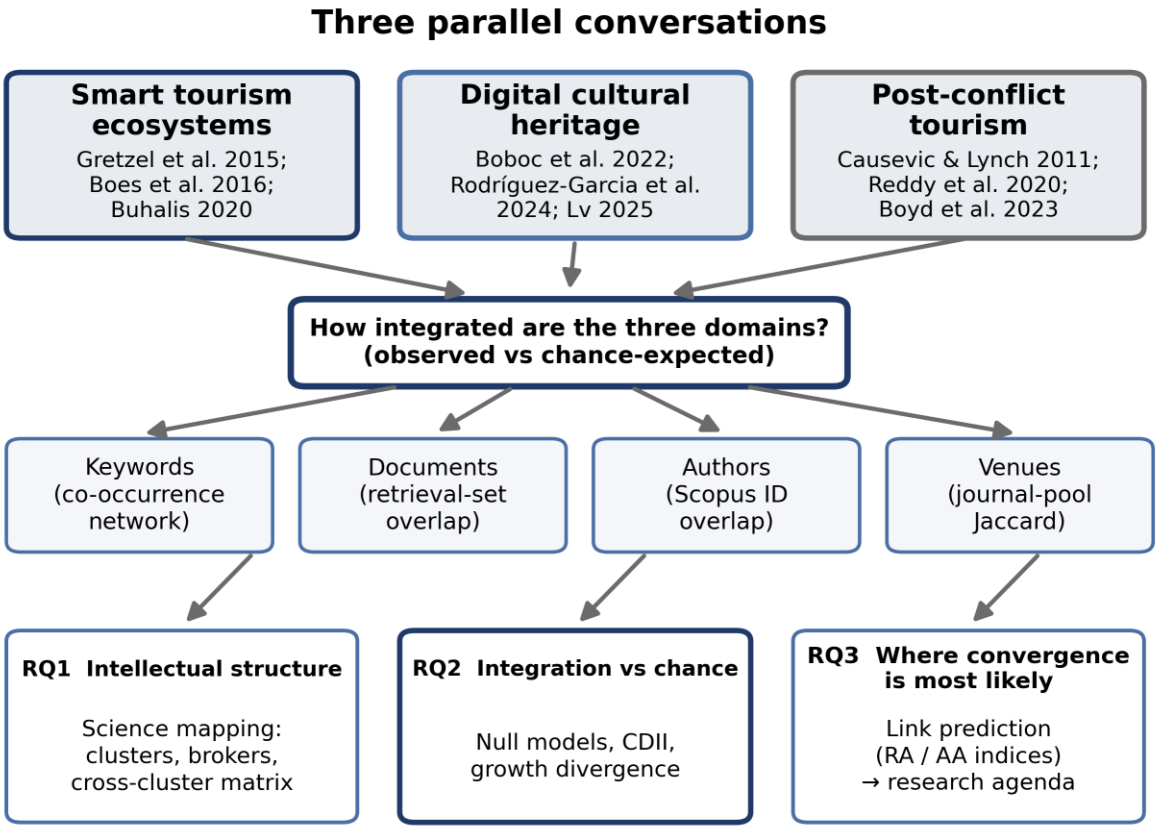


Fig. 1 *Conceptual and analytical framework of the study*

Source: authors' own elaboration

2. The continuity premise and the three literatures that bear on it

2.1. The continuity premise

The foundational architecture of smart tourism is an architecture of layers. Gretzel et al. (2015) define smart tourism in data-centric terms, with layers of data collection, exchange and processing serving the components of destination, business ecosystem and experience; Buhalis (2020) describes a passage from e-tourism to ambient intelligence in which technology becomes part of the experience environment; Koo et al. (2025) add artificial intelligence and the metaverse. In each formulation the destination, with its territory, infrastructure, population and heritage, is the ground on which the layers rest, and the contribution of smartness is to make an existing system more efficient, better personalised, more sustainable or more competitive. Boes et al. (2016) shift the emphasis from technology towards human capital, innovation networks and institutions, but these too are treated as present and continuous. The reviews discussed in Section 2.2 document the spread of this additive logic over a decade; we have not found in them a case that departs from it.

The premise is largely invisible in ordinary conditions and becomes visible in crisis, where the field has tended to rely on one conceptual instrument. Tourism resilience at the individual, organisational and destination levels (Lew 2014; Hall et al. 2017) frames a crisis as a disturbance to a system that persists: the system absorbs the shock, adapts and returns to a functioning, possibly transformed, state. The COVID-19 pandemic made this the dominant crisis frame in smart tourism as well, with calls for transformative e-tourism research (Gretzel et al. 2020) and a growing literature on the role of digital tools in recovery. Prayag (2023) observes that the concept is used inconsistently in tourism research and that its framing has largely left out questions of politics and power. Whatever its breadth, resilience retains two commitments: an earlier state exists, and a system endures through the shock. Its criterion of success is, in one form or another, return.

Post-conflict destinations fit these commitments poorly. The recovery frameworks of the post-conflict literature, such as the five phases of Reddy et al. (2020), the opportunity spectrum of Boyd et al. (2023) and the conditions under which heritage recovery can be integrated into reconstruction (Barakat 2021), describe a process of construction rather than return: institutions are rebuilt, populations partly replaced, heritage reinterpreted, and tourism introduced into places where it may not previously have existed. Phoenix tourism (Causevic and Lynch 2011) is, by its name, concerned with what emerges after destruction rather than with what recovers. These frameworks contain no digital component and do not use the vocabulary of smart tourism, but their underlying logic, building forward rather than returning, is one the smart tourism literature has had little occasion to develop.

Practice has moved ahead of both literatures. Since March 2022 the digital documentation of Ukrainian heritage under attack has produced digital twins of buildings that no longer stand: citizen scanning through the Polycam application in cooperation with UNESCO and Blue Shield, Skeiron's laser survey of more than a hundred monuments with ALIPH funding, and the SUCHO volunteer archive (World Economic Forum 2023; Culture in Crisis 2026; Skeiron 2026). The digital record precedes the physical reconstruction and is expected to guide it. In the terms of the layered model this is an inversion: the data layer exists before the territory it is meant to describe. We refer to the alternative as the scaffold model and develop it in Section 5.3: smartness as a structure around which a destination is rebuilt rather than a layer added once it stands. The remainder of Section 2 reviews the three literatures that hold its components, and Section 2.5 sets out what a scaffold model would require of each.

2.2. Smart tourism ecosystems

The foundational definition of smart tourism belongs to Gretzel et al. (2015): a social phenomenon arising from the convergence of information technologies with the tourism experience, business processes and physical infrastructure. Boes et al. (2016) shifted the

emphasis from technologies to the quality of relations: the competitiveness of a smart destination is determined by human capital, innovation networks and institutional frameworks rather than by the mere fact of technology adoption. Del Chiappa and Baggio (2015) applied network analysis to three smart destinations and argued that knowledge-based destination management depends on the structure of both their real and their virtual networks, an argument that supports the use of network instruments in this review. Buhalis (2020) traced the evolution from e-tourism to ambient intelligence tourism, in which technology dissolves into the experience environment, and Koo et al. (2025) updated the foundational model with layers of artificial intelligence and the metaverse. Systematic reviews (Kontogianni and Alepis 2020; Ye et al. 2020) recorded the field's rapid expansion around experience enrichment, destination management optimisation and data-driven decision-making, while recent work extends the ecosystem lens to networking behaviour beyond destination borders (Alzua-Sorzabal et al. 2025), entrepreneurial ecosystems in smart cities (Eichelberger et al. 2020), resident-centred impact measurement (Wei et al. 2024) and meta-analytic evidence on technology-enhanced experiences (Sustacha et al. 2023). The stream now has its own reviews of reviews: Buhalis et al. (2023) trace the path from smart cities through smart tourism to agile business ecosystems in networked destinations; Ivars-Baidal et al. (2023) test whether the smart-destination approach has changed the indicators by which sustainability is measured; Bekele and Raj (2025) and Jiang and Phoong (2023) map the digital-transformation and digitisation literatures bibliometrically. None of these reviews contains the word conflict.

The internal critique of the stream is relevant to our argument. Femenia-Serra et al. (2019) demonstrated the gap between the hypothetical "smart tourist" of the models and the actual behaviour of visitors; Stankov and Gretzel (2020) called for a human-centred turn in tourism technology; Cavalheiro et al. (2020), a rare exception, explicitly included socio-cultural values in a smart destination development model, albeit without operationalising the mechanisms. The

common thread of this critique is that the field has been more inventive technologically than socially. Post-conflict contexts have not, to our knowledge, been part of that critique, and the data below suggest that this is not because they are irrelevant.

2.3. Digital cultural heritage

The second stream grew from a different root, documentation and conservation practice, and its instrumental trajectory is notable: laser scanning and photogrammetry for three-dimensional recording, virtual museums, augmented and virtual reality for interpretation, digital twins and metaverse applications (Boboc et al. 2022; Unnikrishnan and Sibi 2025), and, more recently, blockchain architectures for provenance and preservation (Trček 2022). Systematic reviews document the stream's consolidation from both directions: tourism digitalisation at large (Rodrigues et al. 2023) and the immersive wing in particular, where Rodríguez-Garcia et al. (2024) record hundreds of validated reconstructions, established pipelines and quality standards. Reflection is maturing in parallel: questions are shifting from "what can be digitised" to "who decides what and how to digitise", towards community participation in representation (Baswarani and Novianto 2025), intangible heritage (Lv 2025) and the ethics of representation. Barrado-Timón and Hidalgo-Giralt (2019) found that immersive applications in urban heritage spaces tend to reproduce prior assumptions about what is valued and why; De Bernardi et al. (2019) identified the institutional logics that hinder the digital transformation of heritage by isolating preservation from community engagement; Kasemsarn and Nickpour (2025) reviewed how digital storytelling integrates social media to engage younger audiences. The technological frontier moves faster than the participatory one: metaverse environments for heritage (Zhang et al. 2022) and immersive documentation services built around historical figures (Fan et al. 2022) were proposed before the field had settled who owns the digital twin of a community's past. The one context where documentation and destruction coincide, the digital transformation of the preservation and restoration of Ukraine's heritage, has so far been discussed from the media

and communication side (Pletsan et al. 2023) rather than within the heritage-technology stream itself.

The institutional profile of the stream is twin-peaked: half of the conversation lives in tourism journals, half in computer science conference series. Vlase and Lähdesmäki (2023) mapped the growth of heritage research in Web of Science and related it to the shift in the heritage regime after 2003; Li et al. (2025) did the same for digital conservation technology. Our data add the tourism and technology dimensions to this portrait. The twin peak has consequences: a conversation split between two publishing worlds has half the chance of systematically meeting a third.

2.4. Post-conflict tourism

The third stream is the oldest in its intellectual anchors and the slowest in its dynamics. Its classics were written in 2007–2013: post-conflict heritage and postcolonial tourism at Angkor (Winter 2007), phoenix tourism as a mechanism of economic regeneration and social reconciliation (Causevic and Lynch 2011), tourism in situations of fragility (Novelli et al. 2012), and the impact of political instability on tourism flows (Ivanov et al. 2017). The most recent widely recognised anchor is the post-conflict recovery framework of Reddy et al. (2020), with five phases from restoring safety to long-term sustainability, complemented by the POCTOS spectrum (Boyd et al. 2023), which typologises post-conflict tourism opportunities from memorialisation to beach escapism. Latin American scholarship added an important community dimension: peacebuilding through tourism that addresses structural violence (Guasca et al. 2022) and community-based governance of post-conflict rural destinations (Díaz Rocca and Zielinski 2022). Heritage enters the stream as an object of recovery rather than of technology: Barakat (2021) sets out the conditions under which heritage recovery can be integrated into post-conflict reconstruction, and Carbone (2022) examines war museums in the tourism–peace nexus. In the Ukrainian case, rural green tourism has been studied as a driver of

innovation (Roman et al. 2024), and the three-decade evolution of community-based tourism has recently been mapped (Tuyen et al. 2025); neither line of work reaches the smart-destination vocabulary.

The digital dimension is absent from these frameworks as a class: no phase of any recognised recovery model contains digital infrastructure as a distinct component. Russia's invasion of Ukraine generated a wave of new research, including the earliest econometric assessments of the war's global tourism effects (Pandey and Kumar 2022), war narratives in global media (Tan and Cheng 2025), hot-war tourism (Ivanov and De Marchi 2025), tourism in the recovery of territorial communities (Yermachenko et al. 2024; Romanova and McGinley 2025; Yanchuk and Boienko 2023), and innovative approaches to wartime smart tourism (Chukut et al. 2025), building on earlier work on political instability and Ukrainian tourism (Tomczewska-Popowycz and Quirini-Popławski 2021). Yet, as the analysis will show, this wave has not yet connected with the digital domains at the level of research communities.

2.5. What a scaffold model would require

A scaffold model would need three components, each of which is found in a different literature. From research on smart tourism ecosystems it would take the architecture (the layers, the stakeholders, the data infrastructure), reordered so that the digital layer can precede and organise the physical one. From research on digital cultural heritage it would take the instruments that already perform that reordering: documentation that survives destruction, immersive reconstruction that can be visited before the site itself, and the participatory ethics of deciding what is rebuilt (Neglia et al. 2024; Baswarani and Novianto 2025). From research on post-conflict tourism it would take the sequence and the constraints of recovery, including safety, memory, community and the pace at which visitors can be reintroduced (Reddy et al. 2020; Boyd et al. 2023), together with the regenerative aim of leaving a destination better than it was rather than as it was (Bellato et al. 2023). Design methods already applied to smart

experiences, such as quality function deployment (Tsang and Au 2024), could help translate community requirements into digital specifications. Taken together, the three-way intersection amounts to an agenda of culturally grounded digital reconstruction, relevant to Ukraine, the Western Balkans, the South Caucasus and future post-conflict destinations. Whether the field is in a position to develop that agenda is the empirical question of the sections that follow.

2.6. From descriptive to inferential bibliometrics: three methodological anchors

Bibliometric reviews in tourism have matured rapidly, and the guidelines that now govern them (Zupic and Čater 2015; Donthu et al. 2021; Mukherjee et al. 2022) are explicit about what such reviews can and cannot claim. Science mapping describes the intellectual structure of a field; it does not test whether a feature of that structure (a cluster, a bridge, a gap) differs from what a random arrangement of the same material would produce. This review moves the analysis into an inferential mode, and rather than improvising the step it borrows from three research traditions in which the questions we ask have already been formalised.

The first is literature-based discovery. Swanson (1986a 1986b) showed that two bodies of literature can each be internally coherent, share no authors and no citations, and nonetheless contain jointly a hypothesis that neither states: the papers on dietary fish oil and the papers on Raynaud's syndrome were linked through blood viscosity, a term present in both and noticed in neither. His ABC model, in which a literature A and a literature C are disjoint from one another but connected through intermediate concepts B, has since become a field of its own, with systematic reviews of its models (Henry and McInnes 2017) and a bibliometric map of its 35-year development (Kastrin and Hristovski 2021). Contemporary implementations reformulate the ABC search as link prediction on a term network, ranking absent A–C pairs by the structure of their shared B-neighbourhood (Liben-Nowell and Kleinberg 2007; Xiong et al. 2022). Nearly all of this work is biomedical; we have found no application in tourism or hospitality research. The three conversations examined here are, in Swanson's vocabulary,

complementary but disjoint literatures, and the Resource Allocation and Adamic–Adar indices used in Section 4.4 (Adamic and Adar 2003; Zhou et al. 2009) are the standard ranking devices of automated literature-based discovery. What we call a research agenda derived from the network is, in that tradition, a set of ABC hypotheses ordered by structural support.

The second anchor is the statistical validation of co-occurrence networks. A keyword network is the projection of a bipartite structure, with documents on one side and terms on the other, and whether an observed number of co-occurrences is large or small can be judged only against a null model that preserves the marginal frequencies and randomises everything else (Tumminello et al. 2011; Neal 2014; Saracco et al. 2017). Cimini et al. (2022) compare the main families of such null models and show that the hypergeometric model, the simplest, reproduces the variance of the co-occurrence statistic with surprising accuracy. The document-level test in Section 3.4 is exactly this model, applied to domain labels rather than keywords; the network-level test uses the configuration-model expectation that underlies modularity (Newman and Girvan 2004). The usual purpose of validation is to retain links that are significantly stronger than chance and discard the rest. We use the same machinery in the opposite direction, to establish that an absence is significant: a zero where the null model expects more than a hundred is a structural fact about the field, not a sampling accident.

The third anchor is the measurement of interdisciplinarity, and it defines what the proposed index is and is not. The dominant indicator, the integration score of Porter and Rafols (2009), is mathematically the Rao–Stirling diversity (Stirling 2007): the variety, balance and disparity of the disciplinary categories a document set cites. Betweenness centrality has been proposed as an alternative and criticised as capturing multidisciplinarity rather than integration (Leydesdorff et al. 2019), and the debate over what the diversity family measures continues (Rousseau 2018; Nakhoda et al. 2023; van den Besselaar 2025). These indicators answer a question about a single set of documents: how spread out are its references. Our question is

different. It concerns two sets, and asks how often they meet relative to how often they would meet by chance. The Cross-Domain Integration Index therefore belongs with the observed-to-expected logic of Uzzi et al. (2013), who scored the novelty of a paper by the atypicality of its reference pairings against a randomised baseline, and with Chen's (2012) structural variation, which treats new links between previously unconnected clusters as the signature of transformative work. CDII is the mean observed-to-expected ratio of a domain pair across independent levels of observation; it is not a diversity measure and should not be compared with one. Wagner et al. (2011) note that the choice among interdisciplinarity measures must follow the unit of analysis. Ours is the pair of literatures, and the index is built accordingly.

Taken together, the three anchors turn the review's central claim from an observation into a test. Whether the three conversations are separate is answered by validated null models; where they are most likely to meet is answered by literature-based discovery; and how far apart they stand, in a form that travels to other fields, is answered by an index whose lineage is the observed-to-expected tradition rather than the diversity tradition.

3. Methodology

3.1. Corpus construction

The corpus was assembled from eleven Scopus search queries (April 2026) covering the three domains: four queries for smart tourism (S), three for digital heritage (H) and two for the conflict domain (C): a topic query on post-conflict tourism and a country query on Ukrainian tourism, the largest current case of destination recovery under and after war (the union is referred to as the conflict domain, and Section 4.4 tests every result with the country query removed), plus two auxiliary queries, a methodological one and a regional Carpathian one, used for sensitivity analysis and kept outside the tri-domain core. The full search strings are provided in Online Resource 1. The eleven exports yielded 3,686 raw records; deduplication by DOI and

title (one query had been exported twice, which is documented) left 2,271 unique tourism-relevant records. Two research-hygiene filters were then applied: 28 publications with Russian-affiliated authors and 5 retracted publications were excluded. The final corpus contains 2,238 records spanning 1977–2026; the tri-domain core comprises 2,074 records. The full exclusion log with reasons and DOIs is provided in Online Resource 3. By document type, the corpus consists of articles (58%), conference papers (24%), book chapters (13%) and reviews and other types (5%); all types were retained because conference series are the principal channel of the computer science wing of the heritage domain. Fig. 2 summarises the corpus flow.

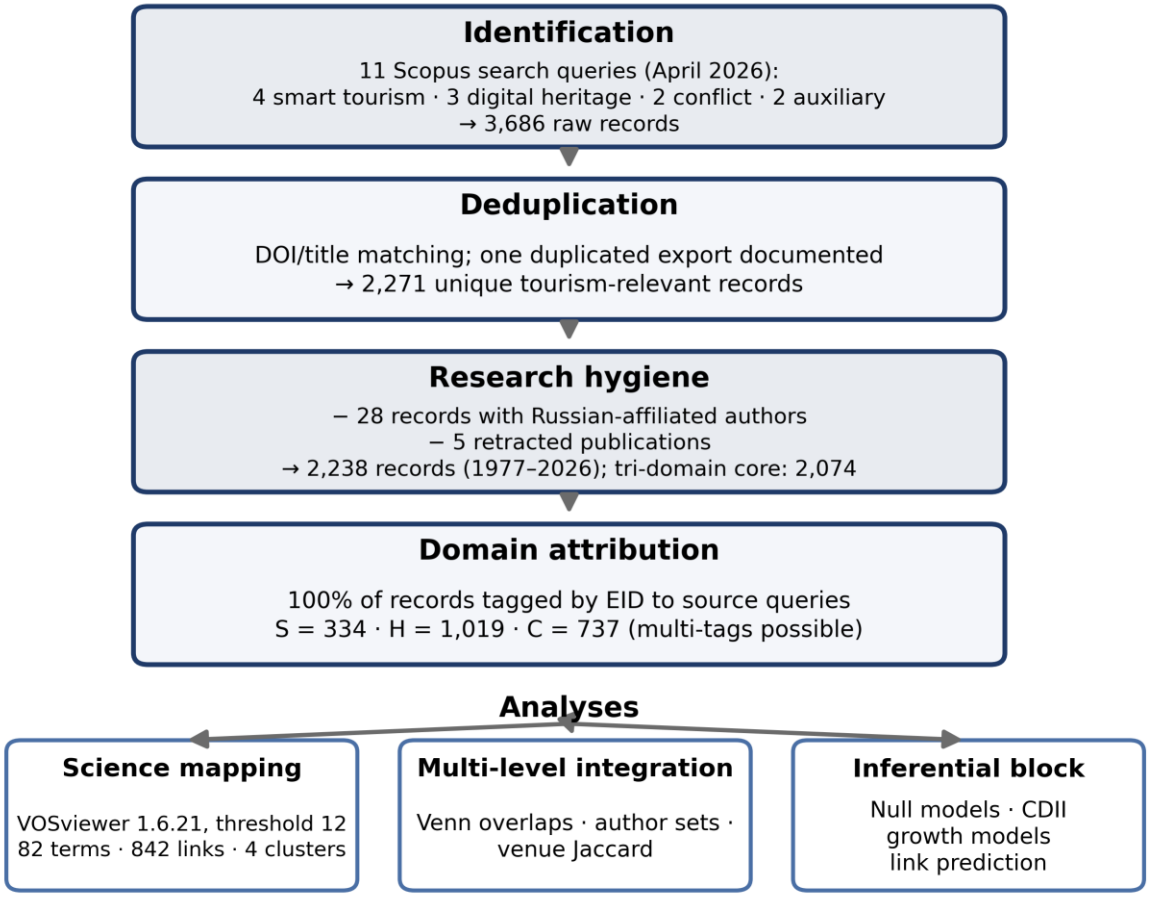


Fig. 2 *Corpus construction and the analytical branches of the study*

Source: authors' own elaboration based on Scopus data (17 April 2026)

3.2. Science mapping

The author-keyword co-occurrence network was built in VOSviewer 1.6.21 with an occurrence threshold of 12 and a 51-rule normalisation thesaurus (merging spelling variants, singular/plural forms and parenthesised abbreviations; the full thesaurus is in Online Resource 1). The network contains 82 keywords and 842 links with a total link strength of 1,870; clustering used the built-in VOSviewer algorithm at resolution 1.0. For the network we computed density, average path length, Newman modularity on the VOSviewer partition (weighted; networkx 3.6; Newman 2006), node betweenness centrality and the cross-cluster matrix of link strengths. Robustness was checked by excluding two methodological terms that passed the threshold and by comparison with an alternative run on the wider pre-hygiene corpus.

3.3. Multi-level integration analysis

Because every query belongs to a defined domain, every corpus record received a domain tag through its EID identifier (multi-tags possible); 100% of records were mapped. This opened three measurement levels above keywords: overlaps of document sets (Venn analysis), overlaps of author sets by Scopus ID, and the similarity of venue pools using the Jaccard coefficient for venues with two or more domain publications. Attribution by search strategy measures the overlap of retrieval sets rather than "true" thematic membership, so the estimates should be read as a conservative lower bound of integration; the convergence of conclusions across four independent levels, including the keyword level, which does not depend on the strategies, serves as a robustness check. The machine-readable attribution table (EID → domain tags for all 2,238 records) is provided in Online Resource 2.

3.4. Inferential analyses

Four instruments move the analysis from a descriptive to an inferential mode. The first is a configuration null model of the network (Newman and Girvan 2004): under random rewiring that preserves node strengths, the expected link weight between node blocks A and B is

$$E[w_{AB}] = \frac{s_A \cdot s_B}{2W} \quad (1)$$

where s_a and s^b are the total strengths of the post-conflict block and the technological core, and W is the total weight of the network; the probability of the observed zero is assessed with the Poisson approximation

$$P(\mathrm{w} = 0) = e^{-E[w]} \quad (2)$$

The second is a hypergeometric null model at the document level, the simplest member of the family of statistically validated projections (Tumminello et al. 2011; Cimini et al. 2022): under random assignment of domain labels preserving the marginals, the expected intersection of domains A and B equals

$$\mathrm{E}[|\mathrm{A} \cap \mathrm{B}|] = \frac{n_A \cdot n_B}{N} \quad (3)$$

and the exact probability of a zero intersection follows from the hypergeometric distribution. The third is the Cross-Domain Integration Index:

$$CDII(\mathrm{A}, \mathrm{B}) = \frac{1}{L}\sum_l \frac{O_l}{E_l} \quad (4)$$

— the mean ratio of observed O to expected E across L independent levels; a value of one means integration at the level of chance, zero means complete disconnection. CDII is not a diversity index: Rao–Stirling diversity and the integration score characterise the spread of categories within one document set, whereas CDII characterises the co-occurrence of two labelled sets against a null expectation, in the manner of Uzzi et al. (2013); the two families answer different questions and no ordering between them is implied. The fourth is link prediction (Liben-Nowell and Kleinberg 2007): for the missing edges between the post-conflict block and the digital cores we computed the Resource Allocation index (Zhou et al. 2009)

$$RA(\mathrm{u}, \mathrm{v}) = \sum_{z \in \Gamma(u) \cap \Gamma(v)} \frac{1}{k_z} \quad (5)$$

where Γ denotes the neighbour set of a node and kz the degree of a common neighbour, together with the related Adamic–Adar index with a logarithmic denominator (Adamic and Adar 2003). Domain dynamics were described with exponential models

$$N(\mathrm{t}) = a \cdot e^{bt} \tag{6}$$

fitted to the 2010–2025 annual series (the partial year 2026 excluded), with estimates of the rates b, doubling times ln2/b and out-of-sample forecasts.

Because similarity-based link prediction rewards pairs that share many neighbours, and because generic terms (tourism, sustainability, sustainable development) are neighbours of almost every node, the ranking could in principle be driven by hub structure rather than by substantive proximity. A second concern is compositional: the post-conflict domain of the corpus is dominated by papers with a Ukrainian affiliation (48% of the domain, 17.6% of the corpus), so the prominence of the ukraine node may reflect who writes about post-conflict tourism rather than where the field as a whole is heading. We therefore re-estimated the prediction under eleven specifications that vary the network, the weighting and the corpus; results are reported in Section 4.4. Three use the reported VOSviewer network: unweighted (S0), strength-weighted (S0w) and with generic hubs removed (S1: the five largest generic terms; S2: all 23 generic and sector-generic terms). Five rebuild the co-occurrence network in Python from the corpus with the same thesaurus and threshold, which also allows the corpus itself to be varied: the full tourism-relevant corpus (P0, a check that the rebuild reproduces the VOSviewer structure), the tri-domain core (P1, n = 2,074), the corpus without any paper carrying a Ukrainian affiliation (P2, n = 1,843), both restrictions together (P3, n = 1,689), P2 without generic terms (P4), and two specifications that remove the country query from the conflict domain: records retrieved only by the Ukrainian-tourism query removed (P5, n = 1,698) and all its records removed, so that C is the post-conflict topic set alone (P6, n = 1,660). A twelfth check re-runs the ten queries in Lens.org, whose index aggregates Crossref, OpenAlex, PubMed and Microsoft Academic

and therefore reaches journals outside Scopus, and repeats the document-level hypergeometric test on the resulting 5,371 unique records (Section 4.4). For each specification we report the three highest-ranked absent pairs, the rank of the two pairs of interest and block-level aggregates: the mean RA index between the post-conflict block and each technological core, and the technology terms with the largest summed predicted connectivity to the block.

3.5. Limitations of the method

The corpus is Scopus-bound and English-centric; the search strategies, however broad, do not guarantee complete domain coverage; domain attribution is retrieval-based; clustering is sensitive to the threshold and the thesaurus (robustness was checked and the conclusions coincide across runs); link prediction describes the structural probability of research appearing, not a guarantee of its appearance; and the composition of the corpus, in particular the share of Ukrainian-affiliated papers in the post-conflict domain, is treated as a potential source of bias and tested explicitly rather than assumed away, as is the decision to define the conflict domain partly through a country query.

3.6. Use of AI tools

An AI assistant (Claude, Anthropic) was used under the authors' direction for three tasks: bibliographic data processing and DOI verification against the Crossref API; the computational implementation of the network metrics, null models, link prediction and the robustness specifications of Section 3.4, in Python (networkx, pandas, scipy), with all code checked and re-run by the authors; and language editing of the manuscript. The analytical design, the interpretation of the findings and the text of the article are the authors' own, and the authors take full responsibility for the content. The analysis code, the VOSviewer files and the derived outputs are supplied as Online Resource 4 and deposited on Zenodo (https://doi.org/10.5281/zenodo.22733979; record released on publication).

4. Results

4.1. Dynamics and venues of the field

The tri-domain field is in a phase of exponential growth: almost half of the corpus (1,010 of 2,238 records) was published in 2024–2026, and annual output rose from 204 publications in 2022 to 510 in 2025. The aggregate curve, however, conceals an important feature: a marked asymmetry of rates between the domains (Fig. 3, Table 1).

Table 1. Exponential growth models of the domains (2010–2025)

Domain	**b (± SE)**	**CAGR**	**Doubling time**	**R^2**	**Forecast 2030**
Digital heritage (H)	0.466 ± 0.036	59.4%/yr	1.5 years	0.971	≈3,137/yr
Smart tourism (S)	0.325 ± 0.029	38.4%/yr	2.1 years	0.964	≈436/yr
Conflict (C)	0.170 ± 0.023	18.5%/yr	4.1 years	0.875	≈278/yr

Source: authors' calculations on the Scopus corpus (exponential fits, 2010–2025)

The digital heritage domain doubles every year and a half, smart tourism every two years, the conflict domain every four. The difference between the fastest and the slowest rates (0.296) exceeds the combined standard error almost twentyfold. The consequence shows in the structure of the corpus: the share of the conflict domain fell from 52.8% in 2010–2014 to 28.5% in 2023–2025. At current rates, by 2030 the heritage domain will produce around 3,100 publications per year, the conflict domain fewer than 280.

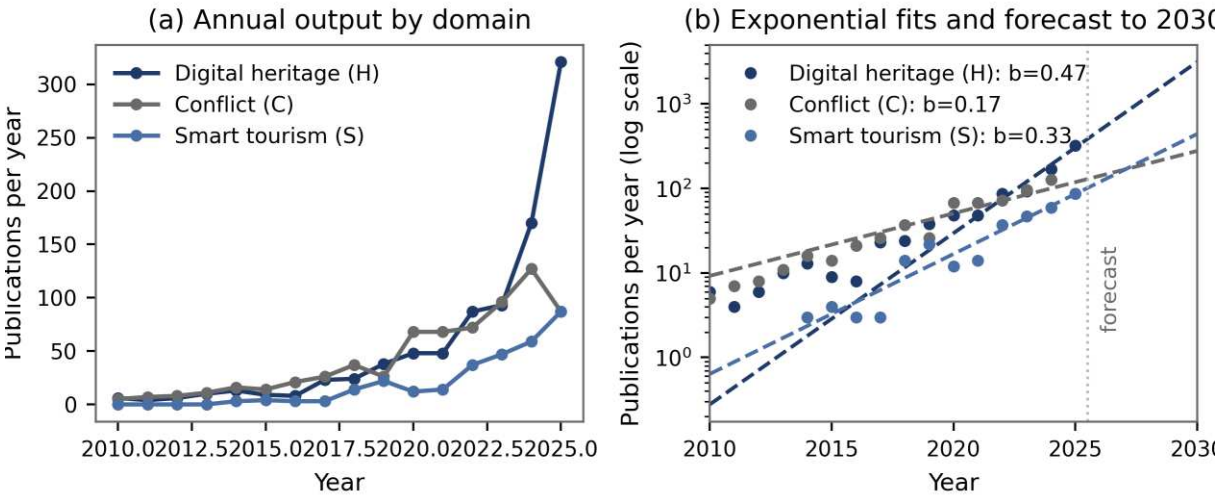


Fig. 3 *Annual output by domain (a) and exponential fits with a forecast to 2030 (b)*

Source: authors' calculations on the Scopus corpus

The distribution of venues is twin-peaked: alongside tourism journals (Current Issues in Tourism, Geojournal of Tourism and Geosites), a substantial share is held by computer science conference series (LNCS, CCIS, the ISPRS archives) and multidisciplinary platforms such as Sustainability. The geography of participation reflects both the subject and the search optics: Ukraine leads (398 papers with Ukrainian participation), followed by China (257), Italy (195) and Spain (144), the Mediterranean leaders of digital heritage, and then Poland and Romania as Carpathian neighbours. The total citation count of the corpus is around 26,600 at a mean of 11.7 per paper. The temporal profile of the intellectual anchors differs considerably: the top-cited works of smart tourism and heritage date from 2015–2023, while the anchors of the conflict domain date from 2007–2013, the only recent one being the recovery framework of Reddy et al. (2020). The post-conflict conversation continues to draw on theoretical work that is now some fifteen years old.

4.2. Intellectual structure: four clusters

The co-occurrence network (Fig. 4) comprises 82 keywords, 842 links and four clusters (Table 2).

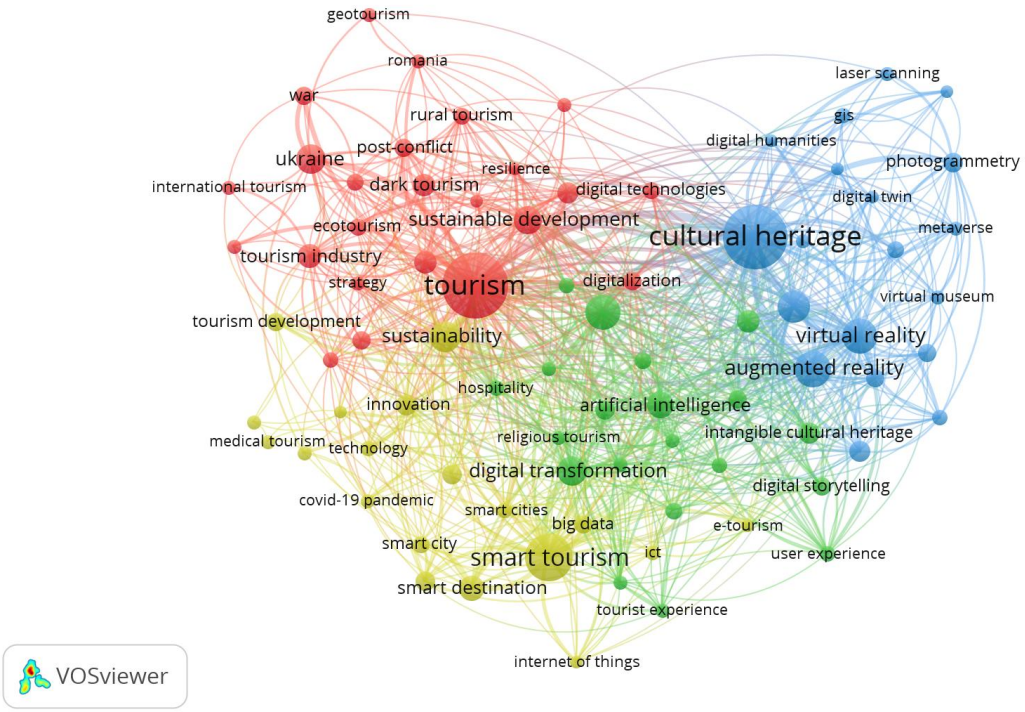


Fig. 4 *Author-keyword co-occurrence network: 82 terms, four clusters (VOSviewer)*

Source: authors' analysis in VOSviewer 1.6.21 (Scopus author keywords, minimum 12 occurrences)

Table 2. Four thematic clusters of the co-occurrence network

Cluster	n	Mean year	Core terms	Working label
C1	24	2021.3	tourism, ukraine, sustainable development, dark tourism, post-conflict, war, resilience	Tourism, sustainability and post-conflict contexts
C2	20	2023.5	sustainable tourism, digital transformation, artificial intelligence, intangible cultural heritage	Digital transformation and AI in sustainable tourism
C3	19	2022.1	cultural heritage, augmented reality, virtual reality, photogrammetry, digital heritage	Heritage digitalisation and immersive technologies
C4	19	2021.6	smart tourism, smart destination, big data, smart city, IoT, ICT	Smart tourism destinations

Source: authors' analysis of author-keyword co-occurrence in VOSviewer 1.6.21

Cluster C1 unites the general tourism core with the post-conflict wing: ukraine, war, post-conflict, dark tourism and resilience sit here together with rural tourism, ecotourism and covid-19; it is a cluster of crises and responses to them, and the oldest by centre of gravity (2021.3). C2 is the youngest (2023.5): digital transformation, artificial intelligence, social media and, notably, intangible cultural heritage; the more recent discussion of culture appears to be emerging in a digital context. C3 is the instrumental heart of the heritage domain: AR/VR, photogrammetry, digital twins and the metaverse around the massive cultural heritage node. C4 is the classical smart tourism core with its full set of technological terms. The temporal structure of the clusters is shown by the overlay map (Fig. 5): the post-conflict wing is blue (2020–2021), the digital zones yellow (2023–2024); the conversations occupy not only different places in the network but different temporal phases.

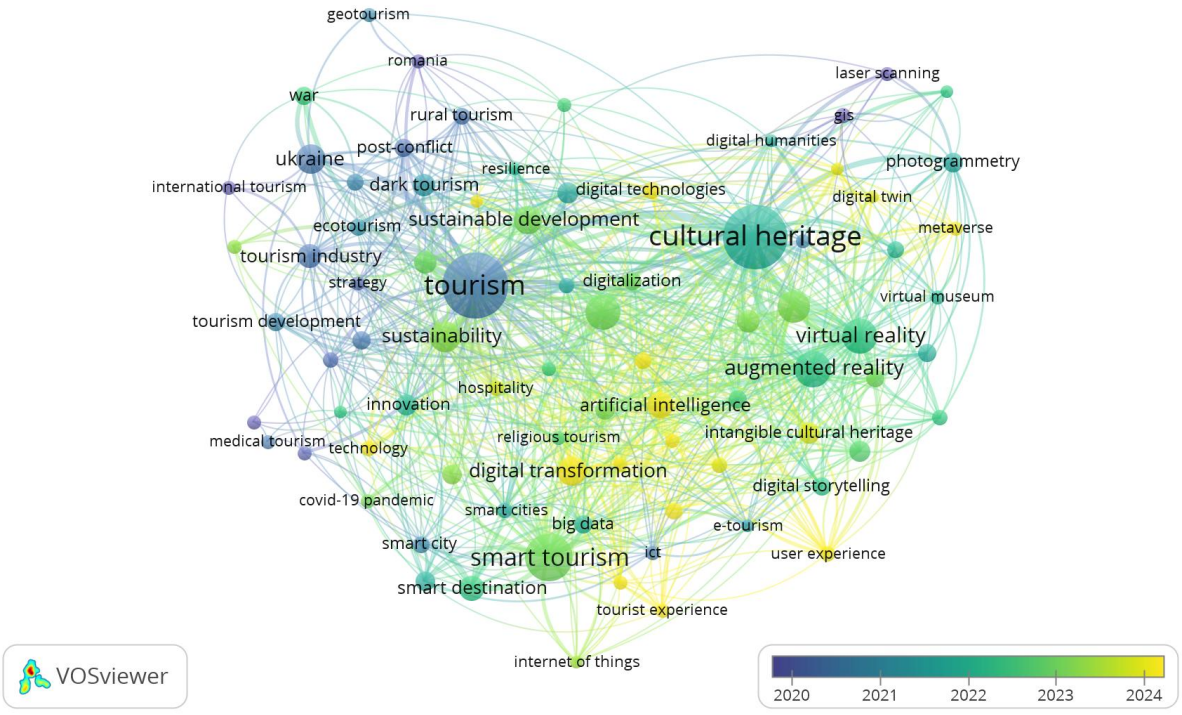


Fig. 5 *Temporal structure of the network: node colour corresponds to the mean publication year of the term (VOSviewer)*

Source: authors' analysis in VOSviewer 1.6.21 (overlay visualisation)

Table 3. Metrics of the co-occurrence network

Metric	Value
Nodes / links / total link strength	82 / 842 / 1,870
Clusters	4
Modularity Q (Newman, weighted)	0.243
Density	0.254
Average path length	1.77
Intra- / inter-cluster strength	50.2% / 49.8%
Sensitivity (2 method terms excluded)	Q = 0.242; density 0.258

Source: authors' calculations on the VOSviewer network (networkx 3.6)

The network metrics (Table 3) describe a field that is well connected yet has recognisable communities: modularity below the conventional 0.30 threshold means the clusters are identifiable but not rigidly separated; ideas travel fast, and half of the total strength (49.8%) runs between clusters. In structural terms the field appears ready for convergence; the question is between whom the inter-cluster strength flows. The cross-cluster matrix (Table 4) answers it and reveals the central asymmetry.

Table 4. Cross-cluster matrix (% of total link strength)

	C1	C2	C3	C4
C1	14.3	8.3	9.0	7.6
C2		8.6	11.8	8.6
C3			19.1	4.4
C4				8.2

Source: authors' calculations on the VOSviewer network

The strongest inter-cluster dialogue is C2×C3 (11.8%): digital transformation actively converses with heritage. The weakest is C3×C4 (4.4%): immersive heritage and smart destinations, two technologically related conversations, intersect very little. The post-conflict wing of C1 is connected to the rest of the network mainly through generic words. Betweenness centrality confirms this: the brokers are the broadest terms, tourism (0.187) and cultural heritage

(0.093), whose centrality reflects terminological breadth rather than conceptual integration. The ukraine node ranks fourteenth (0.011); its strongest links are tourism, war and dark tourism: a subject node of the post-conflict wing, isolated from the digital clusters. No keyword connecting all three domains appears near the top of the broker list.

4.3. Cross-domain integration at four levels

The central result of the review is condensed in Table 5: the integration of the smart tourism × conflict pair at four independent measurement levels against the chance benchmark.

Table 5. Integration of the smart tourism × conflict pair: observed versus expected

Level	Expected (null model)	Observed	O/E	Significance
Keywords (link weight)	11.0	0	0.000	$P = 1.6\times10^{-5}$
Documents (shared papers)	118.7	0	0.000	$P \approx 10^{-71}$
Authors (shared researchers)	274.2	12	0.044	—
Venues (pool Jaccard)	—	0.103	—	—

Source: authors' calculations; null models as described in Section 3.4

At the keyword level there is no co-occurrence between the post-conflict block (post-conflict, war, dark tourism) and the ten-term technological core of smart tourism: zero of 842 links, where the configuration null model expects 11 units of weight. Widening the block with ukraine and resilience adds only three links (0.16% of total strength), and their composition is informative: two of the three run through resilience, so that the main path between the conversations is laid in the language of resilience rather than of technology.

At the document level the pattern is more pronounced (Fig. 6). Of the 2,074 core papers, only 16 (0.77%) were retrieved by the queries of two domains: twelve at the heritage × smart intersection, four at heritage × conflict. The smart × conflict intersection is empty: zero documents against 119 expected; the probability of such an outcome is of the order of 10^{-71}.

The triple intersection is empty as well. The temporal cut indicates that the zero is not a snapshot: in none of the periods examined (before 2014, 2015–2019, 2020–2022, 2023–2026) does the corpus contain a document combining post-conflict and smart-technology keywords.

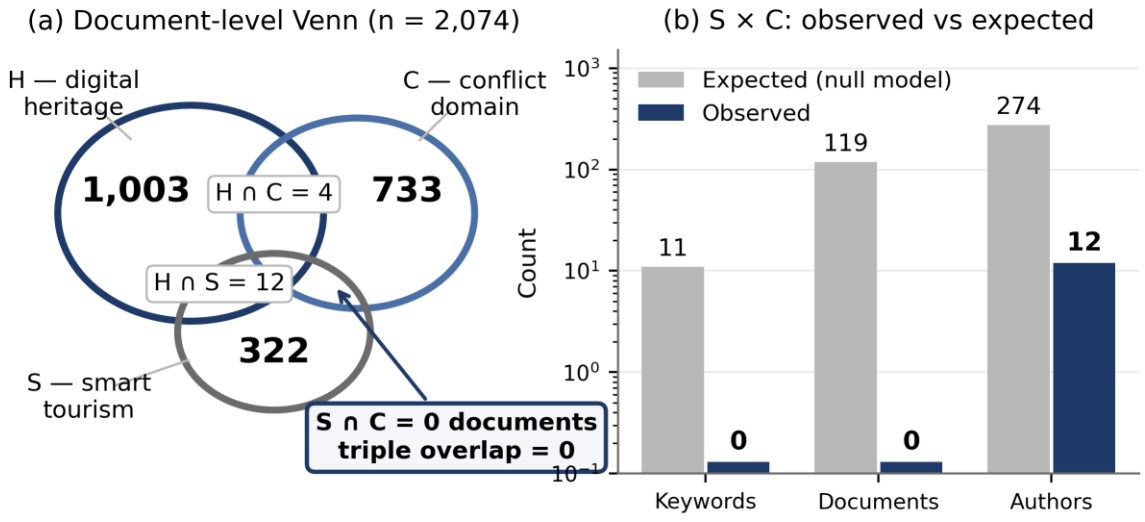


Fig. 6 *Domain disconnection: (a) document-level Venn; (b) observed versus expected under the null models, log scale*

Source: authors' calculations; null models as described in Section 3.4

The author level gives the statistics a more concrete form. Of the 5,804 unique researchers in the corpus, 81 (1.4%) work across domain boundaries. Only four are present in all three domains: the Portuguese tourism safety group (Seabra, Serra, Correia) and M. Petrova. Twelve researchers cross the smart × conflict boundary against 274 expected, and the composition of this group is informative: C. M. Hall, R. Law, H. Pechlaner and T. Gajdošík, senior researchers with wide portfolios. The bridge between the conversations rests on a small number of individuals rather than on a research community. The venue level closes the picture institutionally: the domain venue pools overlap weakly (Jaccard 0.10–0.11 for all pairs); there are thirteen shared venues where both the smart tourism and the conflict conversations are heard, among them Tourism Management, Current Issues in Tourism and the European Journal of Tourism Research.

Aggregating the O/E ratios across levels yields the Cross-Domain Integration Index: CDII(S,C) = 0.015, that is, integration at one and a half per cent of the chance-expected level. For comparison: CDII(H,C) = 0.018 and CDII(H,S) = 0.093. Even the closest pair of the field, heritage and smart tourism, is integrated at only nine per cent of the level of chance.

4.4. Where convergence is most likely

If the descriptive part records the gap, link prediction indicates where the structure of the network makes closure most likely. For all missing edges between the post-conflict block (including ukraine and resilience) and the digital cores we computed the Resource Allocation and Adamic–Adar indices (Table 6).

Table 6. Predicted bridges: top-10 missing links by structural probability of emergence

Rank	Pair	RA	AA
1	ukraine — smart tourism	0.533	3.56
2	ukraine — digital transformation	0.453	3.41
3	ukraine — virtual reality	0.404	3.07
4	post-conflict — smart tourism	0.401	3.28
5	dark tourism — digital transformation	0.389	3.04
6	dark tourism — smart tourism	0.385	3.03
7	ukraine — digitalization	0.373	2.78
8	post-conflict — digital transformation	0.370	2.99
9	post-conflict — virtual reality	0.361	2.97
10	ukraine — artificial intelligence	0.358	2.75

Source: authors' calculations on the VOSviewer network (Resource Allocation and Adamic–Adar indices)

The first line of the forecast is the ukraine × smart tourism intersection: the ukraine node has the richest set of common neighbours with the technological core of the entire post-conflict block. The top of the list is formed by combinations of post-conflict terms with four technological directions: smart tourism, digital transformation, virtual reality and artificial intelligence. Before these combinations are read as an agenda, two objections must be met: that

the ranking is an artefact of generic hubs, and that it is an artefact of who writes about post-conflict tourism.

The ranking is not an artefact of hub structure (Table 7). Removing the five largest generic terms leaves the top pair unchanged (RA = 0.538), and removing all 23 generic and sector-generic terms strengthens it (0.583): the common neighbours that carry the ukraine × smart tourism prediction are not confined to tourism and sustainability but include destination-level and technology-adjacent terms. Strength-weighting reorders the first two positions (ukraine × digital transformation, then ukraine × smart tourism) without changing the set. Rebuilding the network from the corpus reproduces the VOSviewer structure (81 versus 82 nodes) and the same top pair, and restricting the corpus to the tri-domain core raises the index further (0.572), so the auxiliary retrieval sets diluted rather than produced the result.

The composition test is the informative one. When every paper with a Ukrainian affiliation is removed (P2, n = 1,843), the ukraine node remains in the network (26 of its 60 occurrences come from non-Ukrainian authorship), but the pair ukraine × smart tourism falls to rank 55. The top of the ranking is then occupied by dark tourism × digital transformation (0.496), post-conflict × smart tourism (0.466) and dark tourism × smart tourism (0.430). Removing the country query altogether (P5, P6) sharpens the picture: the ukraine node falls below the occurrence threshold and disappears, and post-conflict × smart tourism leads the ranking (0.425–0.429), followed by dark tourism × digital transformation, post-conflict × virtual reality and post-conflict × smart city; at the document level, with C restricted to the topic set, the observed $S \cap C$ intersection is still zero against 24.9 expected ($P = 6 \times 10^{-13}$). The empty intersection is a property of the post-conflict tourism literature, not of the Ukrainian tourism literature. At block level the prediction is invariant (Table 8, Fig. 7): in ten of eleven specifications smart tourism is the technology term with the largest summed predicted connectivity to the post-conflict block, and the digital-transformation core has the highest mean

index in every specification. What changes with the corpus is the anchor on the conflict side, from ukraine to post-conflict and dark tourism; what does not change is the technological side of the predicted bridge. Reformulated as research questions at the level of the post-conflict block, these combinations constitute the agenda of Section 6.3.

Table 7. Robustness of link prediction across network, weighting and corpus specifications

Spec.	Specification	Top-ranked absent pair (RA)	Rank: ukraine × smart tourism	Rank: post-conflict × smart tourism	Top-ranked pair outside ukraine
S0	VOSviewer network as reported (82 nodes, 842 links), unweighted RA	ukraine × smart tourism (0.533)	1	4	post-conflict × smart tourism (0.401)
S0w	As S0, RA weighted by link strength	ukraine × digital transformation (0.397)	2	5	post-conflict × digital transformation (0.293)
S1	S0 minus the five largest generic hubs	ukraine × smart tourism (0.538)	1	5	dark tourism × digital transformation (0.455)
S2	S0 minus all 23 generic and sector-generic terms	ukraine × smart tourism (0.583)	1	19	dark tourism × digital transformation (0.379)
P0	Rebuilt from the full corpus (n = 2,238; 81 nodes, 893 links)	ukraine × smart tourism (0.525)	1	10	resilience × digital technology (0.419)
P1	Rebuilt from the tri-domain core (n = 2,074; 73 nodes)	ukraine × smart tourism (0.572)	1	15	post-conflict × digitalisation (0.417)
P2	Rebuilt without Ukrainian-affiliated papers (n = 1,843; 68 nodes)	dark tourism × digital transformation (0.496)	55	2	dark tourism × digital transformation (0.496)
P3	Tri-domain core without Ukrainian affiliation (n = 1,689; 62 nodes)	dark tourism × digital transformation (0.455)	37	2	dark tourism × digital transformation (0.455)
P4	P2 minus all generic terms	dark tourism × digital transformation (0.449)	55	24	dark tourism × digital transformation (0.449)
P5	Records retrieved only by the Ukrainian-tourism query removed (n = 1,698; 62 nodes)	post-conflict × smart tourism (0.425)	— (node absent)	1	dark tourism × digital transformation (0.404)
P6	All Ukrainian-tourism-query records removed; C = post-conflict topic set only (n = 1,660; 61 nodes)	post-conflict × smart tourism (0.429)	— (node absent)	1	dark tourism × digital transformation (0.405)

Note: RA = Resource Allocation index; the post-conflict block comprises post-conflict, war, dark tourism, ukraine and resilience; the technological set comprises 29 terms grouped into a smart-tourism core (S), a digital-transformation core (D) and an immersive-heritage core (I). S0–S2 use the VOSviewer network; P0–P4 are rebuilt from the corpus with the same thesaurus and a minimum of 12 occurrences.

Source: authors' calculations; specifications as described in Section 3.4

Table 8. Predicted connectivity between the post-conflict block and the three technological cores

Spec.	Mean RA, S core	Mean RA, D core	Mean RA, I core	Technology terms with largest summed RA to the block	Post-conflict terms with largest summed RA
S0	0.136	0.201	0.111	smart tourism (1.37); artificial intelligence (1.31); digital transformation (1.22)	ukraine; post-conflict; resilience
S0w	0.077	0.124	0.061	smart tourism (0.94); digital transformation (0.94); artificial intelligence (0.88)	ukraine; post-conflict; dark tourism
S1	0.128	0.190	0.091	smart tourism (1.45); digital transformation (1.26); artificial intelligence (1.24)	ukraine; post-conflict; dark tourism
S2	0.094	0.102	0.079	smart tourism (1.09); gamification (0.70); augmented reality (0.66)	dark tourism; resilience; ukraine
P0	0.215	0.252	0.122	smart tourism (1.39); artificial intelligence (1.36); augmented reality (1.35)	ukraine; post-conflict; resilience
P1	0.200	0.254	0.116	smart tourism (1.37); digital transformation (1.24); smart city (1.09)	ukraine; post-conflict; dark tourism
P2	0.182	0.199	0.112	smart tourism (1.21); digital transformation (1.20); augmented reality (1.10)	post-conflict; resilience; dark tourism
P3	0.152	0.189	0.103	smart tourism (1.14); digital transformation (1.13); augmented reality (0.83)	post-conflict; dark tourism; ukraine
P4	0.128	0.142	0.092	augmented reality (0.98); digital transformation (0.89); gamification (0.87)	dark tourism; resilience; post-conflict

Source: authors' calculations; specifications as in Table 7

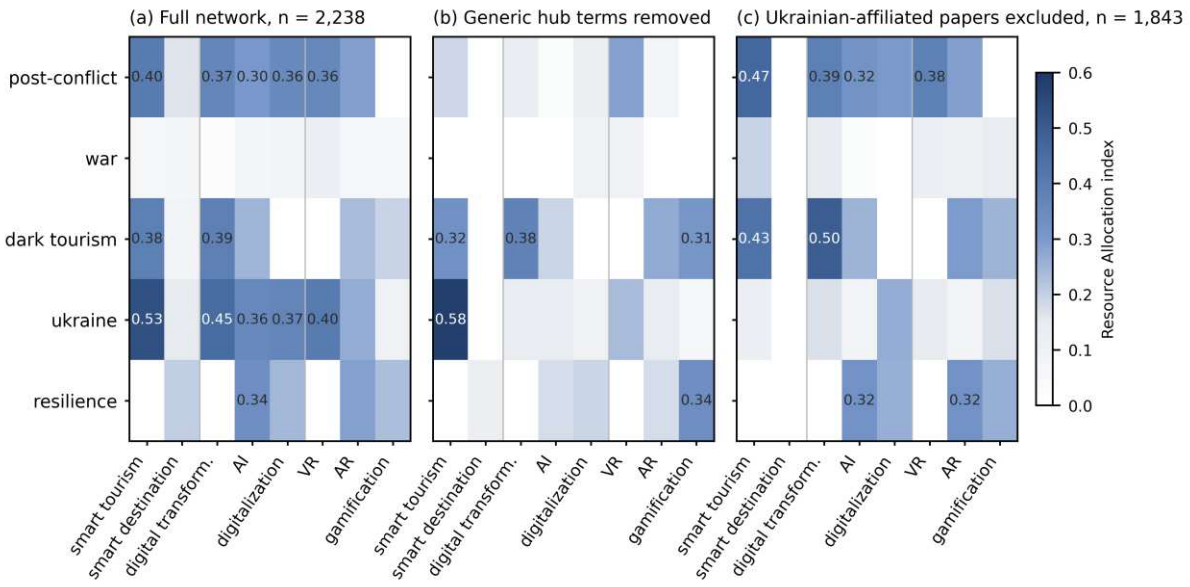


Fig. 7 *Resource Allocation index for absent pairs between the post-conflict block and selected technology terms: (a) full network; (b) generic hub terms removed (S2); (c) network rebuilt without Ukrainian-affiliated papers (P2). Values ≥ 0.30 are printed*

Source: authors' calculations (specifications S0, S2 and P2 of Table 7)

The cross-database check replicates the disconnection outside Scopus (Table 9). The ten queries re-run in Lens.org return 5,371 unique records; exports are capped at 1,000 per query, so five

sets are truncated and the Lens queries are broader than their Scopus counterparts, which makes the replication approximate: it tests whether the disconnection is an artefact of Scopus, not whether the Scopus counts are reproduced. The S ∩ C intersection contains 13 records against 552 expected. Most of the 13 are generic (a review of destination branding, a review of gamification, a national sustainability report, two book prelims); two are substantive, and both are instructive: a paper on innovative approaches to smart tourism during war and post-war recovery in Ukraine (the Chukut et al. 2025 paper cited in the Introduction) and a paper on the tourism potential of Shusha in the revival of Karabakh (Ismayilova 2025). Neither is indexed in Scopus. In a multi-source corpus of 5,371 records, the substantive papers that combine the smart tourism and post-conflict vocabularies come from national journals of the two countries currently rebuilding after war.

Table 9. Document-level intersections in the Lens.org replication (N = 5,371 unique records)

Set	Records	Observed	Expected under hypergeometric null	P(X ≤ observed)
Smart tourism (S)	1,494			
Digital heritage (H)	1,977			
Post-conflict / Ukraine (C)	1,986			
S ∩ H		63	549.9	$< 10^{-250}$
S ∩ C		13	552.4	$< 10^{-300}$
H ∩ C		12	731.0	$< 10^{-300}$
S ∩ C, C restricted to the post-conflict topic set		8	278.2	$< 10^{-100}$

Note: Lens.org queries follow the Scopus strings of Online Resource 1 without document-type limits; five query exports were truncated at the 1,000-record cap. Membership is by Lens ID; P-values from the hypergeometric distribution.

Source: authors' calculations on Lens.org exports (September 2026)

5. Discussion

5.1. Why the conversations do not hear one another

The convergence of results across four levels, with zero or near-zero integration at keywords, documents, authors and venues, calls for an explanation rather than a statement of fact. We see three interrelated mechanisms of disconnection. The first is institutional. The domain venue pools barely overlap, and inside the heritage domain an additional twin peak operates: half the conversation lives in computer science conference series with their own cycles, reviewers and novelty criteria. A post-conflict tourism researcher and the developer of a photogrammetric pipeline for destroyed architecture meet institutionally nowhere: different conferences, different funding panels, different reviewer pools. The twelve authors on the smart × conflict boundary are senior generalists who can afford to publish outside the core of their own field; for an early-career researcher such a crossing offers few structural rewards. Disconnection appears to reproduce itself institutionally rather than thematically.

The second mechanism is methodological. The conflict domain has historically been built on case methods, ethnography, interviews and conceptual work; its 2007–2013 classics are of this kind (Winter 2007; Causevic and Lynch 2011; Novelli et al. 2012), and its recent community-based studies continue the tradition (Guasca et al. 2022; Díaz Rocca and Zielinski 2022). The digital domains are increasingly data-driven: large samples, computational methods, technical validation. The difference lies not only in the instruments but in the criteria of evidence and in the language in which a contribution is phrased. A paper combining the ethnographic sensitivity of post-conflict studies with the computational rigour of smart tourism would have to satisfy both reviewer canons simultaneously; we found no such paper in the corpus.

The third mechanism is temporal, and the growth models quantify it. The domains live in different phases: digital heritage doubles every year and a half and absorbs every technological wave, while the conflict domain doubles every four years and rests on anchors fifteen years old. The rate gap means that, other things equal, the share of the conflict conversation in the field will keep falling from the recorded 28.5%, and the probability of a chance meeting of the

domains will keep declining. The divergence is likely to be self-reinforcing: the smaller a domain's share, the fewer the shared venues, authors and citations, and the lower the odds of convergence.

5.2. Ripeness without a meeting

At first sight these results contradict the connectivity metrics: density of 0.254, an average path of 1.77, modularity below the threshold; the field looks well mixed. The contradiction dissolves once one looks at what exactly the inter-cluster strength flows through: half of it passes through the generic brokers tourism, cultural heritage and sustainability. The field is integrated at the level of the broadest umbrella terms and disconnected at the level of subject terms. This is the profile of ripeness without a meeting: the infrastructure for convergence (a shared upper-level language, short paths, forerunners such as Chukut et al. 2025 or Neglia et al. 2024) already exists, but the subject bridges have not been built. The value Q = 0.243 is better read as evidence of the possibility of integration than of integration itself.

Two bodies of evidence outside the corpus qualify the empty intersection. The first is practice. The documentation initiatives described in Section 2.1 have been operating since 2022; the one scholarly treatment of them we have located is in architectural history (Garduño Freeman and Leibowitz 2024). The intersection that our corpus shows as empty has, in practice, existed for four years. The second body of evidence is the national literature, and the Lens.org replication of Section 4.4 locates it precisely: the substantive papers in a multi-source corpus that combine the two vocabularies are published in national journals of Ukraine and Azerbaijan (Chukut et al. 2025; Ismayilova 2025), and Ukrainian journals outside Scopus have, since 2024, taken up wartime and post-war destination recovery (Khanenko and Bobko 2024; Matviichuk et al. 2025), in some cases in the vocabulary of smart tourism and digital transformation (Pletsan et al. 2023; Chukut et al. 2025), which is the vocabulary the international post-conflict literature does not use. Both observations point the same way as the robustness analysis of Section 4.4:

convergence is being attempted from the destination outward, by practitioners and by national scholarship, while the indexed international literature has not followed. The gap this review measures is therefore less a gap between reality and possibility than a gap between what is being done and what tourism scholarship has so far recorded.

5.3. The scaffold model

The results support a diagnosis and a proposal. The diagnosis is that the continuity premise is not merely a stylistic habit of smart tourism theory but is reflected in the structure of the field: the post-conflict literature reaches the digital domains through one channel, resilience, and resilience is a concept that preserves the premise by treating each crisis as a disturbance with an earlier state to return to. A field whose main bridge to conflict is a concept of return is unlikely, on its own, to produce a model of formation. The empty intersection at the document level, the small number of boundary-crossing authors and the widening gap in growth rates appear to be aspects of the same condition.

The proposal is the scaffold model (Fig. 8). In the layered model the destination comes first (territory, then infrastructure, then a resident population and its heritage) and smartness is added as an upper layer that improves what exists. In the scaffold model the digital record comes first: documentation of what stood, of what was lost and of what the community wishes to rebuild. It is followed by a data and platform infrastructure that organises reconstruction, by the gradual return of residents and visitors that this infrastructure makes possible, and only then by the physical destination, which is built around the scaffold rather than beneath a layer. The dependencies also run in the opposite direction: physical reconstruction updates the record, and returning residents revise it. The model changes the order of the layers without discarding them; each component of the layered model is present, but as an outcome rather than a precondition.

Three propositions follow. They are stated for future examination rather than as findings of this review. P1 (precedence): in destinations recovering from conflict, the completeness of the digital heritage record is associated with the sequence and pace of physical tourism reconstruction, rather than the reverse. P2 (authorship): reconstruction outcomes that communities regard as legitimate are more likely where the digital record was co-produced with returning residents than where it was drawn from external documentation alone. P3 (absorption): as post-conflict destinations rebuild, their scholarship is likely to enter the international smart tourism literature through the resilience frame before it does so through a scaffold frame, if it does at all; the link-prediction ranking of Section 4.4 offers one way of following this over time. The model is a conceptual proposal derived from the structure of the field and from observed practice; the destinations that could provide a test of it are, at the time of writing, still at war.

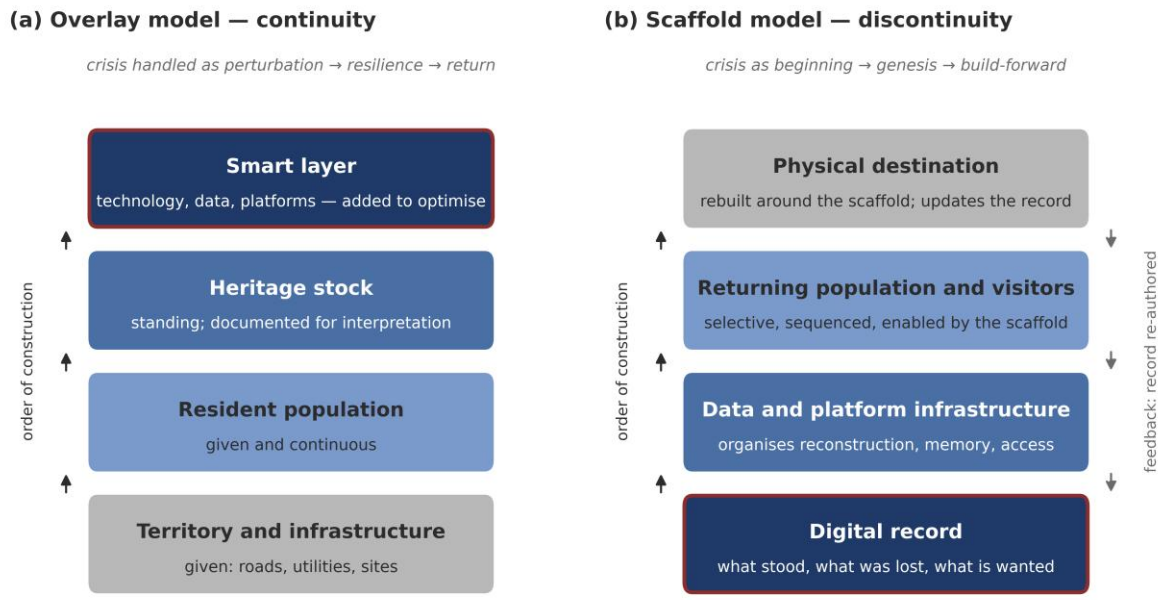


Fig. 8 *Layered and scaffold models of the smart tourism ecosystem: order of layers and direction of dependence under continuity (a) and under post-conflict discontinuity (b)*

Source: authors' own elaboration

In relation to earlier bibliometric work, the review also makes three methodological moves. Existing mappings treat each domain separately (Madzík et al. 2023; Vlase and Lähdesmäki 2023; Kumar et al. 2024; Li et al. 2025); we consider the three as one field and measure their integration. Existing reviews are descriptive; we add an inferential layer grounded in literature-based discovery and validated null models (Section 2.6), which allows a statement such as "the intersection is small" to be replaced by an estimate of how improbable the observed intersection is under chance. Existing research agendas rest on expert judgement; ours is derived from link prediction. The CDII, as a mean observed-to-expected ratio across independent levels, may be applied in other fields where a similar blind spot is suspected but has not been measured.

6. Conclusions

The review posed three questions and obtained three answers. The intellectual structure of the tri-domain field (RQ1) consists of four clusters with asymmetric dialogues: digital transformation converses actively with heritage, immersive heritage and smart destinations form the weakest pair of the network, and the post-conflict wing is connected to the rest of the field only through generic terms. The integration of the domains (RQ2) is far below chance at four levels: zero shared keywords, zero shared documents against 119 expected, twelve shared authors against 274, and venue pools with a ten per cent overlap; the CDII of the smart × conflict pair is 0.015. The most probable point of convergence (RQ3) is the intersection of the post-conflict block with the smart tourism and digital transformation cores; this result survives hub removal, edge weighting, removal of the country query from the conflict domain and replication in a second bibliographic database. Ukraine is its most active empirical instance, and its position at the top of the full-corpus ranking is carried mainly by Ukrainian-affiliated scholarship.

6.1. Theoretical implications

The review identifies a premise that smart tourism ecosystem theory has carried largely without stating it, the continuity of the destination beneath the smart layer, and suggests that its consequences are visible in the structure of the field: there is one conceptual channel for conflict, resilience, and that channel tends to preserve the premise rather than to question it. The separation of the post-conflict literature from the digital domains is statistically pronounced, persistent over time and, on current growth rates, likely to widen. For the theory of smart tourism ecosystems this implies that its models have been developed without reference to a class of destinations, those recovering from conflict, and without a model of ecosystem formation as distinct from ecosystem recovery. The scaffold model of Section 5.3 offers an outline of such a model and three propositions through which it could be examined. For post-conflict studies the implication is complementary: the recognised recovery frameworks give little attention to the digital dimension at a time when reconstruction is increasingly digital in practice. Methodologically, the review introduces literature-based discovery into tourism studies and indicates that the inferential protocol described in Section 3 can be used to identify a conceptual blind spot in a field and to locate where it is most likely to be addressed.

6.2. Practical implications

The main practical conclusion is addressed to those who govern research infrastructure. The divergence of rates means there is little reason to expect organic convergence: the fields are drifting apart, and the publication system is unlikely to build the bridges by itself. Deliberate instruments are needed, such as special issues at the domain intersections, targeted funding calls, cross-domain doctoral programmes and conference tracks. The list of predicted bridges gives such instruments concrete coordinates, and the composition of the current dozen bridge-builders suggests the mechanism: engaging senior generalists as editors and mentors of cross-domain initiatives. For recovering destinations and reconstruction donors the conclusion is the mirror image: the scholarly base of culturally grounded digital reconstruction has not yet been

assembled, so investment in it, from pilot projects to a research component embedded in reconstruction programmes, may yield comparatively high returns. The structure of the network locates that assembly at the post-conflict × smart tourism intersection, and the composition of the literature shows where it is already being attempted: in the destination that needs it, by practitioners and national scholarship whose work the international literature has not yet absorbed.

6.3. Future research agenda

Within the limitations of the method (Section 3.5), the predicted bridges of Tables 6–8 can be restated as an agenda of ten research questions, grouped according to the three components a scaffold model would require (Section 2.5) and formulated at the level of the post-conflict block; Ukraine appears where it is the case in which the predicted bridge seems closest to being built:

RQ-1. How should the smart tourism ecosystem architecture of a post-conflict destination be designed, and how does it differ from conventional models? (post-conflict × smart tourism; the pair that leads every specification without Ukrainian authorship)

RQ-2. Which mechanisms of digital transformation accelerate the recovery of tourism destinations after conflict? (post-conflict × digital transformation)

RQ-3. How can immersive technologies represent destroyed and surviving heritage for tourist audiences without re-traumatising communities? (post-conflict × virtual reality)

RQ-4. What role do data and analytics play in managing visitor flows to sites of memory? (dark tourism × smart tourism)

RQ-5. How does digital transformation change the economics and ethics of dark tourism? (dark tourism × digital transformation; the leading pair once Ukrainian-affiliated papers are excluded)

RQ-6. Which digitalisation models work for the intangible heritage of communities that have lived through conflict? (post-conflict × digitalisation)

RQ-7. How can artificial intelligence support destination recovery, from demand forecasting to the personalisation of sensitive experiences? (post-conflict × artificial intelligence)

RQ-8. What distinguishes the digital reconstruction trajectory of Ukrainian tourism, where national scholarship and heritage-documentation practice already combine the two vocabularies, from previous post-conflict cases? (ukraine × smart tourism; ukraine × digitalisation)

RQ-9. How does virtual reality perform in the therapeutic and memorial functions of tourism in recovering destinations? (resilience × virtual reality; ukraine × virtual reality)

RQ-10. What methodological standards are needed for research that combines ethnographic and computational canons of evidence at cross-domain intersections?

Each of these questions carries a structurally confirmed probability of becoming a bridge; whether it does depends on whether the three parallel conversations hear one another before the next post-conflict destination begins its reconstruction without the scholarship that should accompany it.

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