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INVITED PAPER

AI-powered smart tourism 2.0: A 10-year retrospective and updated model

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Abstract

This paper revisits the publication "Smart Tourism: Foundations and Developments" published in Electronic Markets in 2015, which presented a data-centric definition of smart tourism and a foundational model of smart tourism layers and components. Recognizing the dramatic evolution of smart technologies over the past decade, the extensive digital transformation of tourism accelerated by the global COVID-19 pandemic, the Artificial Intelligence revolution fueled by large language models, and the continuing efforts to advance the Metaverse, the paper is a 10-year retrospective and incorporates recent developments in Artificial Intelligence and Metaverse technologies, resulting in an updated "AI-powered smart tourism 2.0" model. The new framework bridges past insights with future possibilities and reflects on emerging smart tourism experiences, smart tourism industry practices, and governance approaches. It thus offers an updated vision for smart tourism to guide future research, policymaking, and industry innovation in an era of extremely rapid and profound technological changes.

Keywords Smart tourism · Smart destination · Artificial intelligence · Metaverse · AI-human integration · AI governance

JEL Classification Z3

Introduction

The term "smart" first appeared in academic literature in the 1990s, referring to the use of technology and data-driven approaches to enhance urban environments (Gomstyn & Jonker, 2025). The origins of smart development therefore lie in smart governance and its promise to successfully address the various societal challenges brought about by modernization (Pereira et al., 2018; Yigitcanlar et al., 2018). However, the potential of smart technologies to support fundamental shifts in innovation and value creation opportunities was also quickly recognized in the business sector (Pencarelli, 2020). Since then, many industries—including manufacturing, energy, transportation, and infrastructure—have embraced smart strategies to enhance the effectiveness and efficiency of their core operations (Oztemel & Gursev, 2020). The same enthusiasm for smart development has spread to tourism, where it started gaining traction in the early 2010 s as both a countermeasure to mass tourism-induced problems and a catalyst of smart economic development to establish and serve a competitive visitor economy (Shafiee et al., 2021).

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Smart tourism continues to be a focal area of government agendas, industry practice, and academic research, yet the concept of smart tourism has evolved significantly since the publication of "Smart Tourism: Foundations and Developments" by Gretzel et al. (2015a) in *Electronic Markets*. The paper, with over 3000 citations on Google Scholar, has inspired research across a variety of disciplines with a keen interest in the roles and impacts of smart technologies because it provided a workable definition of smart tourism and elaborated on its fundamental premises. These foundational principles continue to be relevant. However, recent developments, such as rapid technological advancements including the rise of AI as a revolutionary travel search tool (Shin et al., 2023), changing lifestyles and travel behaviors like those involving digital nomads (Hannonen, 2020), and global crises like the COVID-19 pandemic that accelerated digitalization (Gretzel et al., 2020) and increased the acceptance of virtual communication and contactless service technology (Rathjens et al., 2023) but also highlighted the need for adaptable tourism governance (Ivars-Baidal, et al., 2024), call for a reassessment of the original framework of smart tourism and its components proposed in 2015.

Over the past decade, smart tourism has centered on data-driven processes, app-enabled travel information, and the seamless interconnection of stakeholders within a digital ecosystem. However, the rapid emergence of conversational AI technologies such as ChatGPT has triggered a paradigm shift (Um & Koo, 2024). With AI systems becoming increasingly human-like in their processing capabilities, new opportunities are arising for AI-embedded applications in travel search and itinerary recommendations, moving travel enhancement efforts beyond traditional app-based approaches (Kim et al., 2025). Additionally, AI tools now assist in generating initial drafts of tourism marketing content, improving logical flow and wording—tasks that previously required professional marketing agencies (Kastia, n.d.). Further, AI can deliver precision through predictive analytics, guide channel management, and identify target audience segments. It also curates content and engages diverse traveler types, such as adventurers, luxury seekers, or families planning vacations. Furthermore, AI supports the creation of narrative-driven campaigns aligned with social media trends and enables real-time audience engagement. This marks a turning point and a significant shift for professionals in the tourism industry. Early smart tourism research predicted the pivotal role of AI but understandably remained vague regarding impacts on human-like interactions, enhanced information processing, and tourism marketing support. Yet, the travel industry is already experiencing substantial transformation due to AI, particularly in areas such as supply-side marketing and traveler-side information seeking. Therefore, it is essential to develop a deeper understanding of AI advancements, examine how they extend the original concept of smart tourism, and explore their future potential and role in smart tourism.

The original smart tourism framework focused on three key aspects: 1) Smart experiences as enhanced on-site tourism experiences; 2) Smart destinations as governance mechanisms able to provide improved traveler support and residents' quality of life; and 3) Smart business ecosystems (Gretzel et al., 2015b) as open and collaborative interaction spaces to drive tourism development and to facilitate value (co-)creation. Over the last decade, smart tourism practice has expanded beyond this initial conceptualization and business models, integrating a variety of emerging technologies such as virtual reality, augmented reality, Metaverse technologies, QR code scanning, and digital payment systems. While digitalization in tourism has generally improved, one of the most notable enhancements is the increased use of technology for facilitating transactions (Gretzel et al., 2023). Another is the growing implementation of blockchain technology (Onder & Acikgoz 2023). Importantly, service automation (Ivanov & Webster, 2019) has given rise to new interaction paradigms and experiential dimensions. Recently, Artificial Intelligence (AI) (Koo et al., 2021) and Metaverse technologies (Buhalis et al., 2023a, 2023b; Chen, 2024; Koo et al., 2023) have created new opportunities which change data modalities and sources, processing capabilities, and experiential interfaces. One of the latest developments is the increasing integration of AI and Metaverse technologies, which fosters the emergence of AI supported augmented reality and avatar-based interactions that can adapt seamlessly to evolving environmental conditions, resulting in contextually appropriate and highly immersive experiences. Forlini (2025, n.p.), for instance, reports that Apple has shown interest in "AI-powered wearables across the board. It's also looking to add cameras to AirPods and Apple Watches in a push for so-called 'Visual Intelligence'." These wearable devices "see" what the wearer sees and, together with AI-enhanced voice assistants, they can allow the user to query their surroundings. Among all the technological developments that impact smart tourism, it is this power of AI to enhance basically all domains of computing and to fundamentally affect a myriad of application areas that especially warrants revisiting the original smart tourism framework.

According to the theory of sociotechnical change (Bijker, 1997), emerging technologies will evolve through a process of interpretation, implementation, and adaptation of the technical artifacts and users (i.e., travelers) within a specific social, political, economic and technological settings. Smart tourism offers an important sociotechnical context in which AI-enhanced Metaverse applications and other technological developments will take shape. However, Adaptive Structuration Theory (DeSanctis & Poole, 1994) reminds us of the dynamic interplay between technology, social structures,

and individual actions. Organizations and individuals constantly adapt and modify their use of technology, leading to changes in both the technology and the social structures surrounding it. For instance, as travelers interact more with AI, their behavior is changing, and tourism systems adapt to new forms of demand. As AI becomes a key component of smart tourism, it fundamentally alters approaches to destination management and reshapes value (co-)creation practices, effectively redefining the entire tourism business ecosystem (Gretzel et al., 2015b). As such, we propose and formulate an updated model of smart tourism that captures these fundamental changes and allows us to articulate a new framework that extends beyond application-based, data-centric development efforts, which we label as "AI-powered smart tourism 2.0."

The emergence of AI-powered smart tourism 2.0 has critical implications for enhancing smart tourism goals, processes, and outcomes but also requires new governance models. By leveraging AI's power to process and interpret vast amounts of data, AI-powered smart tourism 2.0 provides tourism businesses with opportunities to offer highly marketable and cost-effective services and helps Destination Management Organizations (DMOs) optimize their resource allocations while enabling real-time, context-aware decision-making capabilities for travelers. AI integration into smart tourism simultaneously supports efforts to enhance the quality of tourism experiences (Yang & Wang, 2023) while also promoting more sustainable and equitable smart tourism development and governance practices (Gretzel, 2022). This leads to outcomes that benefit a wide range of stakeholders—from travelers and destinations to local communities. However, AI integration also challenges the very existence of DMOs and of established electronic markets for tourism products (e.g., online travel review platforms and flight aggregators). Hunter et al. (2015) note that smart tourism supports new ways of meaning-making and social exchanges. It can be expected that AI will create and shape new experiences and new connections between travelers, destination residents, technology providers, tourism businesses, and government agencies. AI-powered smart tourism 2.0 practice needs to recognize this complexity of human-technology interaction (Koo et al., 2017) and develop appropriate avatar- or real human-based interaction mechanisms, business models, and governance principles. At the same time, smart tourism research needs to engage with theories and methodologies that can capture and explain these developments and help envision desirable smart tourism futures.

The AI-powered smart tourism 2.0 model not only reflects the contemporary state of smart tourism but also serves as a guide for future research, policymaking, and industry practices in an increasingly digital, interconnected, and AI-integrated world. As we move forward, it is crucial for researchers, policymakers, and industry practitioners to embrace and further develop the concepts outlined in the AI-powered smart tourism 2.0 model presented in this paper. By integrating critical smart tourism principles and acknowledging new technological realities, the model provides a roadmap for innovation, sustainability, and inclusivity, paving the way for a more interconnected, efficient, and responsible global travel industry and more justice-focused tourism governance.

In the next section, we briefly review the main arguments and the smart tourism framework proposed in the original article. In the third section, we conduct a bibliometric analysis of the journal articles and conference papers citing the original article to justify the need to update the original smart tourism framework. This need is addressed in the fourth section, where we propose an updated, AI-powered smart tourism 2.0 framework that takes into account emerging technology trends, sentiments, and especially the paradigm shifts connected with AI developments. Finally, we discuss the implications of this new framework for future research on smart tourism.

Literature review

Smart tourism: Foundations and development

The primary purpose of the original paper (Gretzel et al., 2015a) was to conceptualize "smartness" as an attribute that goes beyond the simple implementation of smart technologies and thus to envision it as entailing the technology-driven collection and open exchange of data, widespread interconnectivity among physical objects, information systems, organizations and end-users, and the use of real-time data analytics to achieve innovation across the physical and governance structures of destinations, the value (co-creation) and interaction mechanisms of the dynamic business ecosystem, and the decision-making and consumption dimensions of tourism experiences. The core focus of smart tourism was to bridge the phygital and the digital to ultimately deliver superior experiences to tourists, greater agility and opportunities to businesses, and improved management and monitoring capabilities as well as increased resilience to destinations.

Theoretically, the original framework built on smart city development literature that had identified necessary shifts in the management and governance models for addressing contemporary challenges in urban environments (Lee et al., 2013). Practically, it was inspired by government and industry commitments (mostly in Europe and Asia) to technology-driven, "smart" innovation. Further, the original view of smart tourism was critically informed by disruptive technological developments. Most notably, it identified the smartphone as a powerful mobile interaction and

experience-augmentation device with tremendous potential to fundamentally change service-delivery and experiential consumption (Wang et al., 2016). The initial conceptualization of smart tourism was also based on emerging developments and visions for the Internet of Things (IoT) and the many technologies related to it (e.g., Wi-Fi connectivity, sensor technologies and near-field communication) (Novera et al., 2022). By recognizing the centrality of data for different aspects of smart tourism, the framework was able to identify the core components and layers of smart tourism systems, as illustrated in Fig. 1.

The centrality of data is also reflected in the definition of smart tourism in the 2015 paper. First, it recognizes that smart tourism depends on integrated efforts at a destination. Second, it emphasizes that smart tourism opportunities emerge from the collection, aggregation and harnessing of data using advanced technologies. Third, it acknowledges the many data sources that smart tourism needs to embrace, including data derived from physical infrastructure, social connections, government/organizational sources, and human bodies/minds. Last, but not least, it stresses that the transformation of data into business value-propositions and augmented on-site experiences needs to be guided by principles defined as efficiency, sustainability and experience enrichment in the original paper. As such, it offers a holistic perspective on smart tourism, more comprehensive than tourist-centered smart tourism definitions that can also be found in the literature.

Bibliometric analysis of smart tourism literature

A decade has passed since the publication of the original smart tourism definition and framework. We conducted a bibliometric analysis to examine the evolution of research on the topic of smart tourism that refers to our definition and/or framework. Using our original paper as the focal point of analysis allowed us to filter out literature that simply equated smart tourism with technology use by tourists without recognizing the data-focused nature of smart tourism and its specific development principles and goals. Our analysis aimed to determine how popular the topic of smart tourism has become, which disciplines have contributed to its development, and what research themes have emerged and disappeared over time. This analysis attempted not only to establish the impact of the original article, but also to test its continued relevance and identify potential blind spots.

We utilized two popular bibliographic databases, namely Web of Science and SCOPUS, to search for all academic papers citing the original article, resulting in a total of 1,102 articles. From these, we selected a total of 900 journal articles and conference papers, while excluding review articles, editorials, research notes, and book chapters to concentrate on original research contributions. These 900 selected articles, published between 2015 and 2024 and sourced from 374 different publication outlets, were used for the bibliometric analysis (see Appendix A for the list of 900 articles). We conducted the analysis using Bibliometrix, a widely adopted online software tool for literature review studies (Anlesinya & Dadzie, 2023). The results of the bibliometric analysis are presented in the following three sub-sections: "Smart tourism research popularity," "Interdisciplinary exploration of smart tourism," and Major themes discussed regarding smart tourism."

Smart tourism research popularity

We explored the evolving popularity of smart tourism as a research topic, focusing on the number of target articles published annually from 2015 to 2023 (Fig. 2). The final year of our analysis, 2024, was excluded for this specific analysis due to its ongoing status at the time of data collection. Despite a minor decrease in 2023, our examination revealed a consistent upward trajectory in the citations of the original paper over the span of approximately a decade. Concurrently, we delved into the geographical distribution of papers representing the academic smart tourism discourse resulting from our 2015 paper by scrutinizing the affiliations of authors of target articles across different time intervals. Lastly, we divided our analysis into three intervals: 2015–2018, 2019–2021, and 2022–2024. The specific intervals were determined based on the frequency distribution patterns that emerged from Fig. 2 and to ensure that each interval contained a sizable number of papers. The last

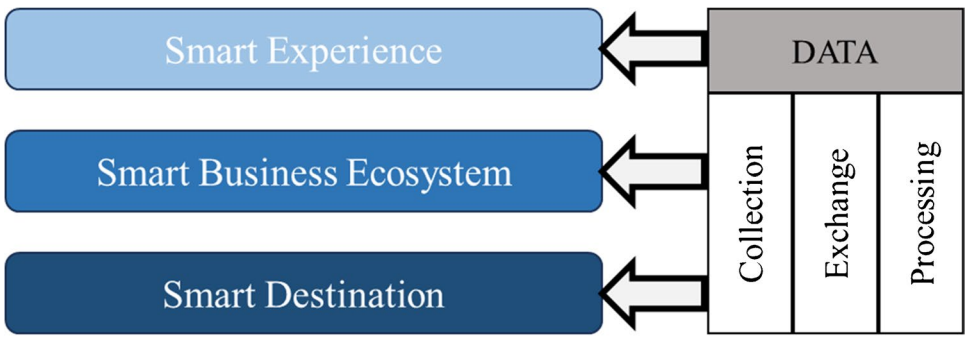


Fig. 1 The original model of smart tourism

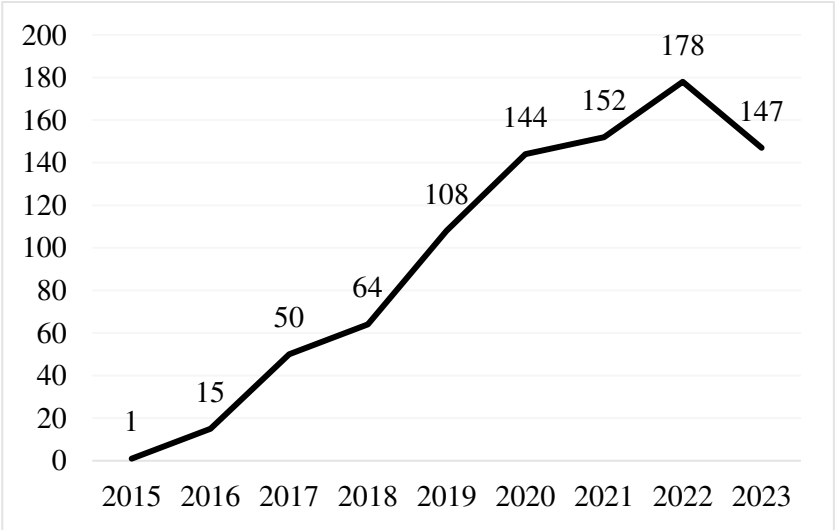


Fig. 2 Number of target articles in each year

interval not only reflects post-pandemic tourism resurges but also the emergence of Metaverse efforts and AI investments (including the rebranding of Facebook to Meta and the release of the generative AI tool ChatGPT, both of which took place in 2022).

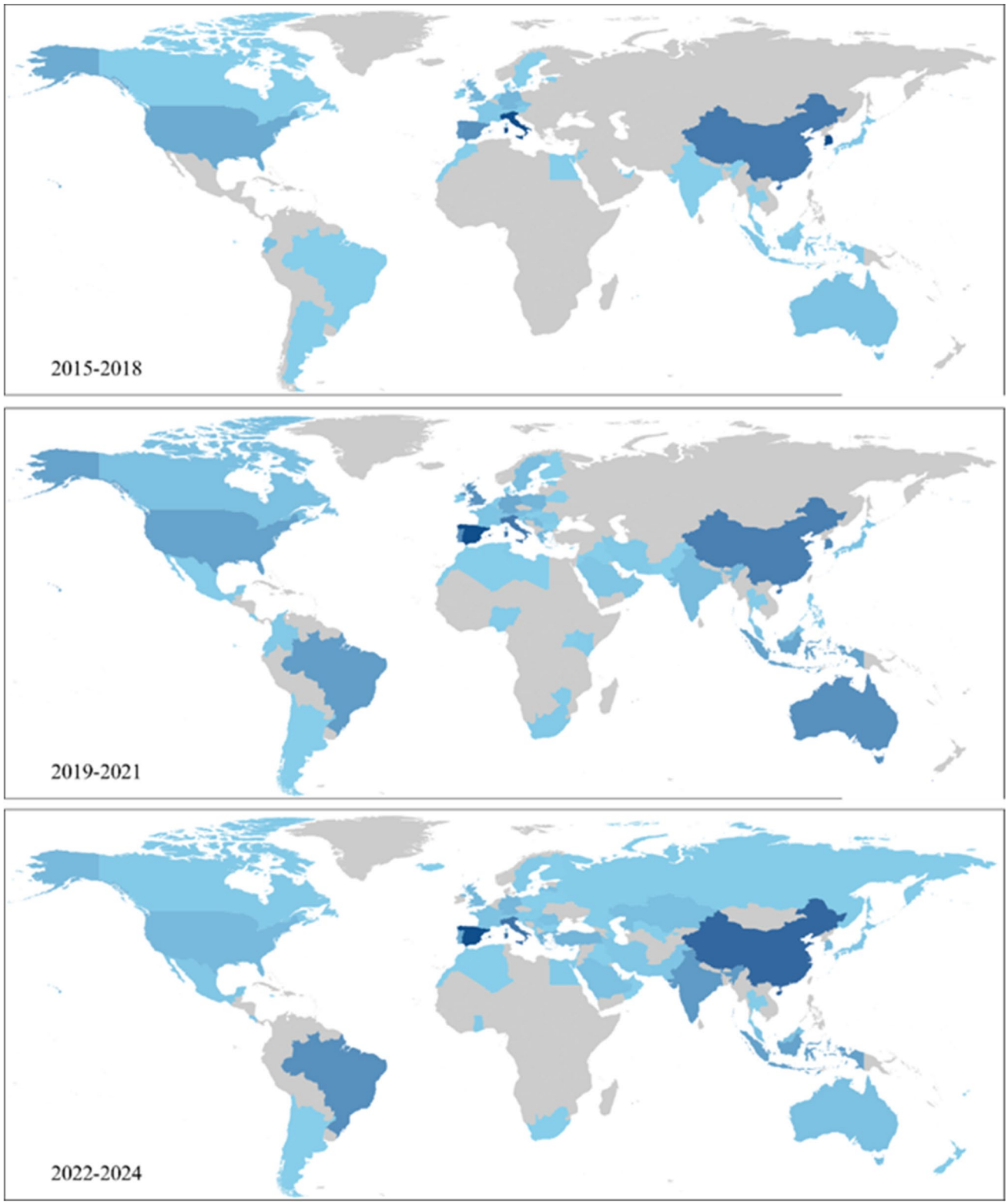
As shown in Fig. 3, there has been an increase in global engagement with the concept of smart tourism since the publication of the original paper. While Italy, Spain, China and South Korea were early smart tourism powerhouses and remain important producers of smart tourism research publications, smart tourism research based on the original smart tourism framework spread across the globe in the latter intervals. These insights regarding publication outputs and geographic engagement with our smart tourism paper collectively underscore the enduring and global appeal of smart tourism as a prominent research topic and the continued relevance of our original framework.

Interdisciplinary exploration of smart tourism

Our investigation into the diverse disciplinary nature of the conversation on smart tourism commences by listing the journals and conference proceedings that cited our 2015 paper in Table 1. While a substantial portion hailed from the hospitality and tourism domains (e.g., *Annals of Tourism Research, International Journal of Contemporary Hospitality Management, and Tourism Management*), our analysis yielded an intriguing revelation: the top-ranking relevant source, *Sustainability*, originates from a field distinct from hospitality and tourism studies. Furthermore, within the top 10 sources identified, 40% emanated from non-hospitality and tourism disciplines, encompassing sustainability, economics, e-commerce, and computer science (i.e., *Springer Proceedings in Business and Economics, Electronic Markets, and Lecture Notes in Computer Science*). This trend persisted consistently within the top 20, 30, 40, and 50 sources, incorporating an expanding array of scientific domains such as computing or information systems *(Advances in Intelligent Systems and Computing, Information Systems Frontiers*), management or business (*European Journal of Innovation Management, Journal of Business Research*), and information science (*International Journal of Information Management, Information Processing and Management*). These findings underscore the multidisciplinary nature of smart tourism research that connects across a spectrum of diverse scientific domains beyond tourism. They also show the bridge-building function of the journal of *Electronic Markets* and its influence across disciplines.

Major themes discussed regarding smart tourism

We identified major themes that have emerged in the target literature related to smart tourism since 2015. Using the above-determined time intervals, we identified important keywords used by authors in each period. We used co-work network and clustering analysis to extract these keywords (Fig. 4). Based on this analysis, we find that the use of "smart" as a prefix was more prevalent in the keywords during the first period compared to the subsequent periods. This suggests that early studies concentrated on introducing and defining the smart concept within the hospitality and tourism context. In contrast, later studies sought to apply this concept to other established topics, such as "tourism services," "business models," and "destination image." Secondly, while broad topics like "tourism experiences," "tourism destinations," and "destination management" were prominently discussed in the first two periods, more specific topics began to emerge in the third period, such as "sustainable tourism" and the "COVID pandemic." This shift indicates that academic advancements in smart tourism have encouraged researchers



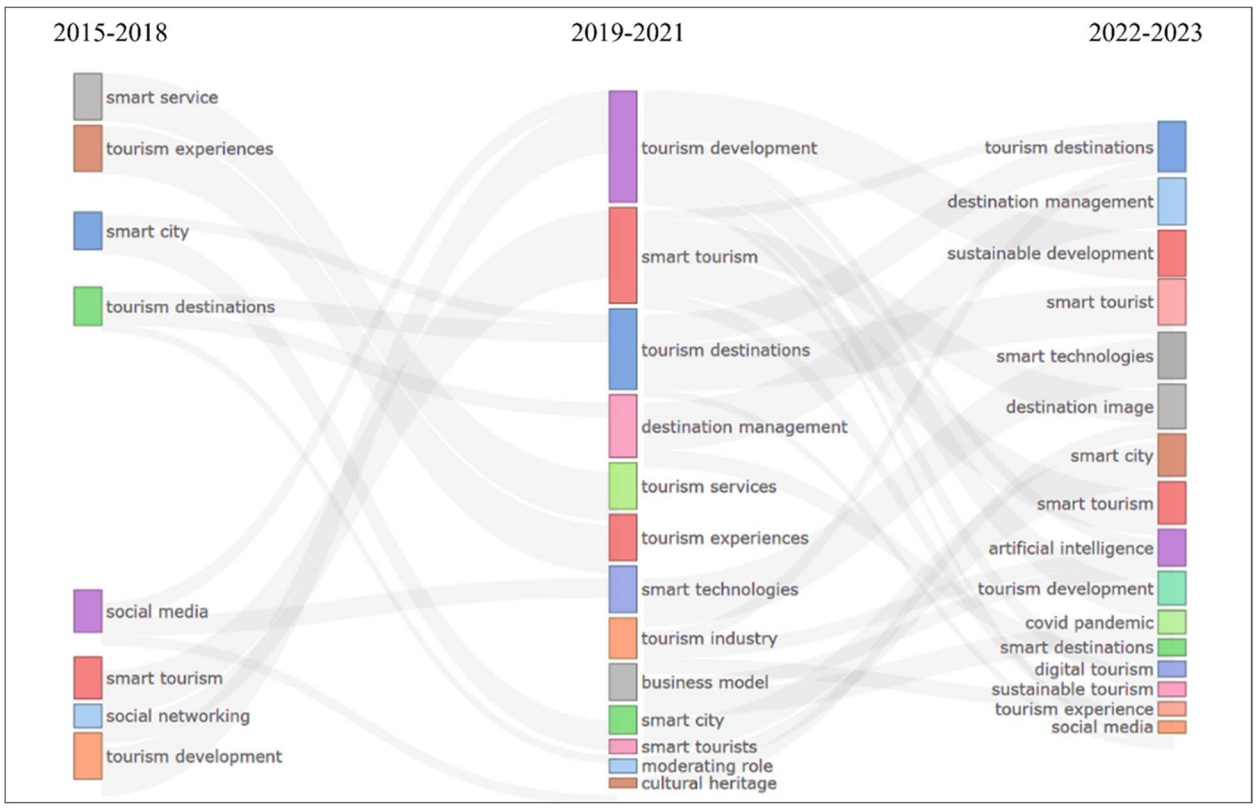
Note: The darker the blue shading is, the greater the number of publications by authors whose institutions are located in the respective country. Grey indicates zero publications

Fig. 3 Regions of target article authors' institutions across three time periods

Table 1. List of journals and conference proceedings of the target articles (top 50)

	Sources	Articles
1	Sustainability	67
2	Current Issues in Tourism	22
3	Asia Pacific Journal of Tourism Research	20
4	Springer Proceedings in Business and Economics	19
5	Journal of Hospitality and Tourism Technology	16
6	Tourism Review	16
7	International Journal of Tourism Cities	15
8	Electronic Markets	11
9	European Journal of Tourism Research	11
10	Lecture Notes in Computer Science	11
11	Tourism Management Perspectives	11
12	Journal of Information Technology and Tourism	10
13	International Journal of Contemporary Hospitality Management	10
14	Technological Forecasting and Social Change	10
15	European Journal of Innovation Management	9
16	Journal of Destination Marketing and Management	9
17	Rosa Dos Ventos-Turismo E Hospitalidade	9
18	Tourism Recreation Research	9
19	ACM International Conference Proceeding Series	8
20	Communications in Computer and Information Science	8
21	Journal of Sustainable Tourism	8
22	Worldwide Hospitality and Tourism Themes	8
23	Advances in Intelligent Systems and Computing	7
24	Information Processing and Management	7
25	Journal of Tourism and Development	7
26	Annals of Tourism Research	6
27	Geojournal of Tourism and Geosites	6
28	Information and Management	6
29	International Journal of Hospitality Management	6
30	Journal of Business Research	6
31	Journal of China Tourism Research	6
32	Journal of Environmental Management and Tourism	6
33	Journal of Hospitality and Tourism Management	6
34	Journal of Tourism Futures	6
35	Service Industries Journal	6
36	Smart Innovation, Systems and Technologies	6
37	Tourism Management	6
38	Tourism Planning and Development	6
39	Electronics	5
40	International Journal of Information Management	5
41	Investigaciones Turisticas	5
42	Journal of Heritage Tourism	5
43	Journal of Hospitality and Tourism Insights	5
44	Tourism Economics	5
45	African Journal of Hospitality, Tourism and Leisure	4
46	Asia Pacific Journal of Information Systems	4
47	CEUR Workshop Proceedings	4
48	Cities	4
49	Industrial Management and Data Systems	4
50	Information Systems Frontiers	4

Table 1. (continued) Non-hospitality and tourism sources were highlighted in grey



Note. Each node represents a keyword, with each keyword assigned a specific color block for each time period. The connections between different keywords over time, depicted with grey lines, indicate that these keywords were mentioned together in later periods. The thickness of the grey line signifies the level of relevance of the keywords—the thicker the line, the higher the relevance. See the Appendix to check the number of papers associated with each keyword

Fig. 4 Thematic evolution in smart tourism literature

to adopt more specialized perspectives which explore particular smart tourism dimensions or the context-specific relevance of smart tourism. Lastly, regarding technology-related themes, the focus evolved from "social media" in the first period to "smart technologies" in the second period, and ultimately to "artificial intelligence" in the last period. This progression suggests that there could be numerous technological enablers for smart tourism and that the prominence of specific enablers can change over time.

Conceptualizing smart tourism 2.0

We derive two important insights from the bibliometric analysis. First, smart tourism research across disciplines continues to rely on the original smart tourism framework published in *Electronic Markets* ten years ago. Although the literature recognizes the emergence of new technologies and the analysis shows that keywords such as Artificial Intelligence achieve relatively high levels of relevance in the latest period, no new conceptual work has been published that would reflect these developments. Second, the smart tourism research discourse is shifting and diversifying to address pressing sustainability needs and to make sense of the role of emerging smart technologies from a greater array of perspectives. The range of relevant keywords has both expanded and become interconnected over the past three years. This indicates that technological enablers—particularly those associated with AI—are actively driving the development of smart tourism. With the increasing integration of AI across most aspects of tourism, it is evident that the smart tourism literature is evolving into diverse research streams aligned with various AI uses and impacts. This trend highlights the need for a comprehensive framework capable of unifying the literature. We refer to this framework as the "AI-powered smart tourism 2.0 model".

Conceptualizing the shift from smart tourism to AI-powered smart tourism 2.0 demands deep engagement with the original framework and the literature that cites it, but also a wider reading of academic and practitioner literature on technological trends. We tackled this as a team and through regular virtual meetings over a year-long time span. Adopting the framework for conceptual contributions by MacInnis (2011), we used a graphical device, namely the smart tourism layer model by Gretzel et al., 2018), as an analytical tool and engaged in iterative amendments followed by discussions to achieve the integration of emerging smart tourism perspectives. The theoretical contribution of the resulting updated framework is therefore situated at the domain-level of smart tourism and involves the provision of a holistic perspective on relevant constructs and relationships within the domain. The next section presents and discusses the updated framework.

AI-powered smart tourism 2.0

From E-tourism to smart tourism and beyond: The evolution to AI-powered smart tourism 2.0

In the original article, we compared smart tourism with E-tourism to explain the fundamental shift smart tourism involved in terms of core technologies, rationales, and priorities. Table 2 replicates this thought process across an extended number of dimensions. We introduce a column for smart tourism 2.0 to highlight smart tourism's evolution considering technological advancements, evolving economic realities, and new governance needs. This allows us to conceptualize the foundations of the AI-powered smart tourism 2.0 framework.

In terms of technological foundations, while E-tourism allowed economic activity to extend to the digital realm (Werthner, 2022), smart tourism was fundamentally about digitally connecting and enabling physical infrastructure. Smart tourism 2.0 distinguishes itself from E-tourism and smart tourism by adding a virtual layer to the mix. This virtual layer provides functionality in the form of AI-guided activity, but also emotional and embodied engagement through new experiential modalities provided through virtual or augmented reality technologies. The goal is to provide "better-than-real" tourism through seamless transitions across digital, physical, and virtual scenarios. Because of these differences in the spheres of activity, the travel phases that these evolutionary steps cater to differ as well. For E-tourism, the focus is on supporting pre- and post-travel information and communication processes and transactions (Huang et al., 2017). Smart tourism shifted its attention to

Table 2 E-tourism vs. smart tourism vs. smart tourism 2.0

	E-tourism	Smart tourism	Smart tourism 2.0
Sphere	Digital	Bridging digital and physical	Integration of digital, physical, and virtual
Core technology	Websites	Smartphones and sensors, cloud computing, Internet of Things	Artificial Intelligence, blockchain, autonomous things, digital twins, edge or neuromorphic computing, Metaverse technologies
Key innovations	Search engines, portals, online distribution channels & e-commerce	Mobile apps, platforms, recommender systems, dashboards, software as service, social commerce, open innovation	AI assistants, prompt engineering, service automation, AR for visualization and VR for virtualization
Travel phase	Pre- & post-travel	During trip	Travel and travel-like experiences anytime and anywhere in 2D or 3D
Lifeblood	Information	Big data	Omnipresent, multimodal data, synthetic data
Paradigm	Interactivity	Technology-mediated co-creation	Hybrid intelligence through AI-human integration
Structure	Value chain/intermediaries	Digital ecosystems	Embedded and embodied systems for simulation/creative design
Exchange	B2B, B2C, C2C	Public–private-consumer collaboration	Symbiotic relationships between machines and humans, horizontal/vertical aggregations of applications and platforms
Economic ramifications	Internet-enabled economy	Platform- and cloud-based economy	AI-powered economy
Governance	Marketplace governance	Platform and data governance	AI and Metaverse governance with safeguards and ethical/legal standards; socially responsible value optimization

enriching experiences while at the destination (Goo et al., 2022; Koo et al., 2017). Smart tourism 2.0, however, is characterized by blurring lines between the travel phases and between travel and non-travel experiences, offering both physical travel and travel-like experiences anytime and anywhere (Bec et al., 2021; Gretzel & Koo, 2021; Gursoy et al., 2023).

E-tourism's foundational technologies were those that supported the development of websites, allowed for the aggregation and distribution of online information, and facilitated e-commerce. In contrast, smart tourism's technological basis rests on smartphones and other mobile devices, sensors, cloud computing and the Internet of Things (IoT) (Want et al., 2015) for generating data and interaction among devices and a variety of applications. Key innovations that emerged from these technologies are a diverse landscape of mobile apps (Wang & Xiang, 2012), sophisticated platforms, real-time data dashboards, software as service, context-aware recommender systems, social commerce applications, and open innovation (Egger et al., 2016).

In smart tourism 2.0, these smart tourism technologies are complemented by AI, blockchain technologies, autonomous things (including robots and vehicles), digital twins (Deng et al., 2024), Metaverse technologies, such as virtual reality, augmented reality, and 3D modeling (Koo et al., 2023), and innovative forms of computing (e.g., neuromorphic computing and edge computing, Hu & Li, 2023) that support energy-hungry and computationally intense applications. Smart tourism 2.0 innovations that emerge from these technological developments are AI assistants that support all smart tourism stakeholders in a myriad of ways, prompt engineering as a new form of interaction with smart technology, extensive service automation (Ivanov & Webster, 2019), but also new ways to visualize and virtualize experiences, whether they involve interactions with data or with touristic offerings.

Data are considered the lifeblood of all three concepts, but different aspects have been emphasized. The focus of E-tourism is the structuring of data and the display and exchange of information. A shift in the scale of data, referred to as big data, was crucial for the move from E-tourism to smart tourism (Ardito et al., 2019; Xiang & Fesenmaier, 2017), as was the accelerated generation of and real-time access to data (Femenia-Serra & Ivars-Baidal, 2021). Open data repositories and data clearing houses or data observatories are markers of smart tourism initiatives (Alvares et al., 2020). In the smart tourism 2.0 context, data generation, processing and exchange/use becomes omnipresent and multimodal. AI provides significant opportunities for collecting and processing more data in new ways, and for moving beyond numerical and text data. Advances in computer vision and voice interactions are especially noteworthy. The emergence of machine-generated, synthetic data is another distinct characteristic of smart tourism 2.0 (Zhong & Dong, 2024). Synthetic data not only supports machine learning but has implications for overcoming data silos and combining proprietary and open data, thus allowing organizations to better leverage existing data sources.

In terms of structural and economic foundations, the three evolutionary steps also differ in their modus operandi and underpinning philosophies. E-tourism's paradigm focused on supporting interactivity, and especially on providing convenient interactions between tourists and service providers. In smart tourism, the paradigm shifted to technology-mediated co-creation among traditional and non-traditional tourism actors (e.g., sharing economy hosts and tech start-ups), with data being central to resource exchanges (Gretzel et al., 2015a, 2015b). In smart tourism 2.0, the focus is on AI-human integration, meaning the incorporation of AI into human processes rather than thinking of AI as stand-alone applications.

Distinct phases in the evolutionary process can also be observed from an economic perspective with respect to how market exchanges are facilitated, and how value is created. E-tourism's central tenet was the value chain generated by supply chains, such as intermediary platforms for booking accommodation and transportation. Intermediation, disintermediation, and re-intermediation (Law et al., 2015; O'Connor, 2023) emerged as new avenues for value generation. Optimizing B2B, B2C and C2C exchanges through technological offerings inspired E-tourism's business models. In comparison, smart tourism adopted a digital ecosystem perspective and made the facilitation of flexible, innovative digital business ecosystems a priority (Buhalis et al., 2023a, 2023b; Gretzel et al., 2015b). Within these smart tourism ecosystems, collaborations based on shared technology infrastructure and data are critical, and public–private-consumer collaborations are central (Buhalis & Amaranggana, 2014). For smart tourism 2.0, value creation shifts to embedded and embodied systems. On one hand, this means that AI and Metaverse technologies will be increasingly integrated into existing systems (like they are already being integrated into search engines and smartphones). Embodied AI, on the other hand, refers to the combination of sensors with machine learning, which will tremendously increase the monitoring and action potential of smart tourism infrastructure. The main mantra of smart tourism 2.0 is the creation of symbiotic relationships between machines and humans, for instance AI and humans working together to improve data (Peng et al., 2020). Thus, AI will be integrated and embedded in human processes such as language translation, content creation for program design, travel recommendations, and tourism marketing programs across applications and devices.

E-tourism was a main driver of a growing Internet-enabled economy. Smart tourism was intricately linked to the disruptive platform and cloud-based economy that started emerging in the early 2000s. It revolutionized the

travel industry's business models, introducing new market structures, practices, and customer value propositions (as exemplified by platforms like Airbnb and Uber Eats). Smart tourism 2.0 is aligned with the AI-powered economy and its efforts to automate and integrate services (Koo et al., 2021).

With distinct economic structures come distinct governance needs and approaches. E-tourism involved marketplace governance to regulate transactions and protect data. Smart tourism moved to platform and data governance and explored different participatory governance models. Smart tourism's governance rests on four distinct pillars: technology development, sustainability, accessibility/mobility, and creativity/innovation (Gretzel et al., 2023). It also emphasizes resilience (Gretzel & Scarpino-Johns, 2018). For the AI-powered economy with which smart tourism 2.0 is associated, new AI and Metaverse governance models that establish safeguards and ethical standards are currently being discussed and partly implemented (Werthner et al., 2024). While environmental sustainability continues to be a major concern, studies by García-Maroto et al. (2024), Gretzel and Jamal (2020), and Shen et al. (2020) have argued that the social sustainability of smart tourism needs prioritization. This is especially critical considering the social disruptions connected with the move towards the AI-powered economy. We therefore argue that smart tourism 2.0 governance will also have to consider socially responsible value optimization in addition to environmental sustainability, which will be challenged by AI-driven energy use and resource depletion.

AI-powered smart tourism 2.0 model

While the original smart tourism model explained how data flows and transformations fuel smart destination governance, value co-creation in the smart tourism business ecosystem, and enrichment of the smart tourism experience, the *AI-powered smart tourism 2.0 model* offers a more layered perspective that acknowledges the complexity of the sociotechnical system that smart tourism represents (see Fig. 5). As such, this model presents new challenges and opportunities in system design and application development, emphasizes the facilitation of human–human, human–machine, and machine-machine interactions throughout the model layers, highlights innovation needs and value creation potential, and explores governance requirements pertaining to the various layers and their intersections. It also encourages us to think about how this complexity can be transferred to research endeavors relating to smart tourism, for instance through constructivist perspectives (Hunter et al., 2015).

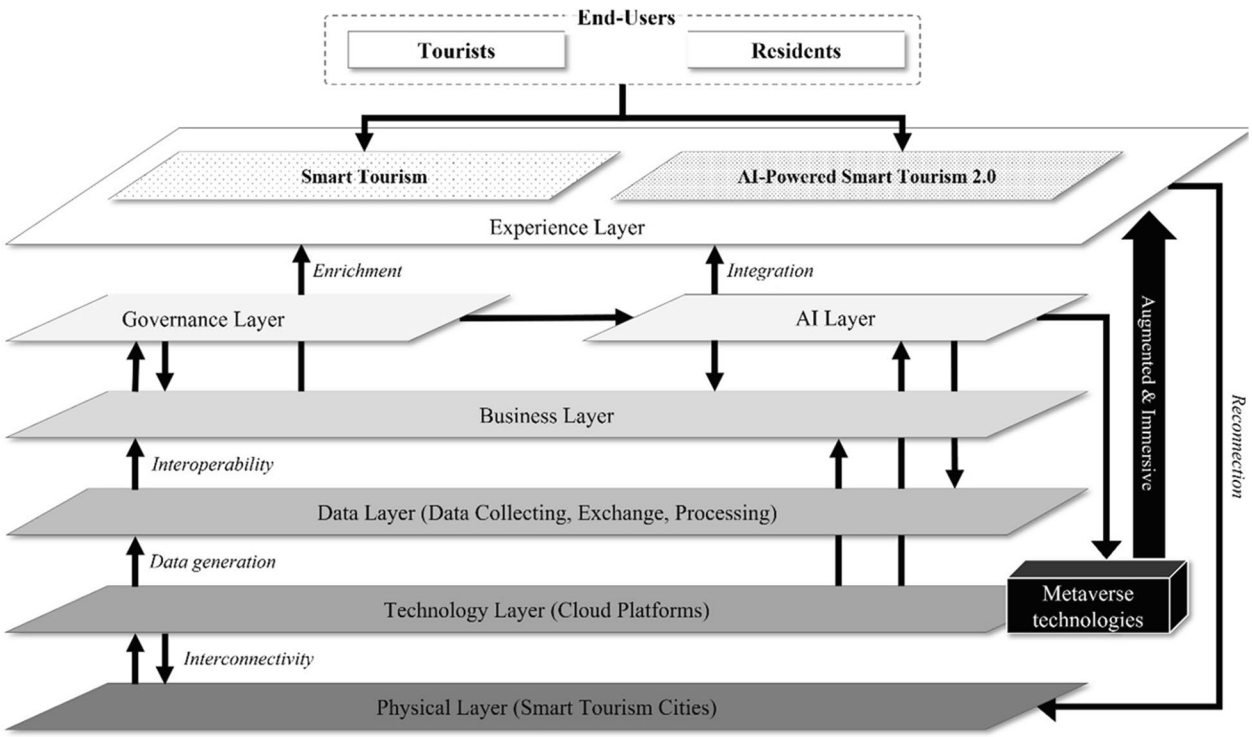


Fig. 5 AI-powered smart tourism 2.0 framework (Adapted from Gretzel et al., 2023). The parallelograms represent specific layers within the system. Arrows depict the flow of data between the different system layers, while the downward arrows pointing to the experience layer illustrate how both residents and tourists simultaneously engage with traditional smart tourism offerings and AI powered smart tourism 2.0 experiences. Italicized text is used to emphasize the functional roles and business implications of each layer. Shading is included solely for visual distinction and does not convey specific meanings

At its core, the *AI-powered smart tourism 2.0 model* recognizes that the interconnectedness between the physical and technological layers within a smart tourism system, as envisioned by the IoT, create the foundation for the kinds of phygital experiences smart tourism offers (Ballina et al., 2019). It further builds on earlier conceptualizations that situate smart tourism within the broader contexts of smart cities, recognizing that much of the physical and technological infrastructure employed by smart tourism is not necessarily restricted to tourism uses (Gretzel & Koo, 2021). It extends the technological layer by adding Metaverse technologies, including the hardware and software needed to implement Metaverse applications. AI-related technologies form a separate layer because of their centrality for smart tourism 2.0. The technological and physical layer together generate data, which are collected, processed and exchanged within the data layer. The business layer transforms data into value propositions and the governance layer monitors resources and guides processes within the smart tourism ecosystem. From these base layers emerges the experience layer, which offers technologically enriched smart tourism experiences enjoyed by tourists and residents alike. The central AI layer supports the integration of technology and data into the experience layer but also feeds data and insights back into the business and data layers and supports the realization of immersive Metaverse offerings.

The introduction of Metaverse technologies and of an AI layer adds important opportunities that AI-powered smart tourism 2.0 seizes, but also unique challenges that an AI-powered smart tourism 2.0 system needs to tackle. As extensions of the technological layer, Metaverse technologies create more and more diverse and complex data. At the same time, they directly affect the experience layer by offering augmented and immersive experiences beyond those currently offered by smart tourism (Ioannidis & Kontis, 2023; Koo et al., 2023). These immersive offerings have obvious experiential and economic value, but issues relating to accessibility, authenticity and representation, privacy, consumer vulnerabilities, energy consumption, barriers to sustainable behavior, e-waste, etc. will have to be tackled in the governance layer, which therefore assumes a much more prominent role than in the original framework.

Following Yigitcanlar et al.'s (2020) conceptualization of AI as involving multiple paradigms ranging from logic-based to probabilistic and sub-symbolic approaches and affecting various domains of smart development (i.e., perception, reasoning, knowledge, planning, communication), the AI layer is conceptualized as encompassing a broad spectrum of AI approaches, technologies and applications such as large language learning models, and various stand-alone and embedded AI applications. The AI layer is supported by the technological, data, and business layers and regulated by the governance layer. Importantly, it also contributes to the data and business layers. For example, the function of AI is becoming increasingly vital for data integration and transaction processing, encompassing both social data sources and structured database administration. Its role in business innovation is also increasingly recognized (Jorzik et al., 2024; Wang et al., 2022). Its effect on the experience layer happens indirectly through its support of Metaverse technologies (Randieri, 2023) and directly through its increasing integration into all aspects of tourism experiences (Bulchand-Gidumal, 2022; Grundner & Neuhofer, 2021).

The integration of Metaverse technologies and AI will drive progress in three key areas: augmented reality 3D environments, contextual real-time analysis and human-like dialogue, and advanced visualization, including holographic displays across interconnected devices such as phones, watches, earphones, glasses, and head-mounted displays. The result is an AI-powered smart tourism experience that is more efficient, personalized, relevant, augmented, and immersive (Stankov et al., 2025). It also shapes the physical interaction with the destination, e.g., by changing tourist and resident mobilities, reconnecting the experience layer with the physical layer (Signorile et al., 2018). At the same time, AI-powered smart tourism allows for the spatial and temporal extension of the tourism experience beyond the constraints of the physical destination and the actual visitation period.

Yet, as discussed above, the AI layer also introduces new governance needs. While the model suggests a relationship between governance and AI, it is not clear what this involves. Existing IT governance models are conceptualized at the organizational level and cannot be directly transferred to complex AI-powered smart tourism 2.0 ecosystems. Similar issues have been identified for Metaverse ecosystems by Schöbel and Leimeister (2023). On the other hand, digital humanism discussions (Werthner et al., 2024) are too broad and philosophical to offer concrete suggestions for governing AI and Metaverse developments and uses within smart tourism contexts. AI-powered smart tourism 2.0 therefore requires advances in data and IT governance models.

Smart tourism elevated the travel experience by integrating mobile technology and enabling real-time connectivity. Through smartphones, sensors, and big data analytics, it bridged digital and physical experiences, permitting travelers to actively co-create their journeys through platforms like Expedia, TripAdvisor, and Airbnb, leading to more personalized and interactive travel experiences. It provided businesses with new value (co-)creation opportunities and destinations with enhanced governance capabilities through data. The AI-powered smart tourism 2.0 model extends smart tourism experiences beyond the immediate physical destination and augments them by minimizing inconveniences (e.g., language barriers and

uncertainty, Fujisaki et al., 2022) and by increasing their immersiveness. Through the integration of AI into all its processes, smart tourism 2.0 also supports tourists, residents, businesses and governing bodies with new abilities to engage with data and make decisions. Additionally, it offers new interfaces for interaction among human and non-human actors within the smart tourism system. AI integration and hybrid intelligence form the basis of AI-powered smart tourism 2.0.

Looking specifically at the experience layer, we illustrate how AI-powered smart tourism 2.0 changes fundamental aspects of smart tourism. In the initial phases of smart tourism development, the smartphone evolved from a simple communication device to serving as a multifunctional platform, supporting activities such as calling, texting, internet browsing, photography, GPS navigation, app usage, and social networking. With AI-powered smart tourism 2.0, a new paradigm is emerging. With the smartphone now being AI-powered (Stankov et al., 2025) and connectable to wearable devices, it enables the seamless interplay between AI-powered applications, Metaverse technologies, tourism offerings and destination features. Within our proposed framework, AI and Metaverse technologies work together to facilitate and mediate traveler behaviors, transforming how travelers engage with both virtual and physical tourism environments. For AI-powered Metaverse experiences, for instance, we identify three types of virtual interactions:

- Traveler avatar interacts with service avatar: Travelers engage with AI-powered service avatars in branded environments within the Metaverse to perform tasks such as hotel bookings and virtual check-ins. These service avatars provide efficient, personalized support and create immersive service experiences that often surpass those available in the physical world.
- Traveler avatar interacts with resident avatar: Traveler avatars interact with resident avatars within themed virtual environments, such as amusement parks or cultural heritage sites. These interactions foster social exchange, allowing users to share advice, experiences, and participate in activities that transcend cultural, linguistic, and physical barriers.
- Traveler avatar interacts with traveler avatar: Travelers use the Metaverse to share authentic reviews and personalized virtual narratives based on their real-world experiences. AI enhances this process by curating and organizing content, making valuable insights more accessible and facilitating peer-to-peer learning.

Through these interactions, AI and Metaverse technologies collectively redefine how travelers purchase, plan, experience, share, and navigate tourism. However, the AI-powered smart tourism 2.0 model also suggests that many different pieces across all the layers need to be in place for these experiences to be feasible and safe.

Conclusion

The AI-powered smart tourism 2.0 model represents the current frontier of technology-enabled tourism development, enabled by AI and Metaverse technologies. This new adaptation of smart tourism creates symbiotic relationships between human users and AI-powered systems. The integration of AI into the very fabric of tourism systems fundamentally reimagines how we engage with travel in physical, virtual, and phygital realms. This progression reflects not just technological advancement, but a fundamental shift from simple digital presence to complex, AI-human symbiotic relationships and communal ecosystems that continuously enhance the travel experience through human–machine collaboration. On the supply side, these ecosystems drive innovation through new service design and new business models, while on the demand side they facilitate different types of experiences characterized by less friction, heightened personal relevance, more cognitive and emotional stimulation, greater embodied immersion, and reduced negative impacts on destinations. Throughout all layers, AI enhances interoperability and integration across platforms and stakeholders, enabling hybrid intelligence—where human insight and AI capabilities combine to achieve superior outcomes (Dellermann et al., 2021).

Despite this potential, the hospitality and tourism industries may not yet see AI as a sufficient catalyst for operational improvement. AI integration remains limited in key operational areas. While some progress has been made in providing online review summaries, translating content, automating marketing communications, using AI for revenue management, and employing chatbots to deliver guest services, much of AI's potential remains untapped. There are also operational as well as governance challenges that remain untackled, for instance, the complexity of integrating legacy systems and AI applications or dealing with the hallucinations by AI in the process of creating travel itineraries (Christensen et al., 2024). The increasing dependence on AI also suggests that updated IT malfunction models are overdue to help businesses, governing bodies, and entire destination ecosystems prepare for or mitigate AI-outages and errors. Overall, the introduced AI-powered smart tourism 2.0 model can help smart tourism practitioners identify development and business opportunities as well as resources/capacity gaps, vulnerabilities, and uncertainties that can stifle smart tourism 2.0 development efforts.

Every layer and every relationship in the AI-powered smart tourism 2.0 model represents a research opportunity in terms of understanding technological and human needs,

processes, and changing relationships. Smart tourism 2.0 research should examine the nature and implications of AI within broader sociotechnical systems rather than focusing solely on the technology itself. The notion of AI integration across smart tourism layers further challenges current notions of information systems that assume neat organizational boundaries. Smart tourism 2.0 therefore constitutes a rich conceptual playground for testing existing information systems theories and for developing new ones. There is also a need to theoretically link the elements within the model to the four pillars of smart tourism (i.e., technology development, sustainability, accessibility/mobility, and creativity/innovation, Gretzel et al., 2023) and to adapt the original smart tourism governance mandates for smart tourism 2.0 needs. This ties into efforts to define and develop "Responsible AI" (Mikalef et al., 2022). In addition, the complexities of AI sensemaking and acceptance by human actors (Kim et al., 2023) need to be further explored. Such research should not be limited to tourists and local visitors but also include service providers and extend to understanding AI-fueled workplace transformations. Several areas of research emerge from the emergence of heterogeneous data within the smart tourism 2.0 system and the resulting need for new data management approaches and new research methodologies.

Future research should also focus on the practical implementation of smart tourism 2.0 principles, measuring their impact on various stakeholders, and continuously adapting the model to emerging technologies and changing global dynamics. Traditional IS success models originally focused on system quality and information quality (DeLone & McLean, 1992) and their ten-year update, which added service quality (DeLone & McLean, 2003), offer useful evaluation frameworks but fall short in capturing the diverse experiential, social, environmental, and economic outcomes enabled by AI integration. We need interdisciplinary efforts to develop methodologies that can measure complex outcomes beyond existing indicator systems (e.g., Ivars-Baidal et al., 2021). By developing new measurement approaches, we can ensure that smart tourism continues to evolve in a way that benefits travelers, businesses, destinations, local communities, and the environment alike.

This paper positions current smart tourism at a transitional phase where foundational concepts coexist with the emerging opportunities and challenges introduced by AI and Metaverse technologies. While the majority of users continue to engage with smart tourism primarily through smartphone-based functional services, an increasing number of commercial actors are exploring advanced AI and Metaverse experiences that span digital, physical, and virtual realms. Our framework, therefore, integrates both the established and emerging dimensions of smart tourism. We contend that, although AI and Metaverse technologies have not yet fully replaced the existing data-centered, information-processing-focused smart tourism model, they signal significant future directions and hold transformative potential for smart tourism.

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