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# Exploring the landscape of smart tourism: A systematic bibliometric review of the literature of the internet of things

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*Review*

# Exploring the Landscape of Smart Tourism: A Systematic Bibliometric Review of the Literature of the Internet of Things

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**Abstract:** This study explores the transformative impact of IoT technologies on smart tourism, striving to boost operational efficiency and enrich the traveler experience. Using a systematic literature review with bibliometric analysis, we examined a sample of 83 studies indexed in SCOPUS to identify research activity on this topic until November 2023. The integration of cutting-edge technologies, including big data, smart sensors, cloud computing, machine learning, artificial intelligence, wearables, mobile applications, augmented reality, and virtual reality, establishes the foundation of the IoT-enabled smart tourism ecosystem. These innovations bring distinct capabilities, from facilitating data collection with embedded sensor technologies to using cloud computing for essential services like data storage and analytics. Examining various IoT applications in smart tourism, such as recommender systems, smart cities, payment systems, and electronic ticketing, reveals their positive effects on safety, efficiency, and personalized services. However, challenges like security, privacy, software complexity, scalability, and interoperability necessitate robust measures. This study identifies future research directions, including enhancing security and privacy, exploring blockchain integration, investigating edge computing, and improving interactions between tourists and smart tourism systems. These endeavors aim to address challenges and seize opportunities, fostering innovative solutions for the evolving needs of the tourism industry in a technologically advanced landscape.

**Keywords:** smart tourism; Internet of Things; IoT technologies; systematic literature review; bibliometric analysis

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## 1. Introduction

The rapid evolution of information technology has spurred a growing demand for precise and efficient technologies and information systems. This surge in demand has catalyzed the onset of the Industrial Revolution 4.0, marked by the development of advanced technologies reshaping the entire value creation chain. Key among these transformative technologies is the Internet of Things (IoT), a revolutionary innovation that interconnects people, objects, systems, and processes to the Internet through a virtual network (Rymarczyk 2020; Car et al. 2019).

In essence, the IoT enables the seamless communication of everyday devices embedded with computing technologies in real-time, thereby revolutionizing data collection, processing, and transmission. This paradigm shift finds extensive applications across various industries, with tourism standing out as a major beneficiary (Hamzah et al. 2022). As a pivotal service industry catering to local and global customers, tourism has emerged as a significant driver of internet use (Wise and Heidari 2019). Leveraging information technologies, the tourism sector connects tourists with hotels, entertainment, attractions, and transportation, fostering improved efficiency, productivity, customer satisfaction, and overall experience through the adoption of IoT.

The integration of information and communication technology (ICT) tools within the framework of smart tourism further enhances accessibility to products, services, experiences, and spaces. These practices contribute to improved resource management, operational efficiency, and elevated customer service standards. The incorporation of IoT into smart tourism supports the development of smart services, applications, and management strategies, thus promoting evidence-based practices (Wise and Heidari 2019). Notably, the infusion of IoT in the tourism industry has opened numerous opportunities by expanding access to information, refining content marketing strategies, and integrating social media interactions. Furthermore, IoT enables access to cutting-edge innovations such as big data, wearables, and sensors, empowering companies to collect and analyze data for informed decision-making (Dlodlo et al. 2016).

Given the pivotal role tourism plays in contributing to a country's GDP, the judicious application of these revolutionary innovations holds the potential to significantly boost both local and international economies. The transformation brought about by IoT in the tourism ecosystem is evident in interconnected transportation systems, personalized experiences, and enhanced sustainability. Connected transportation systems, for instance, provide travelers with real-time updates, allowing professionals to predict congestion and optimize routes (Car et al. 2019). Moreover, IoT facilitates streamlined check-in processes, personalized room preferences, and energy-efficient room management.

However, it is crucial to acknowledge potential challenges in the widespread adoption of IoT in smart tourism. As highlighted by Novera et al. (2022), issues such as inadequate data infrastructure and insufficient data security measures can pose significant obstacles. Considering these challenges, this systematic bibliometric literature review synthesizes data from 83 sources, offering a comprehensive exploration of the applications, opportunities, and challenges associated with the use of IoT in smart tourism.

## 2. Materials and Methods

The literature search adhered to the guidelines outlined by the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) for the identification, screening, and determination of study eligibility (Moher et al. 2009). Initially, the Scopus database was chosen to select pertinent sources, including journal articles, conference papers, and book chapters, to mitigate potential publication bias. The keyword "smart tourism" was initially employed, yielding 1248 documents. To refine the relevance of the sources, the specific term "internet of things" was subsequently added. Following the database search, duplicate entries were removed, and the remaining studies underwent a two-stage screening process.

The first stage involved screening titles, keywords, and abstracts to evaluate the studies' relevance to the research topic, excluding those not meeting the inclusion and exclusion criteria. The eligibility criteria encompassed: (i) exclusion of studies containing information unrelated to the use of IoT in smart tourism; (ii) inclusion of peer-reviewed academic publications, such as journal articles, book chapters, and conference papers; (iii) restriction to sources published within the 2013–2023 timeframe to capture developments in IoT and smart tourism; (iv) inclusion of studies specifying their methodological criteria; and (v) incorporation of sources published in English. The second step involved a full-text screening for the sources that passed the initial screening, with exclusions based on content relevance to the research topic and adherence to eligibility standards, as illustrated in Figure 1 below.

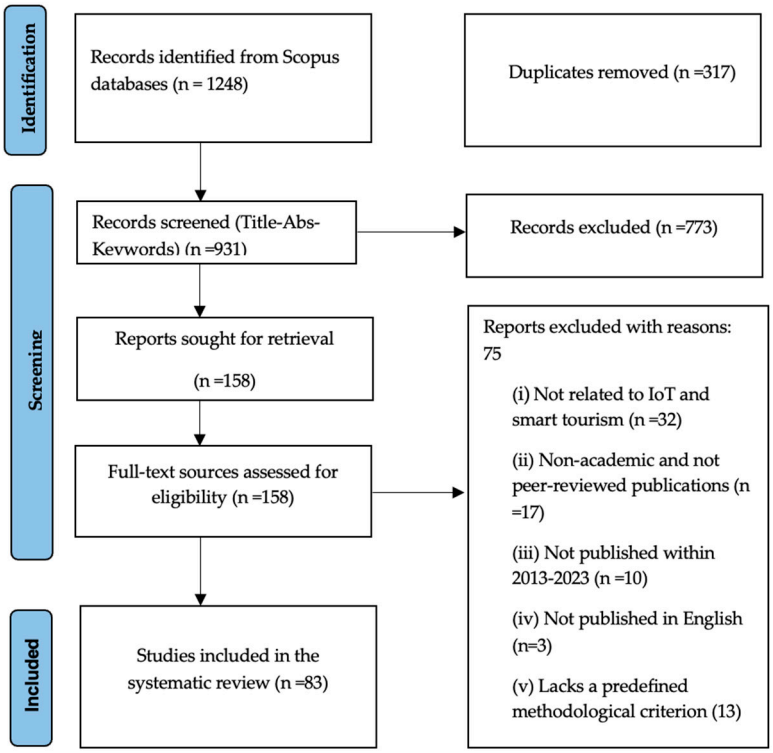


**Figure 1.** Network of all keywords. Source: Segmentation criteria—adaptation from the PRISMA model (Moher et al. 2009).

The decision to exclusively use Scopus was based on its prominence as the primary repository for academic journals and magazines, hosting around 19,500 titles from over 5000 global publishers. This repository encompasses 16,500 peer-reviewed journals across scientific, technical, medical, and social sciences, providing a comprehensive perspective on subjects of genuine scientific and academic significance. However, it is essential to acknowledge that this study's focus is confined to the Scopus database, with the exclusion of other academic databases, as discussed in the works by Rosário and Dias (2023), Rosário et al. (2021), and Raimundo and Rosário (2021). Among the 83 scientific and/or academic documents, 47 are conference papers, 33 are articles, 2 are book chapters, and 1 is retracted.

## 3. Literature Analysis: Themes and Trends

The examination of peer-reviewed documents extended until November 2023, revealing that the year 2022 witnessed the highest volume of publications on the subject, totaling 23. Figure 2 provides a comprehensive analysis of peer-reviewed publications extending through 2023, categorized as follows: the Advances In Intelligent Systems And Computing series (four); the ACM International Conference Proceeding Series (four); *Wireless Communications And Mobile Computing* (three). Publications with two instances include *Mobile Information Systems*, *Journal Of Sensors*, the Iberian Conference On Information Systems And Technologies (CISTI), IEEE Access, and International Wireless Communications And Mobile Computing (IWCMC) 2021. Remaining publications had a count of one each. The data suggest a notable surge in research interest on the topic of smart tourism Internet of Things in the year 2023.

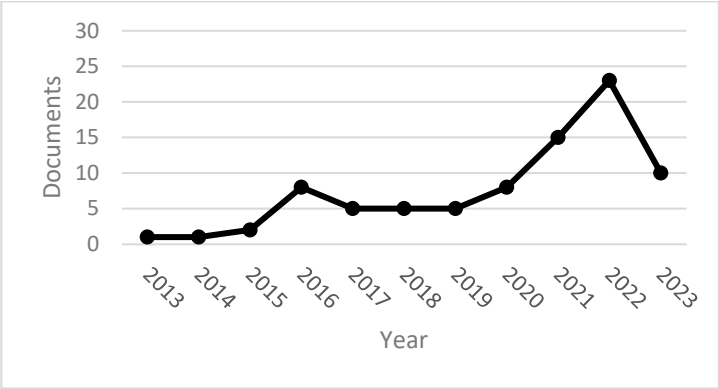


**Figure 2.** Documents by year. Source: own elaboration.

In Figure 3, the countries with the most significant scientific output in specific research areas are highlighted, placing a particular emphasis on China, Italy, and India, which stand out as the leading contributors with the highest number of publications.

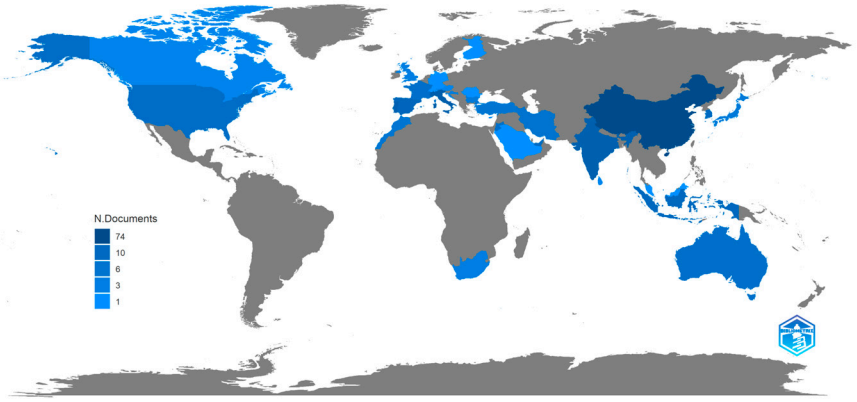


**Figure 3.** Scientific production by country.

Table 1, along with Figure 3, visually illustrates the top 10 nations making notable scientific contributions in the examined domains. The objective of this investigation is to identify countries that prioritize harnessing cutting-edge technology in the realm of smart tourism Internet of Things.

**Table 1.** Top 10 countries by number of publications.

| Country | Number of Publications |
|---|---|
| China | 74 |
| Italy | 23 |
| India | 19 |
| Portugal | 18 |
| Spain | 12 |
| Indonesia | 11 |
| South Korea | 10 |
| United Arab Emirates | 9 |
| USA | 8 |
| Australia | 7 |

Source: own elaboration.

In Table 2, we assess the Scimago Journal and Country Rank (SJR), focusing on the best quartile and the H index by publication. The IEEE Network emerges as the highest quality, with an SJR of 4.270, Q1 designation, and an H index of 143. Among the 70 publication titles, 13 fall into the best quartile (Q1), 7 in Q2, 7 in Q3, and 5 in Q4. Q1 publications account for 19% of the total, Q2 for 10%, Q3 for 10%, and Q4 for 7%, while data for 38 publications are not available, constituting 54%. Table 2 underscores that the substantial majority of articles on smart tourism Internet of Things hold positions in the Q1 best quartile index.

**Table 2.** Scimago journal and country rank impact factor.

| Title | SJR | Best Quartile | H Index |
|---|---|---|---|
| *IEEE Network* | 4.270 | Q1 | 143 |
| *IEEE Internet Of Things Journal* | 3.750 | Q1 | 149 |
| *Technological Forecasting And Social Change* | 2.640 | Q1 | 155 |
| *Electronic Markets* | 1.550 | Q1 | 49 |
| *ACM Transactions On Internet Technology* | 1.210 | Q1 | 63 |
| *EURASIP Journal On Wireless Communications And Networking* | 0.990 | Q1 | 70 |
| *Geo Spatial Information Science* | 0.970 | Q1 | 33 |
| *IEEE Access* | 0.930 | Q1 | 204 |
| *IEEE Consumer Electronics Magazine* | 0.920 | Q1 | 45 |
| *Mobile Networks And Applications* | 0.840 | Q2 | 92 |
| *Soft Computing* | 0.820 | Q2 | 102 |
| *Sensors* | 0.760 | Q1 | 219 |
| *Journal Of Tourism Futures* | 0.760 | Q1 | 27 |
| *Multimedia Tools And Applications* | 0.720 | Q1 | 93 |
| *Journal Of Simulation* | 0.690 | Q2 | 28 |
| *Journal Of Supercomputing* | 0.680 | Q2 | 74 |
| *Procedia Computer Science* | 0.510 | - * | 109 |
| *Security And Communication Networks* | 0.490 | Q2 | 58 |
| *Mediterranean Archaeology And Archaeometry* | 0.480 | Q1 | 22 |
| *Wireless Communications And Mobile Computing* | 0.450 | Q2 | 73 |
| *Computer Journal* | 0.420 | Q2 | 70 |
| *Journal Of Information Processing Systems* | 0.380 | Q3 | 28 |
| *Journal Of Sensors* | 0.370 | Q3 | 57 |
| *Mobile Information Systems* | 0.360 | Q3 | 42 |
| *Scientific Programming* | 0.300 | Q3 | 39 |
| *International Journal Of Embedded Systems* | 0.270 | Q4 | 18 |
| *International Journal Of Electronic Government Research* | 0.270 | Q3 | 33 |
| *IFIP Advances In Information And Communication Technology* | 0.260 | Q3 | 60 |
| *Computer-Aided Design And Applications* | 0.260 | Q3 | 35 |
| *ACM International Conference Proceeding Series* | 0.210 | - * | 137 |
| *Communications In Computer And Information Science* | 0.190 | Q4 | 62 |
| *Smart Innovation Systems And Technologies* | 0.170 | Q4 | 31 |
| *Proceedings Of SPIE The International Society For Optical Engineering* | 0.170 | - * | 187 |
| Lecture Notes In Networks And Systems | 0.150 | Q4 | 27 |
| Lecture Notes In Electrical Engineering | 0.150 | Q4 | 40 |
| *Advances In Intelligent Systems And Computing* | 0 | - * | 58 |
| Iberian Conference On Information Systems And Technologies (CISTI) | 0 | - * | 20 |

**Table 2.** *Cont.*

| Title | SJR | Best Quartile | H Index |
|---|---|---|---|
| WEBIST Proceedings Of The 12th International Conference On Web Information Systems And Technologies 2016 | 0 | - * | 5 |
| Proceedings Of the 2nd International Conference On Next Generation Computing Technologies (NGCT) 2016 | 0 | - * | 15 |
| Proceedings Of The International Conference On Intellectual Capital Knowledge Management And Organizational Learning (ICICKM) | 0 | - * | 5 |
| Proceedings Of the Joint 8th International Conference On Soft Computing And Intelligent Systems 2016 And 17th International Symposium On Advanced Intelligent Systems (SCIS; ISIS) 2016 | 0 | - * | 8 |
| Proceedings Of The 12th International Conference On Signal Image Technology And Internet Based Systems (SITIS) 2016 | 0 | - * | 13 |
| *Journal Of Physics Conference Series* | 0 | - * | 91 |
| *International Journal Of Pharmacy And Technology* | 0 | - * | 23 |
| Digest Of Technical Papers IEEE International Conference On Consumer Electronics | 0 | - * | 32 |
| Conference Of Open Innovation Association Fruct | 0 | - * | 20 |
| CEUR Workshop Proceedings | 0 | - * | 62 |
| *Boletin Tecnico; Technical Bulletin* | 0 | - * | 10 |
| *Advanced Materials Research* | 0 | - * | 47 |
| IEEE International Smart Cities Conference (ISC2) 2018 | 0 | - * | 15 |
| First Africa Conference Africa 2016 | 0 | - * | 10 |
| *International Wireless Communications And Mobile Computing* (IWCMC) 2021 | - * | - * | - * |
| Proceedings Of The International Research Conference On Smart Computing And Systems Engineering (SCSSE) 2021 | - * | - * | - * |
| Proceedings Of The International Conference On Artificial Intelligence Of Things ICAIOT 2021 | - * | - * | - * |
| Proceedings Of The International Computer Software And Applications Conference | - * | - * | - * |
| Proceedings Of The IEEE ACM 15th International Conference On Utility And Cloud Computing UCC 2022 | - * | - * | - * |
| Proceedings Of The Eighth NAFOSTED Conference On Information And Computer Science (NICS) 2021 | - * | - * | - * |
| Proceedings Of The International Conference On Big Data Artificial Intelligence And Internet Of Things Engineering (ICBAIE) 2020 | - * | - * | - * |
| Lecture Notes In Computer Science Including Subseries Lecture Notes In Artificial Intelligence And Lecture Notes In Bioinformatics | - * | - * | - * |
| Fourth International Conference On Electronic Engineering And Informatics (EEI) 2022 | - * | - * | - * |
| Big Data And Innovation In Tourism Travel And Hospitality Managerial Approaches Techniques And Applications | - * | - * | - * |
| International Conference On Emerging Smart Computing And Informatics (ESCI) 2023 | - * | - * | - * |
| Ninth International Conference On Advanced Computing And Communication Systems (ICACCS) 2023 | - * | - * | - * |
| IEEE Ninth International Conference On Problems Of Infocommunications Science And Technology PIC S And T Proceedings (IEEE) 2022 | - * | - * | - * |

**Table 2.** *Cont.*

| Title | SJR | Best Quartile | H Index |
|---|---|---|---|
| Ninth International Conference On Internet Of Things Systems Management And Security (IOTSMS) 2022 | - * | - * | - * |
| IOT Vertical And Topical Summit For Tourism 2021 | - * | - * | - * |
| International Conference On Computer System Information Technology And Electrical Engineering (COSITE) 2021 | - * | - * | - * |
| Global Information Infrastructure And Networking Symposium (GIIS) 2020 | - * | - * | - * |
| Fifth International Conference On Informatics And Computing (ICIC) 2020 | - * | - * | - * |
| IEEE Global Conference On Internet Of Things GCIOT 2019 | - * | - * | - * |

Note: * data not available. Source: own elaboration.

The 83 scientific and/or academic documents covered a range of thematic areas, including Computer Science (71), Engineering (34), Decision Sciences (15), Mathematics (12), Physics and Astronomy (10), Social Sciences (6), Business, Management, and Accounting (6), Materials Science (4), Medicine (2), Environmental Science (2), Economics, Econometrics, and Finance (2), Psychology (1), Pharmacology, Toxicology, and Pharmaceutics (1), Earth and Planetary Sciences (1), Chemistry (1), Biochemistry, Genetics, and Molecular Biology (1), and Arts and Humanities (1).

The most cited article, "Smart tourism: foundations and developments" by Gretzel et al. (2015), boasts 977 citations and was published in *Electronic Markets*. It holds an SJR of 1.550, designating it as the best quartile (Q1), and an H index of 49. The paper's objective was to define smart tourism, illuminate current trends, and outline its technological and business foundations.

Figure 4 allows us to examine the evolution of document citations until 2023. The number of citations exhibits positive net growth, with an R2 of 85% for the year 2022, totaling 531 citations and reaching a cumulative total of 2382 citations.

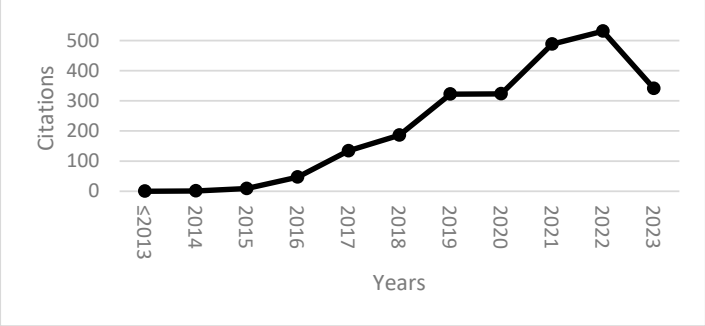


**Figure 4.** Evolution of citations between ≤2013 and until 2023. Source: own elaboration.

The assessment of productivity and impact of published works utilized the h-index, which considers the largest set of articles with a minimum number of citations equal to the index value. Among the documents assessed for the h-index, 13 had been cited a minimum of 13 times.

In Appendix A, Table A1 provides an analysis of citations for all scientific and/or academic documents until 2023. During this period, 21 documents did not receive any citations, resulting in a total of 2382 citations.

Figure 5 visually represents the bibliometric analysis conducted to explore and identify indicators reflecting the dynamics and evolution of scientific information. The examination of bibliometric results, facilitated by the scientific software VOSviewer 1.6.18, aims to identify the primary research keywords within studies in the smart tourism Internet of Things research domain.

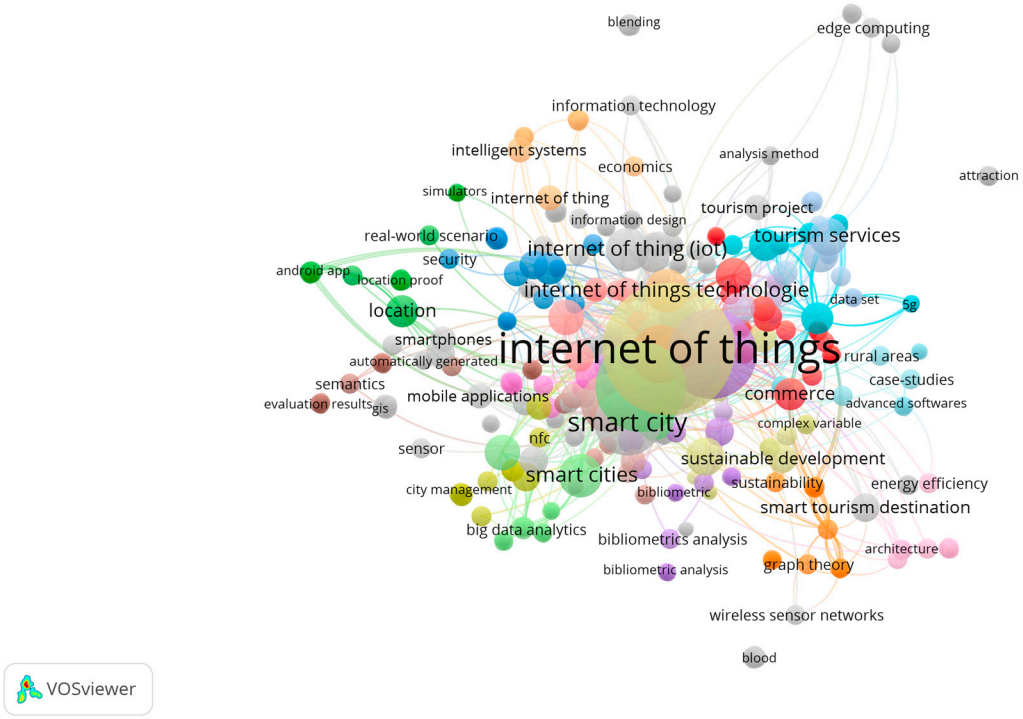


**Figure 5.** Network of all keywords.

The research conducted a thorough analysis of articles related to smart tourism Internet of Things. Figure 6 visually presents the associated keywords, providing clarity on the interconnected network of terms found in each scientific article. This visualization aids in comprehending the topics explored by researchers and assists in identifying potential future research trends. Furthermore, Figure 7 illustrates numerous bibliographic couplings, utilizing a cited reference unit of analysis.

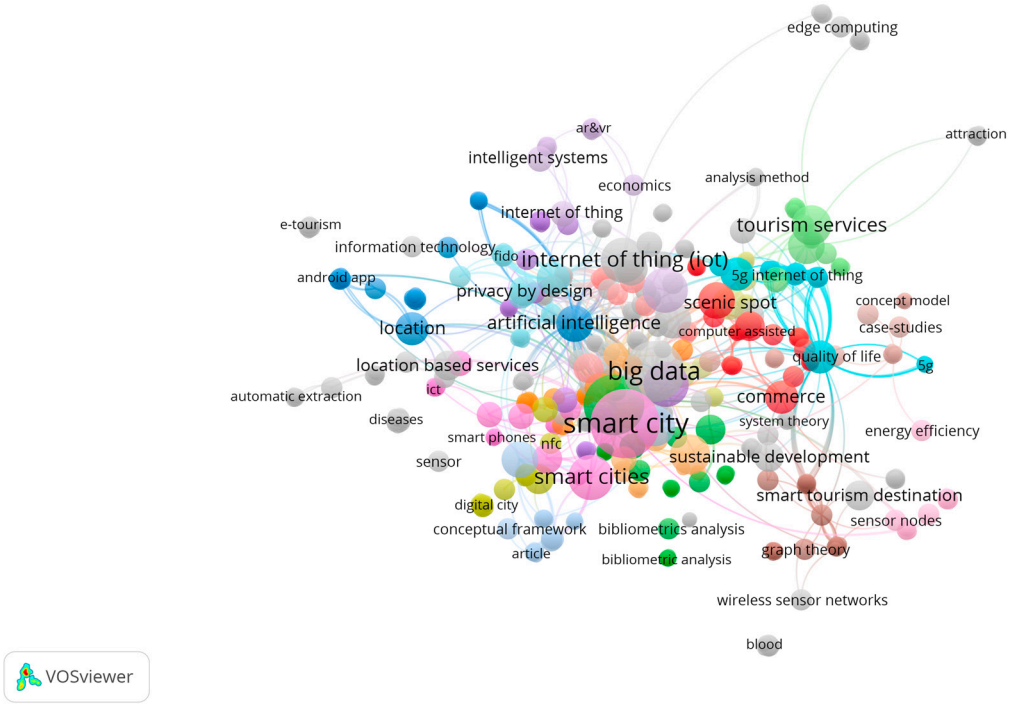


**Figure 6.** Network of linked keywords.

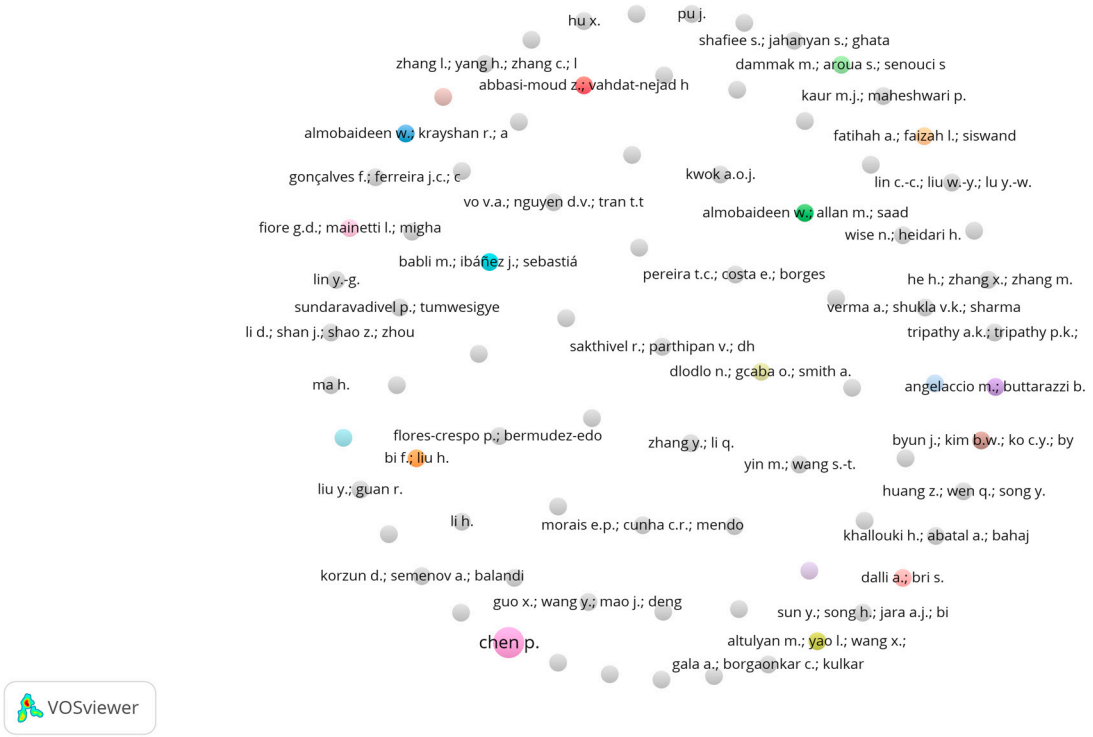


**Figure 7.** Network bibliographic coupling.

## 4. Theoretical Perspectives

In smart tourism, the integration of IoT plays a transformative role, elevating, and customizing the travel experience. IoT technologies are utilized to establish intelligent and interconnected ecosystems that harmonize various facets of the tourist journey (Abbasi-Moud et al. 2019). For example, smart sensors embedded in urban infrastructure, transportation systems, and tourist destinations enable real-time data collection, facilitating efficient crowd management, traffic optimization, and personalized recommendations for tourists (Chen 2021c; Hu 2022). Wearable devices and mobile applications equipped with IoT capabilities provide travelers with immediate access to location-based information, augmented reality guides, and interactive maps (Kwok 2023). These opportunities enhance operational efficiency for tourism companies while simultaneously improving the experience and satisfaction of travelers. Moreover, the interconnectedness of IoT devices in smart tourism contributes to the convenience of travelers and supports the sustainable and efficient management of tourism destinations.

### *4.1. Defining Concepts*

#### 4.1.1. Internet of Things (IoT)

The term "Internet of Things" was coined by Kevin Ashton in 1999. This concept denotes an extensive network of interconnected devices and technologies designed to facilitate communication and data collection (Korzun et al. 2022). Objects within the IoT network are equipped with technologies like sensors, network connectivity, and software, enabling them to gather and disseminate information (Liu 2022). Table 3 provides a summary of diverse definitions of IoT identified through research.

**Table 3.** Definitions of IoT.

| IoT Definition/Description | Author |
| --- | --- |
| IoT describes "scenarios in which Internet connectivity and computing capability extend to a variety of objects, devices, sensors, and everyday items". | Rose et al. (2015, p. 7) |
| IoT is a "network that can connect with anything anytime and anyplace by technologies of RFID (Radio Frequency IDentification), WSN (Wireless Sensor Network) and 3G/4G/5G mobile communication, according to an agreed protocol, in order to identify, locate, track, monitor and manage smart objects". | Car et al. (2019, p. 164) |
| IoT is a global system that connects physical and virtual objects using interoperable ICT tools to enable advanced services. | Verma et al. (2021) |
| IoT is a technology that uses information sensing technologies such as global positioning system (GPS) and radio frequency identification (RFID) to facilitate information exchange between objects or people and objects. | Huang et al. (2022) |
| IoT is a network that uses information-sensing equipment to connect objects to the Internet following an agreed-upon protocol. It is designed to intelligently identify, position, monitor, track, and manage smart objects. | Feng et al. (2022) |

The Internet of Things (IoT) empowers any object to connect to the Internet from any location and at any time, resulting in a complex structure involving various technical infrastructures, ranging from sensors to terminal servers and computers. Huang et al. (2022) elaborate on the division of IoT infrastructure into four layers: application, service, transport, and perception layers, as illustrated in Figure 8. The perception layer, situated at the system's bottom structure, comprises sensors and identification equipment used to detect external information. The transport layer involves multiple gateways transmitting data through the IP/TCP protocol (Huang et al. 2022; Liu and Guan 2022). It transmits and uploads data to the service layer, which subsequently processes, analyzes, and stores the information (Zeng 2022). Positioned atop the system structure, the application layer is responsible for system responses such as real-time monitoring, system management, and addressing parameter abnormalities. This layer directly engages with people. Through these layers, the IoT network can effectively collect and process substantial amounts of data, facilitating data-driven strategies and decision-making.

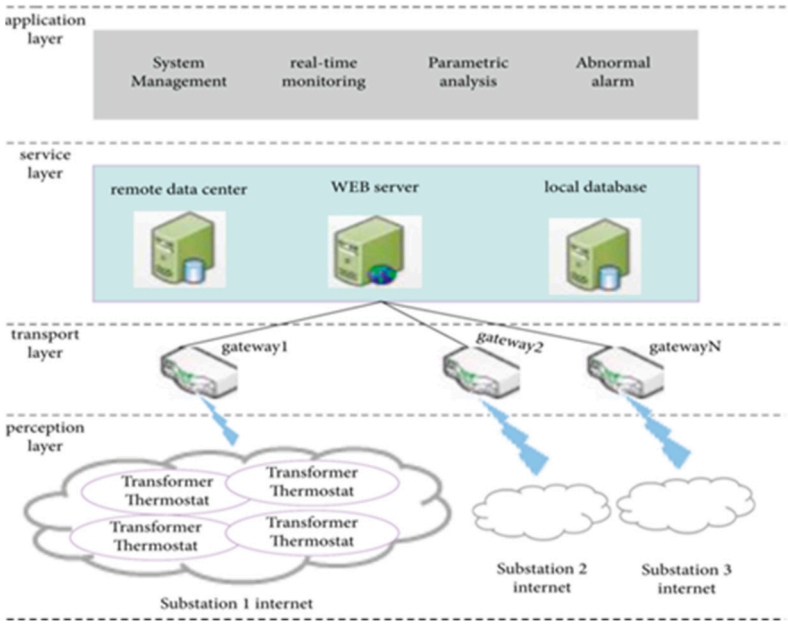


**Figure 8.** Layers of the IoT Infrastructure (Huang et al. 2022).

#### 4.1.2. Smart Tourism

Smart tourism entails the incorporation of cutting-edge technologies to enhance and optimize the overall travel experience (refer to Table 4). It revolves around establishing an intelligent and interconnected tourism ecosystem through the adoption of innovations such as the Internet of Things (IoT), artificial intelligence (AI), data analytics, augmented reality, and mobile applications (Chen 2021a). The application of these technologies extends across different sectors, including accommodation, transportation, and attractions (Ding and Xu 2021), leading to increased personalization, resource efficiency, and operational effectiveness.

**Table 4.** Definitions of smart tourism.

| Definition/Description of Smart Tourism | Author |
| --- | --- |
| Smart tourism is "tourism supported by integrated efforts at a destination to collect and aggregate/harness data derived from physical infrastructure, social connections, government/organizational sources, and human bodies/minds in combination with the use of advanced technologies to transform that data into on-site experiences and business value-propositions with a clear focus on efficiency, sustainability, and experience enrichment". | Gretzel et al. (2015, p. 181) |
| Smart tourism leverages smart technologies to provide a personalized at-destination tourism experience through connectedness that is everywhere, information aggregation, and real-time synchronization. | Babli et al. (2016) |
| Smart tourism is a social phenomenon in which information technologies, such as the Internet and wireless networks, are fused with tourism. | Byun et al. (2017) |
| Smart tourism refers to the use of technologies like IoT, AI, cloud computing, big data, and VR to collect, analyze, and compute tourism data. | Huang et al. (2022) |
| Smart tourism leverages IoT and digital information to create innovative solutions to problems facing the tourism industry, such as collecting data, developing forecasts, intelligent management, providing online services, and building customer relationships. | Flores-Crespo et al. (2022) |

As outlined by Gretzel et al. (2015), smart tourism comprises three primary components: smart destinations, smart experiences, and smart business (refer to Figure 9). Smart destinations involve the development of smart cities designed to support local communities and enhance tourists' access to resources and transportation, promoting sustainability and improving the quality of life and visits. These cities integrate advanced technologies into their physical infrastructure to heighten convenience and enhance the overall experience (Li et al. 2013).

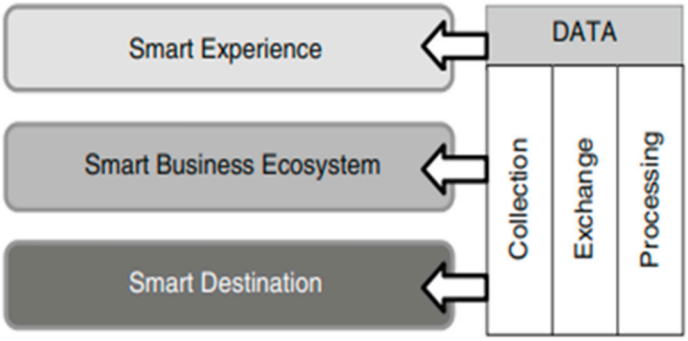


**Figure 9.** Components of the smart tourism ecosystem (Gretzel et al. 2015).

Smart experiences encompass technology-mediated tourism experiences facilitated through real-time monitoring, personalization, and context awareness. Data technologies are utilized to deliver high-quality travel services, such as real-time travel assistance and virtual tour guides or assistants (Gala et al. 2023; Gonçalves et al. 2019).

These services operate within a complex business ecosystem that supports the creation and exchange of tourism experiences, information, and resources, constituting the smart business component.

The incorporation of IoT into the tourism sector has wide-ranging effects, impacting areas such as luggage handling and travel bookings. As outlined by Sharma et al. (2021), sensor-based solutions for baggage and tagged bags can significantly reduce instances of mishandled or missing luggage during travel. Furthermore, IoT technologies can be leveraged to establish an interconnected business travel platform, streamlining booking activities (Kalra et al. 2018). This platform may encompass various travel tools and resources, empowering travel brokers or tour managers in efficiently managing tourist bookings (Yasmin et al. 2022; Farris et al. 2021).

IoT technologies also offer opportunities for enhancing hotel rooms, air travel, and railway station experiences. Providing accurate information regarding tourists' journeys contributes to delivering exceptional services (Zhang et al. 2018). Given the data-centric nature of decision-making in the tourism industry, integrating IoT into the tourism infrastructure can enhance strategic decision-making and planning. This, in turn, can lead to improved business management, operational efficiency, and enhanced customer experiences.

## 5. Presentation of Results

### *5.1. IoT Technologies for Smart Tourism*

At its core, smart tourism relies on diverse information systems to ensure that both tourism service providers and consumers have ample access to essential information. These technologies play a crucial role in facilitating informed decision-making and mobility, thereby contributing to fulfilling tourism experiences (Lin 2014; Morais et al. 2022). The integration of IoT provides access to advanced data technologies, empowering key players in the tourism industry to gather, analyze, and store substantial amounts of data. This encompasses technologies like big data, cloud computing, machine learning and AI, sensors, wearable devices, and mobile applications. These innovations collectively contribute to the establishment of intelligent tourism ecosystems.

#### 5.1.1. Big Data

Big data facilitates the processing and interpretation of extensive and diverse datasets generated within the tourism ecosystem. This technology enables the aggregation and analysis of vast information, encompassing traveler behaviors, preferences, and real-time location-based data (Dong et al. 2020; Wise and Heidari 2019). These invaluable insights empower businesses to adopt tourist-centric strategies, prioritizing customer needs and expectations. Additionally, destination managers and service providers leverage big data in smart tourism to extract actionable insights, identify patterns, and make well-informed decisions (Huang et al. 2022; Sun et al. 2016).

This innovation empowers stakeholders to comprehend trends, optimize resource allocation, and formulate targeted strategies for marketing and customer engagement (Sakthivel et al. 2016; Weng and Zhang 2023). The tourism industry increasingly harnesses the analytical power of big data to enhance operational efficiency, anticipate demand fluctuations, and provide a more personalized and seamless experience for travelers (Wanchun 2017). This approach ultimately contributes to the sustainable development and growth of tourist destinations.

#### 5.1.2. Cloud Computing

Cloud computing stands as a fundamental and transformative technology in smart tourism, revolutionizing the storage, processing, and accessibility of data within the tourism ecosystem (Almobaideen et al. 2016). This technology provides a scalable and centralized infrastructure, facilitating collaboration and real-time information sharing among various stakeholders, including hotels, transportation services, and tour operators (Maio et al. 2022). Additionally, cloud-based solutions enable the secure and efficient management

of vast datasets, allowing for real-time updates, reservations, and personalized services. The agility of tourism operations is enhanced through on-demand access to computing resources, ensuring critical information is available anytime and anywhere (Min 2023; Moiseeva and Zolotovskiy 2021).

Furthermore, cloud computing supports the development of sophisticated applications and services, fostering innovation in the delivery of tourist experiences (Fiore et al. 2016). Its versatility and adaptability contribute to the resilience of the tourism industry, enabling practical responses to changing demands and ensuring a more interconnected and efficient tourism ecosystem.

#### 5.1.3. Machine Learning and Artificial Intelligence

Machine learning (ML) and artificial intelligence (AI) serve as essential IoT technologies in supporting smart tourism, playing a crucial role in shaping personalized and intelligent travel experiences (Bi and Liu 2022). ML algorithms, for instance, analyze extensive datasets derived from tourist activities, preferences, and historical trends, extracting valuable insights (Ma 2023; Mubarak et al. 2021). These technologies are harnessed by agencies and service providers to fuel recommendation engines that provide tailored travel itineraries, accommodations, and activities based on individual preferences. Additionally, the capabilities of AI in natural language processing and sentiment analysis enhance customer service through chatbots and personalized communication (Dong et al. 2020).

Moreover, predictive modeling supported by ML contributes to demand forecasting, optimizing resource allocation and service delivery (Maia et al. 2020). In the realm of smart tourism, the continuous learning and adaptation of ML and AI technologies lead to the creation of dynamic and responsive systems. This gradual evolution elevates the efficiency, personalization, and overall quality of the tourism experience for travelers.

#### 5.1.4. Smart Sensors

Smart sensors form an intricate network of interconnected devices embedded within the physical infrastructure of tourist destinations. These sensors, encompassing elements such as occupancy and environmental detectors, as well as location-based tracking devices, continually collect and transmit real-time data (Sabbioni et al. 2022a). Consequently, they play a multifaceted role in smart tourism by facilitating data collection that is subsequently analyzed and processed to support informed decision-making.

For instance, occupancy sensors deployed in various facilities assist in monitoring visitor numbers (Ma 2022; Ding and Xu 2021), allowing destinations to optimize crowd management strategies and resource allocation. Environmental sensors contribute to sustainability efforts by providing data on energy consumption and environmental conditions, aiding in the implementation of eco-friendly practices (Guo et al. 2022). Location-based sensors enhance the tourist experience by enabling context-aware services that deliver personalized information to visitors based on their geographical location (Leal et al. 2023). These sensors can be employed for various activities, including streamlining traffic flow, monitoring foot traffic at popular attractions, or ensuring energy efficiency in facilities.

Therefore, smart sensors in IoT-based smart tourism enhance operational efficiency and contribute to the creation of a safer, more personalized, and seamlessly managed tourism environment.

#### 5.1.5. Wearable Devices and Mobile Applications

Wearable devices and mobile applications play a pivotal role in shaping the way travelers interact with and experience destinations. These devices and applications are equipped with IoT capabilities, providing on-the-go access to a multitude of services, such as tour guides and traffic updates (Huang et al. 2023). Consequently, they significantly enhance the overall convenience and interactivity of the tourist journey.

Wearable devices, including smartwatches and fitness trackers, extend beyond simple communication functionalities, serving as personal assistants during travel and health

trackers (Chawla 2020; Pu 2021). Conversely, mobile applications with robust IoT integration enable users to access real-time updates, interactive maps, and booking functionalities (Li 2022). The amalgamation of these technologies facilitates personalized recommendations, location-based information, and augmented reality guides, fostering a more engaged and informed travel experience (Zhang et al. 2021).

Moreover, wearable devices and mobile applications enhance connectivity and mobility, addressing the needs of modern travelers and empowering them to navigate and explore destinations in a more personalized and technologically enhanced manner.

#### 5.1.6. Virtual Reality and Augmented Reality

Virtual reality (VR) and augmented reality (AR) technologies present immersive and interactive experiences that redefine how tourists engage with destinations. VR enables users to virtually explore and experience destinations through computer-generated simulations, offering a preview of attractions and accommodations before physical visits (Chen 2021c). In contrast, AR overlays digital information in the real-world environment, enriching physical surroundings with contextual data, historical facts, or interactive elements (Torres Vega et al. 2020).

These innovations find application in smart tourism for providing virtual tours, interactive museum exhibits, and navigation enhancements (Yin and Wang 2015). They play a significant role in creating engaging and informative tourist experiences, bridging the gap between the digital and physical worlds (Dammak et al. 2020). The immersion and interactivity offered by these technologies during the exploration of destinations enhance the overall quality of the tourism experience for travelers, enabling them to create innovative and memorable connections with their surroundings.

### *5.2. Applications of IoT in Smart Tourism*

The incorporation of IoT technologies into the tourism industry has generated opportunities that can be leveraged to enhance services and streamline management. For example, insights derived from the analysis and processing of extensive tourist information can be integrated into recommender systems to elevate personalization (Angelaccio and Buttarazzi 2016). Additionally, IoT offers tools for the development of smart cities by integrating advanced technologies into physical infrastructures (Zhang and Li 2022). These cities serve as attractive destinations, thereby fostering smart tourism and contributing to local and national economic growth. This section delves into the diverse applications of IoT technologies in smart tourism.

#### 5.2.1. Recommender Systems

Recommender systems employ advanced algorithms to provide personalized and context-aware suggestions for travelers. These systems harness the extensive data generated by tourists, encompassing their interests, preferred activities, and real-time location information collected through IoT devices (Altulyan et al. 2022). The analysis of these data enables recommender systems to adapt and refine their suggestions effectively over time, offering tailored recommendations to tourists for accommodations, attractions, dining, and other activities (Chen 2021a).

The integration of IoT enhances the accuracy and relevance of these recommendations, ensuring alignment with the current context of the traveler. For instance, IoT-equipped wearable devices continuously collect and transmit data on user interactions (He et al. 2022; Li and Su 2022). This ongoing data stream enables the recommender system to comprehend the evolving preferences and real-time needs of the traveler (Khallouki et al. 2018). Consequently, this results in a more personalized and satisfying travel experience, as tourists receive suggestions aligned with their tastes and preferences. The collaborative nature of IoT-enabled recommender systems enhances the overall quality of the tourism experience and contributes to the efficiency of the tourism industry.

#### 5.2.2. Smart Cities

IoT-driven smart cities are at the forefront of revolutionizing the tourism experience by establishing intelligent and interconnected urban environments. The applications of IoT within smart cities introduce numerous innovations that significantly enhance the convenience, safety, and sustainability of tourism (Tripathy et al. 2018). By deploying a network of sensors, cameras, and IoT-enabled devices, smart cities can gather and analyze real-time data to optimize various aspects of urban life (Vu et al. 2018). In the realm of tourism, this leads to improved transportation systems, streamlined traffic flow, and enhanced public safety.

Tourists benefit from interactive and compelling services delivered through mobile applications, providing real-time information on transportation options, smart parking solutions, and personalized city guides (Wang et al. 2020a; Maio et al. 2022). The integration of IoT technologies in smart cities not only offers convenient and data-driven services but also contributes to the sustainable and efficient management of urban resources, ultimately elevating the overall visitor experience (Liu 2022). For instance, smart waste management systems utilize IoT sensors to optimize waste collection schedules, thereby reducing environmental impact. As smart cities continue to evolve, the integration of IoT in urban planning and infrastructure holds the promise of a more connected, accessible, and sustainable urban tourism experience for travelers.

#### 5.2.3. Payment Transactions

The integration of the IoT into payment transactions is revolutionizing financial activities in smart tourism. IoT technologies play a crucial role in establishing seamless, secure, and efficient payment ecosystems for both tourists and businesses. Contactless payment methods, such as smart cards, mobile wallets, and near-field communication (NFC) technology, are made possible by IoT devices (Fatihah et al. 2021), enabling tourists to conduct transactions without the need for physical currency. Wearable devices and smartphones, equipped with IoT capabilities, function as payment instruments, promoting convenience and speed during transactions (Chawla 2020).

The IoT-driven cashless payment systems not only enhance the efficiency of financial transactions for tourists but also contribute to a more streamlined payment experience (Lin et al. 2019). Furthermore, these systems improve the traceability and security of transactions, mitigating the risks of fraud and theft often associated with physical cash handling (Kaur and Maheshwari 2017). Consequently, the integration of IoT in payment transactions aligns with the technological demands of modern tourists and supports the evolution of a more secure, efficient, and globally connected financial environment within the smart tourism industry.

#### 5.2.4. Electronic Ticket Systems

IoT-powered electronic ticket systems are revolutionizing ticketing processes in smart tourism, offering heightened efficiency, convenience, and environmental sustainability. Integration of IoT devices, such as smart cards, mobile applications, and QR code scanners, into electronic ticket systems streamlines access to tourist attractions, events, and transportation services (Dalli and Bri 2017). The use of IoT sensors ensures secure and swift validation of electronic tickets, reducing reliance on physical paper tickets and manual checks. This not only minimizes the environmental impact associated with traditional ticketing but also enhances the overall visitor experience by providing a more uniform and contactless entry process (Gautam et al. 2016; Li 2022).

The real-time data generated by IoT-enabled electronic ticket systems contribute to efficient crowd management, allowing attractions to optimize capacity and enhance visitor safety (Popova et al. 2022). Moreover, these systems often integrate with other IoT applications, such as smart city services, to provide tourists with real-time updates and information on their mobile devices, ensuring a well-informed and connected travel experience. Therefore, the adoption of IoT-enabled electronic ticket systems represents

a significant leap in modernizing and enhancing the accessibility of tourist destinations within the smart tourism sector.

#### 5.2.5. Sustainable Tourism Destinations

The integration of IoT in the development of sustainable tourism destinations marks a paradigm shift in fostering coexistence between environmental conservation and tourism. IoT technologies furnish tools and mechanisms for monitoring, managing, and optimizing resources in tourist destinations (Farris et al. 2021); thereby, advancing sustainable practices beneficial to both the environment and the tourism industry. For instance, sensors and devices interconnected through IoT networks can provide real-time tracking of environmental parameters, energy consumption, and waste management (Howells and Ertugan 2019). Analyzing these data enables the implementation of eco-friendly initiatives, reduction in carbon footprints, and promotion of responsible tourism practices.

Moreover, IoT-supported energy management systems can regulate energy consumption in hotels and public spaces, fostering efficiency and sustainability. The incorporation of IoT in sustainable tourism destinations enhances the overall tourist experience by providing eco-friendly alternatives and immersive educational opportunities (Shafiee et al. 2023). This approach is particularly crucial for eco-conscious travelers. Leveraging IoT technologies to establish sustainable tourism destinations strikes a balance between satisfying tourists' needs and preserving the natural and cultural richness of their surroundings. Ultimately, this contributes to a more responsible and resilient tourism industry.

#### 5.2.6. Intelligent Tour Guide System

Intelligent tour guide systems offer tourists personalized, adaptive, and interactive experiences by leveraging IoT-enabled devices such as smartphones, wearables, and AR glasses (Chen 2021b). These systems provide real-time information and guidance based on the user's location and preferences. Embedded IoT sensors continuously collect data on the tourist's surroundings, enabling the system to offer pertinent details about points of interest, historical facts, and recommendations (Dong et al. 2020; Wang et al. 2021).

For instance, as a tourist approaches a landmark, the system can provide historical information or suggest nearby attractions. This technology-driven approach transforms traditional guided tours into dynamic and customized journeys tailored to individual tourists' preferences (Zhang et al. 2021). Moreover, intelligent tour guide systems enhance navigation, minimizing the reliance on paper maps and guidebooks. Tourists can use these systems to navigate the destination or locate nearby points of interest, including entertainment venues, hotels, or parking areas.

#### 5.2.7. Area Capacity Early Warning System

The area capacity early-warning system is pivotal in optimizing crowd management and ensuring a safe and enjoyable experience for tourists in popular destinations. This system utilizes a network of strategically placed IoT sensors in key areas to continuously monitor crowd density and movement in real-time (Ma 2022). When the number of visitors approaches or exceeds predefined thresholds, the system triggers early warnings, enabling authorities to proactively manage crowd flow and implement preventative measures to avoid congestion or safety issues (Nafrees and Shibly 2021; Raj et al. 2023).

Furthermore, the data collected by these sensors are analyzed to provide insights into visitor patterns. Destination managers can leverage this information for better planning of events, resource allocation, and overall destination management (Rafizal Adnan et al. 2020). This application of IoT in smart tourism enhances the quality of the tourist experience by preventing overcrowding, reducing wait times, and optimizing the utilization of public spaces (Sabbioni et al. 2022a). By offering timely alerts and facilitating data-driven decision-making, the area capacity early-warning system exemplifies how IoT technologies positively impact the efficiency and safety of tourist destinations.

#### 5.2.8. Voice Assistant

Voice assistants in smart tourism offer a hands-free method for tourists to engage with their surroundings and access information seamlessly. These AI-powered voice assistants, exemplified by platforms like Amazon's Alexa or Google Assistant, leverage the capabilities of both AI and IoT technologies. They provide tourists with a natural language interface, allowing them to seek guidance, gather information, and control various aspects of their travel experience effortlessly (Moguel et al. 2023).

Integrated into devices like smartphones, smart speakers, and wearables, these voice-enabled assistants utilize IoT sensors and connectivity to comprehend and respond to user commands effectively (Vo et al. 2021; Zeng 2022). Tourists can use voice commands to receive real-time weather updates, navigation directions, information about local attractions, or even language translations. Such tools enhance the overall convenience and accessibility of the travel journey (Wang et al. 2020b). Moreover, the integration of IoT into voice assistant technologies facilitates enhanced connectivity with other smart devices, such as smart hotels or transportation services, fostering a cohesive and integrated travel experience. This hands-free interaction meets the evolving expectations of modern travelers, contributing to the creation of an intuitive, personalized, and connected smart tourism environment.

#### 5.2.9. Smart Support System

The smart support system in smart tourism is a comprehensive application designed to provide real-time assistance, information, and emergency support to travelers. This system utilizes IoT technologies through interconnected devices like smartphones, wearables, and smart infrastructure, offering tourists immediate access to a diverse range of services (Mrsic et al. 2020). Mobile applications equipped with IoT capabilities serve as a central hub for tourists, featuring emergency assistance, local information, and customer support (Sundaravadivel et al. 2020). In unforeseen events or emergencies, travelers can use the smart support system to swiftly connect with relevant services, including emergency services, local authorities, or medical assistance. The incorporation of IoT sensors in smart infrastructure, such as public spaces or transportation hubs, ensures proactive delivery of information and guidance (Sabbioni et al. 2022b). Tourists can access real-time updates on transportation schedules, safety alerts, and location-based services through the IoT-connected smart support system. This application establishes a more responsive travel experience, prioritizing the safety and security of tourists.

#### 5.2.10. Health Tourism Monitoring System

The health tourism monitoring system, a specialized program within smart tourism, prioritizes tourists' well-being and safety. This system relies on a network of IoT-enabled devices and sensors, including wearable health trackers and mobile applications, to continuously monitor and support various aspects of tourists' health during their journeys (Pereira et al. 2022). Health-related data, encompassing vital signs, physical activity, and sleep patterns, are collected and analyzed in real-time (Almobaideen et al. 2017). Tourists can receive personalized health recommendations, medication reminders, and immediate access to emergency services through this monitoring system (Sundaravadivel et al. 2020). Additionally, the IoT-enabled health tourism monitoring system can automatically alert and connect tourists with emergency services in critical situations (Zhang and Li 2022), facilitating a swift and effective response. The data gathered by IoT sensors contribute to a comprehensive understanding of health trends among travelers, empowering tourism stakeholders to implement targeted health and safety measures.

### *5.3. Challenges Hindering Effective Application of IoT in Smart Tourism*

While incorporating IoT technologies into smart tourism can offer numerous opportunities for sustainable development, it also introduces various challenges. At the core of IoT are data technologies, which can present significant security and privacy concerns (Flores-Crespo et al. 2022). The efficacy of the systems and processes in IoT-enabled smart tourism

relies on extensive data collection and analysis, raising potential issues related to privacy infringement or vulnerability to data breaches. Moreover, inaccuracies in data can pose substantial threats, particularly when unreliable information is utilized for decision-making or strategic planning. The gravity of the consequences associated with these challenges underscores the necessity to explore and address them, ensuring the optimal utilization of these innovations.

#### 5.3.1. Security and Privacy

Addressing security and privacy concerns is imperative for overcoming significant challenges in the effective implementation of IoT in smart tourism. The extensive collection and exchange of sensitive data, including personal information and location data, through IoT devices heighten the risk of cybersecurity threats (Dammak et al. 2020). Ensuring the security of these devices and the data they manage is essential to thwart unauthorized access, prevent data breaches, and mitigate potential misuse. Moreover, the constant real-time monitoring and data collection, particularly via wearable IoT devices, can be perceived as invasive. This raises questions about the storage, processing, and accessibility of sensitive personal information (Sundaravadivel et al. 2020). Businesses in the tourism sector must strike a balance between providing personalized services and safeguarding privacy to promote the widespread adoption of IoT in smart tourism.

#### 5.3.2. Software Complexity

Incorporating IoT into smart tourism necessitates integrating intricate and varied software systems. Effectively handling the intricacies of software development, deployment, and maintenance for numerous IoT devices and applications presents a notable challenge (Rafizal Adnan et al. 2020). The complexity of software involves addressing diverse communication protocols, managing devices, and ensuring compatibility among various software components. Excessively complex systems may result in operational inefficiencies, elevated costs, and potential vulnerabilities. Hence, it is essential to simplify and streamline the software development process to guarantee the resilience and dependability of IoT applications in smart tourism.

#### 5.3.3. Scalability

The scalability of IoT solutions in smart tourism poses a critical challenge, especially given the exponential growth in the number of connected devices and data sources. The challenges related to scalability include issues like network congestion, limitations in data storage, and the system's capacity to handle a surge in demand, especially during peak tourism seasons (Car et al. 2019). Ensuring that the IoT infrastructure can seamlessly expand to accommodate the growing volume of devices, data, and user interactions is imperative. Tackling scalability challenges is crucial for maintaining the responsiveness and reliability of IoT applications (Dammak et al. 2020), preventing performance degradation as the smart tourism ecosystem continues to evolve and expand.

#### 5.3.4. Interoperability

Interoperability encompasses the seamless communication and collaboration among diverse devices, platforms, and systems within the IoT-enabled ecosystem. However, the absence of standardized protocols and interfaces among various IoT components can result in compatibility issues (Car et al. 2019). This challenge makes it challenging for different devices and systems to exchange data and operate cohesively (Buhalis and Leung 2018). Overcoming interoperability challenges is crucial for businesses to establish a unified and efficient IoT ecosystem in smart tourism, thereby promoting an interconnected experience for tourists and stakeholders.

## 6. Conclusions

IoT technologies offer numerous opportunities to enhance the operational efficiency and performance of agencies and service providers in the tourism industry. In the realm of IoT-enabled smart tourism, a variety of advanced technologies, including big data, smart sensors, cloud computing, machine learning, artificial intelligence, wearables, mobile applications, augmented reality, and virtual reality, contribute to the overall traveler experience. Each of these innovations brings unique capabilities that play a crucial role in the performance of the IoT-enabled smart tourism ecosystem. For example, embedded sensor technologies facilitate data collection, while big data enables its processing and interpretation. Cloud computing provides essential computing services such as data storage, networking, databases, analytics, and software, serving as a cornerstone for smart tourism by offering computing power and storage solutions. The data collected and processed through IoT technologies inform strategic decision-making, ensuring that tourism activities are consumer-centric, thereby improving business performance and enhancing traveler satisfaction.

Various IoT applications have been integrated into smart tourism, including recommender systems, smart cities, payment systems, and electronic ticketing systems. Recommender systems leverage the IoT to offer personalized recommendations based on individual interests, preferences, and location. The integration of IoT-supported technologies like NFC, mobile wallets, and smart cards enables convenient contactless payment methods. IoT technologies in smart tourism have significantly improved safety and speed in ticket validation processes, easing tourists' access to destinations. Other applications include the development of sustainable tourism destinations, intelligent tourist guide systems, area capacity early-warning triggers, voice assistants, smart support systems, and health tourism monitoring software. The integration of these innovations has substantially increased operational efficiency, promoting tourist safety and enhancing overall experiences in smart tourism.

Despite the numerous opportunities presented by IoT-enabled smart tourism, several challenges exist, such as increased security and privacy concerns, software complexity, scalability, and interoperability. Given that the IoT infrastructure relies on extensive data collection and monitoring, privacy and security vulnerabilities are heightened. Robust measures must be implemented to address these challenges and harness the opportunities associated with IoT-enabled smart tourism.

The integration of smart tourism and the Internet of Things carries theoretical and practical implications for the tourism industry. The theoretical aspects include the aim of enhancing the overall customer experience through personalized and context-aware services, reliance on data-driven decision-making, contribution to sustainability, envisioning interconnected ecosystems, real-time monitoring, smart infrastructure, personalized services, improved safety, and operational efficiency. These implications collectively contribute to the evolution of a more intelligent and responsive tourism industry.

The field of smart tourism and the Internet of Things is dynamic, prompting avenues for future research. Some potential research directions include enhancing the security and privacy of IoT devices and data in smart tourism, exploring the integration of blockchain technology with IoT, investigating the role of edge computing in smart tourism IoT, and improving the interaction between tourists and smart tourism systems. These research directions aim to address challenges and leverage opportunities at the intersection of smart tourism and the Internet of Things, contributing to the development of innovative solutions aligned with the evolving needs of the tourism industry in a technologically advanced landscape.

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A.T.R. and J.C.D.; supervision, A.T.R. and J.C.D.; project administration, A.T.R. and J.C.D.; funding acquisition, A.T.R. and J.C.D. All authors have read and agreed to the published version of the manuscript.

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## Appendix A

**Table A1.** Overview of document citations period 2013 to 2023.

| Documents | | ≤2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Contextual Flow of information in Tourism using BLE Proximit ... | 2023 | - | - | - | - | - | - | - | - | - | - | 1 | 1 |
| The next frontier of the Internet of Behaviors: data-driven ... | 2023 | - | - | - | - | - | - | - | - | - | - | 1 | 1 |
| Developing sustainable tourism destinations through smart te ... | 2023 | - | - | - | - | - | - | - | - | - | 1 | 6 | 7 |
| Machine learning-based cloud IOT platform for intelligent to ... | 2022 | - | - | - | - | - | - | - | - | - | - | 1 | 1 |
| A Decentralized Architecture for Dynamic and Federated Access ... | 2022 | - | - | - | - | - | - | - | - | - | 5 | 7 | 12 |
| A Survey on Recommender Systems for Internet of Things: Tech ... | 2022 | - | - | - | - | - | - | - | - | - | 3 | 1 | 4 |
| Towards an IoT-enabled Tourism and Visualization Review on t ... | 2022 | - | - | - | - | - | - | - | - | - | 4 | 2 | 6 |
| A Real-Time Distribution Algorithm of Face-Recognition Data ... | 2022 | - | - | - | - | - | - | - | - | - | - | 1 | 1 |
| Integrated Development of Smart City Tourism and Cultural an ... | 2022 | - | - | - | - | - | - | - | - | - | - | 1 | 1 |
| Optimization of Rural Smart Tourism Service Model with Inter ... | 2022 | - | - | - | - | - | - | - | - | - | - | 2 | 2 |
| Exhibition Area Digitalization Using IoT Sensorios and Appli ... | 2022 | - | - | - | - | - | - | - | - | - | 1 | 1 | 2 |
| The Development Status and Trend of Urban Smart Tourism Base ... | 2022 | - | - | - | - | - | - | - | - | - | 1 | 1 | 2 |
| Study on the Development Model of Rural Smart Tourism Based ... | 2022 | - | - | - | - | - | - | - | - | - | 1 | 2 | 3 |
| Construction of a Smart Tourism Service Platform based on th ... | 2022 | - | - | - | - | - | - | - | - | - | 1 | - | 1 |
| A Multi-graph Convolutional Network Framework for Tourist FI ... | 2021 | - | - | - | - | - | - | - | - | - | 3 | 5 | 8 |
| Research on the dynamic dispatch of guides in smart tourist ... | 2021 | - | - | - | - | - | - | - | - | - | - | 1 | 1 |
| Smart technologies in tourism: A study using systematic revi ... | 2021 | - | - | - | - | - | - | - | - | - | 1 | 1 | 2 |
| Convergence of IoT in tourism industry: A pragmatic analysis | 2021 | - | - | - | - | - | - | - | - | 9 | 4 | 7 | 20 |
| A Tourism Support Framework using Beacons technology | 2021 | - | - | - | - | - | - | - | - | - | - | 1 | 1 |
| Smart Tourism: A Proof of Concept For Cyprus Museum of Moder ... | 2021 | - | - | - | - | - | - | - | - | - | 6 | 1 | 7 |
| Smart Tourism Scenic Spot Platform Based on 5G Internet of T ... | 2021 | - | - | - | - | - | - | - | - | - | 1 | 1 | 2 |

**Table A1.** *Cont.*

| Documents | | ≤2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Smart Tour Guide Application Based on 5G IoT System Environm … | 2021 | - | - | - | - | - | - | - | - | - | - | 1 | 1 |
| Design of a Blockchain-Oriented System for the Sustainable D … | 2021 | - | - | - | - | - | - | - | - | - | - | 2 | 2 |
| Real-Time Wireless Sensor Network-Assisted Smart Tourism Env … | 2021 | - | - | - | - | - | - | - | - | - | 1 | 1 | 2 |
| Preconditions of development and perspectives of use of smar … | 2021 | - | - | - | - | - | - | - | - | 1 | - | - | 1 |
| Recommendation Strategies for Smart Tourism Scenic Spots Bas … | 2021 | - | - | - | - | - | - | - | - | - | 1 | 1 | 2 |
| IoT-eST: IoT-Enabled Smart Tourism-Shaping the Future of Tour … | 2021 | - | - | - | - | - | - | - | - | 1 | 2 | 1 | 4 |
| Realizing the Potential of Internet of Things for Smart Tour … | 2020 | - | - | - | - | - | - | - | - | 54 | 43 | 36 | 123 |
| A Secure and Interoperable Platform for Privacy Protection i … | 2020 | - | - | - | - | - | - | - | - | 2 | 1 | 1 | 4 |
| Design and Implementation of Intelligent Tour Guide System i … | 2020 | - | - | - | - | - | - | - | - | - | 1 | 1 | 2 |
| Online UAV-Mounted Edge Server Dispatching for Mobile-to-Mob … | 2020 | - | - | - | - | - | - | - | 6 | 14 | 32 | 20 | 72 |
| CROSS City: Wi-Fi Location Proofs for SmartTourism | 2020 | - | - | - | - | - | - | - | - | 1 | 4 | - | 5 |
| IMED-Tour: An IoT-based privacy-assured framework for medica … | 2020 | - | - | - | - | - | - | - | 1 | 5 | 3 | 2 | 11 |
| Technology-Driven Smart Support System for Tourist Destinati … | 2020 | - | - | - | - | - | - | - | 1 | - | 1 | - | 2 |
| Detecting Tourist's Preferences by Sentiment Analysis in Sma … | 2020 | - | - | - | - | - | - | - | 1 | 2 | 4 | 2 | 9 |
| Developing smart tourism destinations with the Internet of T … | 2019 | - | - | - | - | - | - | 2 | 3 | 9 | 13 | 5 | 32 |
| Using smart technology in sustainable entrepreneurship in Is … | 2019 | - | - | - | - | - | - | - | - | - | - | 1 | 1 |
| Three-dimensional internet-of-things deployment with optimal … | 2019 | - | - | - | - | - | - | - | 1 | 5 | 5 | 1 | 12 |
| Improving the tourists' experience | 2019 | - | - | - | - | - | - | - | 1 | - | - | - | 1 |
| Overall structural system solution for supporting services a … | 2018 | - | - | - | - | - | - | 1 | - | 1 | - | 1 | 3 |
| Location Digest: A placeness service to discover community e … | 2018 | - | - | - | - | - | - | - | 2 | - | - | - | 2 |
| A New Way of Being Smart? (reactive Computing and its Applica … | 2018 | - | - | - | - | - | - | - | 3 | 4 | 2 | - | 9 |
| An ontology-based context awareness for smart tourism recomm … | 2018 | - | - | - | - | - | - | 1 | - | 2 | 3 | - | 6 |
| ITour: The Future of Smart Tourism: An IoT Framework for the … | 2018 | - | - | - | - | - | 1 | 11 | 13 | 21 | 24 | 8 | 78 |
| Study on the application frame analysis of the Internet of t … | 2017 | - | - | - | - | - | - | 1 | - | - | - | - | 1 |
| Internet of Things: Geographical Routing based on healthcare … | 2017 | - | - | - | - | 1 | 5 | 14 | 9 | 15 | 11 | 10 | 65 |
| 4G LTE network access system and pricing model for IoT MVNOs … | 2017 | - | - | - | - | 1 | 1 | 7 | 4 | 3 | 7 | - | 23 |
| Design of Electronic Ticket System for SmartTourism | 2017 | - | - | - | - | 1 | - | 1 | - | 1 | - | 1 | 4 |
| Smart tourist for Dubai city | 2017 | - | - | - | - | - | 1 | 1 | 3 | 5 | 2 | - | 12 |
| Regional Revival through IoT-Enabled SmartTourism Process F … | 2016 | - | - | - | - | 2 | 2 | 5 | 2 | 2 | 1 | - | 14 |
| Big data analytics on smart and connected communities using … | 2016 | - | - | - | - | 1 | 1 | 3 | 1 | 1 | - | - | 7 |

**Table A1.** *Cont.*

| Documents | | ≤2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Internet of Things technologies in smart cities | 2016 | - | - | - | - | 2 | 4 | 5 | 8 | 12 | 6 | 3 | 40 |
| A location-aware architecture for an IoT-based smart museum | 2016 | - | - | - | - | - | - | - | 4 | 4 | 3 | 1 | 12 |
| An intelligent system for smart tourism simulation in a dyna . . . | 2016 | - | - | - | - | 1 | 1 | 1 | 1 | 1 | - | 1 | 6 |
| Internet of Things and Big Data Analytics for Smart and Conn . . . | 2016 | - | - | - | 19 | 43 | 86 | 120 | 91 | 136 | 115 | 43 | 653 |
| Smart archaeological tourism: Contention, convenience and ac . . . | 2016 | - | - | - | 1 | 1 | 3 | 2 | 2 | 1 | 3 | 5 | 18 |
| Smart tourism: foundations and developments | 2015 | - | - | 2 | 18 | 70 | 73 | 137 | 162 | 167 | 205 | 142 | 976 |
| Design of the smart scenic spot service platform | 2015 | - | - | - | - | - | - | 1 | - | - | - | - | 1 |
| Research of the architecture of a new leisure agriculture intel . . . | 2014 | - | - | - | 1 | - | - | - | - | - | - | - | 1 |
| Geomatics for smart cities—concept, key techniques, and ap . . . | 2013 | - | 1 | 7 | 8 | 11 | 8 | 9 | 4 | 9 | 6 | 7 | 70 |
| | Total | 0 | 1 | 9 | 47 | 134 | 186 | 322 | 323 | 488 | 531 | 341 | 2382 |

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