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Digital Technologies for Sustainable Tourism Destinations: State of the Art and Research Agenda

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Abstract: This study explores the adoption of digital technology in sustainable tourism destinations and provides insights into current research. Using a bibliometric analysis approach, it comprehensively evaluates research outputs, identifies trends, and highlights key themes and collaborative networks. Employing a bibliometric analysis approach, this study utilizes the Scopus database and bibliometric software. After rigorous data cleaning, bibliographic coupling maps, collaboration networks, and keyword maps are generated using Biblioshiny and VOSviewer for comprehensive analysis. Analyzing 559 papers, the study reveals a consistent growth in publications, indicating increasing research interest in digital technology adoption in sustainable tourism destinations. Europe, Asia, and North America are the primary regions of research activity. Interdisciplinary collaboration is high, emphasizing the multidimensional nature of the field. While valuable, the bibliometric analysis is limited by data availability and quality in the Scopus database. Relevant research outputs may be excluded. The study focuses on overall trends and patterns rather than individual paper content. The study's findings have practical implications for researchers, policymakers, and practitioners in sustainable tourism. The identification of key themes and collaborative networks can guide future research and foster interdisciplinary collaborations. This study contributes to the existing literature on technological innovations in sustainable tourism destinations through its bibliometric analysis approach. Through providing an overview of the research landscape, identifying trends and collaborative networks, it offers valuable insights into the current state of research. The findings serve as a foundation for further exploration and advancement in sustainable tourism and digital technology.

Keywords: digital technologies; technological innovations; sustainable tourism destination; destination marketing; bibliometric analysis; current trends

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1. Introduction

Tourism is one of the largest and fastest-growing industries in the world, contributing significantly to the global economy and providing employment opportunities to millions of people (Aynalem et al. 2016; Fang et al. 2016; Liu and Wall 2006). However, the rapid growth of tourism also brings a range of environmental, social, and economic challenges, including over-tourism, degradation of natural resources, and negative impacts on local communities (Baloch et al. 2023; Brokaj 2014; Mbaiwa 2003; Sisneros-Kidd et al. 2019).

To address these challenges, sustainable tourism has emerged as a critical approach to tourism development, emphasizing the integration of environmental, social, and economic factors in tourism planning and management (Connell et al. 2009; Kauppila et al. 2009). The sustainable development of tourist destinations is a crucial issue in the field of tourism, as it not only contributes to the economic growth of the area but also ensures the preservation

of its natural and cultural resources for future generations (Dunets et al. 2019; Mawby et al. 2016; Welford and Ytterhus 2004).

In recent years, digital technologies have been increasingly recognized as a key enabler of sustainable tourism development, providing new opportunities for improving destination management, enhancing visitor experiences (Polishchuk et al. 2023), and promoting sustainable behaviors among tourists (Boes et al. 2016; El Archi et al. 2023b; Fennell 2021; Xu et al. 2020). Digital technologies, such as social media, mobile applications, and big data analytics, have the potential to revolutionize the way tourism destinations operate, communicate, and engage with tourists and stakeholders (Hays et al. 2013; Leung et al. 2013; Pencarelli 2020; Sigala et al. 2012; Xiang and Gretzel 2010).

Moreover, the adoption of digital technology has emerged as a key factor in promoting sustainable tourism (Della Corte et al. 2019; Gössling 2021; Li et al. 2022; Shen et al. 2020; Van et al. 2020), as it can enhance destination marketing (Buhalis 2019; Buhalis and Sinarta 2019), improve the management of tourist resources, and enhance the visitor experience (Dwyer et al. 2009). Digital technologies contribute to increasing the effectiveness of marketing communication, helping to reduce costs and enabling more precise targeting of preferred segments through personalized marketing. The use of digital technology has the potential to significantly impact the sustainability of tourist destinations, both positively and negatively (Neumannová 2022). However, limitations in using technology for sustainable tourism can stem from a variety of reasons, such as insufficient experience and training of destination managers; a lack of understanding and unwillingness to change established practices among destination managers, local residents, and tourists in the destination itself; or even asymmetry in the cooperation of local actors within a tourist destination. Sustainable tourism has gained significant attention in recent years as a means of balancing economic development with environmental protection and cultural preservation. Sustainable tourism destinations refer to locations that prioritize environmental, social, and economic sustainability to ensure long-term viability and minimal negative impacts on the environment and local communities. These destinations aim to strike a balance between meeting the needs of tourists and host communities while preserving natural and cultural resources for future generations (Lozano-Oyola et al. 2012; Purwanda and Achmad 2022).

The adoption of digital technology has the potential to support sustainable tourism practices by improving operational efficiency, reducing waste and emissions, and enhancing the tourist experience (Pan et al. 2018). Despite the increasing recognition of the importance of digital technology in sustainable tourism, there is a need for a comprehensive understanding of the extent and nature of its adoption in sustainable tourism destinations. However, the adoption and implementation of digital technologies in sustainable tourism destinations is still in its infancy, and there is a need for a comprehensive understanding of the current state of research in this area. Therefore, this paper aims to conduct a bibliometric analysis of the literature on digital technology adoption in sustainable tourism destinations. The aim of the proposed paper is to bridge this gap and contribute to the academic discourse through providing a systematic review of the existing literature on the topic. Through conducting a comprehensive bibliometric analysis, the study intends to map out the current state of research, identify key contributors, highlight research trends and themes, and assess the overall impact and influence of research in this domain.

Bibliometric analysis is a quantitative research method that uses statistical and computational tools to analyze patterns and trends in scholarly literature, providing insights into the intellectual structure and evolution of a research field (Donthu et al. 2021; Moral-Muñoz et al. 2020). This study aims to examine the extent to which digital technology has been adopted and used in sustainable tourism destinations. The purpose of this research is to understand the current state of the use of digital technology in sustainable tourism, with a focus on how it contributes to the sustainable development of tourist destinations. The study will analyze the available literature on the topic, including academic articles, conference proceedings, and other relevant sources, to identify the key themes, trends,

and patterns in the field, such as the volume of publications over time, the distribution of publications across different geographic regions, and the most frequently studied topics.

The specific objectives of this paper are to (1) identify the main research themes and topics in the literature on digital technology adoption in sustainable tourism destinations; (2) analyze the publication patterns and trends over time; (3) identify the most influential authors, journals, and publications in the field; and (4) identify research gaps and future research directions.

The results of this study will contribute to a better understanding of the state of research on digital technology adoption in sustainable tourism destinations and provide insights for academics, practitioners, and policymakers on the current trends, research gaps, and future research directions in this field. Furthermore, this study will contribute to the ongoing debate on the role of digital technologies in sustainable tourism development and provide valuable guidance for tourism stakeholders on how to leverage digital technologies for sustainable tourism practices.

In addition to the general overview of the study, there are a few key elements that make this research particularly important and relevant. First, the use of a bibliometric analysis allows for a comprehensive and systematic examination of the literature on digital technology adoption in sustainable tourist destinations. This method provides a comprehensive and objective view of the field and can identify the most important and influential research and authors in the area. Second, the focus on sustainable tourist destinations highlights the importance of responsible and sustainable practices in the tourism industry.

The use of digital technology has the potential to significantly impact the sustainability of tourist destinations, both positively and negatively (El Archi et al. 2023a), and this research will shed light on these impacts. Third, the study provides recommendations for future research and practice in the area of digital technology adoption in sustainable tourist destinations. These recommendations are based on the findings of the bibliometric analysis and will address key areas for improvement and potential areas for further investigation.

In the first section of this manuscript, the theoretical background on the topic is presented through an introduction. The study's second section describes the methodologies that were selected and applied to reach the results. The third section, which is the findings and discussion part, provides the results that the authors found after carrying out the bibliometric analysis.

2. Methods and Materials

This study depended on bibliometric analysis to achieve its objectives and investigate the scientific production of digital technology in sustainable tourism destinations. Bibliometric analysis is a quantitative method which is regarded as one of the most trustworthy literature review methodologies (Osareh 1996). Using bibliometric analysis for this study was according to four main justifications. Firstly, this method is frequently trustworthy and beneficial for assessing emerging scientific fields in order to find trends and anticipate the future directions of these topics (Aria and Cuccurullo 2017). Secondly, bibliometric analysis is commonly employed as a key methodology for evaluating literature in the area of sustainable development (Camón Luis and Celma 2020; Guo et al. 2019; Hallinger and Nguyen 2020; Maditati et al. 2018; Qureshi et al. 2020; Rosato et al. 2021). Third, the idea of bibliometric analysis is consistent with the study's goal, which is to establish a statistical assessment of the use of digital technology in sustainable tourism destinations based on organized and transparent procedures (Aria and Cuccurullo 2017). Finally, it is a straightforward and impartial research method, which presented robust findings (Archambault and Gagné 2004).

Numerous software programs, including CiteSpace (Chen 2006), HistCite (Garfield et al. 2006), CitNetExplorer, VOSviewer (van Eck and Waltman 2010), SciMAT (Cobo et al. 2012), Science of Science (Sci2) (Guler et al. 2016), and the bibliometrix package in R (Aria and Cuccurullo 2017), are used to do bibliometric analysis. Each of these software is focused on a specific perspective of bibliometric analysis such as visualization, analyze

bibliographic data, etc. This study depended on two main pieces of software to conduct the bibliometric analysis: the Biblioshiny package in R programming language (version 3.6.3) and VOSviewer (version 1.6.15). Biblioshiny is a web interface for bibliometrics. R in general and Biblioshiny in particular were preferred by academics over other scientific computer languages because they can perform practically exhaustive bibliometric and scientometric analyses (Aria and Cuccurullo 2017), as well as having useful statistical algorithms, several numerical paths, and strong visualization tools. Additionally, VOSviewer was used to generate intellectual networks.

In order to conduct bibliometric analysis, a dataset should be collected from well-known peer-reviewed databases such as Scopus, Web of Science (WoS), and Google Scholar. This study relied on the Scopus database to extract records related to digital technologies in sustainable tourism destinations. Among the various literature databases, Scopus is the biggest database of peer-reviewed literature materials, including books, articles, conference papers, and review papers (Salisbury 2009). Additionally, many other academics have used Scopus to perform bibliometric analysis in their research (Morandi et al. 2015; Netto et al. 2020).

In this bibliometric analysis, multiple techniques were used. Science mapping involves the examination of relationships between different components of research. This analysis focuses on understanding the intellectual interactions and structural connections among these research components. Various techniques are employed for science mapping, such as citation analysis, co-citation analysis, bibliographic coupling, co-word analysis, and co-authorship analysis (Donthu et al. 2021).

The researchers employed the following search query to gather the relevant scientific published articles in the field of digital technologies adoption in sustainable tourism destinations scientific: TITLE-ABS-KEY (“digital” OR “technolog*” OR “artificial intelligence” OR “AI” OR “robot*” OR “voice search” OR “blockchain” OR “cryptocurrenc*” OR “service automation” OR “RAISA” OR “VR” OR “virtual reality” OR “mobile” OR “smartphone” OR “ICT” OR “social media” OR “smart technolog*” OR “smart device*” OR “big data” OR “AR” OR “augmented reality” OR “xr technolog*” OR “tech” OR “chatbot” OR “mobile app*” OR “IOT” OR “5G” OR “4G” OR “deep learning” OR “machine learning” OR “internet of things” AND “sustainab*” OR “green” OR “responsible” AND “tourist destination*” OR “tourism destination*” OR “touristic destination*” OR “sustainable destination*” OR “tourist place*” OR “tourism place*” OR “tourist attraction*” OR “tourism attraction*” OR “nature destination*” OR “natural destination*” OR “nature attraction*” OR “ natural attraction*” OR “green destination*” OR “responsible destination*”).

In this section, we elaborate on the criteria utilized for both the inclusion and exclusion of manuscripts in our bibliometric analysis focusing on digital technologies for sustainable tourism destinations. Our primary objective was to carefully select the most pertinent and robust studies for our investigation while ensuring the exclusion of any studies that did not meet our specified criteria. The criteria employed for the exclusion of manuscripts encompassed several aspects, such as the nature of the issues addressed, the journal in which the paper was published, the level of scientific rigor, originality, and the relevance of the subject matter concerning the integration of digital technologies with sustainable destinations. On the other hand, the inclusion criteria were thoughtfully aligned with our research objectives, emphasizing the presence of a well-defined and comprehensible research methodology, as well as relevant and insightful analysis. Through applying these meticulous criteria, we aimed to maintain the integrity and focus of our bibliometric analysis, ensuring that the selected studies contributed meaningfully to the exploration of digital technologies in the context of sustainable tourism destinations. The rigorous application of these criteria strengthens the reliability and validity of our findings and allows us to draw meaningful conclusions from the collected data.

3. Results and Discussion

In this section, we provide a comprehensive analysis of the dataset comprising 559 publications published from 2003 to 2022, focusing on the field of digital technologies in sustainable tourism destinations. Descriptive statistics are presented to highlight key aspects, including the top ten influential authors, articles, sources/journals, research institutions, and countries within this domain. Moreover, we delve into the bibliometric intellectual networks, such as the lexical network, spatial network, and citation source network, to unveil the interconnections and collaborations among researchers and entities. Furthermore, we explore the research direction and themes through factorial analysis and thematic mapping, shedding light on the prevailing trends and topics in this research area.

3.1. Dataset Summary Information

Table 1 presents a qualitative summary of published records on the use of digital technologies in sustainable tourism destinations. The results show that 267 sources/journals were involved in publishing the 559 collected articles between 2003 and 2022. On average, about 29.4 publications were made each year, with an average of 12.39 citations per document. The articles discussing digital technologies in sustainable tourism destinations cited a total of 28,386 references. In terms of authorship, a total of 1694 authors contributed to the collected articles, with 67 of them being single authors and 1627 being co-authors. Lastly, the authors mentioned 1794 keywords that were of significant importance in the field of digital technology adoption in tourism destinations.

Table 1. Summary statistics of collected dataset.

Key Information about the Documents	Statistics
Timespan	2003–2022
Sources/Journals	267
Documents	559
Average publications per year	29.4
Average citations per documents	12.39
Authors	1694
Keywords	1794
Authors of single-authored documents	67
Authors of multi-authored documents	1627
Annual growth rate	23.48

The annual scientific production is presented in Figure 1, showing a general increasing trend in the number of published papers on digital technology adoption in sustainable tourism destinations from 2003 to 2022. Despite the small numbers of published articles in the beginning of the period (two and one articles in 2003 and 2004, respectively), the number of published papers gradually increased from three papers in 2005 to five papers in 2009. From 2010 to 2015, the number of published papers increased significantly. The publication production reached the peak in 2021 with 211 published articles. Prior to that, the published articles were 24, 27, 28, 72, and 89 in 2016, 2017, 2018, 2019, and 2020, respectively. This scientific production timeline of articles that discussed the digital technology adoption in sustainable tourism destinations field ended with 110 published articles in 2022.

Based on the scientific production, the prominence of digital technology adoption in sustainable tourism destinations can be summarized into three main stages, as shown in Table 2. In the early stage (2003–2012), also known as the emerging phase, during which publications were still growing without any salient significance, the number of published articles was 42 articles, representing only 7.5% of the total scientific production. At this stage, the number of published articles varied from one to three, averaging four articles/year. The most popular technologies used in tourism destinations in this early stage were online travel agencies (OTAs), destinations websites, search engines, email marketing, online booking systems, and virtual tours.

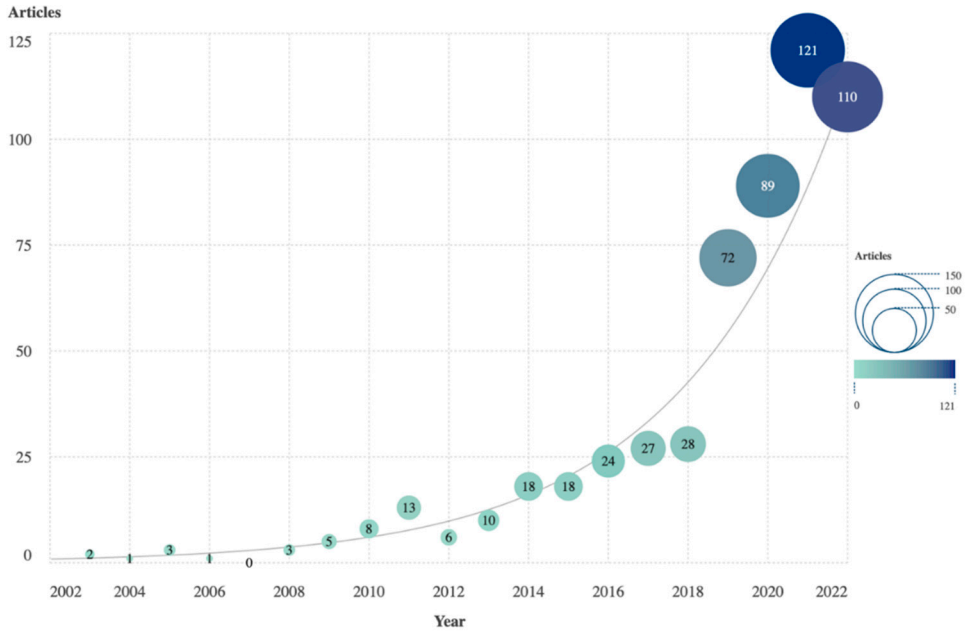

Figure 1. Annual publication of scientific production.

Table 2. Distribution of publications on technologies used in sustainable tourism.

Stage	Period	NP (%)	Used Technologies
Early Stage	2003–2012	42 (7.5%)	Online travel agencies (OTAs), destinations websites, search engines, email marketing, online booking systems, and virtual tours
Growth Stage	2013–2018	125 (22.4%)	Mobile apps, social media platforms, online review sites, location-based services, big data analytics, and cloud computing
Hype Stage	2019–2022	392 (70.1%)	AI, AR, VR, IoT, blockchain technology, chatbots, and virtual assistants

The growth stage between 2013 and 2018, referred to as the expansion phase, was characterized by a notable increase in publications, with 125 articles representing 22.4% of the total scientific production. During this phase, the number of published articles ranged from 10 to 28, with an average of 21 articles per year. The prevalent technologies employed in tourism destinations during this growth stage included mobile apps, social media platforms, online review sites, location-based services, big data analytics, and cloud computing. Finally, the hype stage includes the most recent period from 2019–2022 and constitutes a significant portion of the total publications, accounting for 70.1% (392 articles) of the total. This stage witnessed the adoption of more advanced and cutting-edge technologies, such as artificial intelligence (AI), augmented reality (AR), virtual reality (VR), internet of things (IoT), blockchain technology, and chatbots and virtual assistants.

3.2. Dominant Scientific Production Parameters

Within this section, our primary objective is to comprehensively examine the four fundamental parameters that form the basis of bibliometric analysis. These parameters include authors, publications, sources, and research institutions. Through thoroughly investigating and analyzing these key elements, we aim to deeply understand the intricate research dynamics and patterns within the literature related to technology usage in sustainable destinations. Through this process, we endeavor to uncover valuable insights and discern meaningful trends that can contribute to the advancement of scholarly research and knowledge dissemination in this scientific field (Zupic and Čater 2015).

3.2.1. Authors Analysis

Table 3 presents information on the top productive authors, and it reveals that Na Na has published the highest number of articles related to the use of technologies in sustainable destinations, with 14 publications. The next most productive authors on the list were Zhang J., Foris D., and Wang Y., with five, four, and four publications, respectively. The remaining authors on the list had published no more than three articles, including Badulescu A., Chung N., Cismaru L., Del Vecchiop, Gonzalez-Revertef, and Higham J. (refer to Table 3).

Furthermore, it is imperative to examine the authors' scientific production over an extended period, as demonstrated in Figure 2. This analysis allows us to identify authors who consistently generate high-quality research and those who have exhibited growth and advancement in their scholarly output. Within the presented figure, the visualization of authors' scientific production becomes continuous starting from 2013. Notably, Na Na and Zhang J. emerge as the authors with the longest-standing contributions in publishing articles pertaining to the utilization of technologies in sustainable tourism destinations. However, it is worth mentioning that their number of published articles and total citations remain limited. Conversely, other authors have made significant contributions in specific years, such as Badulescu A. in 2021 and Higham J. in 2020. These authors have made notable strides in their research output during these respective periods, signifying their impact in the field.

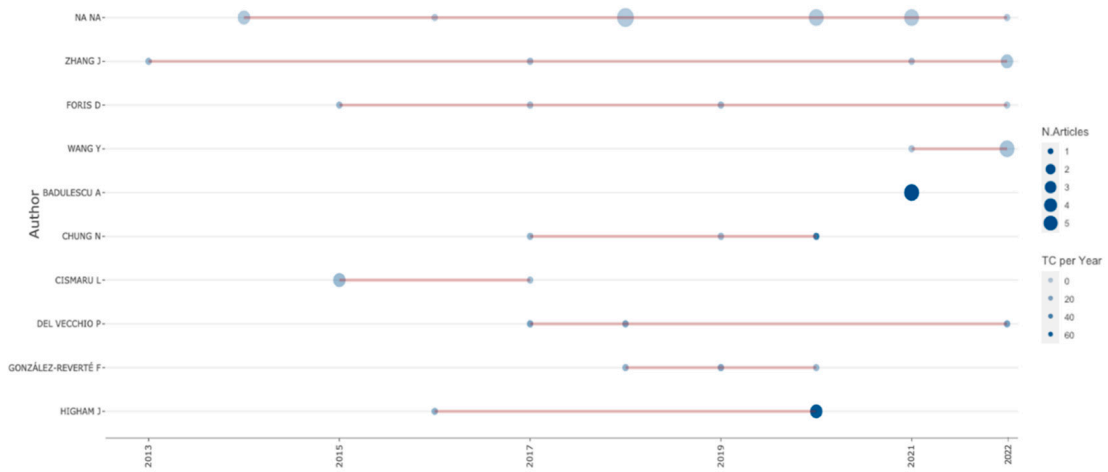

Figure 2. Authors' scientific production over time.

An alternative approach to explore and gain a comprehensive understanding of the authors involved in the literature concerning the utilization of technologies in sustainable tourism destinations is through the analysis of a co-authorship network. This network serves as a graphical representation that visually illustrates the collaborative relationships among authors within this specific domain. The provided Figure 3 presents a visual depiction of this co-authorship network, showcasing the interconnectedness and interdependencies among authors within the scholarly community. Through mapping out the connections and interactions between co-authors, this intricate network offers insights into the collaborative patterns and dynamics prevalent in this scholarly field. The complexity of the network indicates a strong connection between authors, emphasizing the significance and relevance of the research conducted within this scientific domain (Kabil et al. 2022a; Zupic and Čater 2015). The presence of numerous interconnections between authors underscores the collaborative nature of scholarly work in exploring the use of technologies in sustainable tourism destinations. This network visualization serves as evidence of the active and interconnected community of researchers contributing to this specific field of study.

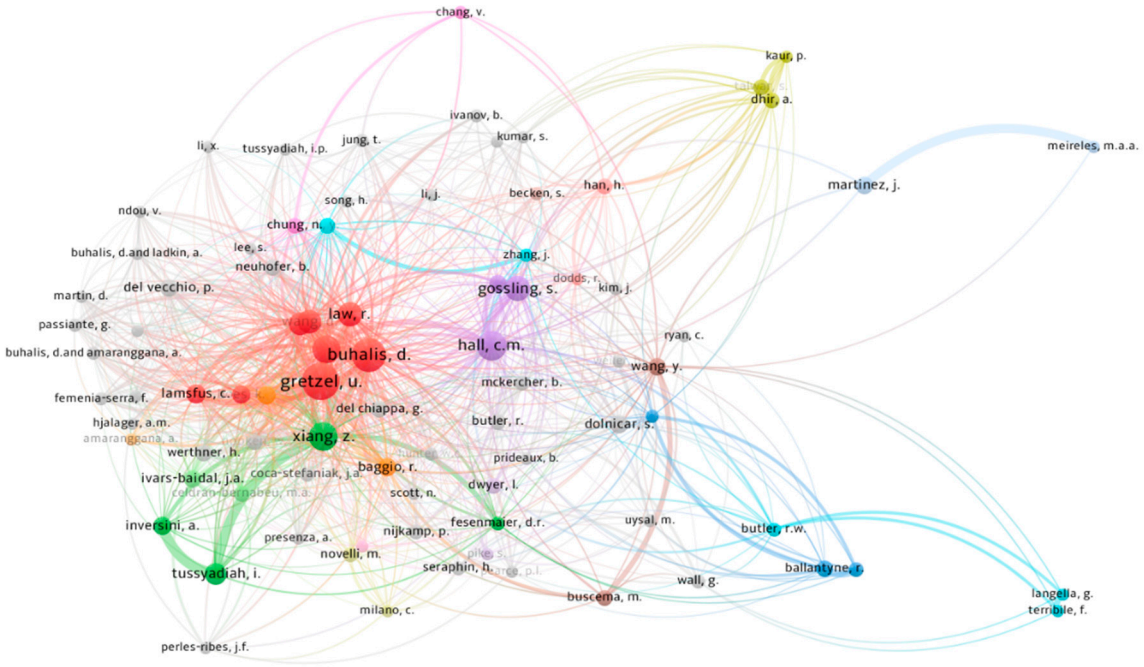

Figure 3. Co-authorship network.

3.2.2. Documents Analysis

Moving to the publications analysis parameter, Table 3 presents the top 10 most impactful papers on the use of technologies in sustainable tourism destinations, based on the number of citations and the sources of the articles among a total of 599 published documents. The table includes two columns, indicating the rank and the total number of citations (TC) for each paper. The results reveal that the highest and lowest numbers of citations among the top 10 influential papers are 289 and 89, respectively. Notably, 8 of the top 10 articles in this list were published after 2010 (Dickinson et al. 2014; Lee and Jan 2018; Lindemann-Matthies et al. 2010; Pencarelli 2020; Pop et al. 2022; Smerecnik and Andersen 2011; Streimikiene et al. 2021; Weaver 2012), in journals such as Current Issues in Tourism, Landscape and Urban Planning, Tourism Management, Journal of Sustainable Tourism, Information Technology & Tourism, Sustainable Development, and Journal of Travel Research. The only two published articles before 2010 were the first and last in the list and were authored by (Dwyer et al. 2009; Nepal 2008), respectively. Additionally, the results of the analysis indicate that, with the exception of 3 papers, all of the top 10 influential papers on the use of technologies in sustainable tourism destinations were authored by multiple authors. Furthermore, none of the papers in the list were published as book chapters.

According to data from Scopus, the manuscript with the highest number of citations to date is a 2009 publication by (Dwyer et al. 2009), which has been cited 289 times. The second most cited paper, published by (Dickinson et al. 2014), has received 219 citations. The third, fourth, and fifth most cited articles are Lindemann-Matthies et al. (2010), Weaver (2012), and Smerecnik and Andersen (2011), respectively, with 136, 135, and 122 citations. Furthermore, the sixth to tenth most cited articles are (Pop et al. 2022), (Pencarelli 2020), (Streimikiene et al. 2021), (Lee and Jan 2018), and (Nepal 2008), with 120, 111, 92, 91, and 89 citations, respectively.

Table 3. Top 10 cited articles on tech utilization in sustainable tourism destinations.

Rank	TC	Authors	Source	Reference
1	289	Dwyer, L., Edwards, D., Mistilis, N., Roman, C., and Scott, N.	Tourism Management	(Dwyer et al. 2009)
2	219	Dickinson, J. E., Ghali, K., Cherrett, T., Speed, C., Davies, N., and Norgate, S.	Current Issues in Tourism	(Dickinson et al. 2014)
3	136	Lindemann-Matthies, P., Briegel, R., Schüpbach, B., and Junge, X.	Landscape and Urban Planning	(Lindemann-Matthies et al. 2010)
4	135	Weaver, D. B.	Tourism Management	(Weaver 2012)
5	122	Smerecnik, K. R., and Andersen, P. A.	Journal of Sustainable Tourism	(Smerecnik and Andersen 2011)
6	120	Pop, R.-A., Săplăcan, Z., Dabija, D.-C., and Alt, M.-A.	Current Issues in Tourism	(Pop et al. 2022)
7	111	Pencarelli, T.	Information Technology & Tourism	(Pencarelli 2020)
8	92	Streimikiene, D., Svagzdiene, B., Jasinskas, E., and Simanavicius, A.	Sustainable Development	(Streimikiene et al. 2021)
9	91	Lee, T. H., and Jan, F.-H.	Journal of Travel Research	(Lee and Jan 2018)
10	89	Nepal, S. K.	Tourism Management	(Nepal 2008)

3.2.3. Sources Analysis

Table 4 displays a roster of the leading ten journals, their impact factors, the number of publications (NP) issued about the usage of technologies in sustainable tourism destinations, and the total citation (TC) and TC/NP of said documents. Among the top ten influential journals, the maximum and minimum numbers of published documents are 87 and 4, respectively. Results indicate that Sustainability, a multidisciplinary journal, is the most notable source for research on technologies in sustainable tourism destinations, despite its impact factor (3.89) being lower than many other specialized tourism journals, such as Tourism Management and Journal of Sustainable Tourism. Of the top ten influential journals, Sustainability's contribution to publications in the research area is 51 articles, with a mean citation of approximately 19.75. This is followed by a low-impact conference series and two high-impact journals: IOP (0.45), Journal of Sustainable Tourism (9.7), and Current Issues in Tourism (7.57). Their share of publications on this research field is 18, 17, and 10 articles, respectively, with average citations of 3.83, 31.35, and 49.7. This is trailed by the highest-impact-factor journal on this list, Tourism Management (12.87), with nine published articles that also possess the highest average citation score of 84.78. The next most noteworthy sources of articles regarding technologies used in sustainable tourism destinations are Springer Proceedings in Business and Economics, Geojournal of Tourism and Geosites, Asia Pacific Journal of Tourism Research, International Journal of Environmental Research and Public Health, and Journal of Cleaner Production, which have published eight, six, five, five, and four documents on the topic, respectively, with mean citations of 3.5, 4.33, 3.8, 6.6, and 36.5.

3.2.4. Institutions Analysis

Regarding the institutions analysis parameter, the following Table 5 presents the top 10 universities that have been most productive in publishing research papers on the topic of utilizing technology for sustainable tourism destinations. The University of Kyung Hee in South Korea is ranked first with ten articles, while the University of Granada in Spain, with six articles, is placed tenth. Most of the universities in this list are from Asian countries, such as Sebelas Maret University (n = 9), Binus University (n = 8), UAJY (n = 6), and UM Malang (n = 6) in Indonesia; IGSNRR (n = 8) in China; Kasetsart University (n = 7) in Thailand; and NKUST (n = 6) in Taiwan. The list included solely two European universities, namely the University of Aveiro in Portugal and the University of Granada in Spain, both of which have six publications. These institutions are placed at the ninth and tenth positions on the list, respectively. This indicates that Asian countries and their sustainable tourism destinations have a significant interest in adopting different technologies to enhance and develop their tourism industry. Additionally, Table 5 illustrates the distribution of article

production across different time periods, with the majority of published articles produced after 2019, which is considered the hype stage and a period of intense article production.

Table 4. Top 10 sources/journals on tech utilization in sustainable tourism destinations.

Rank	Sources	NP	TC	TC/NP	Impact Factor (2022)
1	Sustainability (Switzerland)	87	1718	19.75	3.89
2	IOP Conference Series: Earth And Environmental Science	18	69	3.83	0.45
3	Journal of Sustainable Tourism	17	533	31.35	9.7
4	Current Issues in Tourism	10	497	49.7	7.57
5	Tourism Management	9	763	84.78	12.87
6	Springer Proceedings in Business and Economics	8	28	3.5	0.2
7	Geojournal of Tourism and Geosites	6	26	4.333	2.38
8	Asia Pacific Journal of Tourism Research	5	19	3.8	4.04
9	International Journal of Environmental Research and Public Health	5	33	6.6	3.39
10	Journal of Cleaner Production	4	146	36.5	11.07

Table 5. Ten most productive institutions for publishing articles.

Rank	NP	Publications Overtime		
		Early Stage (2003–2012)	Growth Stage (2013–2018)	Hype Stage (2019–2022)
Kyung Hee University/South Korea	10	0	2	8
Sebelas Maret University/Indonesia	9	0	0	9
Binus University/Indonesia	8	0	1	7
IGSNRR/China	8	0	0	8
Kasetsart University/Thailand	7	0	0	7
NKUST/Taiwan	6	0	0	6
UAJY/Indonesia	6	0	2	4
UM Malang/Indonesia	6	0	0	6
University of Aveiro/Portugal	6	0	4	2
University of Granada/Spain	6	0	3	3

Note: NP: number of publications; IGSNRR = Institute of Geographic Sciences and Natural Resources Research; NKUST = National Kaohsiung University of Science and Technology; UAJY = Universitas Atma Jaya Yogyakarta; UM Malang = Universitas Negeri Malang.

3.3. Bibliometric Networks and Themes

Bibliometric networks are a valuable tool for gaining insights into the interrelationships, collaborations, and patterns within scholarly publications that discuss the usage of technologies in sustainable tourism destinations (Kabil et al. 2022b; Zupic and Čater 2015). In this subsection, we delve into three fundamental components of bibliometric networks: lexical network analysis, spatial network analysis, and citation source network analysis. These analyses provide a more profound comprehension of the connections, dynamics, and influences within the scholarly landscape pertaining to this research area.

3.3.1. Lexical Network

This specific type of visualization network focuses on the examination of word co-occurrence within scientific studies that specifically investigate the utilization of technological tools and strategies to achieve sustainability in tourism destinations. Through constructing a network based on word co-occurrence frequency and proximity, valuable

insights can be gained regarding key concepts, research themes, and emerging trends within the literature (Kabil et al. 2021; Zupic and Čater 2015) (Ogutu et al. 2023). Figure 4 visually represents the co-occurring keyword network that has been derived from the comprehensive analysis of relevant literature.

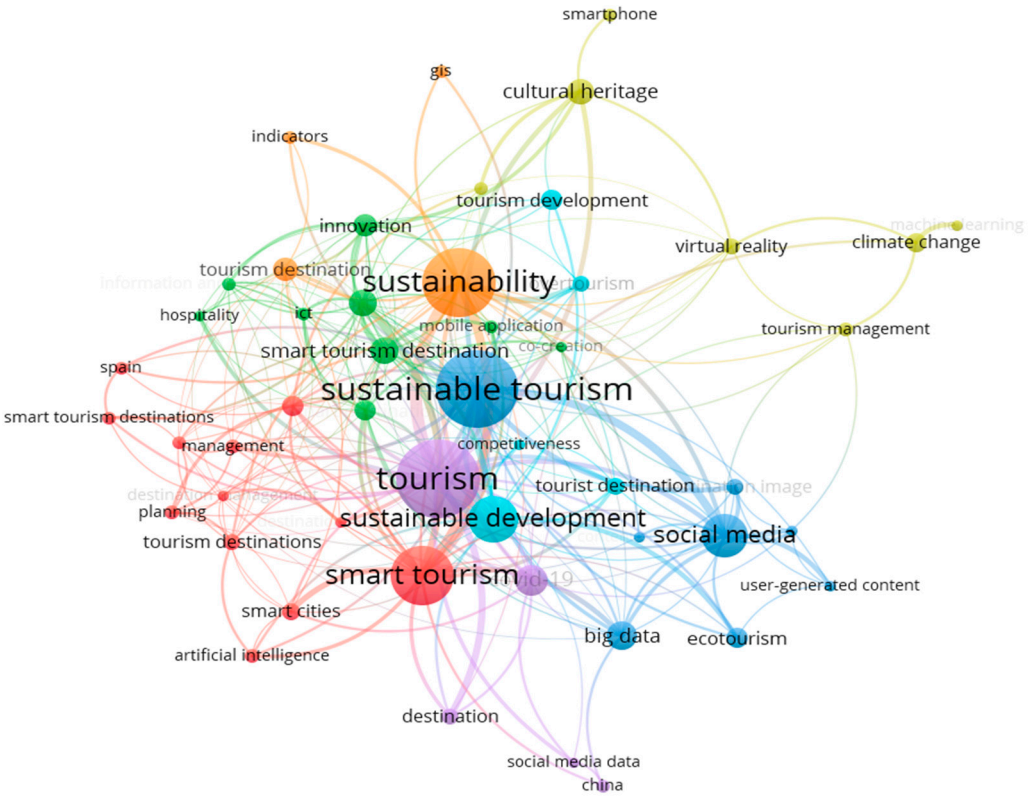

Figure 4. Co-occurring keywords network.

Upon careful examination of the co-occurring keyword network, it becomes apparent that certain keywords hold a dominant position as the most frequently encountered terms within the analyzed literature. These keywords form significant nodes within the network and revolve around the central concept of sustainability in tourism development. Prominent examples of these keywords include "sustainable tourism", "tourism", "sustainability", "smart tourism", and "sustainable development". The prevalence of these keywords underscores their close association with the fundamental notion of sustainability in the context of tourism.

Furthermore, it is worth noting that although the analyzed literature primarily focuses on the use of various technologies in tourism destinations, keywords explicitly related to technology do not emerge as major nodes within the co-occurrence keyword network. This observation suggests that the integration of technologies in tourism destinations remains an emerging and evolving topic, with several avenues yet to be explored. Nevertheless, smaller nodes, albeit with less significance, related to technology do appear in the network. These terms include "GIS", "innovation", "big data", "virtual reality", "smartphone", and "artificial intelligence".

The absence of prominent nodes related to technology in the co-occurring keyword network indicates that the literature emphasizes sustainability and its interplay with tourism, while the discussion surrounding the specific technologies employed in tourism destinations is still relatively limited. This finding suggests a potential research gap and highlights the need for further exploration and investigation into the integration of technologies in the context of sustainable tourism. The presence of smaller nodes associated with technology-related terms signifies that these areas of technological application in tourism destinations,

such as GIS, Big Data, VR, and AI, are emerging topics that warrant attention and further investigation (El Archi and Benbba 2023b).

Furthermore, these findings are corroborated by the frequency of core keywords in the literature pertaining to the use of technologies in sustainable tourism destinations. The accompanying figure showcases the word cloud representation of the most frequently encountered keywords in this body of literature, further reinforcing the significance and prevalence of sustainability-related concepts, as shown in Figure 5.

Figure 5. Word cloud.

3.3.2. Spatial Network

The spatial network analysis focuses on examining the geographical relationships and collaborations among authors, institutions, or countries within the scholarly landscape. Through mapping the geographic affiliations of authors and analyzing their connections, valuable insights can be gained regarding the spatial patterns of research collaborations (Donthu et al. 2021). To illustrate this, Figure 6 presents the collaborative relationships between various countries in the realm of articles related to the use of technologies in sustainable tourism destinations. Within this analysis, China emerges as the leading country in terms of the number of articles published, with a substantial contribution of 193 articles. This indicates a strong research focus on the use of technologies in sustainable tourism destinations within the Chinese academic community. Following closely, Indonesia exhibits significant involvement with 110 articles, demonstrating the country's active engagement in this research field. Spain and Italy also make notable contributions with 100 and 71 articles, respectively. Other countries such as Portugal, the USA, Thailand, the UK, Romania, and Australia have also shown considerable interest in this area, with each contributing a varying number of articles ranging from 49 to 34. The presence of these countries in the analysis further highlights the global attention and research efforts dedicated to exploring the utilization of technologies in sustainable tourism destinations. Furthermore, it is worth noting the strong connections observed between certain countries in terms of collaboration in publishing articles focused on the use of technologies in sustainable tourism destinations. Notable collaborative relationships include China and the USA, China and Australia, as well as Spain and Portugal. These connections signify active collaboration and knowledge sharing among researchers from different countries, indicating a global effort to advance research in this field.

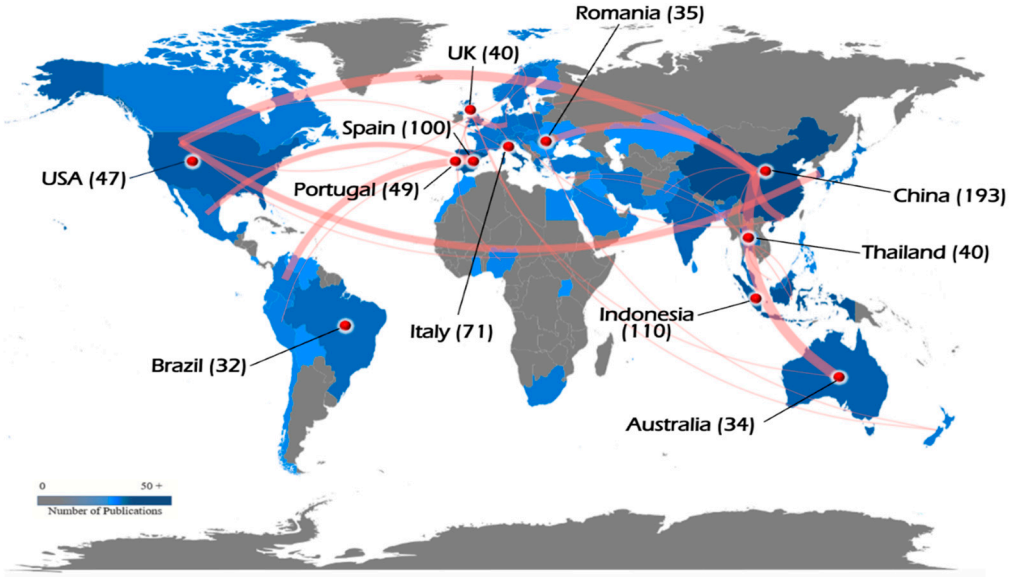

Figure 6. Scientific productions network by country.

3.3.3. Research Directions and Themes

Research directions and themes encompass two crucial aspects: firstly, they encompass the specific paths and avenues of investigation pursued by scholars and researchers in the field of bibliometrics. These directions guide their inquiries within the bibliometric domain, shaping the trajectory of their studies. Secondly, they capture the recurring topics and subjects that hold prominence within the scholarly discourse of bibliometrics. Through methods like keyword analysis, clustering techniques, and topic modelling, these thematic areas emerge, providing insights into the subjects that researchers extensively study and publish on. In the context of this analysis focusing on the utilization of technologies in sustainable tourism destinations, we employ two key bibliometric techniques to identify the prevailing themes and research directions: factorial analysis and thematic analysis.

3.3.4. Factorial Analysis

Factorial analysis was employed in this study to investigate the research directions within the literature focusing on the utilization of technologies in sustainable tourism destinations. Through this analysis, the dataset comprising relevant publications was examined, resulting in the identification of four distinct clusters representing specific research themes (see Figure 7). These clusters shed light on the prevalent areas of inquiry and provide valuable insights into the scholarly discourse surrounding the use of technologies in sustainable tourism destinations (Valderrama et al. 2022).

The largest cluster, indicated by the color red, is characterized by keywords that emphasize the tourism market and its connections. Keywords such as "tourism market", "marketing", "decision making", "communication", and "tourism management" dominate this cluster, highlighting the research focus on understanding the dynamics of the tourism market, effective marketing strategies, decision-making processes, communication practices, and overall tourism management within the context of sustainable tourism destinations.

The second-largest cluster, represented by the color green, is centered around the urban perspective of technology use in tourism destinations. Keywords such as "rural areas", "planning", "landforms", "surveys", and "ecology" are prominent within this cluster. This cluster signifies research efforts aimed at exploring the urban aspects of implementing technologies in tourism destinations, including planning strategies for rural areas, the impact of landforms, conducting surveys, and considering ecological factors.

The blue cluster, denoted by its color, encompasses keywords that highlight emerging factors influencing the use of technologies in tourism destinations. Terms such as "climate change", "COVID-19", "GIS", "virtual reality", and "remote sensing" are notable within this cluster. This cluster signifies the growing interest in understanding the implications of factors such as climate change and the COVID-19 pandemic on the adoption and effectiveness of technologies in sustainable tourism destinations. Additionally, it reflects the exploration of technological tools like GIS, virtual reality, and remote sensing within the context of sustainable tourism.

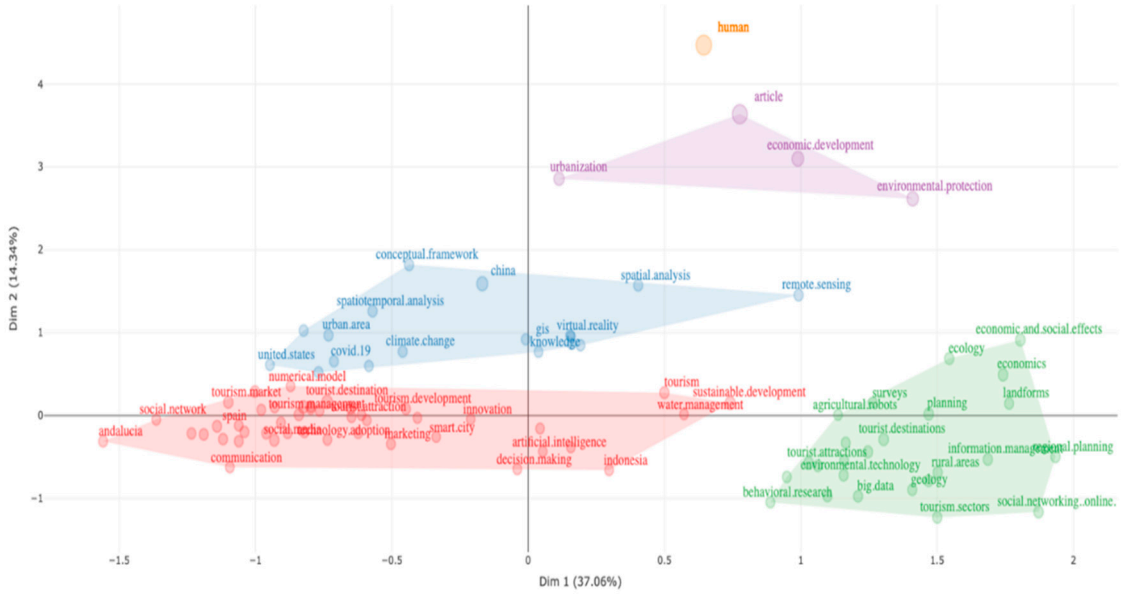

Figure 7. Factorial analysis.

The final cluster, represented by "he c'lor purple, encompasses keywords that represent diverse perspectives on the application of technologies in tourism destinations. Keywords such as "urbanization", "economic development", and "environmental protection" are prevalent within this cluster.

3.3.5. Thematic Analysis

The thematic map in the literature on the use of technologies in sustainable tourism destinations, divided into four quarters (Emerging or Declining Themes, Basic Themes, Motor Themes, and Niche Themes), aims to provide insights into the major themes and their characteristics within the research domain. Each quarter represents a specific combination of two dimensions: centrality and density. Centrality refers to the importance or prominence of a theme within the literature, while density reflects the interconnectedness or co-occurrence of themes (Zeggelink et al. 1996).

In the Emerging or Declining Themes quarter, we find themes with low centrality and low density. These themes, such as China, economic development, sustainable development, and tourism development, indicate areas that may be in the early stages of exploration or experiencing a decline in attention within the literature (El Archi and Benbba 2023a; Cheng et al. 2023). The Basic Themes quarter consists of themes that exhibit high centrality and low density. These themes, including technology, tourism, and accessibility, are considered foundational or fundamental concepts that are widely discussed and recognized within the literature. The Motor Themes quarter represents themes that have achieved high centrality and high density. These themes, such as climate change, tourism management, and ecotourism, are regarded as influential and extensively studied topics that drive research and shape the scholarly discourse in the field. Lastly, the Niche Themes quarter comprises themes with low centrality and high density.

Overall, this thematic map aims to provide an overview of the main themes in the literature on the use of technologies in sustainable tourism destinations. It helps researchers identify the prominence and interconnections between different themes, highlight emerging or declining areas of research, recognize foundational concepts, and pinpoint influential topics that drive the scholarly discourse, as shown in Figure 8.

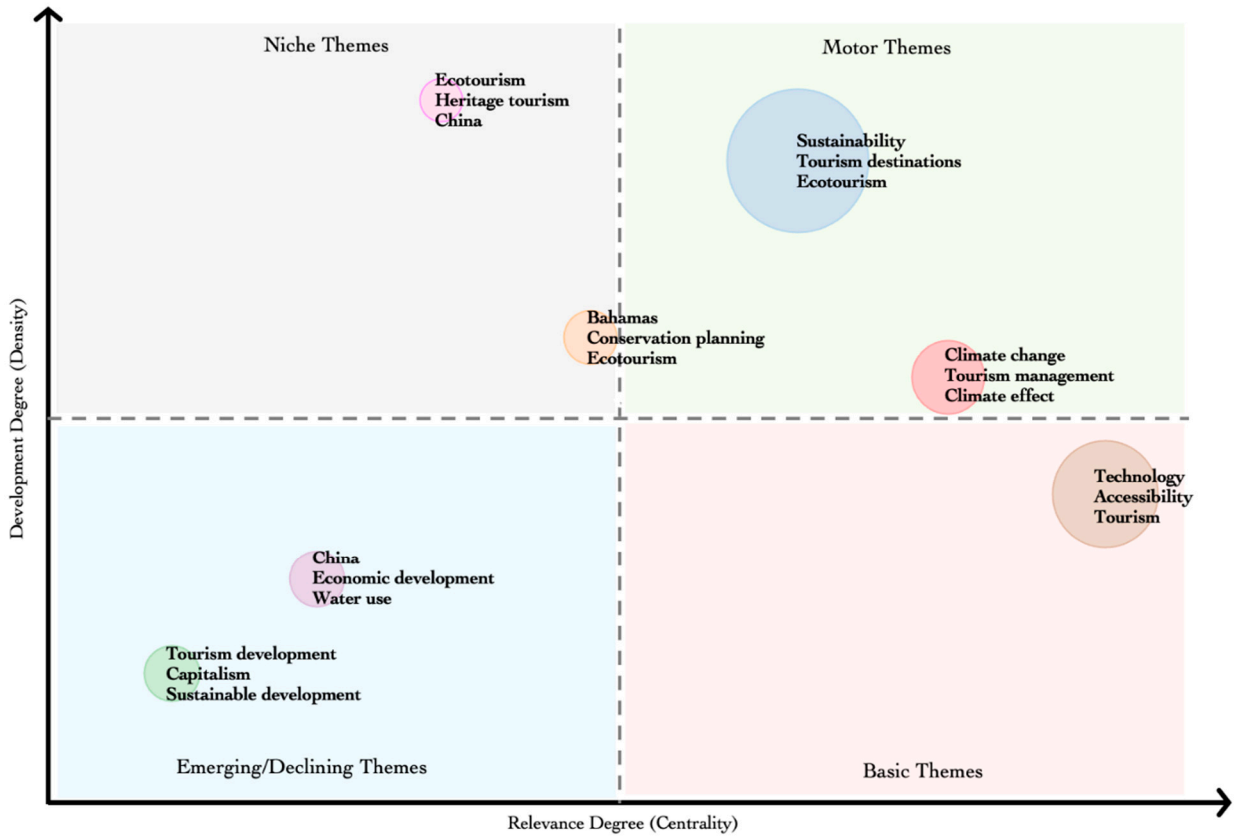

Figure 8. Thematic map.

3.4. Research Gaps and Future Research Agenda

Despite the growing interest in digital technologies for sustainable tourism destinations, the field still exhibits several research gaps that present opportunities for future studies. Addressing these gaps will enhance our understanding of the potential of digital technologies in promoting sustainable tourism practices and improving destination management. The following section outlines the identified research gaps and proposes a future research agenda to guide scholars and practitioners in advancing the domain (Table 6).

This section has highlighted the various research gaps that currently exist within the domain of digital technologies for sustainable tourism destinations. Addressing these gaps will pave the way for a comprehensive understanding of the opportunities and challenges associated with integrating digital solutions in tourism management. The suggested future research agenda emphasizes the need for interdisciplinary collaboration, ethical considerations, and a forward-looking approach to enhance the sustainability and resilience of tourism destinations in an increasingly digital world. Through focusing on these aspects, scholars and practitioners can contribute meaningfully to the advancement of knowledge in this critical and evolving field.

Table 6. Research gaps and future research agenda.

Research Gaps	Future Research Directions
Lack of comprehensive frameworks	Develop holistic models that consider the interplay between digital technologies, sustainability dimensions, and destination-specific factors.
Limited understanding of user behavior	Delve into tourists' attitudes towards digital innovations, their preferences for sustainable options, and the impact of digital interventions on their experiences.
Measuring the impact of digital technologies on sustainability	Establish comprehensive evaluation frameworks to measure the ecological, socio-cultural, and economic impacts of digital solutions on sustainable tourism development.
Privacy and data security concerns:	Explore methods to safeguard tourist data and ensure responsible and ethical data usage.
Long-term sustainability impacts	Investigate the long-term sustainability impacts of these technologies to ascertain their role in creating resilient and future-proof destinations.
Stakeholder collaboration and governance	Explore governance models and strategies to facilitate effective cooperation among governments, businesses, local communities, and technology providers.
Cross-cultural perspectives	Cross-cultural comparisons to identify commonalities and differences in the adoption and impact of digital technologies for sustainable tourism across diverse destinations.
Smart destination management strategies	Propose smart destination management strategies that ensure a balanced and sustainable approach to technology adoption.
Resilience and crisis management	Explore how digital technologies can contribute to destination resilience and crisis management, enabling them to withstand and recover from unexpected shocks.
Environmental Footprint of Digital Technologies	Assess the environmental impact of digital technologies in tourism, including energy consumption, electronic waste, and carbon emissions, and explore ways to minimize their ecological footprint.
Climate Change Mitigation and Adaptation	Explore the potential of digital technologies in supporting tourism destinations' efforts to mitigate and adapt to the impacts of climate change while maintaining sustainability.

4. Research Implications

This research provides valuable insights and implications for the academic community, policymakers, and practitioners in the field of sustainable tourism. The implications can be categorized into two groups: those relevant for practitioners in the tourism industry and those pertinent to policymakers involved in destination management.

For practitioners in the tourism industry, this research presents a comprehensive analysis of research outputs and trends in digital technology adoption within sustainable tourism destinations. The findings offer practitioners a clear understanding of the current state of adoption, enabling them to strategize and invest in innovative digital technologies. Through leveraging these technologies, practitioners can enhance destination experiences, optimize operations, and attract environmentally conscious tourists seeking sustainable and authentic travel experiences. Furthermore, the research sheds light on collaborative networks and key themes, offering valuable guidance for destination marketing practitioners. Through discerning the most influential themes and acknowledging the multidimensional nature of sustainable tourism, marketers can craft compelling narratives that resonate with environmentally conscious travelers. These tailored marketing strategies can attract a niche clientele that values responsible and sustainable destination choices.

On the other hand, policymakers involved in destination management can greatly benefit from the research findings. The evidence-based insights offered by this study provide a foundation for shaping policies that promote the responsible integration of digital technologies in sustainable tourism destinations. Policymakers can develop guidelines that prioritize sustainability, preserve local cultures, and minimize the environmental impacts of tourism activities. Moreover, the study highlights the importance of interdisciplinary collaboration in sustainable tourism. Policymakers can play a pivotal role in facilitating partnerships between technology developers, tourism operators, local authorities, and environmental organizations. These collaborations foster collective efforts toward sustainable destination development, promoting responsible tourism practices and enhancing destination resilience.

5. Conclusions

The utilization of digital technology in tourist destinations has emerged as a prominent and increasingly significant subject within the tourism industry. In order to conduct a comprehensive bibliometric study in this area, the Scopus bibliographic database and bibliometric tools were employed to identify and evaluate relevant research outputs. The analysis of the selected bibliographic data was conducted using Biblioshiny, facilitating the visualization and assessment of patterns and trends prevalent in the research literature.

This analysis encompassed the creation of keyword maps, collaboration networks, and bibliographic coupling maps, enabling the identification of connections between different research fields, the identification of prolific authors and institutions, and the exploration of prevalent themes within the literature. Examining a total of 559 papers, the findings reveal a consistent increase in publications over time, with research activity concentrated in regions such as Europe and North America. Furthermore, a noteworthy level of collaboration is evident among researchers from diverse academic backgrounds, highlighting the interdisciplinary nature of this field. Specific areas of focus include the application of digital technologies in destination marketing, sustainable tourism management, and visitor behavior analysis.

The findings suggest that the adoption of digital technology in sustainable tourism destinations is a complex and multifaceted issue, necessitating collaboration between various stakeholders including tourism operators, policymakers, local communities, and technology providers. Furthermore, the research indicates several distinct areas of study, such as the utilization of digital technology in tourism marketing and management, the environmental impacts of digital technology, and the enhancement of the overall tourist experience. Additionally, other research areas encompass the integration of digital technology in tourism planning, destination management, and sustainable development.

Some of the limitations include the reliance on existing publications, which might suffer from publication bias, and the potential exclusion of unpublished or non-indexed literature. Additionally, the data retrieved from bibliographic databases might not capture the entire landscape of digital technology adoption in sustainable tourism destinations. Furthermore, the study's focus on quantitative analysis might overlook valuable qualitative insights. For further research, a complementary qualitative approach, such as interviews or surveys, could provide a deeper understanding of the experiences and challenges faced by sustainable tourism destinations in adopting digital technologies. Additionally, longitudinal studies could track the evolution of technology adoption and its impacts over time.

This bibliometric study provides valuable insights into the current state of research regarding the use of digital technology in sustainable tourism destinations. The analysis highlights key themes, collaborative networks, and emerging trends within the field, offering a comprehensive overview of the subject and paving the way for future research and development in this dynamic area.

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