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Research Progress and Development of Technology in Tourism Research: A Bibliometric Analysis

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Abstract

The interaction between technology and tourism has been a dynamic research area recently. This study aims to review the progress and development of technology in tourism research via a bibliometric analysis. We derive the source data from the Web of Science (WoS) core collection and use CiteSpace for bibliometric analysis, including countries, institutions, authors, categories, references, and keywords. The analysis results are as follows: i) The number of published articles on the role of technology in tourism has increased in recent years. ii) Technology-related articles in tourism are abundant in *Tourism Management, Journal of Travel Research*, and *Annals of Tourism Research*. iii) The countries with the most contributions are China, the US, and the UK. The most active institutions are the Hong Kong Polytechnic University, University of Central Florida, Bournemouth University, University of Queensland, and Kyung Hee University. iv) The reference analysis results identify eight extensively researched topics from the most cited papers, and the keyword burst analysis results present an emerging trend. This study identifies the effect and development of technology in tourism research. Our findings provide implications for researchers about the current research focus of technology and the future research trend of technology in the tourism field.

1. Introduction

In tourism, technology is a catalyst for development as it determines the strategy and competitiveness of tourism destinations (Buhalis & Law, 2008). With the advancement of technology, smart tourism has developed dramatically, which led to various possibilities. In tourism research, scholars paid close attention to the application of different technologies, such as cloud computing (Zhou, Xu, & Kimmons, 2015), big data (Yang et al., 2020), artificial intelligence (AI; Li, Bonn, & Ye, 2019), robot (Zhong, Yang, Rong, & Li, 2020), augmented reality (AR; Poux, Valembois, Mattes, Kobbelt, & Billen, 2020), and virtual reality (VR; Fang & Lin, 2019). Their efforts have created a new development space and provided powerful technical wisdom for the current tourism industry.

Reviewing literature is critical to understand the topic in-depth in the academic field (Tranfield, Denyer, & Smart, 2003). The unprecedented growth of knowledge caused by the development of information technology makes it difficult for academic researchers around the world to be informed of the specific knowledge in a certain topic. Being faced with the rapid growth of massive literature, it is not easy for academic researchers to understand research progress accurately and timely only through traditional manual retrieval methods. As a result, how to grasp and understand the knowledge structure and evolution process of a certain research field in a scientific,

efficient and intuitive way has been become necessary and important for both academic researchers and industry practitioners.

Bibliometric analysis is originated from the field of library and information science. Driven by the rapid development of computers and Internet, bibliometric analysis has gradually attracted the attention from the scientific community (Bar-Ilan, 2008). Bibliometric analysis can be conducted in many different ways such as analyzing bibliographic data with quantitative network analysis to identify the structure of research (Dzikowski, 2018). Scientific knowledge mapping, in a form of new development of scientific metrology and informetrics, can reflect the complex domain of modern science and technology knowledge through data mining, information processing, and graph drawing., Scientific knowledge can assist researchers in understanding the position of their research in a certain research field and make it easier for them to find new research trends/topics in an effective way (Liu, Chen, & Hou, 2008).

Many studies focusing on specific technologies in the hospitality and tourism have been published in recent years (Mariani, Baggio, Fuchs, & Höepken, 2018; Poux et al., 2020; Shao, Chang, & Morrison, 2017; Tussyadiah, 2020; Yang & Chew, 2020). However, a comprehensive overview of technology development in tourism using bibliometric and knowledge mapping methods is still limited. Hence, the present study applied bibliometric analysis and used the knowledge mapping tool CiteSpace to

analyze and explore technology development in tourism over the past 30 years (1991–2020) visually by answering the following research questions. i)What are the discipline distribution and main source journals relating to technologies in tourism research? ii) Which are main contributors of relevant research field in terms of countries, organizations, and authorship? iii) What are the critical research works and their knowledge foundation in this field? and iv) What are the research hotspots and emerging trends in this area?

2. Literature Review

2.1 Cloud Computing and Big Data in Tourism Research

Cloud computing and big data have become significant parts of modern systems, especially in information processing and intelligent analytics (Dong, Wu, & Gao, 2019). In recent years, big data have provided opportunities in many research fields. However, the storage, transmission, and mining of large amounts of data pose challenges to the current technical foundation. With the development of parallel computing and distributed computing, cloud computing has offered basic technical support concerning problems brought by shared computing resources (Yang, Huang, Li, Liu, & Hu, 2017). In particular, cloud computing has spawned a series of big data processing tools, such as GFS (Ghemawat, Gobioff, & Leung, 2003), BigTable (Chang et al., 2008), and MapReduce (Dean, Ghemawat, & Mehta, 2008), which provide powerful technical support for the efficient processing of big data. In tourism research, the content of cloud computing and big data mainly includes: predicting the development of different hotels (Li, Lu, Xu, & Sun, 2020), exploring the information fusion in the intelligent park (Yu, Song, & Zhang, 2019), monitoring tourist flow in scenic spots (Qin et al., 2019), analyzing and predicting the popularity of tourist destinations (Chen, Law, Xu, & Zhang, 2020), managing tourist destinations using data mining techniques (Zhang & Dong, 2021), reflecting tourists' views on the services through mining tourism blog data (Shao et al., 2017), and designing real-time route recommendation systems for tourists (Mehmood, Ahmad, & Kim, 2019). Smart tourism depends on big data, and the ultimate goal is to extract information from big data for accurate smart tourism planning (Gretzel, Sigala, Xiang, & Koo, 2015). By collecting, analyzing, and interpreting the big data, smart tourism management can provide personalized experiences for tourists (Buhalis & Amaranggana, 2015).

2.2 AI in Tourism Research

For tourists to experience world-class tourism, the tourism industry needs to provide various artificial services to meet their physiological, psychological, and social needs. AI offers personalized services to users, and at present, researchers in the field of tourism and hospitality started to investigate AI, robotics, and other related fields (Tussyadiah, 2020). They mainly focused on AI applications in tourism and the possible development direction and influence of AI on tourism in the future (Ivanov & Webster, 2020; Murphy, Gretzel, & Pesonen, 2019; Murphy, Hofacker, & Gretzel, 2017; Tung & Law, 2017). In smart tourism research, Tsaih and Hsu (2018) provided a conceptual framework for digital management strategy. Wang Kumar, et al. (2020) discussed the capabilities of 5G and AI in realizing the potential of the Internet of Things for smart tourism. Murphy et al. (2019) proposed 11 robot capabilities that can influence anthropomorphism and eventually shape HRI (Human–Robot Interaction). In summary, efficient data collection based on 5G technology and intelligent data processing using AI technology will be of great significance to the development of intelligent tourism technology (Wang Kumar, et al., 2020).

2.3 VR and AR in Tourism Research

In recent years, the rapid development of VR and AR technology has provided highly immersive interactive operations. They offer new ways to present the information required by users in multiple spatial and temporal dimensions. Thus, they have great potential application for the further development of tourism (Gretzel, Zhong, & Koo, 2016). VR technology can create an interactive experience, providing users a strong sense of immersion (Hemanth, Kose, Deperlioglu, & de Albuquerque, 2020). AR allows different interaction styles, which can trigger curiosity and interest from a user-centered perspective (Galatis, Gavalas, Kasapakis, Pantziou, & Zaroliagis, 2016). When VR and AR just began to develop, their application was mainly for gaming and entertainment (Zyda, 2005). After a few years, many academic and industrial fields started to explore deeper needs to solve real-world problems (Guttentag, 2010; Ong & Nee, 2013). In tourism research, Guttentag (2010) suggested that VR offers opportunities to tourism researchers and professionals in several directions, including planning and management, marketing, education, accessibility, and heritage preservation. Regarding application, Paliokas et al. (2020) proposed an AR quiz game designed to increase the time museum visitors interact with artifacts, which offered a playful way to gain knowledge and travel in a 3D space.

3. Methodology

3.1 Data Sources

The selection of databases is a crucial issue in bibliometrics research (Martens, Lacerda, Belfort, & de Freitas, 2016). Thomson Reuters developed Web of Science (WoS), an accurate, prestigious, and well-known database providing widely accepted high-quality scientific publications (Olawumi & Chan, 2018). Thus, this study used the WoS core collection database. The citation database was set as SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, and ESCI, as the sample data source determines the reliability of the data retrieved.

This study focused on different technologies, including cloud computing, big data, the Internet, AI, and VR and AR technology, as previously mentioned in Section 2. The data retrieval strategy used for the search included the following terms: (TI = ["tourist*" OR "tourism" OR "traveler*" OR "travel" OR "hotel*" OR "restaurant*" OR "hospitality"]) AND (TS = ["smart*" OR "technology*" OR "digital" OR "cloud computing" OR "big data" OR "web*" OR "online" OR "Internet" OR "artificial intelligence" OR "robot*" OR "virtual reality" OR "augmented reality"]). To ensure the sample accuracy, we defined the retrieved results by document types, including "ARTICLE," "PROCEEDINGS PAPERS," and "REVIEW." We excluded the papers written in languages other than English and then saved and output the retrieved results in text format. Each document contained authors, institutions, keywords, abstract, date, references, and other related information for analysis. We collected the data in January 2021, with an initial data retrieved of 12,447 articles from WoS. However, only find only a few publications could be found from 1958 to 1990 (i.e., fewer than one publication each year). Thus, data were retrieved from 1991 to 2020, with a total of 12,422 articles. Specifically, through adopting "Duplicates Removal" function in CiteSpace, duplicated articles were discarded. In addition, "Article," "Review" and "Proc." functions were selected to clean the data. As a result, 12,422 articles were reserved for further analysis.

3.2 Analytical Tools

Many science mapping tools, including VOS viewer (Nazir et al., 2021; Ye, Ye, & Law, 2020), CoPalRed (Bailón-Moreno,

Jurado-Alameda, & Ruiz-Baños, 2006), Gephi (Johnson & Samakovlis, 2019), and CiteSpace (Fang, Yin, & Wu, 2018; Yang et al., 2020), have been available for bibliometric analysis. CiteSpace detects the emerging trends and abrupt changes in the scientific literature (Chen, Hu, Liu, & Tseng, 2012). Thus, it can present the panorama and reorganization of knowledge structure intuitively. On this basis, we employed CiteSpace 5.7.R1 to analyze categories, countries, institutions, authors, references and keywords, and research hotspots. We used the following parameters: Period: 1991–2020, Time Slice Length = 5; Node Type: Option based on analysis; Selection Criteria: Top 48 per slice; Pruning: Pathfinder, pruning sliced networks, and the merged network; others were default settings. More detailed parameters are available at the upper left corner of each knowledge map.

4. Analysis and Results

4.1 Annual Publication Trend

On the basis of the retrieved data, the analysis covered articles published from 1991 to 2020. Figure 1 is a bar chart showing the annual publication trend of related studies. The tendency of annual publications showed an upward trend from 1991 to 2020. Specifically, the increased rate of publications was stable from 1991 to 1997. From 1997 to 2007, the number of publications gradually increased. From 2008 to 2020, the number of publications grew quickly, indicating that tourism technology was a hot topic in the past 12 years. The number of tourism publications has grown rapidly since 2008 could be attributed to the rapid development of ICTs (Information and communication technologies) such as smart phones (late-2000s) and social media platforms (mid-2000s). In addition, service delivery in the tourism industry in 2008-2020 experienced the shift form electronic service (e-service) to mobile service (m-service) (Leung, 2019). As a whole, the span of the identified records was 30 years. They included 8,005 articles, 3,866 proceedings papers, and 545 review papers, as shown in the database. The concise statistic presented a general overview from final retrieval results, providing researchers an understanding of the overall trend of tourism technology development.

4.2 Category Analysis

The purpose of this section is to identify the major disciplines involved in tourism research in order to provide an overall picture of technology development of tourism research. Following the discipline system of WoS, one publication might cover one or more fields. Thus, the number of publications may be more than the number of total recorded publications every year. The 12,416 articles about technology in tourism research could be divided into 222 research directions to show the interdisciplinary characters. Figure 1 presents the trend of article output in the top 10 WOS categories from 1991 to 2020 with more than 735 publications. The stacking area map shows the emerging trend of every research area in each year. Figure 2 provides more detailed information about the number of publications every year in each category. Most studies belonged to Hospitality, Leisure, Sport, and Tourism, with 4,106 articles accounting for 31.74%. Moreover, Management (1,837; 14.20%), Business (1,107; 8.56%), Information Systems under Computer Science (1,044; 8.07%), Environmental Studies (898; 6.94%), Theory and Methods of Computer Science (864; 6.68%), Electrical and Electronic Engineering (802; 6.20%), Transportation Science and Technology (797, 6.16%), Economics (745, 5.76%), and Transportation (735, 5.68%) also contributed to this field. From 2005, the number of publications from these ten research areas has increased gradually. In 2020, most published articles were about Hospitality, Leisure, Sport, and Tourism (766), Environmental Studies (201), and Management (218). In 2019, most studies belonged to Information Systems under Computer Science (128), Theory and Methods of Computer Science (128), and Economics (96). In 2018, studies focusing on Business (131), Transportation (99), and Transportation Science and Technology (97) were rampant. In 2017, papers published in Electrical and Electronic Engineering (98) reached the highest number of publications in 30 years. In general, from 2017 to 2020, the number of studies in each of the above areas was the highest. Relevant studies about tourism technologies were extended to business, management, computer science, environment, economics, and transportation, showing the characteristics of multi-direction integration and human-oriented orientation.
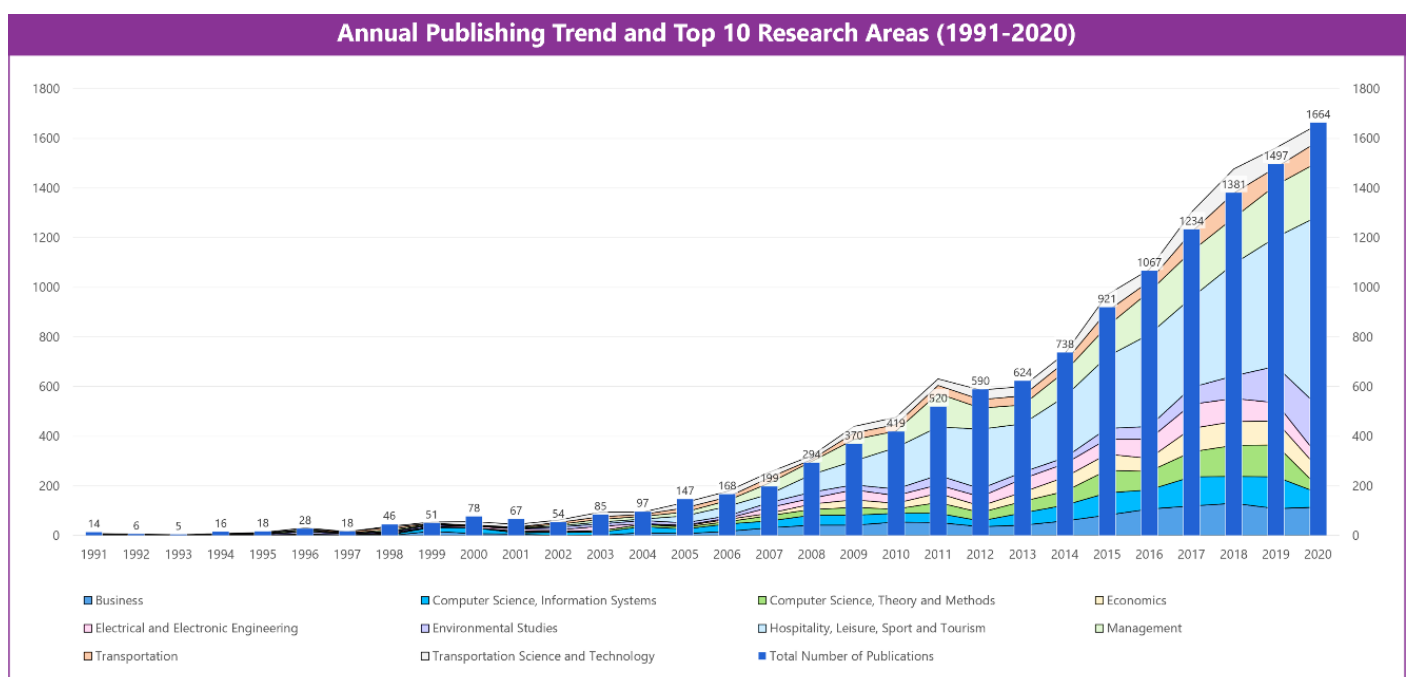

Fig. 1. Annual publishing trend and annual article output in the top 10 WOS categories (1991–2020)

No	Categories	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Total	
1	Hospitality, Leisure, Sport and Tourism	0	0	0	1	3	4	2	3	3	1	1	5	8	6	28	39	34	70	96	166	195	240	196	245	290	372	362	451	519	766	4106	31.74%
2	Management	0	0	1	1	3	4	2	6	4	0	3	6	11	11	15	24	46	53	87	67	135	85	76	101	122	172	187	186	211	218	1837	14.20%
3	Business	2	0	0	4	0	0	0	1	17	8	7	1	2	11	8	18	32	43	43	54	53	36	42	60	82	108	120	131	109	115	1107	8.56%
4	Computer Science, Information Systems	0	1	1	0	1	3	3	3	16	23	5	12	12	25	19	29	27	39	39	36	37	24	50	63	90	77	117	107	128	57	1044	8.07%
5	Environmental Studies	1	0	0	1	3	7	5	3	6	0	2	12	10	12	9	9	20	26	20	27	39	32	25	26	44	51	68	92	147	201	898	6.94%
6	Computer Science, Theory and Methods	0	0	0	0	1	2	0	2	0	1	4	2	7	9	8	10	22	23	31	17	44	34	46	56	92	74	100	126	128	25	864	6.68%
7	Electrical and Electronic Engineering	1	1	0	1	1	2	0	4	2	5	8	6	16	4	3	5	22	23	39	30	33	37	55	53	60	76	98	92	75	50	802	6.20%
8	Transportation Science and Technology	1	2	1	0	1	5	0	5	5	14	11	9	18	10	22	23	22	15	25	30	26	39	38	35	67	49	80	97	79	68	797	6.16%
9	Economics	1	1	0	0	0	0	0	1	1	0	3	2	0	0	5	8	10	22	32	24	37	26	37	57	64	53	95	96	96	74	745	5.76%
10	Transportation	2	2	0	0	0	4	4	10	1	4	2	7	11	7	17	13	21	8	27	26	32	34	36	38	59	41	77	99	70	83	735	5.68%

Fig. 2. Distribution of major disciplines from 1991 to 2020

4.3 Journal Analysis

Academic journals are important outlets for research dissemination in a certain research field. Through the analysis of the source journals, the core journals in this field can be found, which can assist researchers to be informed of the research scope and research goal efficiently (Zhao, Tang, & Zou, 2019). We analyzed the most active journals and their impact (five years), as shown in Figure 3. *Tourism Management* accounted for the most senior research with 346 articles and the highest number of 5,314 citations. The second most prolific journal is *Journal of Travel Research* (3,412), followed by *Annals of Tourism Research* (3,351). Our findings confirmed that journals with high impact factors might have high quotation frequencies. Most journals were from Elsevier Ltd. in the UK and SAGE Publications Ltd. in the US.

4.4 Country Collaboration Networks

As the number of national publications can reflect a country's contribution to the research field, country collaboration networks were analyzed. Figure 4 presents the network of collaborating countries consisted of 66 nodes and 64 links between 1991 and 2020. The thinness of the links between countries implies the level of cooperation. The top 10 countries listed on the right-hand side made the major portion of contributions. From 1991 to 2020, Chinese institutions contributed the most to this research field, with 2,968 published articles. However, its centrality was less than in other countries. The US was the second-largest contributor, with 2,472 papers published, followed by England (852), Spain (805), and Australia (709). Except for China, the major nodes in Asia were South Korea (371), India (295), and Malaysia (291), ranking 7th, 9th, and 10th in publication counts. European countries made significant connections with other countries, such as England, Spain, and Italy, as shown by the links in Figure 4.

Top 10 Active Journals

	Frequency	%	IF	Rank
Tourism Management	5314	21.16%	9.24	1
Journal of Travel Research	3412	13.58%	7.81	2
Annals of Tourism Research	3351	13.34%	8.12	3
International Journal of Hospitality Management	2564	10.21%	7.78	4
Journal of Business Research	1943	7.74%	5.48	5
Journal of Marketing	1857	7.39%	9.92	6
Journal of Travel and Tourism Marketing	1829	7.28%	3.94	7
Journal of Marketing Research	1784	7.10%	7.81	8
International Journal of Contemporary Hospitality Management	1666	6.63%	6.23	9
Computers in Human Behavior	1396	5.56%	5.70	10

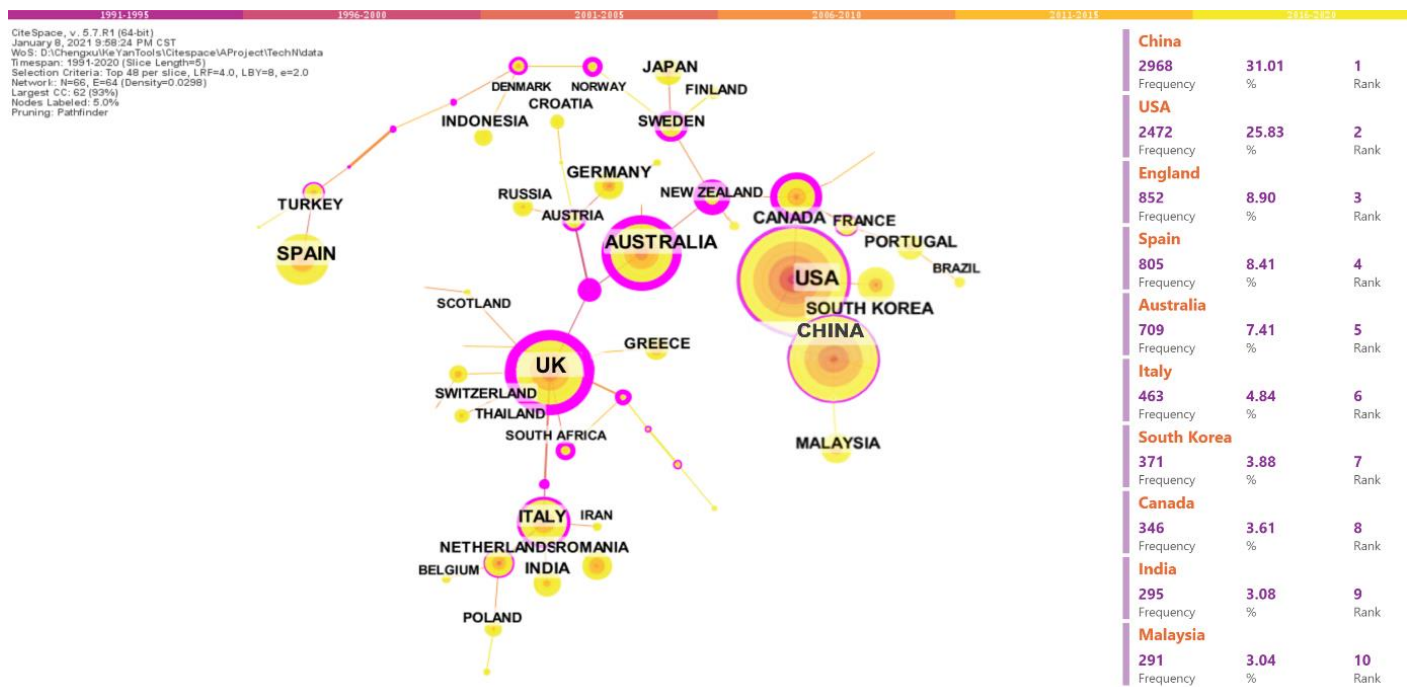**Fig. 3.** Top 10 active journals based on the frequency of citations

Fig. 4. A visualization of the country collaboration networks and top 10 contributing countries

4.5 Collaboration Network of Different Institutions

As cooperation between/among institutions is a key to promote the overall strength of the academic organizations and it is also a critical way to realize complementary scientific research resources for knowledge sharing, which the analysis results can reflect the research status in a certain field (Gu, Li, Li, & Liang, 2017). Figure 5 is a collaboration network, with 178 institutions and 98 collaboration links between 1991 and 2020. The top 10 institutions with the most contributions to the total outputs are presented on the right-hand side of Figure 5. With 404 publications, the Hong Kong Polytechnic University topped the list, followed by the University of Central Florida (145), Bournemouth University (102), University of Queensland (99), and Kyung Hee University (95). China was the top contributor in related fields with two institutions (the Hong Kong Polytechnic University and Sun Yat-sen University, ranking 1st and 9th, respectively). The list also includes three institutions from the US (University of Central Florida, Pennsylvania State University, and the University of Nevada, ranking 2nd, 8th, and 10th, respectively), two institutions from the UK (i.e., Bournemouth University and the University of Surrey), and two institutions from Australia (i.e., the University of Queensland and Griffith University). The contribution of institutions was in direct proportion to the contribution of countries.

4.6 Author Contribution Analysis

The author analysis is considered an effective way to learn the connections between academic organizations and to figure out the main contributors in a certain field. Figure 6 is an author collaboration network of contributions to tourism technology, with 309 authors and 214 collaboration links. The top 10 authors based on frequency are displayed on the right-hand side of Figure 6. The results show that Rob Law contributed the most to the field of tourism research about technology. His affiliation is School of Hotel and Tourism Management, the Hong Kong Polytechnic University, focusing on information and communications technology research in hospitality and tourism (Law, Leung, & Chan, 2019; Leung, Law, van Hoof, & Buhalis, 2013) and mobile technology in hospitality and tourism (Chen et al., 2020). Dimitrios Buhalis is one of the major scholars who focused on electronic tourism (e-tourism; Buhalis & Law, 2008; Buhalis & Wagner, 2013) and smart tourism and hospitality (Buhalis & Amaranggana, 2015; Buhalis & Leung, 2018). Buhalis is the director of the e-Tourism Lab at Bournemouth University in the UK. Ulrike Gretzel is a notable author in smart tourism and hospitality research. Her research focus includes smart tourism development (Gretzel et al., 2015), smart destination brands (Gretzel & Collier de Mendonça, 2019), and e-tourism (Gretzel et al., 2020). Most authors in the top 10 list have affiliations in the department/school relating to the tourism, management, and marketing, associated with institutions in Figure 6. Indeed, the authors in the top 10 list have close research collaborations in tourism.

4.7 Reference Analysis

To acquire the knowledge foundation of relevant research, we adopted co-citation analysis to show the fundamental research achievements in different periods. The nodes are labeled, as shown on the left-hand side of Figure 7. It includes the name of the first author and the publication year of the article. The top 10 article nodes with significant academic influence are shown on the right-hand side. On the basis of the keywords and the number sorted in Figure 7, the most cited papers covered the following eight topics: i) Word-of-mouth (Number 3, 7, 8, 9, and 10), ii) Online reviews (Number 3, 8, and 9), iii) User-generated content and big data (Number 5, 6, and 10), iv) Social media (Number 2, 4, and 10), (v) Marketing (Number 1, 2, 7), (vi) Web and Internet (Number 1 and 4), (vii) Travel choice and consumer choice (Number 3 and 8), and (viii) Online bookings/Hotel bookings (Number 3 and 5). To some extent, these topics can reflect the research focus in this field. In general, the top 10 articles are mainly review articles (1, 4, and 9) and articles that studied the effect of technology on tourism (2, 3, 5, 7, and 8).
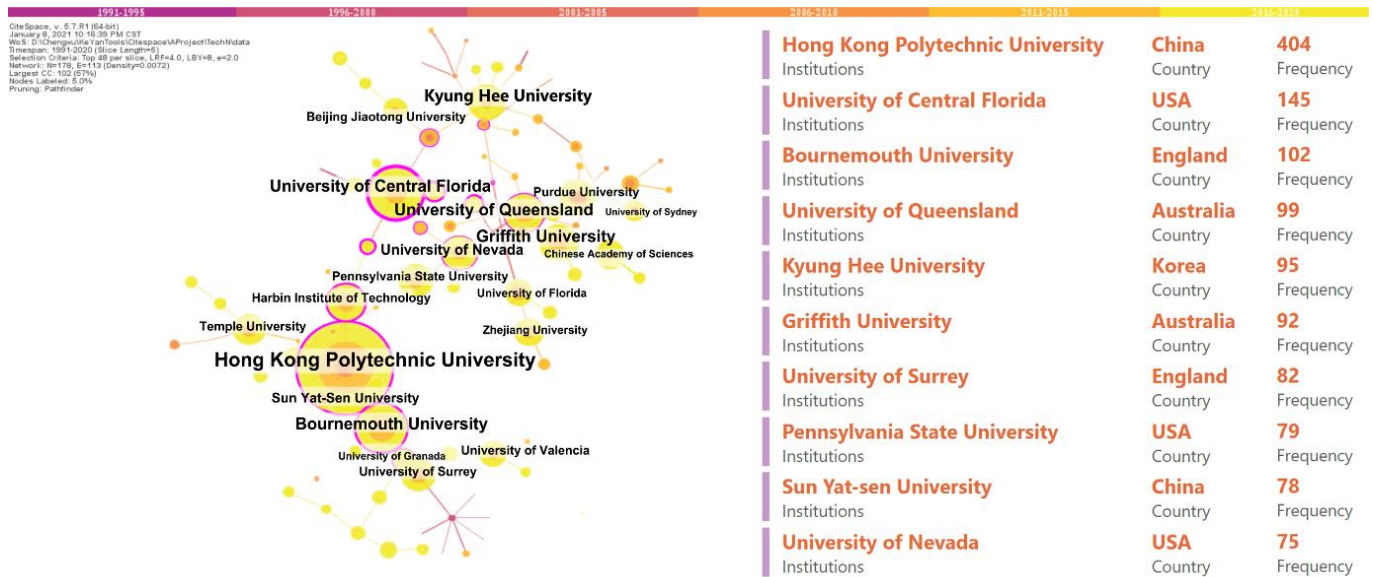
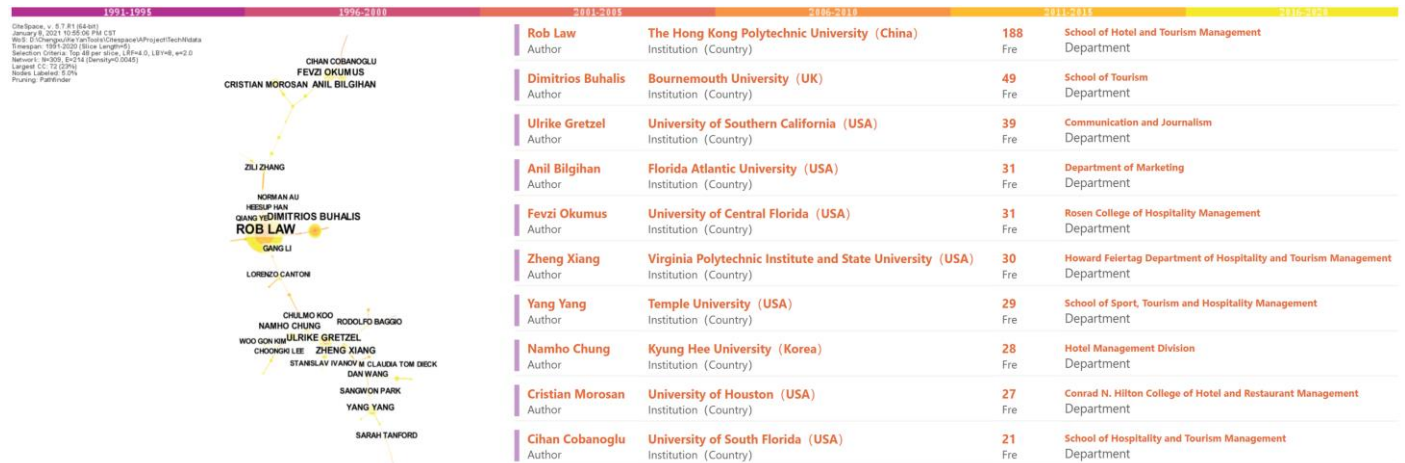**Fig. 5.** A visualization of the institution collaboration network

Institutions	Country	Frequency
Hong Kong Polytechnic University	China	404
University of Central Florida	USA	145
Bournemouth University	England	102
University of Queensland	Australia	99
Kyung Hee University	Korea	95
Griffith University	Australia	92
University of Surrey	England	82
Pennsylvania State University	USA	79
Sun Yat-sen University	China	78
University of Nevada	USA	75

Fig. 6. Visualization of author collaboration network and the top 10 authors

Author	Institution (Country)	Fre	Department
Rob Law	The Hong Kong Polytechnic University (China)	188	School of Hotel and Tourism Management
Dimitrios Buhalis	Bournemouth University (UK)	49	School of Tourism
Ulrike Gretzel	University of Southern California (USA)	39	Communication and Journalism
Anil Bilgihan	Florida Atlantic University (USA)	31	Department of Marketing
Fevzi Okumus	University of Central Florida (USA)	31	Rosen College of Hospitality Management
Zheng Xiang	Virginia Polytechnic Institute and State University (USA)	30	Howard Feiertag Department of Hospitality and Tourism Management
Yang Yang	Temple University (USA)	29	School of Sport, Tourism and Hospitality Management
Namho Chung	Kyung Hee University (Korea)	28	Hotel Management Division
Cristian Morosan	University of Houston (USA)	27	Conrad N. Hilton College of Hotel and Restaurant Management
Cihan Cobanoglu	University of South Florida (USA)	21	School of Hospitality and Tourism Management

Fig. 7. Visualization of co-citation network and top 10 most cited papers with frequency

Number	References	Journal	Fre
1	Buhalis and Law, 2008	Tourism Management	345
2	Xiang and Gretzel, 2010	Tourism Management	343
3	Sparks and Browning, 2011	Tourism Management	242
4	Leung et al., 2013	Journal of Travel & Tourism Marketing	225
5	Q. Ye et al., 2011	Computers in Human Behavior	192
6	Gretzel et al., 2015	Electronic Markets	186
7	Litvin et al., 2008	Tourism Management	176
8	Vermeulen and Seegers, 2009	Tourism Management	163
9	Serra Cantallops and Salvi, 2014	International Journal of Hospitality Management	146
10	Munar and Jacobsen, 2014	Tourism Management	138

1* Progress in information technology and tourism management: 20 years on and 10 years after the Internet—The state of e-Tourism research (Bulhalis & Law, 2008).
2* Role of social media in online travel information search (Xiang & Gretzel, 2010).
3* The impact of online reviews on hotel booking intentions and perception of trust (Sparks & Browning, 2011).
4* Social Media in Tourism and Hospitality: A Literature Review (Leung et al., 2013).
5* The influence of user-generated content on traveler behavior: An empirical investigation on the effects of e-word-of-mouth to hotel online bookings (Ye, Law, Gu, & Chen, 2011).
6* Smart tourism: Foundations and developments (Gretzel et al., 2015).
7* Electronic word-of-mouth in hospitality and tourism management (Litvin, Goldsmith, & Pan, 2008).
8* Tried and tested: The impact of online hotel reviews on consumer consideration (Vermeulen & Seegers, 2009).
9* New consumer behavior: A review of research on e-WOM and hotels (Serra Cantallops & Salvi, 2014).
10* Motivations for Sharing Tourism Experiences Through Social Media (Munar & Jacobsen, 2014).

4.8 Research Hotspots and Emerging Trend Based on Keyword Burst Analysis

Figure 8 displays the top 40 keywords with the strongest citation bursts. Among them, keywords with the longest citation bursts period are "design" (2001–2014, 14 years), "Internet" (2000–2013, 14 years), "system" (1996–2008, 13 years), "e-commerce" (2001–2013, 13 years), and "GIS" (1998–2010, 13 years). From 1996, keywords with strongest citation bursts began to show, including "knowledge management," "web," "e-business," "China," "Internet marketing," "semantic web," "ease," "consumption," and "sustainable tourism." Starting from 2004, "travel agency," "e-tourism," and "network" started to burst. "Smart tourism," "review," and "big data" are the most recent hot topics discussed by authors in tourism and hospitality research concerning technologies with high citation burst, as shown in Figure 8. Moreover, the burst time is associated with the most cited articles shown in Figure 8 for tourism technology (Gretzel et al., 2015; Leung et al., 2013; Serra Cantallops & Salvi, 2014).

Figure 9 is a timeline generated to visualize the co-occurring keywords from 1991 to 2020. Each node represents cited keywords, and the links show the keyword co-citation relationships. To produce a unique result and wide coverage, we used log-likelihood ratio (LLR) as one of the three algorithms (LSI, LLR, and MI) in CiteSpace (Jin, Ji, Li, & Yu, 2017). To generate high-quality clustering with intraclass similarity and inter-class similarity, we deemed the LLR test suitable for our study (Wang, Ma, et al., 2020). On the top of Figure 9, the gradual color pattern indicates a change between each time slice. The deep purple represents the beginning of the study (1991–5), and the yellow color on the right-hand side denotes the end of the study period (2016–20). In the analysis, we screened the top 13 largest clusters. The results showed the top 13 clusters, including "#0 big data," "#1 hotels," "#2 information technology," "#3 teleworking," "#4 website," "#5 reliability," "#6 online reviews," "#7 trust," "#8 loyalty," "#9 online puncher," "#10 system," "#11 managers perceptions," and "#12 consumption." The sequence of the clusters and the time of nodes shown on every horizontal axis intuitively present the rise and fall of specific research content.
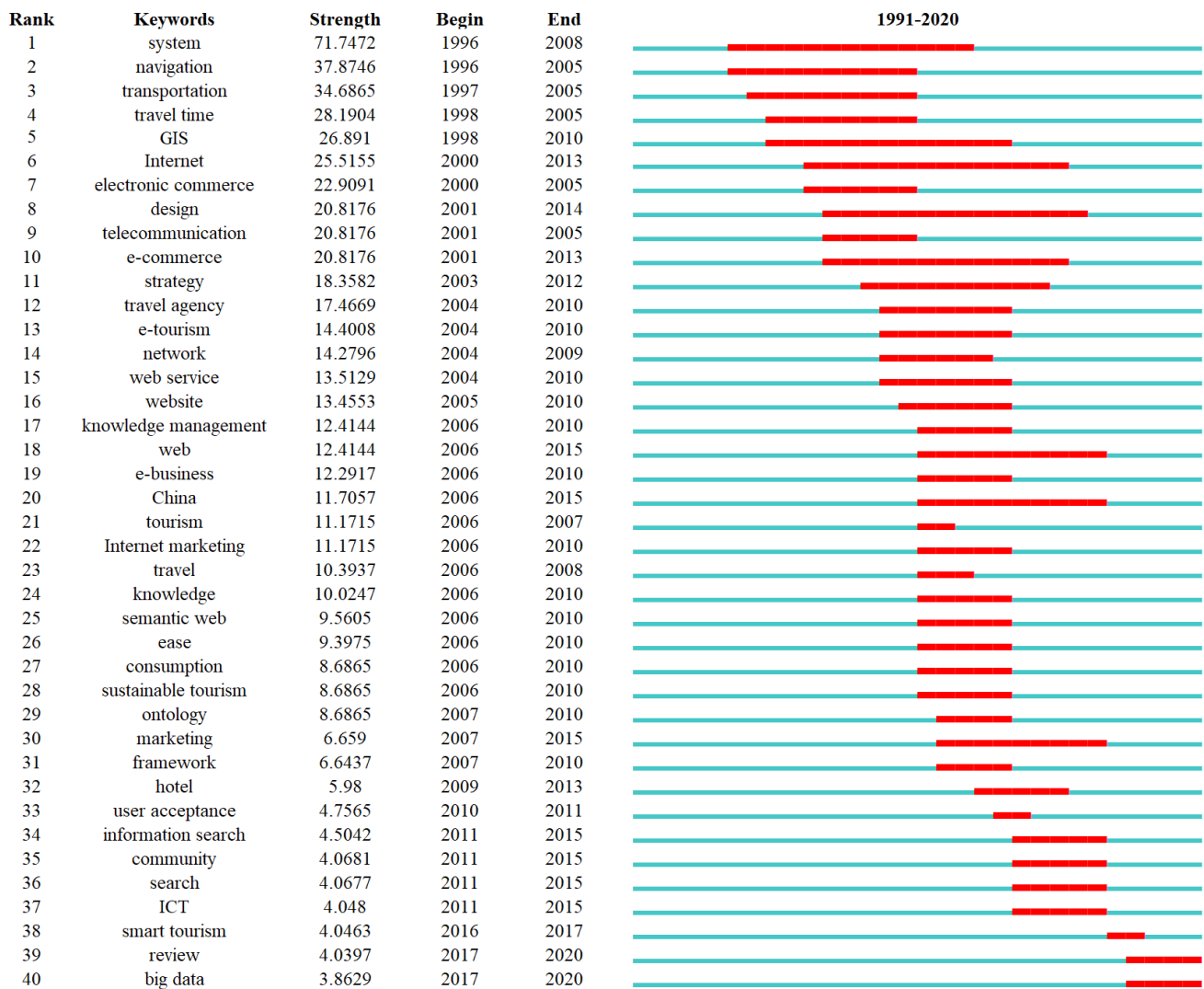
Top 40 Keywords with the Strongest Citation Bursts

Rank	Keywords	Strength	Begin	End	1991-2020
1	system	71.7472	1996	2008	
2	navigation	37.8746	1996	2005	
3	transportation	34.6865	1997	2005	
4	travel time	28.1904	1998	2005	
5	GIS	26.891	1998	2010	
6	Internet	25.5155	2000	2013	
7	electronic commerce	22.9091	2000	2005	
8	design	20.8176	2001	2014	
9	telecommunication	20.8176	2001	2005	
10	e-commerce	20.8176	2001	2013	
11	strategy	18.3582	2003	2012	
12	travel agency	17.4669	2004	2010	
13	e-tourism	14.4008	2004	2010	
14	network	14.2796	2004	2009	
15	web service	13.5129	2004	2010	
16	website	13.4553	2005	2010	
17	knowledge management	12.4144	2006	2010	
18	web	12.4144	2006	2015	
19	e-business	12.2917	2006	2010	
20	China	11.7057	2006	2015	
21	tourism	11.1715	2006	2007	
22	Internet marketing	11.1715	2006	2010	
23	travel	10.3937	2006	2008	
24	knowledge	10.0247	2006	2010	
25	semantic web	9.5605	2006	2010	
26	ease	9.3975	2006	2010	
27	consumption	8.6865	2006	2010	
28	sustainable tourism	8.6865	2006	2010	
29	ontology	8.6865	2007	2010	
30	marketing	6.659	2007	2015	
31	framework	6.6437	2007	2010	
32	hotel	5.98	2009	2013	
33	user acceptance	4.7565	2010	2011	
34	information search	4.5042	2011	2015	
35	community	4.0681	2011	2015	
36	search	4.0677	2011	2015	
37	ICT	4.048	2011	2015	
38	smart tourism	4.0463	2016	2017	
39	review	4.0397	2017	2020	
40	big data	3.8629	2017	2020	

Fig. 8. Top 40 keywords with the strongest citation bursts
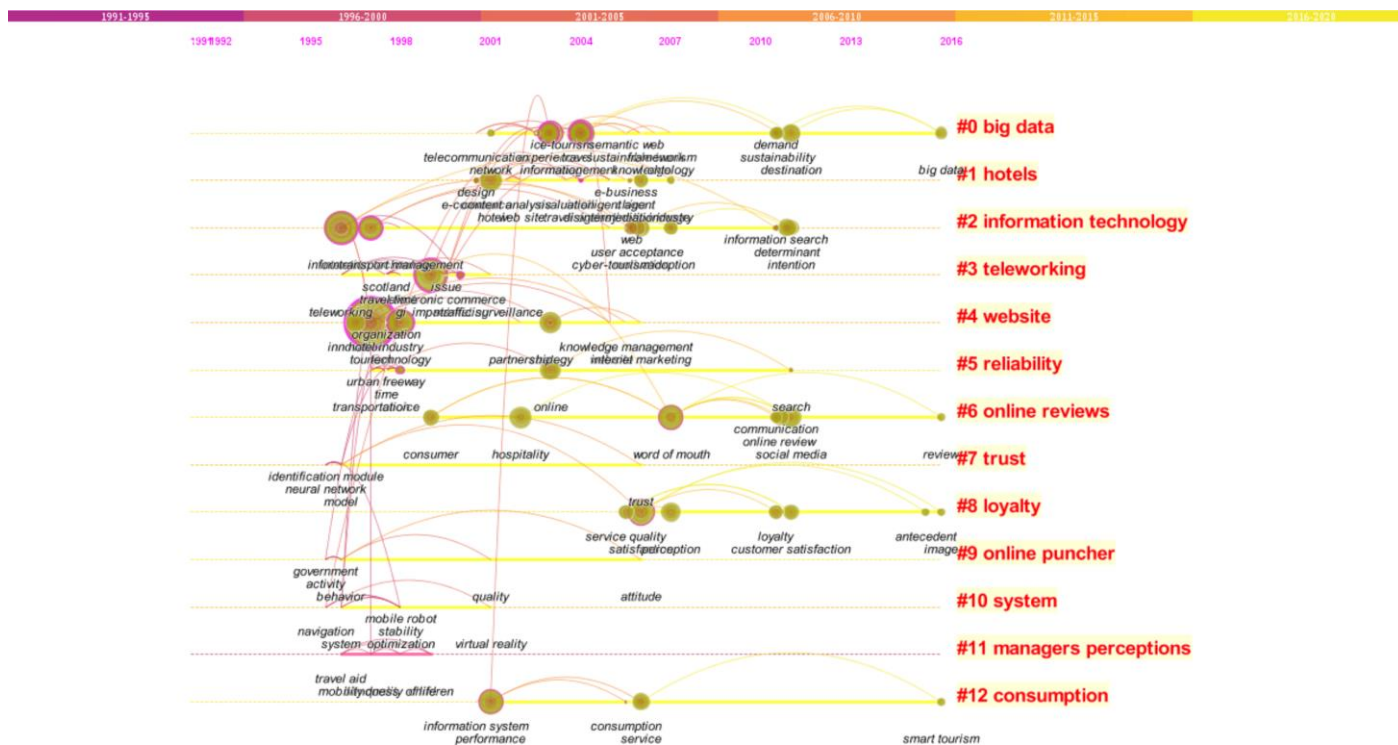
Fig. 9. Timeline visualization of co-occurring keywords

4.9 Changes That Technology Has Brought to Tourism and Future Research Directions

From the demand perspective, technologies enriched the number of options for consumers in hospitality and tourism. Smartphones that are being used today provide the opportunities for consumers to access the Internet anytime and anywhere. Social networking services (SNS) such as Facebook, Instagram and Twitter provide platforms for tourists to get advice from online reviews or share their experience with others. SNS engagement can also have a direct impact on electronic word-of-mouth (e-WOM) of the intentions of users (Okazaki & Yagüe, 2012). In the hotel scene, technological advancements of artificial intelligence (AI) play an important role in enhancing consumers' satisfaction and experience, and stimulating consumers' motivation to engage in the service encounters. From the suppliers' perspective, technologies applied in hospitality and tourism improve the service quality and help proprietors to save costs (Business Wire, 2018). Based on the above analysis, several future research directions are summarized from recent studies:

• Security and privacy problems in AI systems (Ivanov & Webster, 2020; Tussyadiah, 2020)
• Customer's acceptance of different technologies and intentions to use different technologies in various service scenarios (Go, Kang, & Suh, 2020; Lin, Chi, & Gursoy, 2020)
• The coordination problems of multi-agent systems in smart tourism and the establishment of ecosystem (Buhalis & Leung, 2018)
• Applications of AR technologies in hospitality and tourism (Paliokas et al., 2020) and their impact on consumer's behaviors and psychology
• The role of technologies during epidemics and pandemics in tackling complex problems (Pillai, Haldorai, Seo, & Kim, 2021)

4.10 Implications

This paper can assist academic researchers in exploring ideas from the massive research data of predecessors and understanding current research situation in the related fields. The use of CiteSpace to excavate the structure and development of knowledge in a visual way can assist in presenting the research hot spot and emerging trend through reference analysis and keyword burst analysis. In addition, the co-occurrence analysis of countries, authors and institutions efficiently detect the contribution and cooperation between different academic organizations can be regarded as important indicators to evaluate the level and quality of present research status. Furthermore, it is of great importance for academic researchers to select articles with high quality, confirm research objects rapidly, and expand the depth and breadth of certain research area.

5. Conclusions and Future Research

This study presents the role and development of technology in smart tourism research using a bibliometric analysis method. It aims to provide researchers the information on the development of tourism technology, current research focus, and the trend in tourism technology. We draw the following conclusions from the bibliometric analysis results of research on technology in smart tourism:

Scholars focused on the role of technology in tourism, and the number of related papers published has been increasing in recent years. From 2007 to 2020, relevant papers have grown rapidly, reflecting the interaction between technology and tourism. *Tourism Management, Journal of Travel Research*, and *Annals of Tourism Research*, as leading journals in tourism research, include more research about tourism-related technology than other journals. In terms of contributions, the most active institutions include the Hong Kong Polytechnic University, the University of Central Florida, and Bournemouth University. Researchers in these institutions (e.g., Rob Law, Ulrike Gretzel, and Dimitrios Buhalis) have close connections in tourism technology and greatly contributed to the topic, as reflected in the high co-citation frequency of their papers (Buhalis & Law, 2008; Xiang & Gretzel, 2010).

We also conducted reference analysis to identify the most

cited papers. Our findings show eight topics frequently discussed by authors. These topics include word-of-mouth, online reviews, user-generated content and big data, social media, marketing, web and Internet, travel choice and consumer choice, and online bookings/hotel bookings. In general, the top 10 articles are mainly review articles and those related to the effect of technology on tourism. Through keyword burst analysis, we also find research hotspots and emerging trends. The period of the co-occurrence keywords displayed in Figure 9 shows the top 13 clusters, including "big data," "hotels," "information technology," "teleworking," "website," "reliability," "online reviews," "trust," "loyalty," "online puncher," "system," "manager perceptions," and "consumption." However, our study has a limitation. Technologies that were included in the present study is the one that have been widely adopted in tourism, such as cloud computing, big data, Internet, AI, and VR and AR technology, and do not include those rarely applied in tourism. In addition, technology adoption in other industries such as automotive industry was not considered in the present study. Moreover, the method that was adopted in the present study was purely quantitative. Future research can consider other recent technologies, such as quantum computing, and how technology adoption in other disciplines change the use of technology in tourism to investigate big data and brain-computer interface technology. Furthermore, a mixed approach can be adopted in the future to explore potential research direction and help study tourist behavior.

Declaration of competing interests

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