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Research Article

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Analysis of scientific production on Technological Innovation in Tourism

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Abstract: Until the emergence of the COVID-19 pandemic, tourism was one of the sectors with the greatest growth potential on a global scale. It is now highlighted as one of the hardest hit sectors in economic terms and requires strategic recovery capacity coupled with technological innovation. Technology and innovation could provide a strong contribution to the development of tourism by integrating knowledge about tourism products, services and experiences and the new needs and behaviours of consumers. This study analysed the scientific productions on technological innovation in the tourism sector using literature review and bibliometric analysis techniques, with data collected from the main databases of international relevance, Web of Science and Scopus. This study presents the mapping and cluster structures for the trends and dynamics of the investigations on the discovered research themes using the VOSviewer software. The results indicate that research related to innovation and technology in tourism has evolved in recent years, as well as highlighting the main areas of activity and presenting contributions to possible future lines of research.

Keywords: Tourism & Hospitality, Innovation, Technology, Bibliometric Analysis

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1 Introduction

Tourism activity is multi-faceted. It involves human movements and behaviours, contributes strongly to social well-being due to the diversity of experiences it provides, drives development and has a great impact on the economy of several nations. Tourism, which includes the hospitality sector, has been highlighted as having strong potential for expansion worldwide. It is currently identified, however, as one of the sectors most affected in economic terms by the pandemic caused by the SARS-COV-2 coronavirus (COVID-19). As such, there is an urgent need to find solutions for strategic recovery in both the short and long term, in which the factors of technological innovation can be strong allies (Gretzel et al., 2020; Sigala, 2020).

According to World Trade Organization (WTO) data collected before the COVID-19 pandemic, forecasts pointed to a reach of 1.8 billion international tourists in 2030 worldwide, which suggests strong growth of the sector, compared to the 24 million international tourists in 1950 and the more than 1.2 billion registered in 2016 (UNWTO, 2011, 2019b, 2019a). According to a report from the World Travel & Tourism Council (WTTC, 2020b) on the contribution of tourism to the world's economy in 2019, the direct, indirect and induced impact of travel and tourism accounted for a US$8.9 trillion contribution to the world's GDP, 10.3% of global GDP, 330 million jobs, 1 in 10 jobs around the world, US$1.7 trillion visitor exports (6.8% of total exports, 28.3% of global services exports) and US$948 billion capital investment (4.3% of total investment). The year 2019 was considered another year of strong growth for the global Travel & Tourism sector reinforcing its role as a driver of economic growth and job creation however, the growth trend changed with the emergence of the COVID-19 pandemic, and estimates for 2020, in the best of scenarios, point to a reduction in jobs by 31% and a 30% drop in GPD (WTTC, 2020a, 2020c).

In the current context, transformations through technological advances represent strong opportunities to allow safe travel experiences, for example through the use

of biometrics and digital identity, while simultaneously supporting the recovery of the sector (WTTC, 2020a). In view of this situation, the importance of the sector is consensual, as well as the need for a gradual recovery combined with consistent scientific knowledge, which will make it possible to identify the main factors that will be decisive for the current and future development of the tourism sector in an integrated manner (Gretzel et al., 2020; Sharma, Thomas, & Paul, 2021). Technology-based innovation is a strong ally for the development of tourist offers at destinations, for increasing the competitiveness of companies in the sector and for improving the tourist experience by increasing their degree of satisfaction. Consequently, innovation, and especially technology-based innovation, can add value and generate wealth while also boosting the economy of a country or region. It is therefore relevant to identify which research trends are linked to technological innovation in tourism, as well as to identify gaps and needs for future research. This study aims to present such contributions.

In the current economic situation, it appears that the countries that best support the oscillations of the economy are those with the greatest capacity for technological innovation (Cornell University, INSEAD, & WIPO, 2020), and the companies with the greatest capacity for innovation clearly show superior results compared to less dynamic companies with a static product or service offer. Studies based on bibliographic research report that the number of publications focusing on the tourism and hospitality area has increased exponentially in recent years (Koseoglu, Rahimi, Okumus, & Liu, 2016; Mulet-Forteza, Genovart-Balaguer, Mauleon-Mendez, & Merigó, 2019); however, more specific studies on the progress of research in the areas of technological innovation in tourism are not available.

The general objective of the present work is to analyse the scientific production on technological innovation in the tourism sector. One of the specific objectives of the present study is to analyse this literature in regard to its growth and to the scientific areas in which these studies are inserted. This involved the analysis of data collected from the main scientific production databases, Scopus and WoS. This study also investigated whether Portugal is to be found among the countries that stand out for the volume of publications, as well as assessing the degree of participation of Portuguese authors in these publications. Another specific objective of this study consisted in mapping scientific publications to identify trends and possible future research lines in the area of technology-based innovation in tourism. This study includes the analysis of documents published and indexed in the Web of Science (WoS) and Scopus databases, based on a sample for the period between 2010 and 2020. Using the VOSviewer software and applying bibliometric techniques, visualization maps of the cluster structure for trends and research dynamics in the discovered themes were created. After this introduction, sections 2 and 3 address the theoretical framework of the study, in which the perspectives of technological-based innovation are addressed, as well as the main trends of technologies applied to tourism and the state of innovation in Portugal. A brief framework on bibliometric analysis is also provided. Section 4 is devoted to methodological procedures where the criteria for data extracting are presented. In section 5, the results of the study are presented, and the final section presents the conclusions, contributions and future work.

2 Literature Review

2.1 Technological Innovation in Tourism

The relevance of innovation for business and regional competitiveness and success has been recognized by researchers and professionals alike (Omerzel, 2016). Technologies have been identified as a facilitator of innovation and change and an essential tool for tourism resilience, particularly in crisis scenarios (Hall, Prayag, & Amore, 2017). The concept of innovation has multiple approaches that relate it to change and renewal. Innovation involves something new, process, invention or value (Kotsemir, Abroskin, & Meissner, 2013), and most classic theories regard technology as the main driver of innovation (Greenacre, 2012). Innovation is commonly considered a determining factor for the attractiveness and competitiveness of destinations or tourism players (Baggio, 2014; Teixeira & Ferreira, 2018). The tourism sector involves the provision of services where technologies emerge as a driving and fundamental force of innovation, enabling easier and faster ways of doing business, fostering competitiveness and globalization (Pikkemaat, Peters, & Bichler, 2019; Wirtz, Hemzo, & Lovelock, 2020).

Innovation in tourism may include the opening of new markets, the creation of new products, services or tourist experiences, the modification or adaptation of an existing product, the improvement of customer relationship processes and the adaptation of forms of organization leading to a paradigm shift and introduction of new ways of acting (Hjalager, 2010). Currently companies are facing changing scenarios that impose a constant capacity for ever greater and faster adaptation, where technology is

a condition for sustaining that adaptation in increasingly dynamic markets, in terms of technical means and knowledge. Digital transformation comprises the transition from traditional to digital business models and requires a high degree of flexibility in companies. Digital business models are often driven by technological innovations that give rise to new products or services, which are commonly referred to as disruptive business models. Consequently, this implies a new approach, new operational and management procedures, new customer relationship formats or redefinitions of existing commercial possibilities (Wißotzki, Sandkuhl, & Wichmann, 2021).

Technological factors have an impact on many factors of tourism, such as processes, services and distribution mechanisms, with information and communication technologies (ICTs) playing a key role in increasing productivity, flexibility, communication and dissemination in the sector. Strategic measures of human resources management in conjunction with ICTs and new social platforms reveal a high impact – namely in increasing the knowledge, attractiveness and accessibility of tourists, particularly at the level of airline companies, tour operators and hospitality (Dimitrios Buhalis & Law, 2008).

Studies report that there has been interest in the topic of innovation in tourism (Hjalager, 2010; Omerzel, 2016) addressed in different categories, including products, processes, management, marketing and institutional developments. Technological momentum is an important determinant of innovation; however, deficits in skills and diffusion of production and scientific knowledge to the business environment have been identified as barriers to innovation in tourism (Hjalager, 2010). In this context, researchers assume a proactive and mediating role in the innovation process through new ways of disseminating knowledge based on scientific research. In the literature, many authors refer to the importance of new technologies in tourism and highlight trends for the sector (Morgan, 2014; Shabani, Munir, & Hassan, 2019; Sigala, 2020; Turkay, Dıncer, & Dincer, 2019; Wise & Heidari, 2019).

Tourism 4.0, originates from a new paradigm in industry, known as Industry 4.0 – which has been dubbed the new industrial revolution – with the objective of achieving efficient production in intelligent industries based on integrated virtual systems that replace the physical world. Tourism 4.0 appears to be a way to increase the innovation potential in the tourism sector, using information technologies such as artificial intelligence (AI), internet of things (IoT), big data, data security, augmented reality (AR), virtual reality (VR), robotics, cloud computing and blockchain (Turkay et al., 2019). This new paradigm establishes an ecosystem that involves the local population, tourists, service providers and the government; these public and private bodies collaboratively contribute to the co-creation of tourism experiences enriched by digital technology.

Companies in the tourism sector – including airlines, hotels, travel agencies and tour operators – already use these new technologies to streamline processes, optimize resources and offer the best experiences to their customers. Big data collected from a vast number of tourists, has, for example, been used to create personalized travel experiences. Technologies are reflected in the transformations brought about in the digital and post-digital era, as in the procedures for acquiring tourist services and direct managers or the new paradigm of intelligent and interconnected systems that involve less human intervention (Araujo, de Farias, & Fernandes Ferreira, 2020). The variety of technologies that facilitate Tourism 4.0 afford the opportunity to make travel experiences more efficient, safer, more ecological and sustainable and less labour intensive, as well as optimizing travel times and minimizing costs for travellers. Four of the key technologies used in facilitating Tourism 4.0 are big data, the IoT, AI and VR.

Big data refers to the large volume of data generated through many sources, including mobile transactions, user-generated content, social media and website behaviour. Conventional data processing mechanisms are unable to process this large amount of data within a reasonable time. Big data is based on the exponential increase in the amount of data generated every minute in the world and represents a new era in modern society, in which data has become increasingly valuable (Wise & Heidari, 2019). The systematic collection and analysis of that data, which can take place in real time, provides tourism and hospitality companies with powerful tools to gain better insights into observing consumer behaviour patterns, their choices and preferences and interactions, thus making it possible to improve tourism marketing offers. Big data analysis allows the development of more effective strategies to improve performance and make predictions for business optimization, serving simultaneously as a mechanism for building trust and relationships between networks of tourist companies and customers (Line et al., 2020).

The IoT refers to a set of emerging technologies that allow any type of device or system to be connected to a network through the Internet and that allows communication and exchange of information between devices for the purpose of collecting, monitoring, controlling and transferring information to the end customers (Morgan, 2014). Applied in the tourism sector, the IoT can be used to improve travel planning and contribute to tourist satisfac-

tion with the experience through the provision of services such as mobile crowd detection in smart cities, transport availability and tracking, research and last-minute accommodation reservations, real-time information about their lost luggage and real-time parking information, or via mobile applications that offer tourists and residents relevant contextualized information about points of interest (Wise & Heidari, 2019).

AI technologies based on machine learning (ML) make it possible to analyse and learn from data a without human intervention. Typically, AI algorithms can be incorporated into intelligent virtual assistants capable of recognizing spoken language and learning from users. AI brings benefits to tourism in the context of supporting smart business management, decision-making and strategic planning, as well as improving the organization's functionality and task automation. In the scope of customer analysis, AI is mainly used in marketing tourist destinations, identifying markets and specific target group of customers, tracking and analysing customer behaviour over time and analysis of tourism destinations trends (Line et al., 2020).

VR is a technology that allows complete immersion in a simulated environment through multisensory devices, such as virtual reality glasses or any other device that provides multisensory stimuli to the brain. AR, which is related to VR, consists of the confluence of two "worlds" – a real and a virtual one – and occurs when virtual components developed through computer programs interact, in real time, through a device such as a smartphone, with the "real world". A mobile application that gives citizens and tourists the possibility to view, through the smartphone camera, points of interest around them based on their geographical location, can result in an experience of augmented reality. Practical applications can provide tourists with new real-time experiences of real physical environments by changing their perception of the surrounding environment and providing interactive experiences, which may increase satisfaction (Hassan & Rahimi, 2018; Shabani et al., 2019).

As these short overviews of four technologies suggest, stakeholders must realize that they need to use innovative technologies to drive smart and sustainable growth in tourism in the face of increasing competition and competitiveness. AI and big data, together with virtual assistants, VR and AR, will be key disruptive elements for technological innovation in tourism.

2.2 Bibliometric Analysis

Several techniques can be used to analyse the existing literature in a given scientific domain. Bibliometric analysis is a technique for measuring production indexes and the dissemination of scientific knowledge (Guedes & Borschiver, 2005) that makes it possible to assess the impact of publications, identify the most productive authors from the most relevant institutions and observe trends within a particular area of knowledge (Johnson & Samakovlis, 2019). Bibliometric techniques, co-citation analysis, analysis and co-authorship have been widely used to explore the evidence of research advances in various fields of tourism (Mulet-Forteza et al., 2019; Rafael, 2020; Strandberg, Nath, Hemmatdar, & Jahwash, 2018; Teixeira & Ferreira, 2018), and bibliometric analysis is particularly important in this fired to obtain an external evaluation of the interest and quality of the research based on impact and prestige factors (Michael Hall, 2011).

Bibliographic research and evaluative and relational bibliometric analysis encompass several stages of execution, ranging from the choice of the area or theme, the elaboration of the work plan, identification, research, data compilation and storage, analysis and interpretation of results and essay drafting (Marconi, M. A. Lakatos, 2003; Quevedo-Silva, Almeida Santos, Brandrão, & Vils, 2016). There are several software tools that support bibliometric analysis to produce indicators for scientific production and the dissemination of research. VOSviewer is a software tool for the construction and visualization of bibliometric networks that can be built based on citations, co-citations or co-authorship relationships, while also providing a text mining functionality used to build and visualize term occurrence networks of important extracted terms from a database of scientific publications on a given topic (van Eck & Waltman, 2010).

3 Methodology

Considering the objective of mapping scientific production on innovation and technologies in tourism, this study used the exploratory-descriptive method, because this method provides a comprehensive overview of the theme and describes its main particularities, allowing the identification of outstanding elements and potential lines of future research. Data collection, carried out using the ISI Web of Knowledge1 / Web of Science (WoS) and Scopus

1 ISI Web of Science, formerly designated as ISI Web of Knowledge

search engines, took place between June and July 2020. The WoS and Scopus databases are databases of reference and international reputation that gather a wide range of data. This makes it possible to consider a variety of indicators on publications. These platforms provide a range of filters and, at the same time, allow visual analysis of the results through graphs. The research used bibliometric analysis of scientific production centred on the number of documents published (in the categories article, conference proceedings paper and review, book, book review or book chapter and reviews) in the field of tourism and hospitality, with terms related to technology-based innovation and indexed in two of the main international indexing databases: WoS and Scopus using the keywords "tourism AND technology" to filter the results. Data collection involved an initial sample used for the general characterization of the total number of publications recorded on the Scopus and WoS databases up to September 2020 in the area of tourism and hospitality. The remaining data collected filtered more specific data in the areas of tourism, technology and innovation for publications recorded in the last 10 years (2010–2019). VOSviewer software version 1.6.5 was used for bibliometric analysis and presentation of the mapping results of the collected data. For the bibliometric analysis of this study, the following steps were followed: (a) choice of theme; (b) definition of keywords and search terms related to the topic; (c) search for terms in the database of bibliographic references; (d) export of data in the appropriate format for the analysis software; (e) evaluative and relational analysis; and (f) data interpretation.

4 Results

The evaluation of results was carried out in two stages: (a) analysis of growth and evaluation of the evolution of scientific production by scientific areas and by country/region and (b) analysis of the mapping of keyword co-occurrences. The initial search was carried out with the keywords "Tourism" and "Hospitality" in the databases WoS and Scopus using the search fields title, summary and keywords. Table 1 shows the sample with the total number of documents published in the field of tourism and hospitality through September 2020; a total of 74,940 and 100,950 records were found in WoS and Scopus, respectively.

The research data in the two databases show a significant number of publications, particularly in the more comprehensive area of tourism. The term "hospitality" accounted for only about 13% of the total publications. Scopus stands out in relation to WoS as have a larger number of documents published in the areas of tourism and hospitality. After the first analysis of the gross results, it was decided to select only the data related to the more comprehensive search term "tourism", which represents about 86% of the total publications for the hotel industry.

Search criteria that were considered more appropriate in the scope of this study and aligned with the specific objectives in the tourism category, namely "innovation" and "technology", were also used. The period under review covered publications from the period 2010–2020.

The search results from the two databases show the same growth trend in the production of research on tourism and technology in the last 10 years, except for the number of documents published on Scopus, which suffered a decrease in 2015 (see figure 1). In searches carried out on the two databases using the "tourism" and "technology" search criteria, a greater number of records on Scopus were found than for WoS. Overall, Scopus has a greater number of documents representing a record of greater scientific production, although in very different areas of activity (graphs in Figure 1).

In the surveys carried out using the criteria "tourism" and "innovation", it appears that WoS registered a marked growth starting in 2014, surpassing the number of Scopus publications in 2015, thus leading in the indexing of scientific production in the area of innovation in tourism (graphs of figure 1). In the last 10 years, an average of around 200 articles per year have been published in the area of technologies and tourism, and around 100 articles per year in the area of innovation, with the greatest growth observed after 2016. This has resulted in a total volume of publications of around 5,000 in the area of technologies

Table 1: Scientific production according to keywords "Tourism" and "Hospitality"

	WoS		Scopus	
Keywords	No. of documents	%	No. of documents	%
"Tourism"	65,144	86.93%	87,492	86.67%
"Hospitality"	9,796	13.07%	13,458	13.33%
Total	74,940	100%	100,950	100%

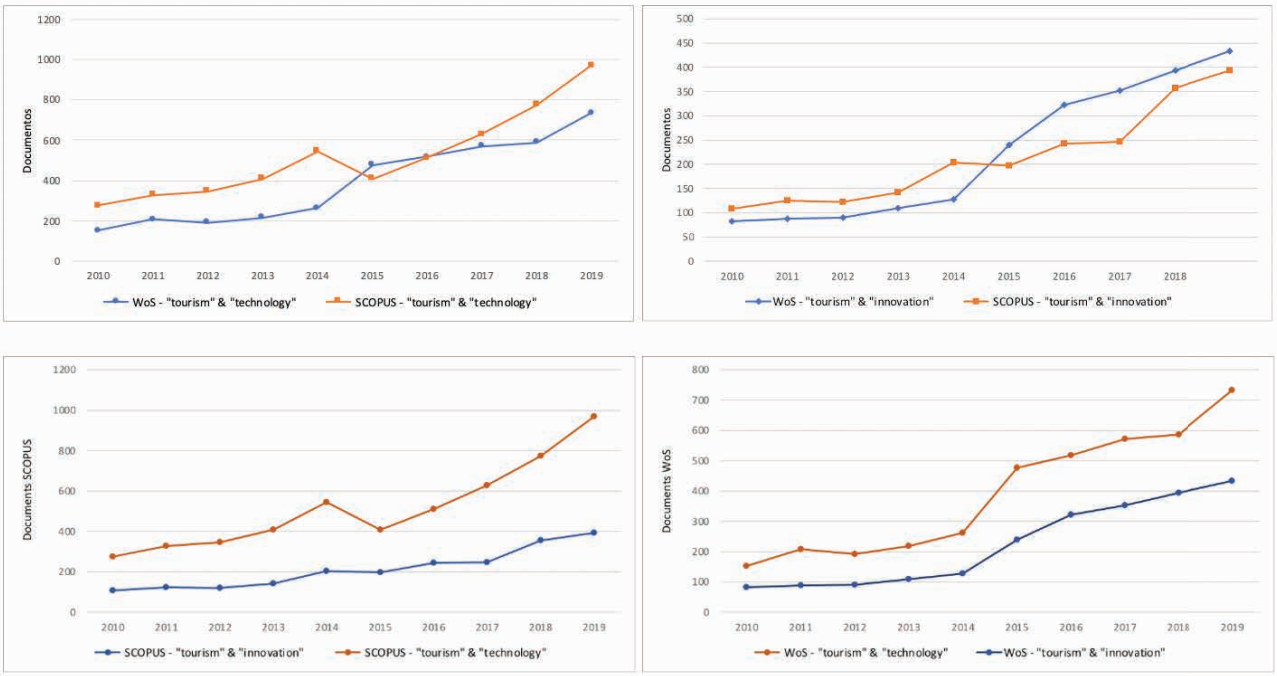

Figure 1: Comparative graphs of the number of publications on tourism, technology and innovation between 2010 and 2019 according to WoS and Scopus databases

and 2,500 in innovation, according to the records of WoS and Scopus.

The results according to research area, as shown in Figures 2A and 2B, allow us to verify that the highlighted areas are: "social sciences", "business" and "computer science" under the search category "tourism AND technology" (Figure 2A). The areas "social science" and "business" represent about 50% of the articles published and indexed on Scopus within the search category "tourism AND innovation" (Figure 2B). These results are also verified in the analysis of data from surveys carried out on WoS, as shown in Figures 3A and 3B. For research in the "tourism AND innovation" category, the "business" and "social sciences" areas also stand out, however, with results in "computer science" assuming a lesser impact. On WoS, the main area is "social sciences" followed by "business economics"; on Scopus, both areas represent around 50% of scientific production in innovation and tourism, with the "business" standing out slightly in relation to "social sciences". Although these are the most prominent areas, research is transversal to other areas, such as arts and humanities, decision science, earth and planet, environmental science ecology, energy, education educational research and sociology.

A bibliometric study was also carried out on the most prolific countries producing research in this field. China, Spain and the United Kingdom lead these rankings, although Portugal also appears on the list. Portu-

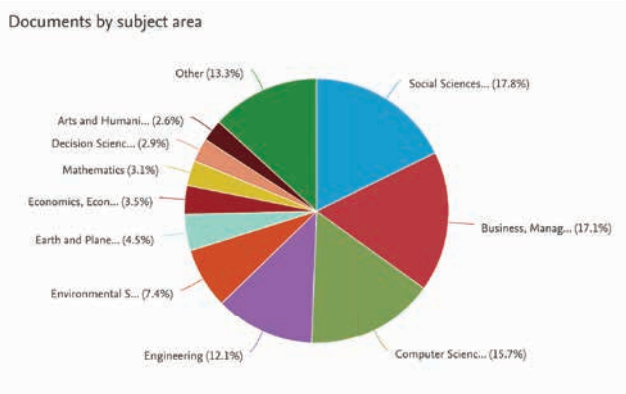

Figure 2A: Distribution of research by area. Search for "tourism AND technology" (Source: Scopus, September 2020)

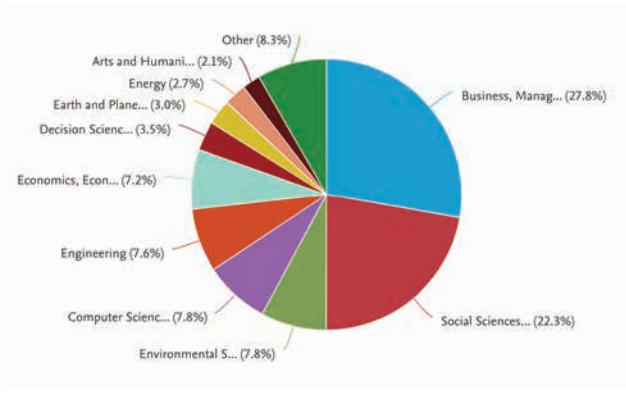

Figure 2B: Distribution of research by area. Search for "tourism AND innovation" (Source: Scopus, September 2020)

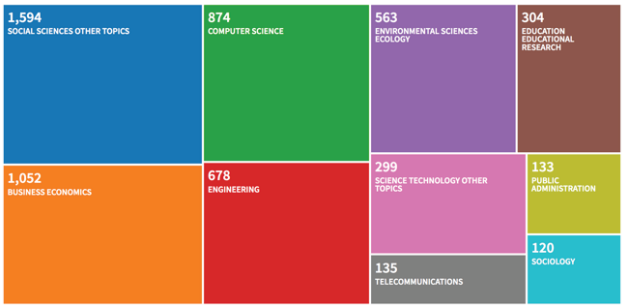

Figure 3A: Distribution of research by area. Search for "tourism AND technology" (Source: WoS, September 2020)

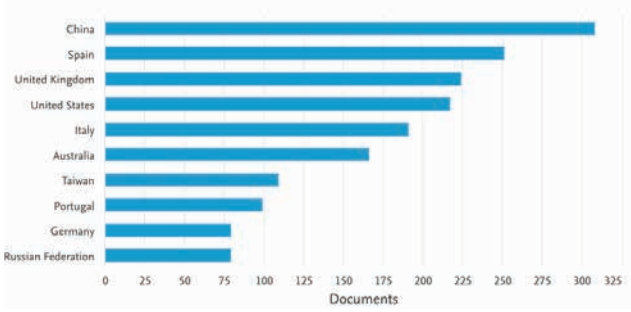

Figure 4: Distribution of research by country or region. Search for "tourism AND innovation". (Source: Scopus, September 2020)

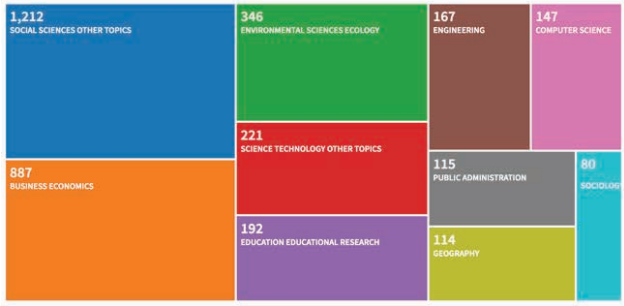

Figure 3B: Distribution of research by area. Search for "tourism AND innovation" (Source: WoS, September 2020)

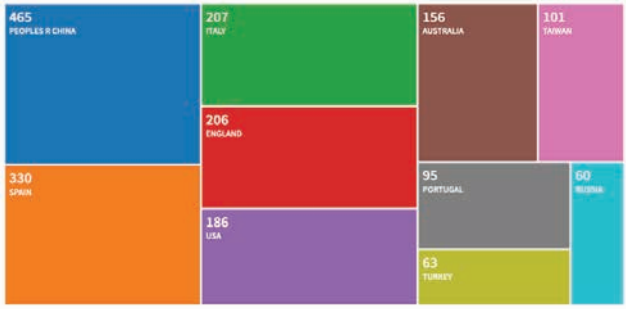

Figure 5: Distribution of research by country or region. Search for "tourism AND innovation". (Source: WoS, September 2020)

gal appears in the ranking of the 10 countries with the largest number of publications on Scopus (Figure 4) and WoS (Figure 5) databases in the innovation category, with around 100 publications that include the participation of at least one researcher with Portuguese affiliation.

However, in the "tourism AND technology" category, there are no publications with the participation of Portuguese authors in the top 10 on Scopus, but there are records of 148 publications on WoS, as shown in Figure 6.

After a preliminary analysis of the different samples, we carried out an evaluative analysis of the relationships among the occurrences of terms from the sample that was more restrictive regarding titles and with greater evidence in the tourism category. The co-occurrence relationship between two keywords or terms is determined by the number of articles in a document database where both occur together, whether in the title, in the abstract or in the keyword list (van Eck & Waltman, 2010). When analysing these networks, it is possible to map possible research themes for the topics under analysis. The size of the node indicates the frequency of occurrence of the keyword, and the intensity of the relationship between the nodes is determined by their proximity.

Figures 7A and 7B show the co-occurrence networks of keywords for the documents extracted from the Scopus database in order of relevance for the keywords "tourism and technology" and "tourism and technology" from 2010

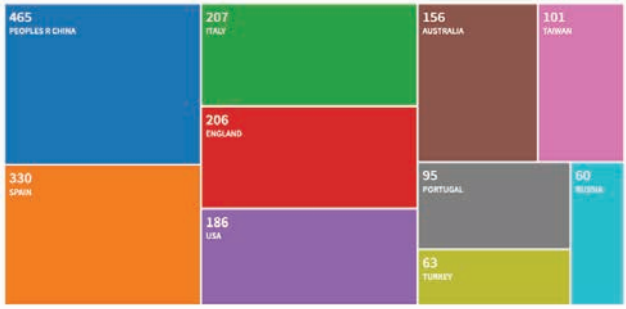

Figure 6: Distribution of research by country or region. "tourism AND technology" research (Source: WoS, September 2020)

to 2019 and from 2010 to 2020, respectively. In the first analysis, records of the most recent publications made in 2020 were excluded (Figure 7A), maintaining the search criteria for "tourism and technology" to compare if there were any significant changes. Figure 7A shows five main clusters. The node with the highest number of connections is "information", followed by "tourist", "design", "web" and "augmented reality". Most of the keywords in this node are related to "communication technology" and "ICT", as well as to "future", "knowledge" and "sustainable tourism". The node with the second highest number of keywords is led by "tourist", which is the keyword that corresponds to the highest number of occurrences. This

node has connections with keywords related to "intention" and "empirical study". The third node is led by "design", which has a strong relationship with "information technology", "augmented reality" and "cultural tourism", and is also linked to the concept of "sustainability." The fourth most relevant node is led by "web" with connections to keywords related to "tourist destinations", "smart tourism" and "smart city", "internet" and "mobile technology". Finally, the fifth node includes "augmented reality", "virtual reality", "mobile application" and "hospitality industry". Sustainability and sustainable tourism are two keywords closely related to ICTs in the tourism sector. Sectors such as hospitality are highlighted with a strong relationship with AR and VR technologies, as well as with mobile applications.

In Figure 7B, five main clusters were also obtained. The node with the highest number of connections is "information", followed by "research", which includes the "design" keyword, and by "web", which includes "e-tourism", "tourism experience" and "mobile technology". Finally there is a cluster with "smart tourism", "smart city" and "mobile application", with a close relation to sustainability ("sustainable tourism"). The appearance of a new keyword, "big data", with a strong relationship with sustainability stands out in this node.

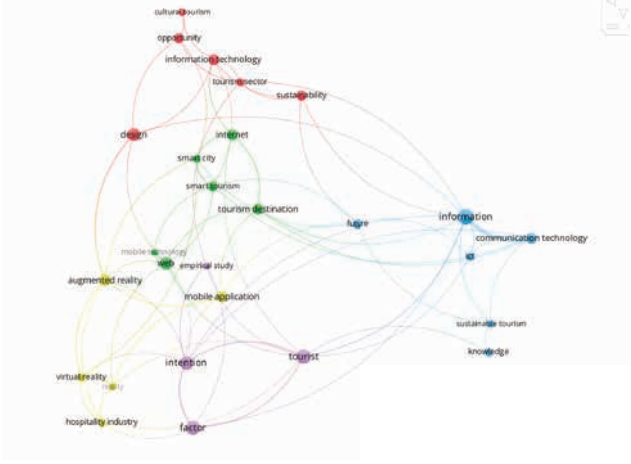

Figure 7 A: Co-occurrence networks for keywords "tourism AND technology" from 2010 to 2019. (VOSviewer output)

Figure 7 B: Co-occurrence networks for keywords "tourism AND technology" from 2010 to 2020. (VOSviewer output)

By analysing the results presented in Figures 7A and 7B it is possible to conclude that a very similar cluster structure is maintained, which can be grouped into: (1) ICTs, (2) smart tourism, (3) AR and mobile application, (4) ICTs and social media and (5) the tourist experience. It should be noted that there is a new research theme highlighted in recent publications, big data, which was not in evidence up to 2019 (Figure 7B).

The density maps in Figures 8A and 8B illustrate trends and areas of interest on which current research in tourism and technology is focused and which originate the most relevant scientific production. Topics such as smart tourism and smart city, VR and AR, mobile applications, sustainable tourism and the hospitality industry are on the agenda of scientific production in tourism and technology.

Figure 9 also reinforces that smart tourism, smart city, VR and big data are the most recent themes highlighted, although they are not the most prominent. This allows us to conclude that the most innovative and emerging themes are still addressed in studies on technology applied to tourism.

The mapping illustrated in Figure 9 suggests that the predominant keywords at the beginning of the study period are more related to information, design and the web. Despite being relevant in this field, these are no longer hot topics. In the middle of the period, keywords emerged on mobile applications, AR and sustainability, with the most recent search terms related to smart cities, AR and big data. With regard to innovation and tourism, as shown in Figure 10, the resulting network structure of clusters comprises: (1) hospitality industry); (2) service innovation; (3) tourism innovation and opportunity; (4) design, sustainable and regional development; (5) competitiveness and social innovation. The density map shows that the most relevant and recent themes of the investigation are social innovation and smart destinations.

5 Discussion

Considering the potential impact of technology-based innovation for business strategies in the tourism sector and, consequently, their importance in development and

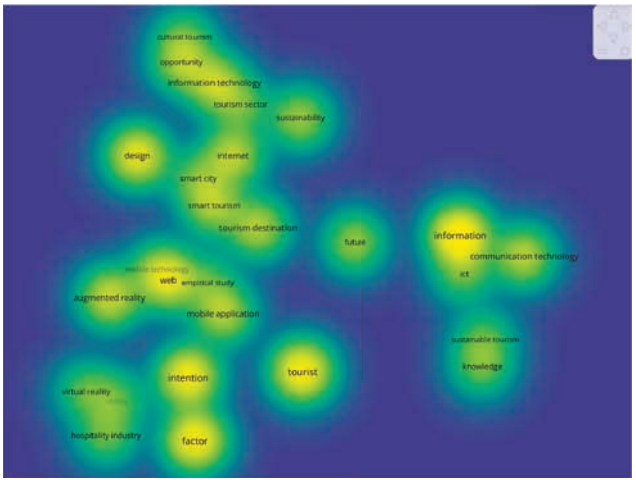

Figure 8 (A): Density map for keywords "tourism and technology" from 2010 to 2019. (VOSviewer output)

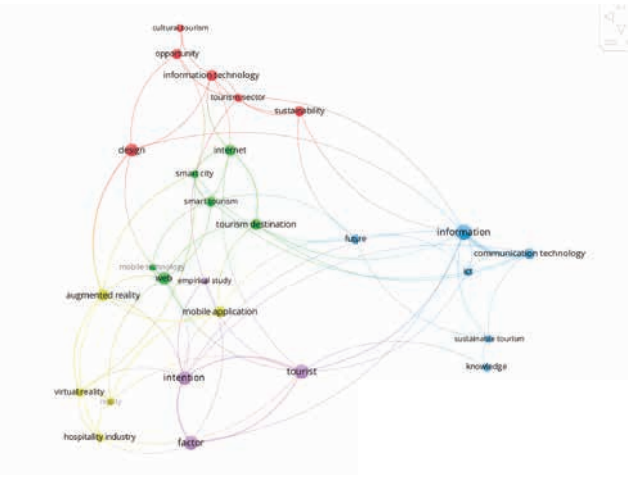

Figure 9: Keyword mapping for "tourism and technology" from 2010 to 2020. (VOSviewer output)

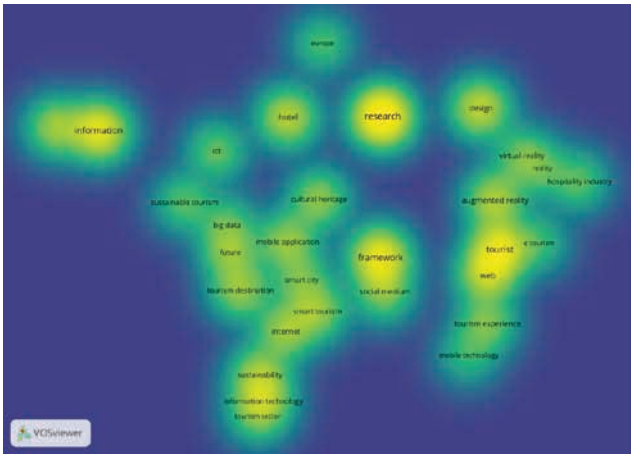

Figure 8 (B): Density map for keywords "tourism and technology" from 2010 to 2020. (VOSviewer output)

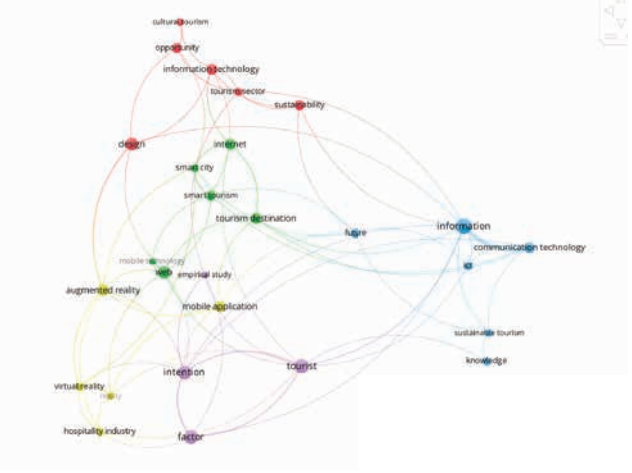

Figure 10: Co-occurrence networks for keywords "tourism and innovation" from 2010 to 2020. (VOSviewer output)

economic recovery after the COVID-19 pandemic (Dimitrius Buhalis, 2003; Hall et al., 2017; Sigala, 2020), this study mapped scientific production on the topic. The article provides a general characterization of the publications, scientific areas and most influential countries in research on technological innovation in tourism, based on the wide range of bibliometric techniques supported by WoS and Scopus platforms. The results allow us to conclude that between 2010 and 2020 the production of research on tourism, technology and innovation followed a growth trend. In the past decade, there has been an increasing focus on the topic of innovation and technology in tourism. Although it is not possible to conclude whether the trend continued in 2020 because only data for the first half of the year re available, this expected to be the case. The results indicate that:

1. research on tourism innovation is dispersed and is going through a period of growth and progress, which suggests advances in reaching maturity, while opening up opportunities for new lines of research and investigation;
2. scientific production related to tourism and innovation is not only directly associated with one area but is multidisciplinary and transversal to different areas of expertise like computational sciences, management processes and the social science but also arts and humanities, decision science, earth and planet, environmental science, energy among others; and
3. most publications are linked to authors from Asia (with China at the forefront), Europe (in particular England, Italy and Spain) and America (the United States), which means these are the countries with more potential to develop partnerships and share research and can be strong allies in the technological development of tourism.

The co-occurrence network showed, through the analysis of clusters, that the main lines of research related to technology are focused on ICTs, smart tourism, AR and mobile applications and social media. The main lines identified for innovation are service innovation, tourism innovation and opportunity, sustainable and regional development competitiveness and social innovation. The analysis carried out with the VOSviewer revealed that the keywords related to mobile, AR and sustainability and in particular to smart city, AR and big data offer high potential research opportunities for tourism and technology. At the beginning of the study period, the predominant keywords extracted tended to be related to information, design and web. In the middle of the period under analysis, keywords such as mobile, AR and sustainability emerged, with the most recent search terms including keywords as smart cities and AR. The keyword big data appeared only in 2020. In the area of innovation, research highlighted competitiveness and social innovation associated with smart tourism. These are recent themes for tourism researchers to consider.

These themes suggest that research addressing the relationship between technology innovation and sustainability and the approach to smart city and smart tourism is common. Such occurrences allow us to conclude that there are established lines of investigation, but it is necessary to develop progress in emerging areas such as big data. A gap in technologies related to AI applied to tourism is also evident. Although there are some transversal themes to technology and innovation in tourism, advances in these two areas show a correlation between them. AI, the IoT, big data, data security, AR, robotics and blockchain are multidisciplinary areas of technology in tourism that, although found in the literature (Turkay et al., 2019), have not yet been highlighted scientific publications indexed in the WoS and Scopus databases. Strategic and commercial management and planning practices in the tourism sector are constantly challenged by the evolution of technology and it is important that companies recognize this, pay attention to new trends and understand when they have to invest in change, innovation and digital transformation.

6 Conclusions

In the post-COVID era, when the sector is expected to recover – and recover quickly – innovation is essential for efficiency of operations and can be assured in the development of new technological solutions and digital tools that improve the tourist experience (Sigala, 2020; WTTC, 2020a). It is important to mention that not all innovation is technology-based, although the digital transformation has seriously affected the tourism industry in operations, jobs and in customer relations, and for this very reason it should be understood as a means and not as an end in itself.

The proximity between research and tourism companies can make information into "usable" knowledge in a timely manner, making control over technology easier and faster. Associating technology with the tourism industry is something that requires active research that involves multiple entities in the discovery of new sources of knowledge to be applied in products and processes. It is essential to invest in research and knowledge dissemination as a factor for competitiveness. Fundamental to the success of the industry is cohesion among educational institutions, research units and companies in the sector and complementary and transversal sectors that allow economies of scale, providing a strong scientific and technological base, a culture that leads to innovation and entrepreneurship.

Finally, this study allows us to conclude that there is room to improve innovation and research in tourism, with the development of collaborative research with the participation of national authors and co-authors, increasing the essential knowledge for Tourism 4.0. While the number of publications quantifies productivity, the number of citations usually measures influence. Future research could be based on a consideration of influence, including a deeper analysis of citations to clarify which areas have the highest level of reputation. As a perspective for future work, the creation of a research agenda that includes both research related to formal quantification and qualitative studies related to the concepts, processes, implications and strategies of innovation in tourism is recommended. Future systematic reviews of the literature should make use of a mixed quantitative and quantitative approach through content analysis of the main featured publications, based on the results of the analysis of the visualization maps. This methodology can be replicated in other more specific themes related to tourism, such as the development of research and use and applicability of AI in the sector.

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