INFORMATION AND COMMUNICATION TECHNOLOGIES (ICT) AS A TOOL FOR SUSTAINABLE TOURISM MANAGEMENT: A BIBLIOMETRIC ANALYSIS

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ABSTRACT

The tourism sector has experienced a steady growth in the last decades, becoming one of the key sectors for the development of countries. However, the pandemic caused by COVID-19 brought about an unprecedented social, economic and health crisis that has forced a change in the way tourism is conducted. This article presents a comprehensive bibliometric analysis of different Information and Communication Technologies' uses in sustainable tourism management to study the literature and serve as a roadmap for future research in this field.

Keywords: tourism management; IC; bibliometric analysis; sustainable tourism.

Las Tecnologías de la Información y la Comunicación (TIC) como herramientas de gestión turística sostenible: un análisis bibliométrico

RESUMEN

El sector turismo ha experimentado un crecimiento constante en las últimas décadas, convirtiéndose en uno de los sectores clave para el desarrollo de los países. Sin embargo, la pandemia ocasionada por la COVID-19 ha traído consigo una crisis social, económica y sanitaria sin precedentes que ha forzado un cambio en la forma de hacer turismo. Este artículo presenta un análisis bibliométrico exhaustivo sobre el uso de las TIC como herramientas de gestión turística sostenible con la finalidad de conocer la producción académica y servir como hoja de ruta para futuras investigaciones en este campo.

Palabras clave: gestión turística; TIC; análisis bibliométrico; turismo sostenible.

1. INTRODUCTION

Nowadays, the tourism market is a fast-paced and changing environment where generating new experiences that meet tourists and specialists' expectations is a must (Moreno-Garrido, 2012). The tourism sector accounted for 10.4% of global GDP in 2019 (WTTC, 2021b). These figures kept rising until the emergence of the COVID-19 pandemic, which brought about an unprecedented social, economic, and health crisis globally affecting the sector's forecasts for the coming years. With the pandemic still looming, it is difficult to assess its impact. However, the World Tourism Organization (UNWTO) estimates issued on March 2020 proved to be conservative (Petrizzo, 2020). In 2020, the tourism sector GDP decreased to 5.5% and 62 million jobs were lost worldwide (WTTC, 2021).

The negative effects of the pandemic on the sector were mainly caused by the strict restrictions on mobility between territories in most countries, as well as by income reductions in many families – which will affect the tourists' spending power in the mid or long term (Rodríguez-Antón and Alonso-Almeida, 2020a). However, it is important to bear in mind that this has created a scenario full of opportunities to foster a necessary qualitative change in the way we do tourism, to consider the environment, economic regeneration, and local identity (Castello, 2020). Specifically, the tourism sector should aim at developing strategies focused on the search for sustainability, the application of new technologies, the improvement of supply quality and on innovative processes enabling new business models (Alonso-Almeida *et al*., 2021).

To understand the concept of sustainability you must go back to 1980, when it was introduced for the first time, referring only to ecology, in the World Conservation Strategy organized by the International Union for Conservation of Nature (IUCN). It was not until the end of that decade when the World Commission on Environment and Development presented the Brundtland Report (Bermejo Gómez de Segura, 2014), adding concerns such as poverty, inequality, environmental degradation, and the pressure that natural and human resources were subject to. In this moment, the environmental capital of future generations

started to gain prominence– the idea that this capital is now being borrowed while future generations cannot decide on the measures implemented (United Nations, 1987). Then, a group of accounting experts began to introduce the "triple bottom line" (TBL) concept. This concept was introduced to measure the performance of companies so that they could be managed in a way that would not only generate financial profits, but also improve the lives of people and the planet (Elkington, 1998). It is then that sustainability starts to be based on three pillars: the economic, the environment and the social ones.

The rise of this new environmental paradigm has led to changes in the way tourism is done, bringing new ethics committed to more responsible development strategies. Sustainable tourism must mean a balance between the maximum use of the destination resources, the satisfaction of tourists, and the negative impacts this activity has on the local population and the environment (Malaga Chamber of Commerce, 2010). To promote sustainable development measures, the main interest groups or stakeholders must be part of and participate in the various fields of action involved in this sector – namely public administrations, customers, suppliers and collaborators, and the natural and socio-cultural environment (Espinoza et al., 2017).

The tourism sector is therefore a very dynamic open system. Its sustainable development is subject to various factors, and influences many others such as the economic, cultural, social, and environmental aspects (Sutyrina *et al*., 2021). Higgins-Desbiolles (2020) analyzed the debate that was generated under the title "the war against tourism" distinguishing two discourses: a) the academic current that goes for a return to normality; and b) those who aim at a more equitable and sustainable future. However, he states that our job as members of the tourism academy is to play the role of researchers, not fighters. That is the reason why the study of tourism must be conducted using a multidisciplinary approach. Academically, there are many sciences such as sociology, economics, psychology, law, ecology, or geography – among others – that study tourism, and the academic debate on this concept is interesting. Nevertheless, in the last decades, the concept of sustainability has been more present in marketing than indirect improvement actions. Thus, it is necessary to develop practical tools and objectives that are feasibly applied to the development of sustainable tourism through its planning (Cardoso *et al*., 2014).

Currently, development plans show concern for the search of sustainable models. Sustainability in the destination and care for the environment stand out as the main objectives. Nevertheless, other important goals should not be forgotten, such as improving the image of the destination, employment policies, or promoting the training of the population and its qualification (Fernández, 2020). Due to the crisis generated in the tourism sector by the COVID-19 pandemic, recovery in the mid and long term must be approached through national and supranational authorities, as only with their joint action can the situation be mitigated (Rodríguez-Antón and Alonso-Almeida, 2020b). To be able to propose and implement these sustainable development models, it is essential to have accurate data analysis to help us collect existing information and to be able to formulate and forecast future scenarios (Ballestero and González Aranda, 2020). For this, we can use the information and communication technology (ICT) as an innovative tool providing an integrated software system that enables the distribution, data processing, and sharing of information (Buhalis, 2003).

Concerning ICT-based tools, we can affirm that they currently play a very important role in the tourism sector. The integration of ICT in this industry has facilitated access to information on tourism products from anywhere in the world in a single "click", thus opening the market in a much more global way (Bethapudi, 2013). The use of ICT has provided new tools and enabled new distribution channels, creating new business formats. In addition, it has provided different tourism businesses with new commercial partners contact networks, new forms of products and services distribution, and a greater impact range. ICT is present in virtually every aspect of tourism: geospatial use, road information, the presence of public services, or helping marketing tools to get more innovative (Shanker, 2008). These tools could reshape the tourism industry value chain because consumers have gradually adapted to new lifestyles and to tourism products now redesigned by technology.

Gössling (2021) divides the specific development of ICT in the tourism sector into four phases. In the first phase from 1985 to 1995, ICT emerged as an opportunity. In that phase, computerized reservation systems, global distribution systems, and company web pages prevailed. The second phase (1996-2006) is the disruptive one, where platform economies and rating systems emerge. New tools offer tourists generic information: information related to accommodation services, catering, transportation, orientation, payment, etc. Some examples are TripAdvisor, AccuWeather, Google Translate, Airbnb, Trivago, the Michelin Guide, Google Maps, etc. The third phase (2007-2015) is the "Immersion" phase, characterized by the social-networks bond, the collection of consumer data, and market concentration. Tools related to social networks, health, and travel emerged. In the fourth phase (2016-present) called the "Usurpation" phase, the relationship with social networks becomes one of dependence, there is greater technological vigilance, and supply is adapted to consumer demand to a greater extent. The tools are more concentrated on a limited number of platforms that have all the consumer information. They are more focused on the emotions and personality of tourists.

On their side, tourists tend to believe that the innovative use of ICT will help solving some issues regarding sustainable tourism development in a more flexible and practical way (Oyebode *et al*., 2022). Academics also agree with this statement: "as emerging new technologies continue to become more prevalent and incorporated into all aspects of daily life, investigation into how technology is affecting sustainability within the tourism industry is warranted" (Roberts et al., 2022).

In such a changing scenario and facing the chance to transform the way tourism is done, the study of the impact and scope these tools can have on sustainable tourism management is a must. To this end, it is important to consider some helpful proposals. Rodríguez-Antón (2021) puts forward four strategies: a) focus on the search for sustainability in its three aspects; b) use new technologies to support digitalization in the sector; c) foster the market search for continuous improvement of the quality offered to tourists, so that quality prevails over quantity; and d) create new business models which can adapt to the specific circumstances of each context. In this line, this paper aims at: a) identifying the most relevant literature on this research topic; b) analyzing the amount of existing information, and c) minimizing subjectivity.

Thus, the specific objectives (SO) of this article are SO1: to identify the most relevant literature on this research topic; SO2: to analyze the amount of existing information; and SO3: to minimize the degree of the subjective component. Through the former,

the main objective (MO) of this paper, namely analyzing the role of ICT in the study of sustainable tourism management, will be achieved.

2. METHOD

With the aim of analyzing and studying scientific activity in this area, this paper proposes a bibliometric analysis of the use of ICT in the tourism sector regarding sustainability. Throughout the literature review, no bibliometric analysis of the proposed topic has been found. Therefore, this research was designed following other bibliometric analyses carried out in the tourism context (Caldevilla-Domínguez *et al*., 2021; Della Corte *et al*., 2019). To collect the data, the Scopus database of Eselvier– origin dated March 2004 – was used. This choice was made because of the accuracy and thoroughness with which its content is examined and selected, and the ease to issue more accurate analyses and results.

Since English is the universal language used by academics, only articles written in English were considered for the information search. To delimit the field of research under study, an algorithm was used to collect the most relevant terms according to the authors in the fields of tourism, sustainability, management, and ICT. The search included the titles, abstracts, and keywords of the publications. In addition, different bibliometric indicators of production, circulation, visibility and impact (Castillo-Esparcia *et al*., 2012) were used on the total number of publications obtained, taking into account: a) the distribution of publications over time and their trend; b) the 10 most productive countries on the research topic; c) the 10 most productive journals in the subject; d) the institutions with the most research; e) the 10 most productive authors; and f) the main related thematic axes. The VOS viewer software tool, developed by the Dutch Nees Jan van Eck and Ludo Waltman, was used to construct and visualize the thematic axes. This tool was selected because it facilitates the visibility of the scientific mapping, allowing the analysis of the information available in an easier way when constructing and visualizing the bibliometric networks (Jan van Eck and Waltman, 2017).
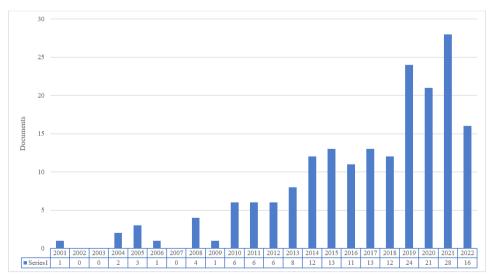
The period covered by this study runs from 2001 – the year of the first publication on this subject – to September 3, 2022. Thus, the data analyzed will not comprise the total number of articles published in 2022, but only those published up to that date. The results were obtained by using the search algorithm: TITLE-ABS-KEY ((sustainable OR sustainability OR {environmental impacts} OR {circular economy} OR {triple bottom line}) AND (tourism OR ecotourism OR tourist OR hospitality OR {smart destination}) AND (ICT OR {information and communication technologies} OR {information technologies} OR {communication technologies} OR {information and communication technology} OR {information and communication technology}) AND (management OR administration OR governance OR planning OR organization) AND (LIMIT-TO (LANGUAGE, "English")) on September 3, 2022. The research was carried out according to the following phases: (a) search for information; (b) analysis of the results obtained; (c) synthesis of the data; and (d) conclusions.

As of September 3, 2022, the formulas TITLE-ABS-KEY ((tourism OR ecotourism OR tourist OR hospitality OR {smart destination}) AND (ICT OR {information and communication technologies} OR {information technologies} OR {communication technologies} OR {information and communication technology}) AND (management OR administration OR governance OR planning OR organization) AND (LIMIT-TO

(LANGUAGE, "English")) and TITLE-ABS-KEY ((sustainable OR sustainability OR {environmental impacts} OR {circular economy} OR {triple bottom line}) AND (tourism OR ecotourism OR tourist OR hospitality OR {smart destination}) AND (management OR administration OR governance OR planning OR organization)) AND (LIMIT-TO (LANGUAGE, "English")) were also used in order to compare the number of published articles which excluded one of the four concepts. The keywords used in this paper were chosen to achieve the main objective of this study. Therefore, all four concepts had to be present in any of the articles analyzed.

3. RESULTS

Applying the search algorithm on the Scopus database, a total of 188 documents published in English which included in their title, abstract or keywords the four concepts (sustainability – or sustainable, environmental impact, circular economy or triple bottom line; tourism – or ecotourism, tourist, hospitality or smart destination; ICT – or information and communication technologies, information technologies, communication technologies or information and communication technology; and management – or administration, government, planning or organization) were obtained.

Regarding the distribution of publications over time, Figure 1 shows an overall rising interest in academics 'production. Furthermore, we can see that this is a topic of emerging interest when comparing the 24 articles published in the first half of the period analyzed (2001-2011) with the 164 articles published in the second half (2012-2021).

Figure 1
DISTRIBUTION OF PUBLICATIONS OVER TIME

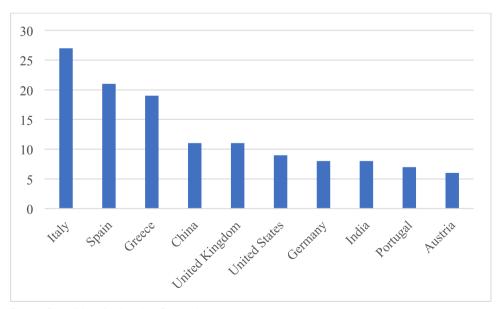|	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Series1	1	0	0	2	3	1	0	4	1	6	6	6	8	12	13	11	13	12	24	21	28	16

Source: Own elaboration based on Scopus data.

This increase in interest is very positive. However, the lack of research in this area becomes obvious if we apply the same formula to the Scopus database removing the concept "sustainable" and all the related ones, and using the algorithm: TITLE-ABS-KEY ((tourism OR ecotourism OR tourist OR hospitality OR {smart destination}) AND (ICT OR {information and communication technologies} OR {information technologies} OR {communication technologies} OR {information and communication technology}) AND (management OR administration OR governance OR planning OR organization)) AND (LIMIT-TO (LANGUAGE, "English"))). The total number of articles obtained is 827 – as of September 3, 2022 –, showing again a clear rising trend.

Although it might seem so, there is not a lack of interest in the study of sustainable tourism. The fact is that there are few studies dealing with the application of ICT tools to tourism management. If we apply the same formula – as of September 3, 2022 – butt his time removing the concepts related to "ICT": TITLE-ABS-KEY ((sustainable OR sustainability OR {environmental impacts} OR {circular economy} OR {triple bottom line}) AND (tourism OR ecotourism OR tourist OR hospitality OR {smart destination}) AND (management OR administration OR governance OR planning OR organization) AND (LIMIT-TO (LANGUAGE, "English"))), the result obtained is 12,984 articles published, again with an increasing trend that becomes more drastic in 2021, with a total of 1,764 articles. These results show that there is no lack of interest regarding the study of sustainability in tourism management, and that the number of publications on the subject increases yearly.

Figure 2
TOP 10 MOST PRODUCTIVE COUNTRIES CONCERNING THE STUDY OF THE USE OF ICTS IN SUSTAINABLE TOURISM MANAGEMENT

Source: Own elaboration based on Scopus data.

Given the relevance the tourism sector has in global economy, it is important to ana-lyze which countries are making the greatest contribution to the topic of study. It must be considered that the historical context has a profound influence on the research leading to new transition methods to enable more sustainable models. As shown in Figure 2, seven out of the ten countries with the greatest presence in the research belong to Europe, two of them to Asia, and one to America. Although tourism is a world-wide activity, it has a higher relevance to certain countries' economies.

Table 1
GDP AND EMPLOYMENT GENERATED BY THE TOURISM SECTOR
IN 2019, 2020 AND 2021

Country	GDP 2019	GDP 2020	GDP 2021	TandT% of total employment
Italy	10.6%	6.1%	9.1%	11.6%
Spain	14%	5.9%	8.5%	12.7%
Greece	20.7%	9.2%	14.9%	19.9%
China	11.6%	4.3%	4.6%	9.7%
United Kingdom	9.9%	4.3%	5.7%	11.7%
United States	8.8%	4.8%	5.5%	6.9%
Germany	9.8%	6.3%	6.4%	11.4%
India	7%	4.3%	5.8%	6.9%
Portugal	17.1%	8.7%	10.9%	18.9%
Austria	10.7%	7.9%	7.1%	10.2%
Global Data	**10.3%**	**5.3%**	**6.1%**	**9.09%**

Source: Own elaboration based on WTTC (2022) data.

Of the ten countries represented in Figure 2, the three with the most contributions to date are Italy –27 documents –, Spain –21 documents – and Greece –19documents. Table 1 shows that the three of them exceed the average percentage of both jobs generated by the tourism sector, and tourism contribution to GDP. These three countries' tourism sec-tor situation after the COVID-19 pandemic was worrying: From 2019 to 2020, Tourism contribution to GD Pin Italy fell by -47.3%; In Spain, it decreased by -62.6%, standing at 5.9% of the Spanish economy; Similarly, Greece experienced a drop of -59.3%. However, even though the pandemic is still looming, in 2021 there was a considerable increase in

the tourism contribution to these three Mediterranean countries' GDP, still not reaching pre-pandemic figures but staging a rapid recovery (WTTC, 2022).

Table 2
TOP 10 SOURCES WITH THE MOST PUBLICATIONS IN THE SUBJECT

Source	Documents
Sustainability	16
Springer Proceedings in Business and Economics	8
Iop Conference Series Earth and Environmental Science	6
Lecture Notes in Computer Science Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics	5
Journal of Hospitality and Tourism Technology	3
Proceedings of the 27th International Business Information Management Association Conference Innovation Management and Education Excellence Vision 2020 From Regional Development Sustainability to Global Economic Growth Ibima 2016	3
Smart Innovation Systems and Technologies	3
ACM International Conference Proceeding Series	2
Advances in Intelligent Systems and Computing	1
Ceur Workshop Proceedings	1

Source: Own elaboration based on Scopus data.

It is also important to analyze which sources are making this topic more visible. As shown in Table 2, the journal with the most articles published is *Sustainability* with a total of 16 articles. This Swiss interdisciplinary journal focuses mainly on the three aspects of sustainability: environmental, economic, and social, thus providing room for studies related to sustainable development. The journal's impact in Scopus was 5.0 in 2021, and the main categories where it is found are social sciences and environmental sciences. The German book series Springer Proceedings in Business and Economics, where conferences and workshops in the areas of economics, business, management, and finance are collected, stands in the second place with 8 papers. In the third place is the British IOP Conference Series Earth and Environmental Science, managed by IOP Publishing – one of the world's largest publishers of conference proceedings and whose subject areas cover physics, materials science, environmental science, bioscience, engineering, computational science and mathematics –, with 6 published papers. Its impact in 2021 was 0.6. The fourth source with the highest impact is Lecture Notes in Computer Sciences, a German journal with publications oriented towards new developments in computer science research, infor-

mation technology and teaching. This journal's impact in 2021 was 2.1 in Scopus and the main categories they fall into are computer sciences and mathematics.

The rest of the journals present lower productivity in the subject area with three or less publications in the field. The fact that the journals with the most contributions to this topic have such diverse areas of study – namely social sciences, environmental sciences, computer sciences, mathematics, etc. –shows the interdisciplinary and cross-cutting nature of the subject analyzed.

Table 3 shows the institutions with the most publications in the field of study. The figures are fairly even, most of them are public universities, and 9 out of the 10 top institutions belong to the European continent, namely Spain, Greece, and the United Kingdom.

Table 3
TOP 10 INSTITUTIONS WITH THE HIGHEST NUMBER OF ARTICLES PUB-LISHED IN THE FIELD OF STUDY

Affiliation	Documents	Country
Universitat de València	4	Spain
National Technical University of Athens	4	Greece
Universität Innsbruck	3	Austria
Universitat d'Alacant	3	Spain
Sheffield Hallam University	3	United Kingdom
Queen Margaret University	3	United Kingdom
Telegeco Research and Development	2	Greece
Universidade do Algarve	2	Portugal
Chinese University of Hong Kong	2	China
Universidad de Málaga	2	Spain

Source: Own elaboration based on Scopus data.

Concerning the institutions with the highest number of affiliated publications, the Universitat de València tops the list. Founded in 1499, it is one of the oldest public universities in Spain renowned by the areas of Physics and Astronomy, Accounting and Finance, and Statistics and Operations Research. The National Technical University of Athens, founded in 1837 in Greece, is second. Its main fields of research are Physical Sciences, Life Sciences, Earth and Environmental Sciences, and Chemistry. Finally, in the third place, and with a similar number of publications to the rest of the institutions, is the Universität Innsbruck, a public University founded in Austria in 1699 whose main areas of research are: Cultural Encounters and Conflicts; Digital Science; Economics, Politics, and Society; Molecular Biosciences; Mountain Regions; Physics and Scientific Computing.

Table 4
TOP 10 AUTHORS WITH THE HIGHEST NUMBER OF ARTICLES IN THIS FIELD

Author	Documents	Country
Ali, A.	3	United Kingdom
Cismaru, L.	3	Romania
Frew, A.J.	3	United Kingdom
Gil-Saura, I.	3	Spain
Stratigea, A.	3	Greece
Ammirato, S.	2	Italy
Antonkiewicz, J.	2	Poland
Chan, C.S.	2	China
Ciarkowska, K.	2	Poland
Felicetti, A.M.	2	Italy

Source: Own elaboration based on Scopus data.

Considering Lotka's law (1926) and concerning the productivity of the authors represented in Table 4, we can state that there is not a specific group of authors that comprises most of the publications, but the amount of scientific production is fairly evenly distributed. In this case, the most productive authors in the research area are Alisha Ali, Laura Cismaru, Andrew J. Frew, Irene Gil-Saura and Anastasia Stratigea, with three published papers each.

PhD in tourism from Queen Margaret University, Alisha Ali, is a lecturer and researcher at Sheffield Hallam University. Her main areas of research include service sector management, sustainable development, ICT, innovation, corporate social responsibility, tourism destination management, and hospitality and tourism. In addition, she teaches in the areas of innovation, IT, sustainable tourism, operations management, hospitality, and tourism. Secondly, Prof. Dr. Laura Cismaru is an Associate Professor at the Faculty of Food and Tourism at Universitatea Transilvania Brasov (Romania). Her main areas of research are destination marketing, generational theory, and branding. Thirdly, Andrew J. Frew is an Emeritus Professor of ICT and Tourism at Queen Margaret University. His main fields of research are hospitality and tourism, and the application of IT and information systems in tourism management. Besides, Irene Gil-Saura is Professor at the Universitat de València and her main area of research is marketing and market research. Finally, Anastasia Stratigea is an Associate Professor in the Department of Geography and Regional Planning at the National Technical University of Athens. Her main areas of research are regional development and planning, ICT impacts on regional development, regional policy, foresight methodologies and tourism. The rest of the authors represented in Table 4 have two articles in the research area.

Table 5
ANALYSIS OF THE 10 MOST CITED PAPERS IN THE SUBJECT AREA.

Citation	The objective of the document
Young and Kielkiewicz-Young, (2001)	*"Sustainable Supply Network Management"* analyses eight economic sectors in North America and Europe, including tourism and ICT, presenting an overview of sustainability practices, considering ethical, social, and environmental issues. In addition, the article demonstrates that most organizations are focused solely on the environmental pillar. This is due to the presence of external drivers such as legislation, market pressure or lack of external pressures on social and ethical issues.
Gössling, (2017)	Stephan Gössling analyses in his article *"Tourism, information technologies and sustainability: an exploratory review"* the main changes in the tourism system following the emergence of IT. These changes are discussed from four perspectives: sociocultural, environmental, economic, and psychological. The author concludes by stating the potential of IT to support more sustainable tourism; however, he highlights the need for literature analysing many new issues.
Encalada *et al.*, (2017)	The article entitled *"Identifying tourist places of interest based on digital imprints: Towards a sustainable smart City"* presents an analysis of the spatial distribution of tourists in the city of Lisbon to understand the consumption of space within urban tourist destinations. In this way, it is possible to identify the most overcrowded places and those with growth potential. The main purpose is to enable the design of new forms of planning and management toward an intelligent and sustainable future.
Bassano *et al.*, (2019)	*"Storytelling about places: Tourism marketing in the digital age"* highlights the need to involve all stakeholders of a destination in the construction of the place's own identity. To this end, they present a storytelling model that local governments and cultural organizations can take advantage of to improve the marketing and sustainable tourism competitiveness of a destination.
Romão and Neuts, (2017)	*"Territorial capital, smart tourism specialization and sustainable regional development: Experiences from Europe"* studies how ICT, through innovation and knowledge integration, can contribute to increasing the added value of tourism and strengthening links with other economic sectors in the same destination. This derives from the results obtained from the model proposed by the authors, which shows, among other things, that the European regions most dependent on tourism are those with the lowest levels of regional GDP and the highest levels of unemployment.
Racherla *et al.*, (2008)	In the article *"Exploring the role of innovative technologies in building a knowledge-based destination"*, the authors, through focus groups, reveal the economic, social, and technical factors that are fundamental to the development of a knowledge-based destination. ICT is present as tools that have transformed the business and social landscape of the tourism sector and stimulated debate on their role in the future of tourism destinations.

Citation	The objective of the document
Mora-Mora *et al*., (2015)	*"A computational architecture based on RFID sensors for traceability in smart cities"* presents a system designed to obtain, represent, and provide the flow of people in densely populated areas. The main objective of this article is to continue advancing in the design of smart cities that rely on real information when making strategic decisions related to transportation or the tourism sector.
Sigala and Leslie, (2005)	The book *"International cultural tourism: Management, implications, and cases"* analyses the evolution, use, and impact of ICT in the management and promotion of resources related to cultural tourism. It focuses on sustainability aspects linked to the social and environmental dimension and analyses the changing nature of this type of tourism and consumer behaviour.
Ali and Frew, (2014)	The article "*ICT and sustainable tourism development: An innovative perspective*" aims at raising awareness of ICT use as an innovative approach to sustainable tourism development in destinations. To this end, it focuses on the Abernathy and Clark model at the business level and its usefulness in applying ICT as an innovation in sustainable tourism management.
Belli *et al*., (2020)	"*IoT-enabled smart sustainable cities: Challenges and approaches*" focuses on how the application of the Internet of Things is associated with the concept of a smart city, thus increasing the inhabitants' quality of life. This concept is related to the sustainability and innovation of cities in aspects such as transport, industry, health, education, or tourism. The city of Parma (Italy) is presented as a success case.

Source: Own elaboration based on Scopus data.

As can be seen in Table 5, sustainability is often studied by considering one or two of the three pillars it comprises. In the paper published by Young and Kielkiewicz-Young (2001), ethical, social, and environmental issues are addressed, but not economic; Racherla *et al*. (2008) reveal economic and social factors, but not environmental; Sigala and Leslie, (2005) link their research to the social and environmental dimension, but not to the economic one, and Romão and Neuts (2017) focus mainly on elements related to the economic dimension. Researchers need to address this issue dealing with these three pillars, as they are a schematic representation of the planet experienced by humans. Only when sustainability is present in all three concepts, it can be ensured on the planet from a holistic point of view. A different case are the works by Ali and Frew (2014) or Gössling (2017), who address the concept of sustainability in a comprehensive way, considering the three aspects.

Young and Kielkiewicz-Young, (2001) and Belli *et al*., (2020) do not carry out a specific study on the tourism sector. The first one analyzes sustainability from a general view and the tourism sector is just one of the sectors included. The second just includes tourism as one element of the concept of smart city. On the other hand, Bassano *et al*., (2019) defend identity as an element capable of improving destinations' tourism competitiveness. Finally, Racherla *et al*. (2008) lay the foundations on the role that ICT-based tools can

have in the future of tourist destinations through a qualitative study. Later, in 2017, both Romão and Neuts and Gössling, state that ICT tools increase the added value of tourism and that they have great potential for the sustainable management of tourist destinations.

Figure 3 shows the connections between the different documents analyzed in the article. For this purpose, a network map has been made using the VOS viewer software. It shows a series of nodes representing the keywords used in the different papers analyzed. Depending on the size of the nodes, we can see whether the keyword is used to a greater or lesser extent. Nodes with a larger size indicate that the word has been used more frequently than those with a smaller size. In addition, we can also analyze the nodes according to their chromatic similarity and closeness to each other. Nodes of the same color are more similar, just like those that are closer together, which are more similar than those that are farther. In this figure we can see five different clusters that are interrelated, sharing some keywords. The keywords used most frequently in the compilation and that make up the five clusters are "sustainable development", "tourism", "ICT", "innovation" and "information management".
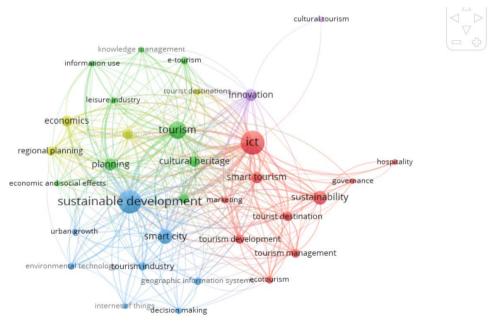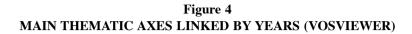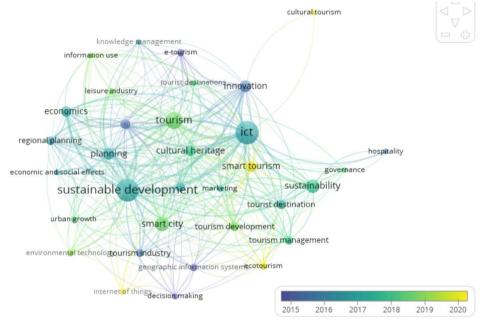
Figure 3
MAIN THEMATIC AXES LINKED (VOSVIEWER)

Source: Own elaboration using VOS viewer software based on Scopus data.

In Figure 4, the nodes are grouped chromatically according to the period when the number of times they were cited increased. This bibliometric map helps us to understand the trend of publications over time. For example, the concepts "e-tourism" and "geo-

graphic information systems" boosted in 2014. From 2015 to 2017, the concepts "sustainable development", "planning" or "ICT", among others, stand out. Whereas in the most recent period, topics such as "smart city", "smart tourism", "cultural tourism" "internet of things" or "ecotourism" have been addressed.

Figure 4
MAIN THEMATIC AXES LINKED BY YEARS (VOSVIEWER)

Source: Own elaboration using VOS viewer software based on Scopus data.

DISCUSSION

Thanks to the method used, the present study managed to objectively extract the metadata of the existing literature dealing with the use of ICT and sustainable tourism (SO3) and to identify the most relevant research on this topic (SO1). A total of 188 articles published from 2001 to September 2022were obtained. The comparison (SO2) of these articles addressing sustainable tourism or tourism and ICT, proved that this topic has received scarce attention to date but is clearly booming. Researchers need to focus on analyzing how ICT-based tools can help addressing some sustainability problems caused by the increasingly visible tourism activity – such as destinations overload or fast carbon emissions' production (Ali, 2021).

Ali and Frew (2014) show the significance ICT has to address some aspects of tourism when reducing the impact of such activity: a) energy control, b) waste management, or c) information management. This would enable the improvement of critical decision making

and provide a future advantage by enhancing the understanding of the tourism product or the forecast of new trends. However, the current use of ICT does not help destinations become more resilient or respect environmental limits. Instead, it is used improvise monitoring and profiling of tourists to generate profits. It is thus utterly important to take advantage of the opportunity presented by ICT-based tools to make significant contributions to the sustainability of destinations (Gössling, 2021). Consequently, researchers should focus on addressing these concerns.

4. CONCLUSION

This section discusses the presence of ICT in the study of sustainable tourism management (STM). As this paper shows, the presence of ICT in the study of sustainable tourism management is scarce. However, there is an increasing interest in the subject, especially in the last decade. The increase in scientific literature is due to the growing social ecological awareness developed in recent years. In addition, many destinations have exceeded their load factor and/or are going for alternative planning, management, and sustainable tourism development to fight the almost obsolete traditional practices based on mass tourism. Likewise, the rise of other tourism models such as eco-tourism or rural and nature tourism (HOSTELTUR, 2020) – increasing after the appearance of the COVID-19 pandemic – has also brought about a rise in the will to create new models of tourism development.

Among the main results obtained, it is worth noting that the countries with the greatest concern for studying new models of sustainable tourism management supported by ICT-based tools are the most developed ones– Europe is the continent with the most studies – and those where tourism represents a major part of their GDP. The environment inevitably transforms the tourism sector processes and practices, producing an impact on services, strategy, management, and competitiveness that affects all the agents involved (Buhalis, 2019). This is the reason why the rest of the destinations must also contribute to this area of study. Europe plays a leading role in the theme according to all the indicators analyzed.

The sources with the highest productivity in the subject matter follow the same parameters as in the previous point, since the four of them are European. In addition, by analyzing the topic and main areas of research of the journals, the interdisciplinary nature of the subject of study becomes obvious. These diverse approach eses are definitely an advantage but require concepts and studies to be unified.

Thanks to the scientific mapping carried out through the VOS viewer software, we can perceive that the keywords most frequently repeated in the extracted documents are: "sustainable development", "tourism", "ICT", "information management" and "innovation", among others. In addition, the four main concepts of these studies– sustainability, tourism, management, and ICT – have become increasingly unified in recent years as environmental concerns rises. In addition, the knowledge about the use of technology is increasing, and more and more studies are analyzing how to use ICT to provide a competitive advantage and in turn help to halt the damage caused by tourism activity. The analysis shows that the trend in this field of study initially focused on tourism management through innovation and new IT, while it continued to develop in a direction more concerned with issues such as sustainable development or cultural heritage. In the last period, new tourism

trends – ecotourism or the smart city concept –stand out, the concept of sustainability is implicit in the planning of a destination, and its management is supported by the use of new technologies.

The tourism sector is one of the sectors most hardly hit by this pandemic –its contribution to global GDP fell by -50.4% between 2019 and 2020 (WTTC, 2022) – so many destinations have begun to re-consider their mid and long-term future. This activity is highly valued and practiced worldwide and will continue to be in demand in the future. According to UNWTO data (2022), the sector has recovered almost half of the pre-pandemic level of 2019, with Europe and the Americas leading the global recovery. Thus, we are facing a moment of transition towards more sustainable management models, where researchers play a key role.

The analysis of the most cited articles on the subject –Table 5 – shows the variety of topics that can be covered through ICT, ranging from Bassano *et al*. (2019) presenting storytelling as an element that enhances the tourism competitiveness of a destination, to the 8 economic sectors proposed by Young and Kielkiewicz-Young (2001). Destination management must be approached from both a microeconomic and macroeconomic point of view. All stakeholders must be part of this transition, from local commerce to the different States. However, due to the extent of the subject, we can also see that the object of study does not follow one single line when presenting results and that there is no model applicable to tourist destinations to help professionals in the sector – although there is one for companies proposed by Ali and Frew (2014).

Considering that the technology sector is in constant development, it is necessary for researchers in this field and the different actors involved to keep up to date with ICT innovations as they emerge, using them as support tools capable of generating a social, environmental, and economic benefit to destinations and the local population. In a study conducted by Buhalis *et al*. (2020), it was concluded that the new generations – students – have positive attitudes towards e-commerce in tourism companies, which favors online purchasing and e-loyalty in this segment, thus opening up a broad market niche regarding new technologies and marking the future lines to be followed by companies and destinations.

5. LIMITATIONS AND FUTURE LINES OF RESEARCH

The present study analyzed the scientific production collected in the Scopus database considering documents written in English. Therefore, the first limitation is that all the scientific production available in other databases or languages was not analyzed. In addition, other bibliometric indicators were not used in this study. In the absence of previous bibliometric analyses on the subject, it was not possible to compare the results obtained with similar studies.

After analyzing the literature available in the Scopus database, the need for further research on the application of ICT-based tools to facilitate a transition to more sustainable production and consumption models is obvious. Consequently, it is essential to conduct empirical studies that develop models applicable to tourist destinations. In future lines of research, it would be key to create a relational model between the use of ICT in tourist

destinations and their degree of sustainable development, considering the different tourist models that may exist in a territory. Another possible line of research is to analyze how small and medium-sized tourism companies are using these tools to create a competitive advantage in the market, and how, through the use of these tools, newly created business networks can promote cooperation among themselves, providing greater visibility and competitiveness in the market.

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