Influence of Technologies on Sustainable Tourism

Subjects: Management | Area Studies
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This study's objective is to provide an overview on literature state-of-the-art related to sustainable tourism and technological innovations, offering insights for further advancing this domain. We employ a bibliometric analysis and a comprehensive review of 139 articles, collected from Web of Science and Scopus databases, for the purpose of: (i) exploring and discussing the most relevant contributions in the publication network: (ii) highlighting key issues and emerging topics; (iii) uncovering open questions for the future. Our findings reveal contradictory views on the risks and benefits of technology adoption. Artificial intelligence, internet of things, circular economy, big data, augmented and virtual reality emerge as major trends. Five work streams are identified and described, leading to a broader perspective on how technology can shape the future of sustainable tourism. Relevant theoretical and managerial implications are derived. Finally, a research agenda is proposed as guidance for future studies addressing the outcomes of digital disruption on sustainable tourism.

Keywords: bibliometric analysis ; eco-tourism ; sustainability ; tourism ; artificial intelligence ; virtual reality ; augmented reality ; research agenda ; future trends

1. Introduction

When the COVID-19 pandemic erupted, Hospitality and Tourism (H&T) was the largest and fastest growing industry worldwide [1][2], accountable for substantial environmental impacts, related to water consumption, carbon footprint and waste generation, among others, and overall pressure on resources conservation. Nowadays, even though green lodging and eco-tourism are gaining preference among travelers [3][4], and are essential for the sector's future success, tourism is considered one of the least developed industries with regard to the implementation of sustainable practices [5][6]. The development of sustainable tourism is of utmost importance, especially in the post-pandemic period, considering the severe economic challenges it is facing, as well as the environmental crisis and climate changes experienced globally [7]. Sustainable tourism is defined by [8] as "*tourism that takes full account of its current and future economic, social and environmental impacts, addressing the needs of visitors, the industry, the environment and host communities*", pointing out toward the three dimensions of sustainability: economic, social, and environmental. For exploring this topic, concepts such 'green' and 'eco-tourism' will be explored to focus on the environmental aspects of sustainable development in tourism.

The most recent technological advances are already disrupting even the most traditional markets and can enable strategically agile processes. The effects on sustainability can be both positive and negative [4], affecting the achievement of United Nations' Sustainable Development Goals (SDG), and a more fairly distributed economic prosperity [9]. Conversely, while some authors examining the H&T sector highlight the lack of studies on how the introduction of AI-enabled solutions, enriched virtual interactions and social robots will change the engagement with customers and employees in the future [10][11]; others argue how the fourth technological revolution is already altering the paradigm of the H&T industry [12][13], which includes breakthrough innovations, such as Virtual Reality (VR), Augmented Reality (AR), Artificial Intelligence (AI) [14][15], and the benefits of mobile interactivity for H&T customer engagement [16].

VR is an immersive 3D-simulated setting that allows consumers to have the feeling of being in a real-world environment [17]. The expression was originally coined by Jaron Lanier in the 1980s, leading to the invention of virtual reality gears, such as the Dataglove and the EyePhone head-mounted display [18][19]. AR relates purely virtual to purely real environments, where the observer is seeing the real world and can also visualize virtual objects overlaid on it, usually by wearing see-through displays, or interacting with their own mobile devices. VR and AR can both be used to promote a touristic destination or site, providing an immersive stimulation to tourists, for a totally new, memorable experience [18][20][21].

With regard to AI, the lack of a consensual definition has not prevented the spread of research about its new applications [22], where various definitions of AI systems are summarized into four categories along two dimensions: *reasoning–*

behaviour dimension and *human performance–rationality dimension*. These are: (1) systems that think like humans, (2) systems that act as humans, (3) systems that think rationally, and (4) systems that act rationally. Authors elaborate on the exciting capabilities of AI systems, and report on four different levels of intelligence (e.g., *mechanical, analytical, intuitive, empathetic*), as AI-enabled entities evolve over time, with increased potential to transform society and organisations [23], exhibiting new skills, such as the ability to process and communicate in natural language, to store information and use it to answer questions, or *machine learning* (e.g., ability to adapt to new circumstances, detect and extrapolate patterns).

2. Cooperative Network of Authors, Countries of Affiliation and Documents

Co-authorship analysis illustrates the intellectual collaborations among academics (see **Figure 1**), where researchers can find three distinct cooperative networks. One group (red colour) comprises authors located in Australia [24][25] dealing with the use of immersive technologies (e.g., VR) for destination experiences, in situations of over-tourism leading to deterioration of the sites. Another group (in green), aggregates researchers from different countries, such as USA, France, or England, [26][27][28][29], and deals with AI for sustainable purposes at a firm level but considering different external stakeholders. The blue group also examines AI and other related technologies, for sustainable issues (e.g., France, England, Australia, Malaysia), but more focused in internal stakeholders [30][31].

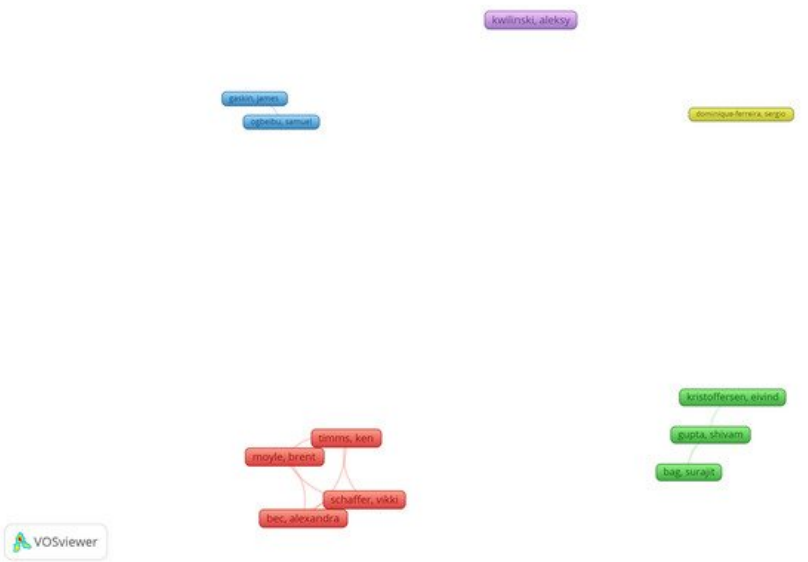

Figure 1. Cooperative network of authors. Note: The colours show the main networks established. The size of the frame represents the number of citations.

Figure 2 and **Figure 3** display, respectively, the network of universities' countries of origin, from where the first authors are affiliated to, and the network of documents. When applying bibliometric coupling technique to countries of affiliation, four major networks emerge: the two in red and yellow colours link European countries, while the other two extend their connections across universities from different continents. This analysis is conducted based on the assumption of similarity between two articles that sharing common references [32]. Regarding the documents' bibliometric coupling (articles published in indexed journals), **Figure 2** highlights the articles' proximity—due to sharing similar content—and recency, where these examples exhibit a central, closely related position [33][34][35].

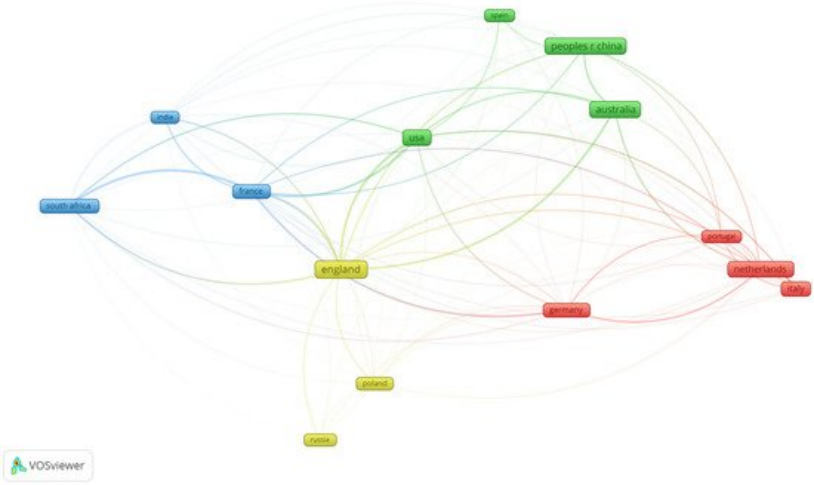

Figure 2. Network of countries of affiliation, using bibliometric coupling.

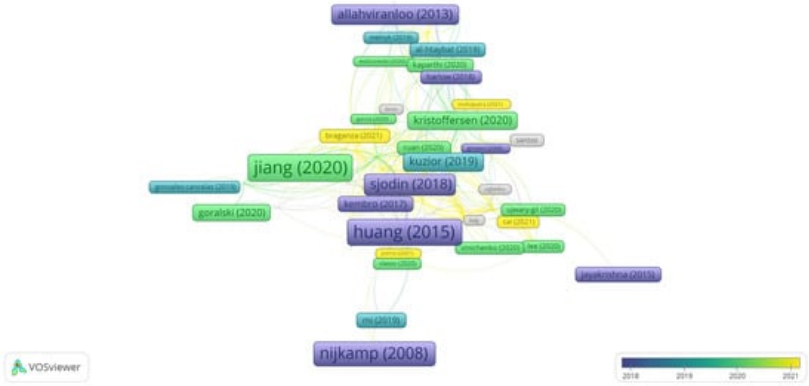

Figure 3. Network of related documents using bibliometric coupling. Note: The size of the frame represents the number of similar citations.

3. Citation and Co-Citation Analysis

The citation analysis allows scholars to understand the relationship among article publications [36] and to identify the most influential publications in a research field. **Figure 4** exhibits the most influential articles, where some examples, such as [26][37][38] stand out from the rest. These articles focus on the implementation of AI technologies within companies in the transition towards the Fourth Industrial Revolution.

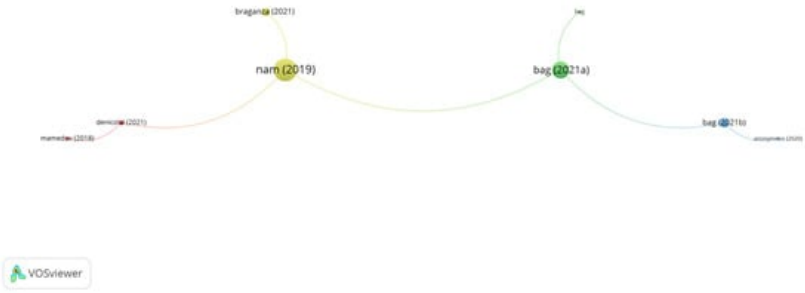

Figure 4. Citation network of articles.

Co-citation analysis represents the number of times two secondary articles are cited together in a third article. The **Figure 5** examines how often secondary journals are co-cited and reveals the network composition of journals where research is published. In each cluster, it is possible to uncover the leading journal [39]. In the red cluster, Journal of Cleaner Production is the most cited source, which includes articles mainly dedicated to sustainable issues. The green cluster reflects sources from the fields of management and marketing, where Journal of Business Research and Tourism Management are the most prevalent, in terms of citations and networks established. The blue cluster illustrates strategy and management journals, with Strategic Management Journal emerging as one of the most relevant. A final yellow cluster can also be visualized, with Technological Forecasting and Social Change prevailing in this niche group, intending to link technology to social issues.

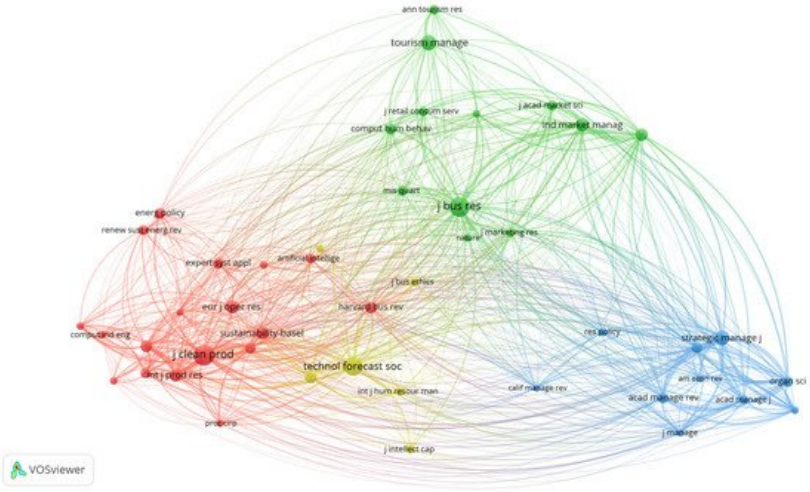

Figure 5. Co-citation network of journals. Note: The circles in the figure represent the cited reference and the size of the circle denotes the total link strength of respective cited reference.

4. Co-Occurrences of Keywords

A keyword co-occurrence network represents the relationships between keywords, which reflect the main context in the literature (see **Figure 6**). The most prominent node is *artificial intelligence* (AI). This node links with others in the same cluster, such as *internet of things, big data, sustainable development,* or *automation*. The yellow network intersects the blue one, through the *management* and *performance* terms. The green network aggregates words such as *circular economy* and *industry 4.0*, with others associated with AI, e.g., *big data analytics, machine learning* or *systems*. Finally, the red network links the word *sustainability* with *VR* and *AR technologies*, *innovation,* or issues related to the adoption of such technologies.

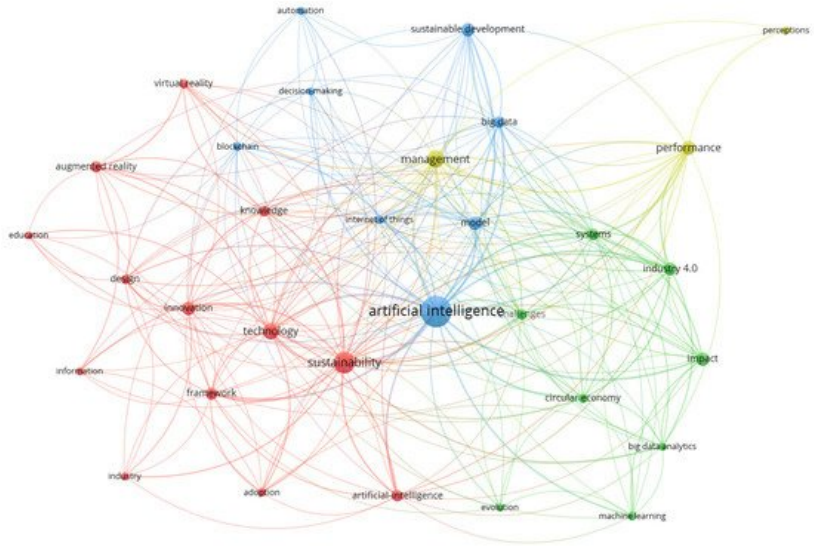

Figure 6. Keyword co-occurrence network. Notes: (1) Each node in a network represents a keyword wherein: size of the node indicates the occurrence of the keyword (i.e., the number of times that the keyword occurs); (2) the link between the nodes represents the co-occurrence between keywords (i.e., keywords that co-occur or occur together), (3) the thickness of the link signals the occurrence of co-occurrences between keywords (i.e., the number of times that the keywords co-occur or occur together), (4) the bigger the node, the greater the occurrence of the keyword, and (5) the thicker the link between nodes, the greater the occurrence of the co-occurrences between keywords. Each colour represents a thematic cluster, wherein the nodes and links in that cluster can be used to explain the theme's (cluster's) coverage of topics (nodes) and the relationships (links) between the topics (nodes) manifesting under that theme (cluster).

Most of the articles analyzed are related to AI (N = 123, 88.5%). The articles on VR and AR (N = 16, 11.5%) links the use of VR and AR technologies to support and promote sustainable concerns in enterprises, tourism, stores, or education [25][40][41][42]. The adoption of VR, AR and related technologies facilitates distant contacts in real time, consumer decision, and can reduce the costs of travel or new product development [33][40][43]. Retailers and educational institutions can both benefit with the use of VR and AR: the former can use it for framing advertisement messages, to promote sustainable products [42], while educationally, teachers should consider the intersections of design thinking and emerging technologies, for students to engage with the sustainability theme [41]. Benefits for the tourism sector are suggested in studies concerned with the destruction of destination sites [24][25][44]. The usage of VR/AR technologies can control the overcrowd [45], for instance, when tourists assist a VR immersive visualization, instead of being there, as they have recently provided access to visitors, during the lockdown periods caused by COVID-19 [46].

Although the first articles aggregating AI with sustainability, in the analyzed database, were published back in 2008 and 2013 [47], it is since 2017 that we assist to an explosion of publications about the Fourth Industrial Revolution. These are mainly focused on industry-level applications but represent the usage of technology to create an inclusive, human-centered future culture [48]. Thus, leaders, employees and citizens need to create a new organizational culture to incorporate AI technology, taking into consideration the sustainability issues and the well-being of society [48][49].

The incorporation of AI in industry and society creates benefits because it facilitates better resources allocation, treating large amounts of data, which allows a focus on what customer really desires, and to reduce waste. With AI-enabled agents (robots or otherwise) performing traditional jobs and tasks, a reformulation of labor and of the whole society, can be expected. In 2019, some publications started to discuss the ethical concerns and risks, resulting from the incorporation

of AI algorithms and agents in our industry and society [50]. Furthermore, the year of 2020 is marked by the discussion of the AI impact on the United Nations (UN) Sustainable Development Goals (SDGs). The fact that some countries are more open culturally and economically than others to the implementation of AI systems, creates new inequalities [51][52] widely discussed in literature.

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