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Looking at the tourism industry through the lenses of industry 4.0: a bibliometric review of concerns and challenges

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Abstract

Purpose – The technological and digital revolution has introduced important changes in the tourism industry. However, capturing the extent of the new tourism 4.0 paradigm is still difficult. This study aims to assess the dimensions related to the concepts of industry 4.0 in tourism and hospitality, tourism innovation and tourism ecosystem when considered simultaneously, and their role in promoting a new wave of competitiveness in the tourism industry.

Design/methodology/approach – A bibliometric study was conducted based on tourism 4.0, hotel 4.0, tourism innovation and tourism ecosystem using 120 eligible articles published between 2008 and 2021 from the Web of Science database.

Findings – This study demonstrated the advances in industry 4.0 in tourism and hospitality publications over 13 years and identified five interconnected dimensions: (1) knowledge transfer in tourism; (2) networking tourism innovation; (3) sources of tourism innovation; (4) smart tourism ecosystem and (5) innovation research in tourism. It was also concluded that tourism development should be a regional competence based on strategic networking and externalisation of regional knowledge flows.

Research limitations/implications – This bibliometric review provides important implications and recommendations for several players of industry 4.0 in tourism and hospitality and policymakers. Not only did it make it possible to create a state of art, but also to categorise the existing interconnections between the dimensions of Tourism 4.0, Hotel 4.0, Tourism innovation and Tourism ecosystem to optimise its implementation and generate greater value. In addition, practical implications were inferred that improve the tourism sector's competitiveness, helping strategic decision-making at the level of policymakers and actors in this sector.

Practical implications – Apart from state of the art, this bibliometric review made it possible to categorise the existing interconnections between the dimensions of tourism 4.0, hotel 4.0, tourism innovation and tourism ecosystem to optimise its implementation and generate greater value. Practical implications were inferred that improve the tourism sector's competitiveness, helping strategic decision-making at the level of policymakers and several players in this sector.

Originality/value – This study addresses the existing literature gap in the interconnection of industry 4.0 with tourism and hospitality by describing the most relevant conceptual interconnections and setting practical implications for improving the competitiveness of the tourism industry. Furthermore, it integrates previous studies and outlines future lines of investigation.

Keywords Hotel 4.0, Tourism 4.0, Tourism innovation, Tourism ecosystem, Bibliometric analysis

Paper type Literature review

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Introduction

Since the beginning of the millennium, a rapid acceleration of the digital age has been experienced (Bimbe *et al.*, 2015), often referred to as a revolution: the fourth industrial revolution or the digital revolution (Pencarelli, 2020). Industry 4.0 emerges, triggering radical changes in society and the economy worldwide, despite insufficient knowledge and debate about its implications and consequences.

The revolution of Industry 4.0 may have countless definitions without one consensus due to the high spectrum of its dimensions (Culot *et al.*, 2020). It is an umbrella term often used to embrace a wide set of transformations – some more radical than others – that occur in the organisation of the economy and society due to digitisation and technological advances (Jamwal *et al.*, 2021). Mazali (2018) argues that the ongoing change goes beyond the economic and technological fields reaching and implying large-scale social and cultural transformation. This means that automation, digitisation, interconnectivity, big data, vertical and horizontal integration, new forms of production and consumption, and new business models and logics are driving social and economic transformation. However, the breadth and depth of these implications are poorly understood (Mazali, 2018). Inexorably, this digital transformation entails profound changes in tourism (Buhalis, 2020). Innovation in tourism can be defined as the creation of new knowledge or the combination of existing knowledge that is transformed into several dimensions of innovation: products, processes, organisation/management and marketing (Hjalager, 2010b). As the tourist experience is determined by services but also by products, tourist destinations and interrelated local communities, innovation in tourism occurs in many ways (Pikkemaat *et al.*, 2019), being driven by the technological context (Yeh and Ku, 2019).

Although the tourism industry is often characterised by a late adoption of technology (Berger, 2016), different hotel systems are exploiting opportunities provided by technological advances at all stages of the value chain, reaching their end customer. Gone are the times when a hotel just sold rooms, even if aggregated into central reservation systems, computer networks and reservation tools to make bookings, enabling the hotel inventory's dynamic management (Ercan, 2019). With technological developments, most hotels have been able to adapt and integrate their local and digital offers. Wi-Fi throughout the hotel, preferably broadband, has become the norm that allows the connection of guests through numerous devices, namely applications that allow personalising the experience in the room and hotel (Richard, 2017). On the other hand, digital communication channels began to be interconnected and operate in both directions (Zamyatina and Solntseva, 2020).

In this way, the traditional experience of a customer physically in the hotel facilities is losing place, valuing more personalised, accessible and ubiquitous tourism experiences. A new era that we label hotel 4.0 emerged in the tourism industry, in which technology became essential in its processes and procedures. Hotel 4.0 is based on transformations based on technology with highly interconnected systems in the tourism industry (Stankov and Gretzel, 2020): automated algorithms to distribute work to mobile and always available workers (Degryse, 2016), reservations and hotels and restaurants check-in are increasingly digital, as well as the reservations of attractions (Zamyatina and Solntseva, 2020). Additionally, the platform economy gains strength and expands its tentacles: transport sharing, digital guides (Bohlin and Brandt, 2014) and gamification applications for visitor experiences (Xu *et al.*, 2017) are other areas profoundly changing the experience and expectations of tourists. At this stage, networks can define tourism ecosystems in which many players in the sector are interconnected (Lusch and Nambisan, 2015), allowing to take advantage of intelligent technology in the management, creation and provision of tourist services, with more intensive data-sharing and greater value co-creation for tourist companies (Gretzel *et al.*, 2015).

With hotel 4.0 is achieved the decade of digital activation for hotel operators: the focus is no longer oriented to beds, location and destination. The focus for travel providers will be on

the traveller and their specific individual needs, desires and values (Olsen and Connolly, 2000). At hotel 4.0, guests do not need to ask for the room type and services they want as it is offered (timely) individualised options and services based on the analysis of specific data previously collected about their habits, tastes and desires through interactions with other players in the region, with complementary offers, comments previously provided, information collected during the planning phase of the trip or inferred from social networks and other data from, e.g. iBeacons in a given radius (Stylos *et al.*, 2021).

Introducing and updating new technologies in hotel units is a win-win option (Ercan, 2019): guests end up having better quality service at more attractive prices, and hoteliers, through digital tools and greater use of technology, can raise quality and reduce operational costs. However, technology is only a means to the end: the ongoing digital transformation should not – cannot – change the essence of sectors made from people to people, where human contact and intuition are central for the best experience (Choi *et al.*, 2020).

According to Tsai *et al.* (2009), technology is one factor that boosts hotel competitiveness through adopting new techniques that encourage better results, boosting long-term performance. However, despite the recognition of the need to incorporate technology into the tourism industry, there is still no effective evaluation of how incorporating this new technological era increases the competitiveness of the tourism industry (Hua, 2020).

Despite the rapid growth of the hospitality industry, the recognition and adaptation to these emerging trends, there are still few scientific studies that capture the new paradigm of the hotel 4.0 concept, its dimensions and the role played in the promotion of competitiveness in the industry (Pencarelli, 2020; Gretzel *et al.*, 2015). A recent systematic review of the literature by Elkhwesky and Elkhwesky (2023) showed that, in the last seven years, the Internet of Things (IoT) has brought many advantages but also challenges to the hotel industry, namely as a result of the transition to the application of more flexible and innovative strategies resulting from greater automation of services. However, they also concluded that studies on the application of IoT in the hotel industry are still very scarce and need further investigation.

The present bibliometric study aims to assess the dimensions interconnected to tourism 4.0 and hotel 4.0. Specifically, their role in promoting the competitiveness of the tourism industry by defining a set of practical implications. In this line, the main research questions are (1) What are the main dimensions interconnected to the theoretical concepts of tourism 4.0 and hotel 4.0? and (2) What is the role of tourism 4.0 and hotel 4.0 in promoting the competitiveness of the tourism industry?

This study brings three main contributions. First, few scientific studies simultaneously relate the concepts of "Hotel 4.0", "Tourism 4.0", "Tourism innovation" and "Tourism ecosystem". Previous studies have focused on examining only tourism innovation (e.g. Medina-Munoz *et al.* (2013) or tourism experiences (e.g. Rachao *et al.*, 2020). In contrast, this study provides a state of the art of the highlighted themes and categorises the interconnected dimensions of these concepts. Second, studies tended to focus on their practical implications in general (e.g. Medina-Munoz *et al.*, 2013) or on a specific industry (food tourism activities, e.g. Rachao *et al.*, 2020) without particularising any actor. Blended with the dimensions' assessment linked to the concepts of tourism 4.0 and hotel 4.0 and their role in promoting the competitiveness of the tourism industry, this approach highlights the practical implications for governments and policymakers, tour operators, tourism business managers and higher-up education institutions. Finally, this study provides insights into future research.

Methodology

A bibliometric analysis is performed to study the state of knowledge and literature trends (Echchakoui, 2020). We selected the Web of Science (WoS) database for this study as it is the

largest database, with 171 million records, more than 34,000 articles indexed and 1.9 billion cited references (Elkhwesky and Elkhwesky, 2023; Elkhwesky *et al.*, 2022a; Clarivate, 2022). Academics generally consider the WoS as one of the most prestigious scientific databases, including the most relevant studies in several fields (Lopes *et al.*, 2021b), and is a more selective database as it allows several options of essential content filters for carrying out bibliographic reviews of literature and, therefore, the most used database for these studies (Elkhwesky *et al.*, 2022a; Elkhwesky and Elkhwesky, 2023).

The search was performed on 21 July 2021, and the starting year was 2008. The year 2008 was considered because the first study on the topic under analysis appeared with the article by Carson and Taylor (2008). The search was conducted by topic (title, abstract and keywords), using as key search terms per topic "Hotel 4.0" OR "Tourism 4.0" OR "Tourism innovation" OR "Tourism ecosystem", thus obtaining 173 publications. Next, we selected for analysis "scientific articles" (Lopes *et al.*, 2021a) and achieved a sample of 120 scientific articles. Figure 1 summarises all the steps taken for sample extraction: identification of databases and keywords, screening of relevant articles, eligibility of relevant articles and the inclusion of the selected articles in bibliometric review.

To carry out the bibliometric analysis of the WoS results, the VOSViewer software was used and made available at https://www.vosviewer.com/. VOSviewer directly supports the export of WoS publications and allows the creation, visualisation and exploration of the

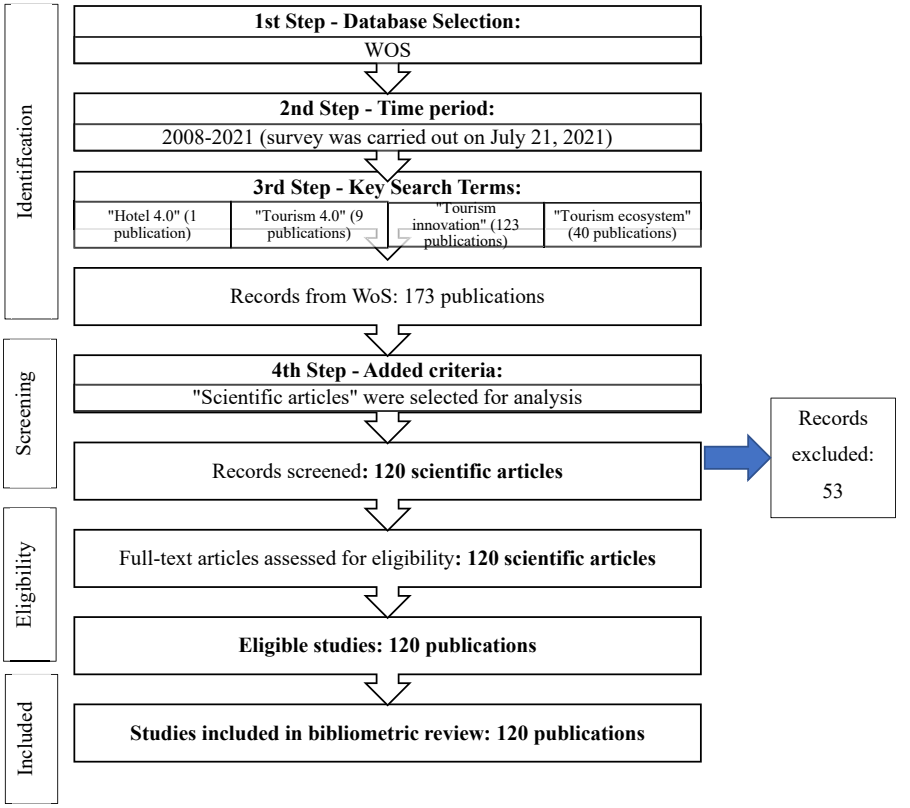


Figure 1.
Sample extraction

Source(s): Author's own creation/work

results in a graphical way and maps of several categories, highlighting the more relevant results as well as the visualisation of clusters, groups of publications with common or similar characteristics (Van Eck and Waltman, 2022).

Results

Evolution of publications

Since one of the premises of the bibliometric analysis is to understand the evolution of publications and citations, we have drawn up Figure 2, which shows that 1,961 citations (1,781, excluding the self-citations, which corresponds to 9.18% of the total) are present in the sample, meaning one average of 16.34 times per article.

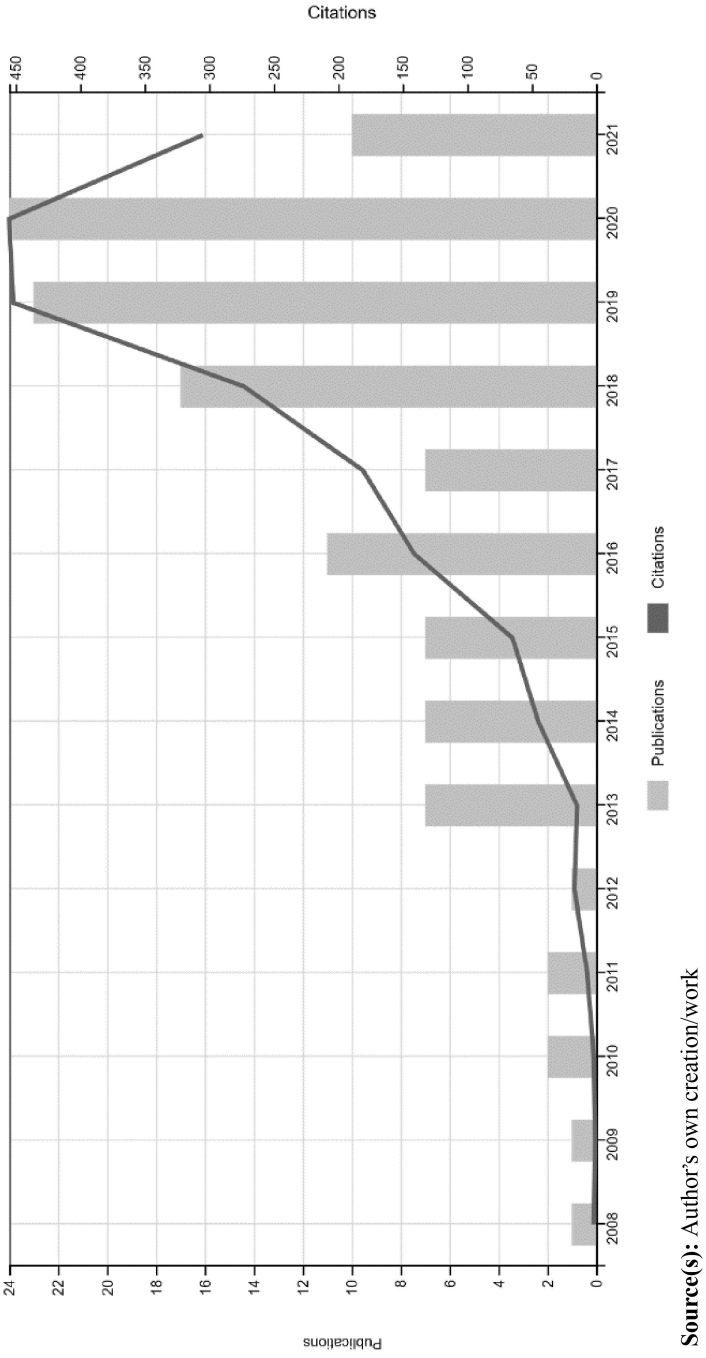
As seen in Figure 2, the first article published on the subject under study was in 2008 by Carson and Taylor (2008). The paper studies four-wheel drive tourism in the Australian desert and contemplates the analysis of four primary and two secondary data collections to conclude that, in the desert tourism sector, tourists like to return to their preferred destinations and environments, however, they want to have new experiences when they return. Carson and Taylor (2008) state that successful destinations will be those that will offer diversified routes and access to many heritage, cultural and natural attractions. The authors also suggest that travellers with little experience are willing to engage in processes to mitigate cultural, social and environmental impacts, although they do not understand them, which can lead to irresponsible driving practices.

Figure 2 shows that from 2008 to 2012, only seven articles were published. From 2013 to 2017, publications increased by 39. However, from 2018 to 21 July 2021, more publications are concentrated (74 published articles), representing 61.67% of the sample. The results suggest that academics became more interested in the topic in this last period. The year with the most publications was 2020 (24 published articles).

The number of citations follows the growth of published articles: from 2008 to 2012, there are 29 citations; from 2013 to 2017, 447 citations and from 2018 to 21 July 2021, 1,485 citations (which corresponds to 75.73% of the citations in the sample). Again 2020 was the year with the most citations (455). The year 2021 already has 305 citations, compared with the growth trend, it could exceed the citations of 2020.

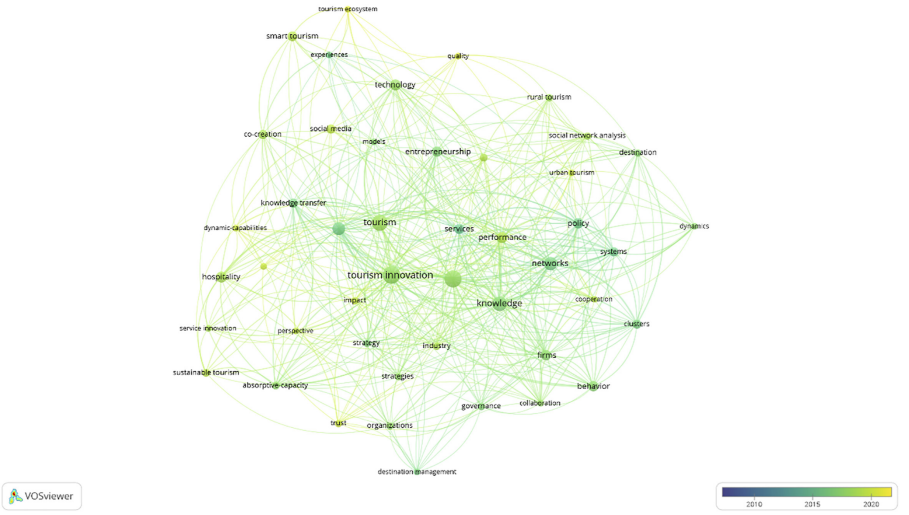
We used the software VOSviewer version 1.6.16 to examine the publication trends over the years. We performed a co-occurrence analysis of the keywords of the 120 articles under study, with 714 keywords present. As we applied the criterion for the occurrence of the keywords at least four times, 46 keywords remained for analysis. In Figure 3, we can identify the evolution of the publication tendency by years and colours.

Considering Figure 3, we can say that, from 2008 to 2012, the themes were very dispersed, so the VOSviewer did not show significant results. From 2013 to 2017, the research topics were very diverse and not specialised, making it hard to define a trend. The most studied topics related to the tourism and hospitality industry 4.0 were management (e.g. Booyens and Rogerson, 2017a), networks (e.g. Booyens and Rogerson, 2017b), policy (e.g. Booyens, 2016), systems and knowledge transfer (e.g. Weidenfeld, 2013), strategy (e.g. Holm *et al.*, 2013), destination management (e.g. Hsu *et al.*, 2016), behaviour (e.g. Lee *et al.*, 2017), and services and experiences (e.g. Hsu *et al.*, 2016). From 2018 to 2021, there is a significant specialisation in the theme of innovation in tourism (e.g. Pencarelli, 2020). Nevertheless, there are still studies related to performance (e.g. Wu, 2020), cooperation and dynamics (e.g. Brandao *et al.*, 2018), rural tourism (e.g. Li, 2020), analysis of social networks (e.g. Saura *et al.*, 2019), hospitality (e.g. Harchandani and Shome, 2021), and innovation in services and technology (e.g. Araujo *et al.*, 2020). Finally, the results show emerging and current themes: smart tourism, tourism ecosystem, quality, trust, urban tourism, dynamic capabilities, co-creation of value and sustainable tourism.



Source(s): Author's own creation/work

Figure 2.
Evolution of publications



Source(s): Author's own creation/work

Figure 3.
Co-occurrence analysis

Most relevant publications and journals

To study the most relevant publications, we considered the most relevant articles with more than 100 citations as a criterion. These publications are "highly impactful" and, as such, reference publications in the study area (Pech and Delgado, 2021). Five of the 120 articles correspond to this criterion (Table 1), with 568 citations representing 28.96% of the citations of the sample.

As shown in Table 1, the most impactful publication on the topic under study is from Gretzel *et al.* (2015), with 206 citations, corresponding to 10.50% of the citations of the sample. Gretzel *et al.* (2015)'s conceptual study addresses the idea of a smart tourism ecosystem based

Authors	Article	Citations	Journal	Impact factor 2020
Gretzel *et al.* (2015)	Conceptual foundations for understanding smart tourism ecosystems	206	*Computers in Human Behavior*	6.829
Omerzel (2016)	A systematic review of research on innovation in hospitality and tourism	138	*International Journal of Contemporary Hospitality Management*	6.514
Paget *et al.* (2010)	A tourism innovation case. An actor-network approach	115	*Annals of Tourism Research*	9.011
Carlisle *et al.* (2013)	Supporting innovation for tourism development through multi-stakeholder approaches: Experiences from Africa	112	*Tourism Management*	10.967
Souto (2015)	Business model innovation and business concept innovation as the context of incremental innovation and radical innovation	109	*Tourism Management*	10.967

Source(s): Author's own creation/work

Table 1.
Most relevant publications

on concepts such as smart tourism, smart cities and smart technologies that envision new ways of exchanging, creating and consuming value. The authors described the essential technologies for a smart tourism ecosystem, based on information and communication technologies that allow connecting the different actors that add value to the experience.

The study from Omerzel (2016) is the second most impactful, with 138 citations, or 7.05% of the citations in the sample. This systematic review of the literature on innovation in tourism uses the WoS database to analyse 152 articles and conclude that there is still much to be done regarding the development of innovation theory in tourism. The cluster analysis defines nine networks: 1 – "fundamental studies"; 2 – "RBV and competitive advantage"; 3 – "Organisation studies"; 4 – "Networking"; 5 – "Innovation in services"; 6 – "Innovation systems"; 7 – "Knowledge"; 8 – "Management of organisational innovation" and 9 – "Technology".

Paget *et al.*'s (2010) paper, with 115 citations, is the third most relevant study on the topic (5.86 citations in the sample). The study aims to examine the innovations of a tourism company in ski resorts in France and relates the company's growth with new associations between non-human entities and actors. Paget *et al.* (2010) point out that for innovation to exist in tourism, the following conditions must be met: (1) The leader must be innovative and have the ability to identify market expectations and develop a service that is safe and original and (2) External resources must be mobilised, articulated with regional stakeholders and available, such as the cable cars and the ski area.

The fourth most impactful study has 112 citations, corresponding to 5.71% of the citations of the sample. Carlisle *et al.* (2013) aim to study indigenous entrepreneurship and the promotion of innovation in two contexts of less economically developed countries (Tanzania and The Gambia) through two approaches: (1) marketing innovation in a Gambian trade association and (2) capacity-building to support innovation and entrepreneurship in wildlife in cultural tourism and through a training programme in Tanzania.

The fifth most impactful study is by Souto (2015), with 109 citations (5.59% of the total). The article aims to display how hotel and tourism companies innovate, as well as to analyse whether it is possible to obtain successful innovations. The article concludes that successful innovation does not depend only on scientific and technological progress.

Concerning the journals that most publish on the theme under study, *Sustainability* stands out, with six published articles corresponding to 5% of the sample. Next comes the Journal of Hospitality and Tourism Management, with five publications corresponding to 4.18% of the sample. Subsequently, several journals appear with four publications.

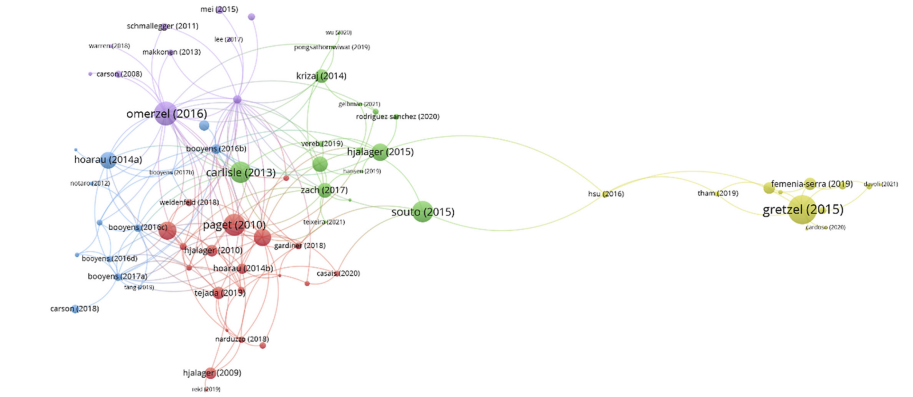
Cluster analysis

With the software VOSviewer version 1.6.16, we performed a citation analysis per document and identified that of the 120 articles of the sample, only 71 were clustered. Therefore, 49 articles were excluded from this analysis. Figure 4 shows that the VOSViewer software formed five clusters. Each colour corresponds to a cluster named as follows: Cluster 1 – Knowledge Transfer in Tourism; Cluster 2 – Networking Tourism Innovation; Cluster 3 – Sources of Tourism Innovation; Cluster 4 – Smart Tourism Ecosystem and Cluster 5 – Innovation Research in Tourism.

As we can see in Figure 4, Cluster 1 is composed of 20 scientific articles, Cluster 2 has 16, Cluster 3 is composed of 13, Cluster 4 has 12 and Cluster 5 presents 10.

Cluster 1 (red) – knowledge transfer in tourism

Cluster 1, represented in Figure 4 in red, was designated "knowledge transfer in tourism". Weidenfeld (2013) suggests that tourism facilitates and contributes to the transfer of innovation and knowledge in cross-border regions and that the intensity of this transfer



Source(s): Author's own creation/work

Figure 4.
Cluster analysis

depends on the border and cross-border conditions (existing barriers, types of border, networks, networking between the actors involved, resources, entrepreneurial culture, access and mobility). Tourism plays a key role in cross-border regional innovation systems, and Weidenfeld (2013) has identified key dimensions that increase knowledge transfer driven by tourism: similarities between border and cross-border regions in administrative, regional and sectoral terms; connectivity, internationalisation and mobility of innovation and knowledge; historical, social, institutional and cultural differences; and the balance of governance (state, society and market) in tourism.

The role of knowledge acquisition and assimilation in the tourism-innovation process was studied by Hoarau (2014) through a framework to understand how tourism firms absorb external knowledge. Firms in the tourism sector face difficulties in absorbing and transferring external tacit knowledge and transforming it into original and competitive innovation, which is why they have specific methods for acquiring and absorbing knowledge and transforming it into innovative activities. According to Hoarau (2014), the social competence of tourism actors is a key feature in enhancing innovation. Tejada and Moreno (2013) explored different types of innovation (product, process, marketing and organisational) in the tourism sector to conclude that innovation hangs on variables such as dependency on tour operators, the geographical situation and the relationship between the actors involved.

There are several cases that, in terms of scientific literature, exemplify knowledge transfer and innovation in the tourism sector. Paget *et al.* (2010) studied innovation in tourism companies at the level of French ski resorts. They concluded that many conditions must be met for innovation in tourism, such as the availability and mobilisation of resources (human and physical) and an innovative leader who identifies the needs and expectations of tourists and promotes an appropriate service. The greater the recombinations between actors and the new associations and networks created, the greater the innovation in terms of tourism. Thus, even being a tourism destination, according to Paget *et al.* (2010), regions or countries can innovate with existing resources but recombine and reconfigure the tourism offer into an innovative product. Rodríguez *et al.* (2014) studied the integration of tourism into the Spanish national innovation programme addressing the implementation policies, the innovation process and outcomes. The paper outlines that all actors involved must have the capacity and political authority to combine strategies and resources for common strategic objectives, and

the implementation of these strategies should involve non-public actors that are unorganised sources of innovation creation but with a very important role in the innovation process at the tourism level.

Hjalager (2010a) studied regional innovation systems in the case of sport fishing tourism in Denmark, having analysed the Sea Trout Funen initiative to conclude that knowledge transfer and research collaboration are difficult and management and investment capacity are limited in most companies. Hjalager (2010a) identified 11 benefits of the Sea Trout Funen initiative for the innovation system: the creation of new knowledge and ideas, namely at the ICT level and tourism services; search and dissemination of knowledge and ideas for traditional tourism businesses, namely in terms of organisational marketing; creation of human capital with the training of new professionals in the emerging tourism field; attraction of financial resources; implementation of new products and services; ensuring synergy between the tourism sector and other economic activities; the controlled competition of natural resources; ease of market formation with the tourism market emerging by extension of other markets due to the consistency of marketing initiatives; creation of new businesses; the creation and legalisation of new institutions and the legalisation and promotion of a vis-à-vis environmental system.

That said, regarding Cluster 1, the results point to the fact that innovation in the tourism sector depends on variables such as dependence on tour operators, the geographic situation and the relationship between the actors involved. Thus, the intensity of knowledge transfer in tourism depends on existing barriers such as networks between actors, available resources, entrepreneurial culture, mobility and access. However, companies in the tourism sector have difficulties absorbing and transferring external tacit knowledge and transforming it into original innovation, from which new products or services can emerge, making tourism companies more competitive. Furthermore, the social competence of tourism actors is essential to enhance innovation.

Cluster 2 (green) – networking tourism innovation

Cluster 2 is represented in Figure 4 in green and is called "networking tourism innovation". Radical innovation in tourism is rare since the innovation of tourism enterprises depends on the enterprises' growth objectives and value contribution. Thus, innovation depends on the internal and external perspectives of the actors involved (Brooker and Joppe, 2014). Souto (2015) presented a concept of business innovation and an innovation model in the context of incremental and radical innovation. According to the authors, competitors have privileged access to innovations, technologies and knowledge.

Hjalager (2015) identifies 100 innovations that, despite not having emerged effectively for the tourism sector, have significantly affected this sector, their intensity being dependent on institutional changes and the absorptive capacity of tourism companies. The author divided innovations into categories according to their impact: institutional changes and power relations, externalisation of information across organisational boundaries, formation of new destinations, increased mobility in destinations, increased productivity and efficiency of tourism enterprises by restructuring traditional factors of production, increased social and physical effectiveness of destinations with the production of benefits for tourists themselves, and increased ownership and variety of tourism products and services. For their side, Krizaj *et al.* (2014) identified a set of tools to measure innovation and its adoption by firms in the tourism sector. These tools encompass the classification of similar innovative tourism companies (similarity in terms of innovation), the extraction of information for strategic decision-making, the creation of history, resources and flows (internal and external) of knowledge in the specificities of innovation inherent in each individual tourism company, and the hidden nature of tourism innovation.

The innovation promoters of a tourism destination must leverage their position to increase the flow of ideas and knowledge from businesses which is only possible with the choice of innovation partners (Zach and Hill, 2017). The choice of these innovation partners depends on relational trust and their position in the networking network but, above all, on the recognition that these innovation partners play a central role in mediating the innovation process. Carlisle *et al.* (2013) also studied the valuation of working in a network. In less developed countries, innovation in tourism is the opportunity to promote a more competitive tourism product and enhance the possibility of higher income. Support from various stakeholders, namely at the institutional level, is needed to pursue innovation and entrepreneurship.

Regarding Cluster 2, it was found that in the tourism sector, radical innovation is scarce. The innovation of companies in the tourism sector depends on growth objectives, and therefore, tourism innovation networks strongly depend on the internal and external perspectives of the actors involved. Thus, the choice of partners is fundamental to the innovation of tourism companies, and this choice depends on relational trust, their position in the network and the network actors' recognition of innovation performance.

Cluster 3 (blue) – sources of tourism innovation

Cluster 3 is represented in Figure 4 in blue and is designated as "sources of tourism innovation". The tourism activity uses tacit and explicit knowledge, and the innovative knowledge is co-created with external actors (stakeholders) to the companies allowing innovation at the product, process, management, marketing and institutional level (Hoarau and Kline, 2014). In this way, deliberate reflection stimulates innovation in tourism businesses, and knowledge flows are interrelated with social capital, which is enhanced by intensive and frequent knowledge-sharing.

In competitive markets, small and medium tourism enterprises are forced to innovate, raising diverse sources of innovation. Verreynne *et al.* (2019) analysed the performance of 358 tourism businesses for 18 months and concluded that innovation diversity positively impacts the performance of small- and medium-sized businesses, which translates into increased sales to tourists.

Booyens and Rogerson (2016) measured and analysed innovation in South African tourism firms, pointing out that tourism innovation is a widespread phenomenon in the tourism sector, especially in non-technological services. This region's most prevalent types of innovation are at the product level, marketing, environment, organisation, processes, structure and society.

Also, Booyens and Rogerson (2017b) analysed the learning process and networking of 182 Western Cape tourism businesses to understand how knowledge leads to innovation in the tourism industry. They concluded that external and non-local knowledge gained from external networks (networking), with experts and external staff training, significantly increases the propensity for innovation. However, local knowledge (tacit knowledge, staff qualities, internal R&D and the group of actors involved) provides dense information networks for business and marketing purposes. Thus, extra-regional networks are essential to enhance innovation. Innovation should be planned to increase the competitiveness of tourism enterprises and promote regional economic growth in tourism, which should be achieved by stimulating learning networks and strengthening systemic relationships in the tourism innovation process.

About Cluster 3, the tourism industry uses tacit and explicit knowledge. However, the most innovative knowledge is co-created with the companies' external actors (stakeholders). Generically, knowledge flows are intertwined with social capital, fostered by frequent and intensive knowledge-sharing. Tourist companies in more competitive markets inevitably

have to innovate, which leads to diversity in the sources of innovation. This diversity of innovations positively impacts tourist companies' performance. On the other hand, the knowledge from external networks, such as specialists and training of external personnel, significantly increases the propensity for innovation in tourism companies. In this way, tourism companies must plan innovation to increase their competitiveness.

Cluster 4 (yellow) – smart tourism ecosystem

Cluster 4 is represented in Figure 4 in yellow and is called the "smart tourism ecosystem". Pencarelli (2020) analysed the digital revolution in the tourism and travel sector. In addition to the already much-studied Industry 4.0 that has changed living standards, the tourism sector has also undergone a digital transformation, which has been dubbed tourism 4.0 or smart tourism. These new concepts are similar in encompassing new software, hardware and ICT technologies and an orientation towards efficiency. Still, unlike smart tourism, tourism 4.0 does not encompass a vision of sustainability, social cohesion, smart mobility and natural resource optimisation, tourist involvement and participation, touristic destination facilities, quality of life of tourists and local residents and tourist behaviour. They concluded that tourism ecosystems and territories, besides hosting digital transformation, have to include smart tourism aspects such as sustainability, circular economy, social value and quality of life of tourists and local residents to elevate the tourism experience and increase the competitiveness of smart destinations.

Gretzel *et al.* (2015), meanwhile, presented a smart tourism ecosystem model that is based on digital ecosystems and smart business networks. This concept encompasses smart technologies, smart cities and smart tourism as the basis for creating, sharing and consuming smart tourism ecosystems. These ecosystems are a source of technological innovation and business model creation and allow the identification of new interaction paradigms and forms of value co-creation through the interaction between the various actors involved (consumers, companies and other stakeholders). However, according to Femenia-Serra *et al.* (2019), the role of the tourist is neglected in the smart tourism ecosystem, and a change in the behaviour of tourists can impact this ecosystem. Thus, there is a transformation of the digital tourist into a smart tourist, and the privacy of the tourist is a key aspect of the functioning of the smart tourism ecosystem. This privacy is emphasised in smart destinations due to the location services provided by smartphones, mitigated when these services are drivers of unique tourist experiences, leading to smart technologies' acceptance. On the other hand, the use of smart technologies provides a dynamic co-creation due to the interaction of the different actors involved leading to a smart experience. They concluded that the connection of the smart destination to the factors that affect tourists at the digital level leads to the concept of smart tourist, that is, tourists who adapt to the new tourism ecosystems that encompass smart services, being able to decide the use of technologies for the co-creation of value for other authors in the tourist destination.

Hsu *et al.* (2016) analysed 17 examples of tourism startups in Taiwan, where competitors force inbound tour operators to adopt new technological innovations associated with the collaborative and sharing economy to interact directly with tourist customers through websites. The more technologically literate tourists can create customised trips, the role of tour products and service providers has become less clear, and the barriers to entry are more flexible.

In Cluster 4, tourism 4.0 and smart tourism are similar efficiency-oriented concepts, encompassing new software, hardware and ICT technologies. However, smart tourism is a broader concept as it incorporates a vision of sustainability, social cohesion, smart mobility, optimisation of natural resources, tourist involvement and participation, tourist destination facilities, quality of life for tourists and residents, and even tourist behaviour. Thus, when

tourists are more technologically literate, their experiences in smart destinations are also more valued and unique. The use of technologies by the tourist also allows the co-creation of value for other authors in the smart tourist destination, as they will have more diversity of products and services available and adapted to their consumption profile.

Cluster 5 (purple) – innovation research in tourism

Cluster 5 is represented in Figure 4 in purple and is designated "innovation research in tourism". Pikkemaat *et al.*'s (2019) existing studies on innovation in tourism had several gaps since they focused mainly on the innovation process, context, knowledge and technology and eco-innovations. However, there is still no special attention to small tourism businesses managed by the owner and involvement in a family dynamic is the most common in this sector, thus, it is essential to analyse the behaviour of family businesses in terms of innovation. On the one hand, the concept of sustainability is beginning to spread, and it is necessary to analyse the contribution of emerging eco-innovations and tourist-oriented innovations. On the other hand, existing studies do not value the effects of policy and governance on innovations in the tourism sector. Already Mei *et al.* (2015) analysed the role of the national government as a facilitator of innovation in tourism in Norway, which was not much explored until then. In this case, despite the political will to recognise the importance of tourism innovation, the government still shows minimal efforts, conducting only financial support, advisory services and the training programme regarding human resources. Moreover, the government can be an inhibitor of tourism innovation when it does not demonstrate knowledge to define innovation, leading to the displeasure of tourism actors (Mei *et al.*, 2015).

Tourism innovation research has been rejuvenated with new sources of innovation. The case is presented by Makkonen and Hokkanen (2013) on the use of the existing mobile game at the Pielinen Museum in Lieksa, Finland, in which the integration of innovation at the level of ICT made this tourist attraction have an impact in terms of average expenditure made by tourists higher than other tourist sites in the region. However, as this mobile game is little known to the public, a better integration of this technological innovation among the general public through the improvement of its image and the continuous updating of its contents, namely by incorporating the offer of tourist products and services from other attractive regions activities, will end up in a more integrated regional tourism promotion and will generate additional advertising benefits.

Another example is the case presented by Schmallegger *et al.* (2011), who analysed the tourist destination in the Flinders Ranges (a remote destination in South Australia). In remote destinations, in general terms, the adaptation to new market trends is not valued, nor is the diversification of tourism services and products for their visitors. According to the authors, for these destinations to have competitive advantages, they must operate in tourism innovation systems and participate in collective change. In the case of the Flinders Ranges, it has been able to operate in tourism innovation systems by importing experienced tourism business managers who are leaders in the sector in which it operates (Schmallegger *et al.*, 2011). However, state and regional organisations tend to stifle innovation capacity in more remote destinations, and it is essential to review their role. Carson and Taylor (2008) analysed the impact of four-wheel drive tourism on the economic development of Australia's desert. For this destination to be a promoter of economic development, it must be competitive, innovative and have management attentive to the safety conditions of tourists, environmental, social and cultural impacts. The authors concluded that, although the desert is the most favourable environment for this type of travel, other locations geographically close are more favoured taking into account the motivations of tourists, the activities carried out and the demographic data analysed.

Finally, in Cluster 5, it was found that there are many gaps in the literature on innovation in the tourism sector. Studies have focused on the innovation process, context, knowledge, technology and eco-innovations. However, the management of small tourist companies and the dynamics of family businesses are neglected and relevant to be analysed from the innovation point of view. Existing papers also do not value the effects of policy and governance on innovations in the tourism industry. There is evidence that the government limits itself to making minimal efforts in innovation in this sector, conducting these efforts only with financial support, advice and a training programme in terms of human resources. Thus, the government can inhibit tourism innovation, requiring the government to be aware of innovation, which has led to the dissatisfaction of tourism actors. It is idealised that the destination is innovative and promotes competitiveness and economic development. To this end, careful management of the safety conditions of tourists, environmental, social and cultural impacts must be taken into account.

Discussion and conclusions

Conclusions

The purpose of this study is to assess the interconnected dimensions of the concepts of tourism 4.0 and hotel 4.0 and their role in promoting the competitiveness of the tourism industry, with the definition of a set of practical implications.

From the perspective of the bibliometric review carried out on the concepts of tourism 4.0 and hotel 4.0 with interconnections to the concepts of tourism innovation and tourism ecosystem, we concluded that these concepts are interconnected with five dimensions that were categorised as knowledge transfer in tourism; networking tourism innovation; sources of tourism innovation; smart tourism ecosystem and innovation research in tourism.

Regarding knowledge transfer in tourism, regional, sectoral and administrative similarities between border and cross-border regions; cultural, historical, social and institutional proximity; a balance of the state-society-market triplet and the mobility of innovation and knowledge facilitate knowledge transfer in the tourism sector (Weidenfeld, 2013). This transfer is greater than the absorption of this knowledge by tourism businesses (Hoarau, 2014) and when there is an interconnected network of actors intervening in the tourism sector. Thus, tourism innovation networking, in addition to being essential for knowledge transfer, is a driver of innovation (Brooker and Joppe, 2014; Carlisle *et al.*, 2013) since these networks allow access, in a privileged way, to innovations, technology and knowledge. It is mainly the extra-regional networks that play this essential role in promoting innovation, with experts and external training at the level of human resources significantly increasing the propensity for innovation (Booyens and Rogerson, 2017b).

However, many of the innovations, despite not having emerged implicitly in and for the tourism sector, have eventually been absorbed by this industry (Hjalager, 2015), giving rise to the outsourcing of knowledge, greater mobility in tourist destinations, benefits for tourists, increased productivity and competitiveness of tourist destinations and restructuring traditional production factors through the introduction of technology (Brooker and Joppe, 2014).

The sources of innovation in tourism industry companies are diverse. They can originate, more generally, at the product level, marketing, environment, organisation, processes, structure and society and, more specifically, in accommodation, attraction and tourism activities, travel and visitor services, catering, transport access to tourist destinations, among others (Booyens and Rogerson, 2016). With the evolution of studies on innovation in tourism, new sources of innovation have emerged in the tourism industry, such as gamification (Makkonen and Hokkanen, 2013), hiring experienced human

resources from other tourism destinations (Schmallegger *et al.*, 2011) and digital transformation (Pencarelli, 2020). This digital transformation, dubbed tourism 4.0, introduced the concept of smart tourism, which encompasses not only technological changes but also smart mobility, resource optimisation, higher quality in the tourist experience, social cohesion and sustainability concerns. Thus, the performance of tourism ecosystems and territories does not depend only on adopting this digital transformation but should also include the aspects of smart tourism. However, the role of the tourist is still neglected in the smart tourism ecosystem (Femenia-Serra *et al.*, 2019), and a change in tourists' behaviour can significantly impact this ecosystem.

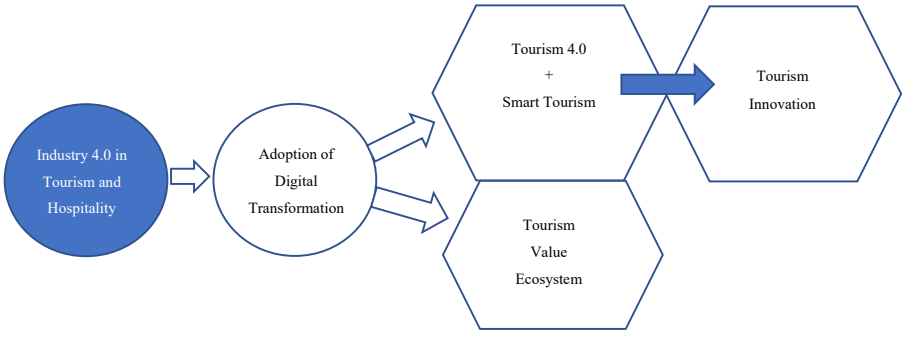
The bibliometric study of the concepts of tourism 4.0, hotel 4.0, tourism innovation and tourism ecosystem allowed not only to provide a state of the art of these themes but also to categorise the interconnected dimensions of these concepts. Nevertheless, also the inference of a set of practical implications for improving the competitiveness of the tourism industry, contributing to the existing literature on the subject and assisting and guiding strategic decision-making by policymakers and managers of the tourism sector.

Theoretical implications

As the demand for memorable experiences rises, the ongoing technological revolution revolutionises and challenges the way the tourism and hospitality industry creates and values these experiences (Buhalis and Sinarta, 2019). We can observe this trend since the beginning of the millennium, and its acceleration as the COVID-19 pandemic made more evident the need to adapt to the ever-changing environment and market (Pikkemaat *et al.*, 2019). Curiously, one of the biggest threats can be a huge opportunity to transform the sector, introducing innovation in products and services, processes and practices, and redefining business models that contribute to increasing productivity, profitability and competitiveness (Tang *et al.*, 2019).

Some changes are taking place quickly and shaping a new tourism and hospitality industry paradigm that highlights the need for a re-envision future (Jayawardena, 2022). In this vein, some new paths seem interesting to explore from a theoretical perspective.

Based on the results of this study, Figure 5 shows future lines of research on industry 4.0 in tourism and hospitality. As the digital transformation increases in the sector, more important becomes to perceive two major lines of research: the convergence of tourism 4.0 and smart tourism, on the one hand, and, on the other, the crucial role of innovation ecosystems in value creation under this new paradigm.



Source(s): Author's own creation/work

Figure 5. Suggestions for future research in industry 4.0 of tourism and hospitality

Line 1: innovation in tourism as a result of the convergence of tourism 4.0 and smart tourism

Tourism research has shown that there are new sources of innovation based on digital technology (Makkonen and Hokkanen, 2013). Tourism 4.0 is the new paradigm that has unlocked the potential and opportunities for innovation across the tourism sector, driven by the enabling technologies of Industry 4.0. (IoT, cloud, artificial intelligence, robotisation and big data, among others). The focus tends to shift from the tourist to the local community, and enabling technologies will converge the concepts of tourism 4.0 with smart tourism through digital innovation. Casais and Ferreira (2023) show that smart hotels play a decisive role in providing a better and more efficient tourism service without losing critical human interaction.

We suggest as future lines of investigation: (1) to evaluate the importance of enabling technologies for the creation of innovative tourism and hospitality services; (2) to analyse the digital influence (big data, virtual assistant and algorithms) on tourism decisions; (3) to evaluate digital tourist behaviour to provide tourist products that meet their habits and preferences; (4) to increase ways of cybersecurity; (5) to analyse costs/benefits of adopting enabling technologies in the tourism and hospitality sector and (6) to pinpoint drivers and obstacles to the implementation of digital technologies through the offer of innovative services.

Line 2: advanced research in the tourism value ecosystem

The smart tourism ecosystem will evolve and increasingly involve the tourist value co-creation, smart tourism businesses and other players in the tourism and hospitality industry, imposing a value ecosystem transition. According to Barile *et al.* (2017), tourism value ecosystems involve actors who are directly and actively involved in the value creation process arising from tourist experiences, such as tourists, destination residents, tourist companies; support technologies, social networks, tourist infrastructure, sector regulatory entities and entities from other sectors that provide support services (commerce, health and education, among others). In this context, private and public entities operating in the tourism industry must rethink their value-creation business model and improve their performance. To this end, it is necessary to better understand new market segments led by digital tourists, as well as their behaviour (Pencarelli, 2020), and future research should (1) deepen knowledge about new value propositions of digital tourist ecosystems; (2) identify digital channels or multichannels for transmitting the value created by tourist experiences; (3) identify new forms of business and management models based on tourist value co-creation and (4) explore new digital resources that tourism players can implement and optimise to obtain better operational performance.

Practical implications

Taking into account the interconnected dimensions of the concepts obtained by the bibliometric study, the tourism industry needs a set of practical implications to promote its competitiveness in the new digital age. These practical implications cover several players in the tourism and hospitality industry 4.0.

Governments and policymakers

The development of the tourism industry must be a core regional competence. As such, strategic networks (collaborative and inter-relational) should be created to externalise regional flows of knowledge (open regions) to promote, through the tourism industry, regional innovation, competitiveness and economic growth in the regions. In addition, governments must invest in Industry 4.0 to build improved infrastructures for digital technologies (Elkhwesky and Elkhwesky, 2023), creating necessary conditions for their efficient use. They should also financially support the implementation of digital

technologies to encourage companies in the tourism sector to invest, demonstrating through training actions the competitive advantages that can be achieved by implementing digital technologies.

Tour operators

To achieve tourism innovation and increase the flow of inter-regional knowledge transfer, it is important to have innovation partners. A network that promotes the co-creation of tourism products should be created, and in this context, tour operators have to consider tourism as an ecosystem when formulating competitive strategies with strong tourist involvement.

Tourism business managers

Companies in the tourism sector have to boost and promote the digital skills of their human resources to accelerate the implementation of digital technologies and, at the same time, invest in more advanced technologies such as artificial intelligence, robotisation and big data, among others (Derhab and Elkhwesky, 2023; Elkhwesky and Elkhwesky, 2023; Kong *et al.*, 2021). For this, tourist company managers must adopt transformational leadership, with a long-term vision shared with their resources (Elkhwesky *et al.*, 2022a) and create a robust organisational culture to manage sustainable development proactively (Elkhwesky *et al.*, 2022b). At the same time, they should pay more attention to the interaction between tourism 4.0 and hotel 4.0 and sustainable human resource management as it can enhance the skills and competencies of the employees required for future organisations (Sharma *et al.*, 2022). In addition to absorbing the technological revolution provided by industry 4.0, tourism companies must value the tourist experience provided to the customer and be concerned with customer expectations, habits and preferences, generating the need to co-create touristic products (Casais and Ferreira, 2023). This co-creation of tourism products can be achieved and even expanded through digital technologies.

Higher education institutions

Higher education establishments play an important role in training human resources for the 4.0 tourism and hospitality industry. The educational offer must align with the sector's needs and provide learning based on digital technologies that can also be incorporated into the teaching methodologies of various curricular units in tourism and hospitality: the university graduate must be a specialised professional with a strong technological component. Furthermore, higher education establishments must promote continuous training in line with tourism 4.0 and hotel 4.0 trends to prepare and update the curricula of professionals already working in this sector.

Limitations and future research

As limitations to this study, we refer to the conceptual nature of the study and the diversification of concepts that derive from incorporating the new technological era in the tourism industry. Considering more similar and interconnected concepts could make this study denser and more complex in categorising the dimensions associated with the concepts analysed and broaden the practical implications.

Finally, it is suggested that future studies use examples of innovations that have emerged from the application of the hotel 4.0 concept in different tourism industries to assess their impact on the competitive performance of that industry and the growth of the region in which it is located. It would also be pertinent to study the concepts of hotel 4.0, tourism 4.0 or tourism ecosystem from an open innovation perspective.

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