





# EXPLORING VIRTUAL AND AUGMENTED REALITY IN THE HOSPITALITY INDUSTRY: A BIBLIOMETRIC ANALYSIS

## Abstract

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*Purpose* – Virtual reality (VR) and augmented reality (AR) technologies are evolving, with scholars highlighting important roles and potential advantages for their use, particularly in the hospitality sector. This bibliometric study examined VR/AR research in the hospitality industry to take stock of the literature in this field and consider potential future directions.

*Methodology/Design/Approach* – Using the Web of Science database, 213 relevant articles were selected and analyzed. Descriptive analysis was conducted using RStudio to identify the most productive countries, journals, authors, and institutions. The most influential topics were identified using keyword co-occurrence analysis in VOSviewer.

*Findings* – The results revealed that VR/AR research in the hospitality sector has recently gained prominence, with China leading in contributions. Three major clusters of themes emerged: (i) the impact of VR on hospitality, tourism, and destinations; (ii) technology enhancing satisfaction and performance in hotels; and (iii) user acceptance of AR in travel.

*Originality of the research* – This study offers an overview of VR/AR research trends in the hospitality industry based on a bibliometric analysis of literature data from the Web of Science database. It provides research mapping to identify current developments in the VR/AR literature within this industry and sheds light on areas for future research.

**Keywords** Virtual reality; augmented reality; virtual environments; hospitality industry; technology; bibliometric analysis

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## 1. INTRODUCTION

The hospitality industry is deeply involved in the latest wave of technological change. This includes extended realities such as virtual reality (VR) and augmented reality (AR) technologies, which are revolutionizing managerial processes by providing users with full (VR) or partial (AR) immersion in digital worlds (Batat, 2021; Orús et al., 2021). These promising technologies have potential strategic, managerial, and marketing advantages for use in the hospitality sector to foster sustainable business models (Cranmer et al., 2020; Flavián et al., 2021; Leung et al., 2020). They are especially crucial in the dynamic context of hospitality businesses, given the ever-increasing importance of engaging consumers and co-creating value (Ali, 2022). As noted in the literature, VR/AR technologies offer opportunities for these businesses in which disseminating information about intangible products is paramount (Batat, 2021; Israel et al., 2019; Zeng et al., 2020). Indeed, the worlds that are entirely or partially virtual created with VR and AR systems have expanded the ways information is disseminated—and thus modes of communication—through new forms of human-computer interaction (Doerner et al., 2022). Accordingly, VR allows users to experience dynamic sensory participation generated by computing systems that can “create entirely imaginary but realistic seeming worlds,” including immersing in a hotel room, in an adventure tour, or in a movie scene (Greengard, 2019, 5; Zeng et al., 2020). Potential guests and travelers can benefit from the possibility of virtually visiting a hotel’s rooms, facilities, and services and comparing them with other hotels’ offerings. AR can also assist businesses and customers in the hospitality industry in innovatively enhancing both their offering and consumption experiences by integrating virtual objects into a physical-world environment using a computer, mobile device, or smart glasses (Ali, 2022). VR/AR technologies are also considered promising training tools, and indeed, VR has been demonstrated to be effective in hospitality training by allowing users to simulate their physical presence in real or imaginary environments (Lui & Goel, 2022).

The recent developments of metaverse environments, which add physical interaction to virtual environments going beyond three-dimensional (3D) interactivity, portend new opportunities for the hospitality sector, such as attracting the digital consumer generations; enhancing business performance, competitiveness, and value-cocreation for stakeholders; and helping sustainable tourism development (Chen, 2023; Go & Kang, 2023). VR technological and application developments are likely to increase by empowering customer experience and behaviors, thus changing the way guests shop and experience hospitality services (Branca et al., 2023; Flavián et al., 2021). While some early studies viewed VR with skepticism, even perceiving it as a possible threat to tourism (Cheong, 1995), VR/AR technologies have evolved and a growing body of literature highlights their potential applications in hospitality business settings and the broader tourism domain (Flavián et al., 2021; Nayyar et al., 2018; Orús et al., 2021).

As Yung and Khoo-Lattimore (2019) pointed out in their literature review on VR and AR in tourism, mainstream consumers have gained access to these technologies only recently, and related studies are fueling a nascent research field. Consequently, research on VR/AR within the broader field of tourism and hospitality has witnessed a noticeable increase in studies, especially in recent years (Hanaa & Abdul, 2023; Wei, 2019). There is currently vibrant scholarly interest in topics related to virtual worlds within the tourism, hospitality, and event industries (Filimonau et al., 2022). Moreover, recent reviews have mapped the literature's knowledge on VR/AR within the overall tourism or tourism and hospitality contexts, examining studies on both technologies, either in conjunction (e.g., Loureiro et al., 2020; Yung & Khoo-Lattimore, 2019; Wei, 2019) or separately (e.g., Hanaa & Abdul, 2023; Jingen Liang & Elliot, 2021; Pestek & Sarvan, 2021). VR/AR technologies are often discussed together, with AR typically regarded as a variation of virtual environments or VR that blends reality and virtuality (Doerner et al., 2022). Nevertheless, there have been no prior reviews specifically focused on the hospitality industry to provide an overview of the state of studies on VR and AR technologies in this industry. Consequently, in an attempt to address this research gap, this study conducted a bibliometric analysis of VR/AR research in the hospitality industry to take stock of the literature in this field and to consider potential future directions. Indeed, VR and AR are gaining increasing popularity and importance in hospitality among researchers and practitioners, thanks to recent technological advancements—as, for instance, tools to promote hotel services (McLean & Barhorst, 2022; Slevitch et al., 2022) or to deliver more appealing and original restaurant services (Ali, 2022; Kulcsár et al., 2018). Mapping the current state of knowledge regarding emerging synthetic worlds in the hospitality sector, thus targeting the focus on this sector with a less general approach, could therefore provide valuable insights into research developments within this particular area. Specifically, this study sought to accomplish the following research objectives (ROs):

- $RO_1$ : determine the evolution of publication volume in the research field of VR/AR and hospitality;
- $RO_2$ : identify the countries, journals, authors, and institutions that have produced the most research on VR/AR in the hospitality industry;
- $RO_3$ : determine the prevalent topics in the literature on VR/AR and hospitality; and
- $RO_4$ : determine the upcoming trends in hospitality and VR/AR.

This bibliometric study distinguishes itself from previous VR/AR literature reviews within the broader tourism context by focusing specifically on the hospitality industry. It examines data from 213 peer-reviewed articles collected in the Web of Science database. The results contribute to providing an overview of the VR/AR research trends in this specific industry up to July 2023. This study thus offers research mapping to aid in the understanding of current developments in VR/AR literature within the hospitality sector and sheds light on areas for future research.

After this introduction, the rest of this paper is organized as follows. An overview of the literature on VR and AR and their application in the hospitality sector is provided in Section 2. Section 3 describes the data and techniques used. Section 4 reports the results of the bibliometrics analysis, which are discussed in Section 5, and key conclusions are presented in Section 6.

## 2. LITERATURE REVIEW

Nayyar et al. (2018, 157) highlighted that the definition of VR provided by LaValle (2016), the early founder of Oculus VR, is useful to understand VR technology: “*Inducing targeted behavior in an organism by using artificial sensory stimulation, while the organism has little or no awareness of the interference.*” This definition encompasses four main components of VR: (i) the *targeted behavior*, or the ability to provide a particular experience such as walking, flying, and exploring space; (ii) the *organism*, that is, the VR user; (iii) the *artificial sensory stimulation*, that is, several sensory experiences can be reproduced using modern techniques of engineering; and (iv) *awareness*, as users experience a smooth interaction and feel truly present in the virtual world (Nayyar et al., 2018). Indeed, VR—commonly defined as the use of a computer-generated 3D environment (or virtual environment) in which one can navigate and interact, resulting in real-time simulation of one or more of the user's five senses—is characterized by three key elements: visualization, immersion, and interactivity (Guttentag, 2010; Vince, 2004; Williams & Hobson, 1995; Yung & Khoo-Lattimore, 2019). VR experiences thus lead a user to become fully involved (or immersed) in a virtual environment or world. Guttentag (2010) argued that VR is one of the most important areas of information and communication technology (ICT) that continue to evolve and identified six fields within tourism that can benefit from VR: planning and management, marketing, entertainment, education, accessibility, and heritage preservation.

AR is also an immersive ICT that is currently gaining traction in extending consumer experiences by supplementing reality, although it lacks the full immersion provided by VR technology (Loureiro, 2020). AR and VR are therefore related but distinct technologies, with AR often perceived as a type of VR in its broadest sense (i.e., in terms of virtual environments) (Doerner et al., 2022; Guttentag, 2010). AR technology has gained popularity in tourism and hospitality thanks to the game “Pokemon GO,” a mobile app used as a travel guide, in which users gather characters situated in real-world locations geographically, thus engaging traveler experiences with educational, entertainment, aesthetic, and escapist realms (Aluri, 2017). Indeed, using mobile devices such as smartphones, glasses, and wearables, AR typically provides guests and travelers with layered information about the real environment overlaid with virtual content such as images and video, which augments their sensory experience (Buhalis et al., 2019). AR, like VR, also has various applications within the tourism context, including the preservation of historical sites and tourist destinations and attractions, education, entertainment, and marketing, as well as planning and management (Ali, 2022).

Tourism and hospitality are two service industries that are quickly evolving thanks to artificial intelligence, which has significantly innovated these industries and gradually transformed their services (Rawal et al., 2022). Researchers and industry experts in the field of hospitality and tourism are now paying more attention to VR and AR, because they provide so many practical applications (Wei, 2019). Buhalis et al. (2019) counted VR and AR among the technological disruptions creating smart environments that drive value co-creation processes across stakeholders in the hospitality and tourism services ecosystem. As pointed out by Loureiro (2020), providing tourists with memorable, personalized experiences has become a priority at the level of destinations, cities, hotels, restaurants, tours, museums, and any cultural or entertainment attraction. Tourists have a *sense of presence* in VR experiences, which effectively shapes their attitudes and behaviors, given the intangible nature of the consumer experience associated with tourism and hospitality services (Tussyadiah et al., 2018). For instance, hotels have the opportunity to offer personalized services to their guests and also attract the younger generation of consumers (Go & Kang, 2023). Similarly, AR can offer new opportunities to hospitality businesses and destinations in the development of unique, innovative services, although in AR immersive experiences—unlike in VR experiences—the space does not change but is enriched with creative elements (Kulcsár et al., 2018). “Le Petit Chef” is an example of an AR experience in the restaurant setting, where a virtual chef entertains diners by cooking and preparing their dishes directly on their table through a projector or an AR device (Batat, 2021). The literature highlights the increasing importance of virtual world platforms in tourism and hospitality, with “Second Life”—an online virtual environment where avatars (an in-depth 3-D rendering of the user) can socialize, network, and design their own virtual places—being the most popular (Huang et al., 2016; Mura et al., 2017; Penfold, 2009). As argued by Yung and Khoo-Lattimore, (2019), several countries have virtual embassies alongside hotel chains like Starwood, Hyatt, STA, and Crowne Plaza in the virtual world of Second Life. This is a way to digitally promote tourism destinations, in which avatars can visit and interact with other avatars (Guttentag, 2021; Hsu, 2012; Wyld, 2010).

The present bibliometric study focuses on VR/AR in the hospitality industry. As highlighted by Israel et al. (2019), VR has become increasingly important for businesses in this industry, including hotels and booking portals, as a way to deliver new product presentations. When combined with online reviews, sensory information via VR strengthens the effects on consumer hotel bookings, thus influencing purchasing behaviors (McLean & Barhorst, 2022; Wen & Leung, 2021; Zeng et al., 2020). In addition to commercial opportunities, VR also provides hotels with other possibilities for use, including employee training (Leung et al., 2020). Leading brands in the hospitality industry have started using VR, including Hilton, Holiday Inn Express, Carlson Rezidor, Airbnb, and Vacasa (Zeng et al., 2020). Similarly, as hospitality businesses offer experiences rather than just products or services, AR applications can provide guests with personalized experiences by assisting them with travel guidance, location research, information retrieval, and accommodation bookings and reservations (Neuhofer et al., 2015). As reported by Cranmer et al. (2020), hoteliers perceive AR as adding potential organizational, marketing, economic, tourist, and epistemic values to hotels. The hoteliers interviewed in their study agreed that AR serves as an informative tool about destinations and facilities, which can improve relationships and communication with both existing and new customers, ultimately affecting the purchasing and selling processes. Koo et al. (2019) also pointed out the need for AR-based training in hotel management.

Previous literature reviews addressed VR/AR in tourism and hospitality contexts as a whole. Loureiro et al. (2020) reviewed studies on VR and AR in the tourism context and highlighted that the number of such studies has grown steadily since 2009, despite early work dating back to 1995. Similarly, Wei (2019), who reviewed 60 articles on VR and AR in tourism and hospitality published between 2000 and 2018, found a dramatic increase in publications after 2010 and that *Tourism Management* was the journal that had published the most articles. Yung and Khoo-Lattimore (2019) synthesized 46 papers on VR and AR in tourism and revealed that research on the topic emerged in marketing and tourism education contexts. Pestek and Sarvan (2021) examined VR trends in 49 related articles published in the period 2010-2019 and concluded that VR, as a smart tourism tool to provide information about destinations and attractions, has the potential to transform the management of tourism experiences. Conversely, Jingen Liang and Elliot (2021) concentrated on AR research within the tourism literature, reviewing 32 articles and identifying user acceptance of AR as a dominant research theme. Hanaa and Abdul (2023) also conducted a bibliometric analysis of AR research in tourism, showing a recent rise in AR studies within the tourism industry. Finally, the bibliometric study of VR in tourism promotion by Sousa et al. (2022) revealed an infrequent use of VR in tourism while acknowledging its potential as a promotional tool. Their study also briefly addressed some VR-related aspects in the hospitality sector, particularly its use in tourist experiences during their stays. Considering the focus by Sousa et al. (2022) on VR as a marketing tool in the broader tourism context, alongside AR studies in hospitality, other possible applications of VR in this industry besides marketing purposes, such as for training and educational purposes (Lui & Goel, 2022; Penfold, 2009), may have been overlooked. Based on this brief overview of previous reviews, it seems that there has not yet been a purposeful study investigating the state of VR and AR research in hospitality. The present study aims to address this gap.

### 3. METHODOLOGY

To examine VR/AR research in hospitality, this study adopted a bibliometric analysis methodology based on the five-step science mapping process proposed by Zupic and Čater (2015). This process, illustrated in Figure 1, was adapted to the present study in a manner similar to that used by Kalia et al. (2022). The figure depicts the five steps (i.e., research design, data collection, analysis, visualization, and interpretation) and actions and techniques performed in each step. First, similar to Kalia

et al. (2022), we checked databases to ensure the exclusivity of our research topic (i.e., VR/AR in hospitality) before deciding to pursue it. As a result, we found previous literature reviews on VR and/or AR in the broader tourism or tourism and hospitality context (e.g., Jingen Liang & Elliot, 2021; Loureiro et al., 2020; Pestek & Sarvan, 2021; Yung & Khoo-Lattimore, 2019; Wei, 2019) and two bibliometric reviews that, however, focused on VR as a marketing tool in tourism (Sousa et al., 2022) or only on AR in tourism (Hanaa & Abdul, 2023). A brief overview of these reviews was provided in the previous section. Accordingly, we proceeded to develop the four research objectives described in the introduction.

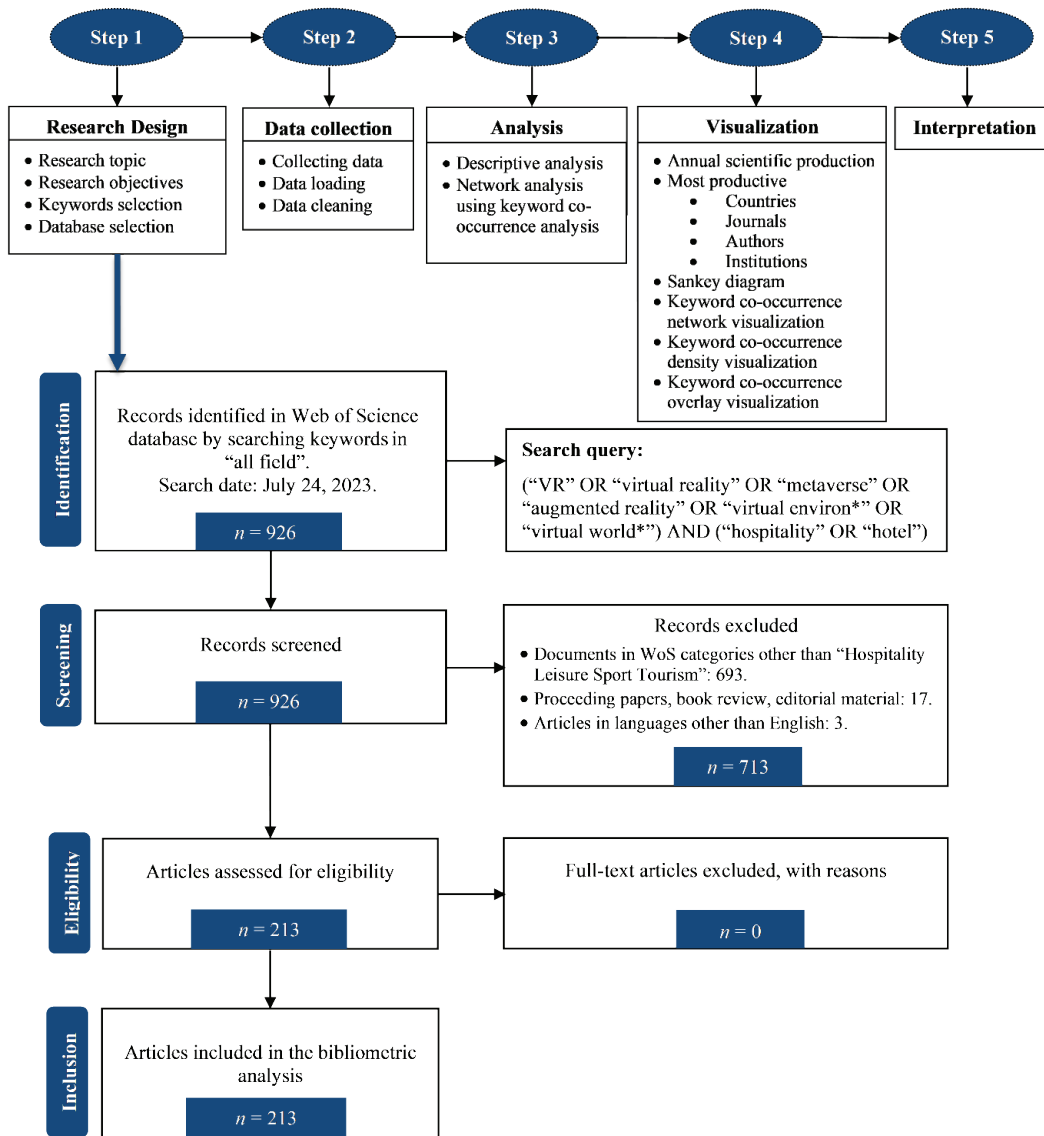
The next stage was keyword selection. To choose the final keywords for use, search terms were established in light of the study's scope (Kalia et al., 2022) as well as based on previous reviews (Yung & Khoo-Lattimore, 2019; Wei, 2019). We therefore considered "VR," "virtual reality," "metaverse," "augmented reality," "virtual environ\*," and "virtual world\*" combined with "hospitality" or "hotel" as the primary keywords to search the Web of Science database using Boolean Operators "OR" and "AND" in the "all fields" search field. We decided to not include the term "tourism" to remain focused on VR/AR topics in the context of the hospitality industry. The Web of Science database was selected as it compiles content from prestigious academic sources. Indeed, this platform is widely acknowledged as one of the most popular and trustworthy databases for collecting data for bibliometric analyses (Echchakoui, 2020; Norris & Oppenheim, 2007). Bibliometric studies in the areas of business and management commonly use Web of Science as their exclusive data source (Xu et al., 2021). Scholars who prefer it to the alternative Scopus argue that it has higher quality standards than Scopus, such as regarding the automatic generation of keywords plus (Forliano et al., 2021; Jabeur et al., 2023). In line with these studies and considering that both Web of Science and Scopus offer similar publication coverage, as well as the presence of low-quality works in Google Scholar (Harzing & Alakangas, 2016), we have chosen to use Web of Science exclusively. As García-Lillo et al. (2023, 3) point out, the simultaneous use of different databases "is unhelpful owing to duplication of records."

The second step in the process was the data collection. We therefore extracted the required data on July 24, 2023, without using any limitation regarding the time period. The initial database search returned 926 VR/AR-focused documents for screening. First, the search was refined using the Web of Science category "hospitality leisure sport tourism," so all of the documents (693) that were not in the hospitality research area were excluded. Second, all materials other than journal articles and reviews were also disregarded, thus excluding a further 17 documents (including proceeding papers, book reviews, and editorial materials). Third, three articles that were not published in the English language were also excluded, leaving 213 articles that satisfied the study's inclusion requirements after their eligibility assessment. We obtained a plain text file from the Web of Science database that contained all of the data fields throughout the data loading and cleaning phase.

We employed both RStudio's Biblioshiny package (Aria & Cuccurullo, 2017) and VOSviewer software (Van Eck & Waltman, 2010) in the third step of the process, which involved data analysis. RStudio's Biblioshiny package was employed for descriptive analysis, while VOSviewer was used for network analysis and, more specifically, to perform keyword co-occurrence analysis. Therefore, these two software packages were used to conduct the two categories of analysis envisaged for the bibliometric analysis (Donthu et al., 2021) as a statistical procedure that assesses academic publications data to categorize aspects of a research field such as the most productive and influential authors, journals, countries, and institutions (Benckendorff & Zehrer, 2013). In addition to these evaluative techniques of productivity and influence, bibliometric analysis includes network analysis or relational techniques that identify networks among publications, journals, or authors (Echchakoui, 2020). In particular, keyword co-occurrence analysis enables the exploration of relationships among topics within publications by identifying recurring keywords and grouping them into clusters, thus creating thematic clusters. This technique aids in comprehending the major themes in a field and forecasting future trends (Donthu et al., 2021).

In the fourth step of the process (i.e., visualization of data), RStudio's Biblioshiny package was used to visualize the most productive countries, journals, authors, and institutions, and create a Sankey diagram (e.g., Khan et al., 2023). VOSviewer was used to visualize the co-occurrence network of keywords (Van Eck & Waltman, 2010), which entails creating a network of words representing topics that is displayed on a map using network visualization (Donthu et al., 2021). We also used density visualization for keyword co-occurrence to observe areas with a higher concentration of topics and their distribution in the network (Van Eck & Waltman, 2010). In addition, we employed overlay visualization to identify recent trends in publication topics by observing the temporal distribution of keywords (Xu et al., 2021). Both Biblioshiny and VOSviewer are suitable tools to produce visual representations of the literature, and graphs can display hotspots, new patterns, and sophisticated networks in the scientific community (Gao et al., 2021). Finally, in the fifth step, the findings were described and interpreted (Zupic & Čater, 2015).

Figure 1: Research methodology chart



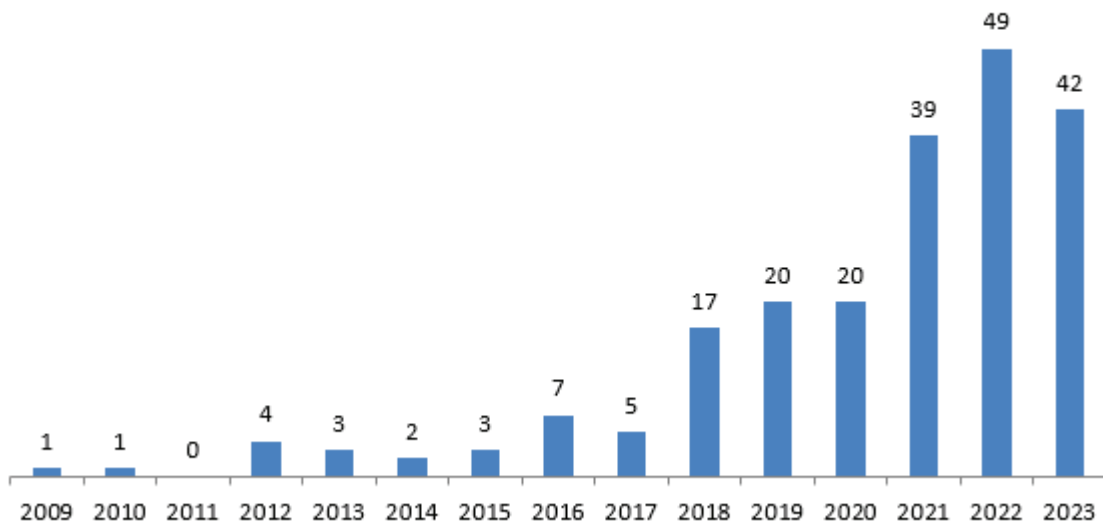
## 4. RESULTS

In this section, the results concerning the evolution of scholarly works on VR/AR in the hospitality industry are presented. The most prolific countries, journals, authors, and institutions are then analyzed. Finally, significant topics are extrapolated from the 213 selected articles using keyword co-occurrence analysis.

### 4.1. The evolution of annual scientific production

Figure 2 illustrates the evolution of the 213 selected articles retrieved from Web of Science. The linear trend demonstrates that, in the past seven years from 2017 to 2023 (as of July 24), scientific production on VR/AR topics in the hospitality industry has increased at a constant pace. To understand the significance of these research topics in recent years, it is crucial to note that 90% of all articles (i.e., 192 out of 213 articles) were published within the last seven years. It is also important to note that 2022 was the most prolific year in terms of the number of publications (i.e., 49 articles, representing 23% of the total publications) and further growth is expected in 2023 considering that 42 articles had already been published up to July. These findings indicate that VR/AR technologies in the hospitality context have recently gained prominence as a topic among scholars.

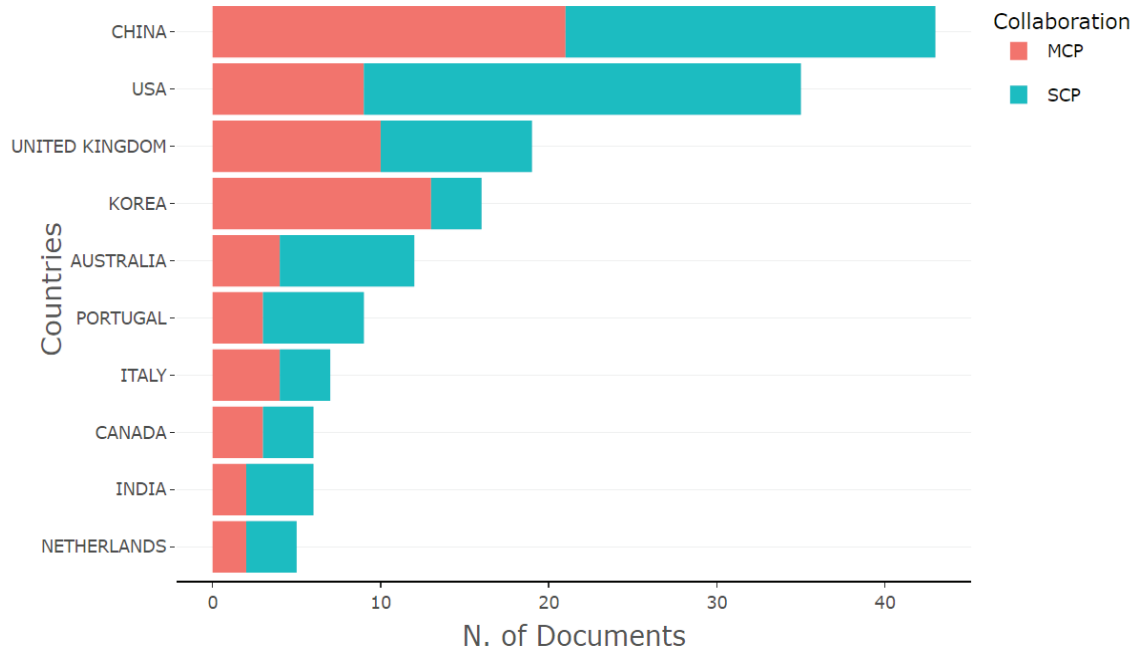
Figure 2: Evolution of the number of articles from 2009 to July 2023



#### 4.2. Most productive countries

Based on the corresponding authors' countries, the total number of articles published per country is shown in Figure 3. The multiple country publication (MCP) value, represented by the red horizontal column next to each country in the figure, shows the number of publications authors from that country jointly produced with their colleagues from different countries. The single country publication (SCP) value, which represents the number of papers published by authors in association with their national colleagues, is displayed in the blue horizontal column. The total number of articles for each country considers both its SCP and MCP values. China is the country that has contributed the most articles to the field (43 articles), followed by the USA (35 articles), the United Kingdom (19 articles), and Korea (16 articles). Further specifics about these findings are provided in Table 1.

Figure 3: Total number of publications per country



As shown in Table 1, China ranks first with the most articles published (i.e., 22 SCPs and 21 MCPs for a total of 43 articles), however, the MCP ratio is modest. This suggests that scholars from China typically choose to work with colleagues from their own country. The same applies for the USA, which shows the lowest MCP ratio (0.26). On the other hand, the nation with the highest MCP ratio (0.81) is Korea, which comes in fourth in terms of the number of articles. Similarly, Italy appears to have the second highest MCP ratio (0.57), although it ranks seventh overall based on the total number of published articles. According to their MCP ratios, therefore, authors in both Korea and Italy frequently work with scholars across national borders.

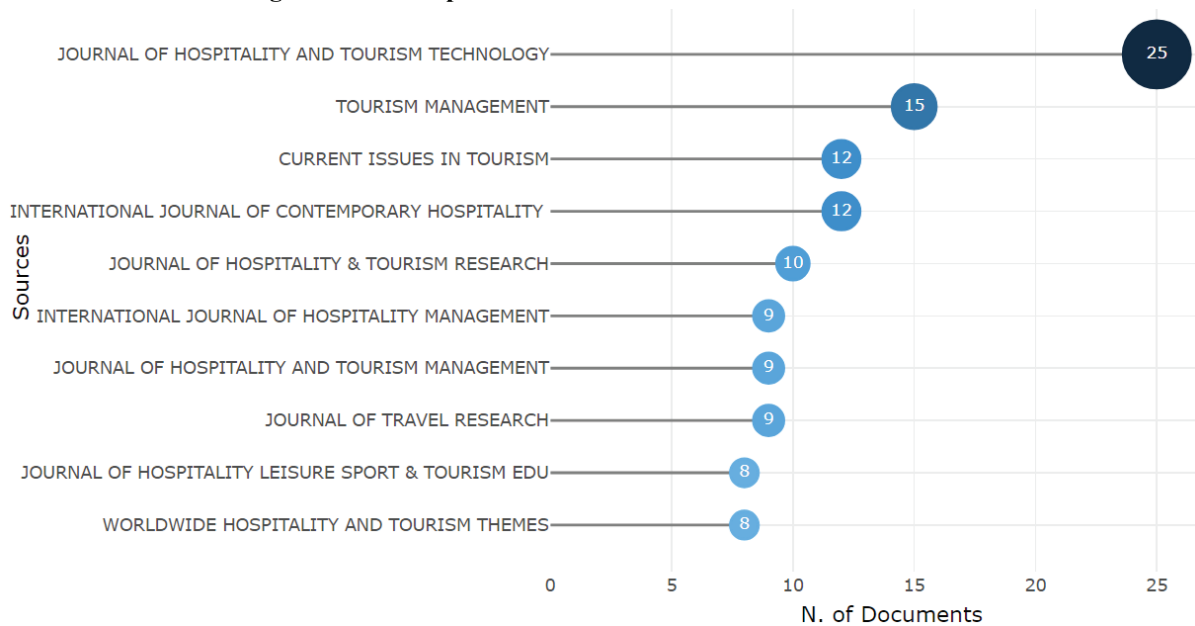
Table 1: Number of articles per country and single country publication (SCP) and multiple country publication (MCP) values

Country	Articles	% of 213	SCP	MCP	MCP Ratio
CHINA	43	20.19	22	21	0.49
USA	35	16.43	26	9	0.26
UNITED KINGDOM	19	8.92	9	10	0.53
KOREA	16	7.51	3	13	0.81
AUSTRALIA	12	5.63	8	4	0.33
PORTUGAL	9	4.23	6	3	0.33
ITALY	7	3.29	3	4	0.57
CANADA	6	2.82	3	3	0.50
INDIA	6	2.82	4	2	0.33
NETHERLANDS	5	2.35	3	2	0.40

### 4.3. Most productive journals

According to the number of articles published on the topics of VR/AR in hospitality, the top 10 most productive journals are shown in Figure 4. Upon closer inspection of each of these journals individually, it becomes clear that the *Journal of Hospitality and Tourism Technology* has the most articles published on the subject, with 25 overall. The journals with the subsequent-highest number of publications are *Tourism Management* (15 articles); *Current Issues in Tourism* and the *International Journal of Contemporary Hospitality Management* (12 articles each); the *Journal of Hospitality & Tourism Research* (10 articles); and the *International Journal of Hospitality Management* (9 articles). It is evident that 34.74% of the articles on VR/AR in hospitality were published in the top five journals.

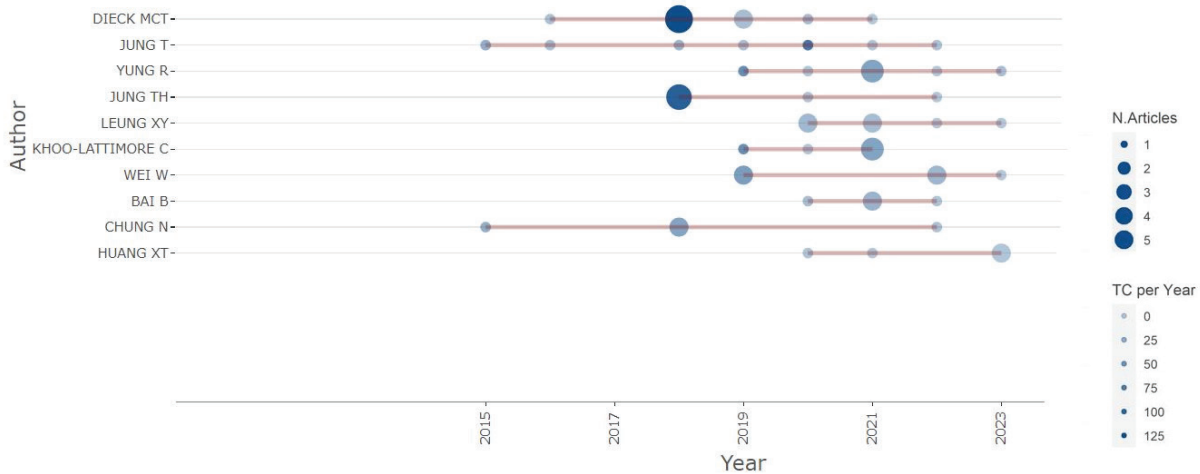
Figure 4: Journals with the largest number of published articles



### 4.4. Most productive authors

The top 10 authors with the most articles published over time are identified in Figure 5. The size of the circle reflects the number of articles published in the year, and the darker the circle, the more citations received per year. It thus appears that the most productive author in the field of VR/AR in hospitality is M.C. tom Dieck, who contributed 10 articles over time, 5 of which were published in 2018, receiving 126.17 total citations per year. The subsequent most productive authors are T. Jung and R. Yung, with seven articles each.

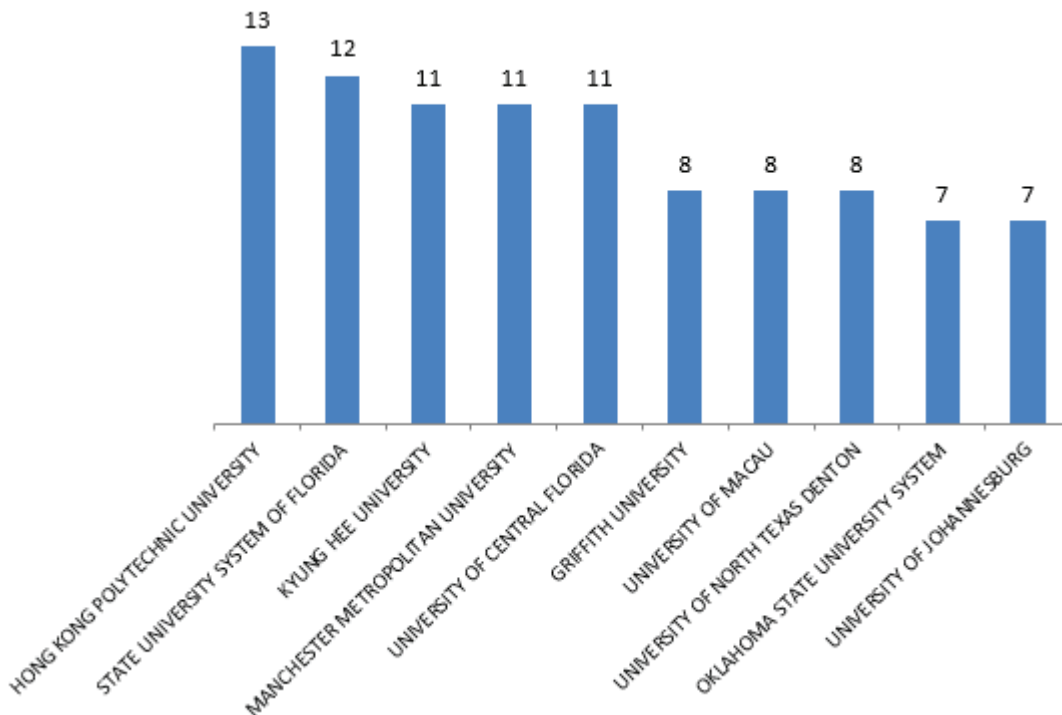
Figure 5: Authors with the most published articles



#### 4.5. Most productive institutions

Figure 6 shows the number of publications linked to the top 10 most productive universities. With 13 and 12 publications each, Hong Kong Polytechnic University and State University System of Florida take the lead among the listed authors' affiliated institutions. Following closely after, Kyung Hee University, Manchester Metropolitan University, and the University of Central Florida have all published a total of 11 articles on VR/AR in the hospitality context. Griffith University, the University of Macau, and the University of North Texas, Denton, contributed eight articles each. Finally, the Oklahoma State University System and the University of Johannesburg contributed seven articles each to the research field considered.

Figure 6. Authors' affiliated institutions with the largest number of published articles.

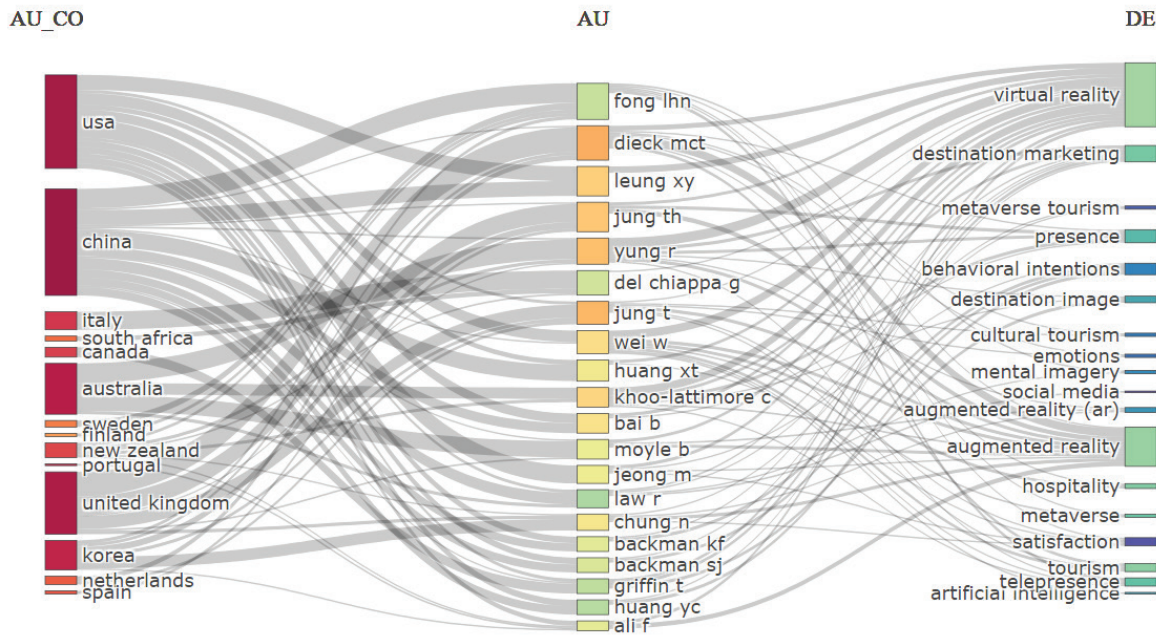


#### 4.6. Sankey diagram

Interconnections among the main keywords (or topics), countries, and authors might offer insightful information. Figure 7 displays the Sankey diagram (plot analysis of three fields) of literature linked to VR/AR in the hospitality industry. This diagram depicts the most pertinent relationships between the authors' affiliated countries (on the left), authors (in the middle), and article

keywords (right). The investigation revealed that the most popular keywords used by authors and relevant nations in the field of VR/AR in hospitality. According to Figure 7, the most popular topics in this field are “virtual reality,” “augmented reality,” “tourism,” “telepresence,” “artificial intelligence,” “cultural tourism,” “metaverse,” “social media,” “destination marketing,” and “hospitality.” The Sankey diagram shows that most articles addressing these topics were published by authors from China, followed by authors from the USA, thus confirming the results shown in both Figure 3 and Table 1.

Figure 7: Connections among keywords, authors, and countries via three field plots



#### 4.7. Keyword co-occurrence analysis

In Figure 8, the keywords co-occurrence network (created in VOSviewer) is visualized based by how often a particular keyword appeared in the 213 articles analyzed. By examining the co-occurrence of keywords, the trending topics in a research field can be easily understood (Gao et al., 2021). Accordingly, to examine such keyword co-occurrence, we set a minimum number of seven occurrences of a keyword. We thus obtained a network of 53 keywords that reached the threshold out of 1,216 total keywords in the database (i.e., both author keywords and keywords plus). The size of the node in the co-occurrence network reflects how frequently a particular keyword appeared in the articles. This network consists of three keyword clusters—or groupings of similar topics across the articles—each indicated by color (Gao et al., 2021). The network thus illustrates the prominent topics (indicated by nodes) and relationships or links among them (indicated by lines) (Echchakoui, 2020). The more frequently two terms co-occur across the articles, the stronger the relationship between them; the terms with higher co-occurrence indices thus appear closer to each other in the network and vice versa. The three clusters shown in the network in Figure 8 are analyzed below.

*Cluster 1 (Red): Virtual reality’s impact on hospitality, tourism, and destinations.* This is the first major cluster identified, consisting of 24 keywords (Table 2). It is led by the term “virtual reality,” followed by “tourism” and “impact.” The cluster also includes the terms “destination” and “hospitality.” Other important terms included “intention,” “attitude,” “telepresence,” “social media,” “technologies,” “dimensions,” “metaverse,” “sense,” “presence,” and “emotion.” This cluster thus represents research into VR’s impact on hospitality, tourism, and destinations. It explores how the use of VR technologies affects the services offered to consumers in this area, influencing their intentions, attitudes, and experiences as well as the destination image.

Table 2: Research topics in Cluster 1 (Red)

Keywords	Occurrences	Links	Total link strength
Virtual reality	71	51	352
Tourism	53	50	234
Impact	36	48	204
Destination	32	41	172
Hospitality	28	35	117
Intention	22	36	122

Keywords	Occurrences	Links	Total link strength
Attitude	19	41	107
Social media	18	31	67
Telepresence	18	40	112
Technologies	15	34	67
Destination image	12	33	73
Environments	12	36	67
Destination marketing	10	32	50
Metaverse	10	10	17
Dimensions	9	29	58
Responses	9	27	46
Sense	9	27	54
Visitors experience	9	27	52
Intentions	8	30	44
Motivation	8	29	36
Presence	8	29	65
Emotion	7	25	45
Interactivity	7	18	38
Word-of-mouth	7	25	36

*Cluster 2 (Green): Technology enhancing satisfaction and performance in hotels.* This second major cluster consists of 16 keywords. It is led by the term “technology,” followed by “satisfaction,” both of which show the highest co-occurrence indices (Table 3). This cluster includes terms such as “behavior,” “emotions,” “engagement,” “experiences,” “consumption,” “determinants,” “performance,” “quality,” and “hotels.” This suggests that the focus of the research in this cluster is the technology’s ability to determine satisfaction, behavioral intentions, and performance in the hotel sector. Indeed, VR/AR literature highlights that these technologies can influence the purchasing and consumption behaviors of hotel customers (e.g., Cranmer et al., 2020; McLean & Barhorst, 2022). Modern hotels now incorporate technology into every area of the visitor experience, from reservation processes to in-room amenities and beyond. Research in this cluster is thus likely to discuss the integration of technology into hotel operations and services to enhance guests’ satisfaction and experiences. The presence of terms such as “flow” and “flow experience” also suggests the role of immersive technologies in enhancing a hotel’s guest satisfaction.

Table 3: Research topics in Cluster 2 (Green)

Keywords	Occurrences	Links	Total link strength
Technology	42	45	226
Satisfaction	31	49	176
Behavior	14	31	58
Emotions	12	27	44
Engagement	12	32	74
Experiences	12	33	78
Consumption	10	19	31
Adoption	8	25	42
Behavioral intentions	8	25	37
Determinants	8	23	35
Performance	8	23	28
Quality	8	21	29
Flow	7	30	45
Flow experience	7	21	36
Hotels	7	21	37
Reality	7	14	24

*Cluster 3 (Blue): User acceptance of augmented reality in travel.* This third major cluster consists of 13 keywords, and it is led by the term “augmented reality” followed by “experience” and “travel” (Table 4). It addresses AR applications in travel experiences. The presence of terms such as “user acceptance,” “acceptance,” and “technology acceptance model” also suggests the research cluster’s focus on traveler user acceptance of AR technology, including consumer opinions, experiences, and perceptions of AR usage. Terms such as “management,” “service,” and “Covid-19” also suggest that the discussion includes how hospitality services benefited from AR technology during the recent pandemic.

Table 4: Research topics in Cluster 3 (Blue)

Keywords	Occurrences	Links	Total link strength
Augmented reality	58	49	263
Experience	39	47	189
Travel	29	42	164
User acceptance	23	41	130
Information-technology	17	29	82
Acceptance	10	24	50
Information	10	33	65
Service	10	24	38
2nd life	9	29	56
Management	8	18	28
Covid-19	7	14	16
Intrinsic motivation	7	23	33
Technology acceptance model	7	24	37

Figure 8: Keyword co-occurrence network visualization

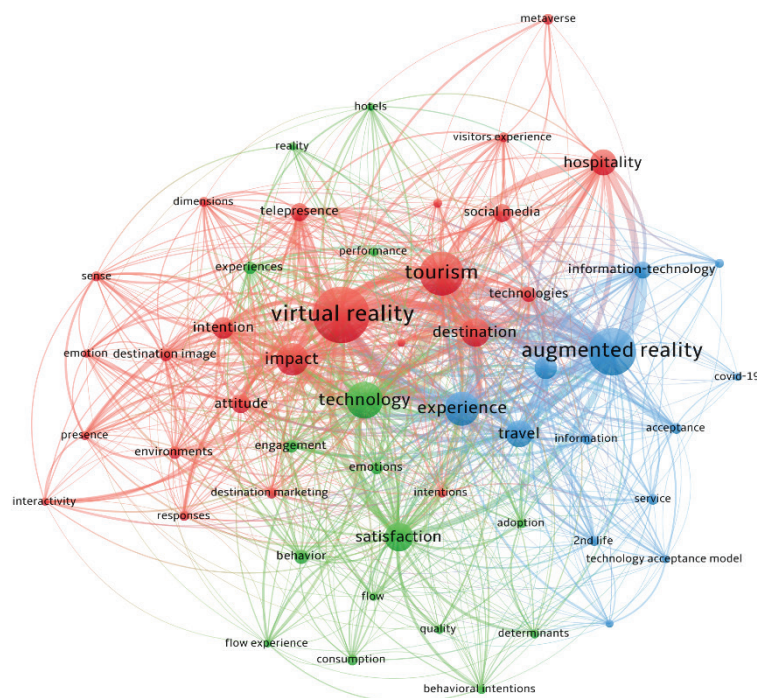


Figure 9 provides a density visualization of the same network of 53 keywords or topics shown in Figure 8. It highlights the densest areas in the network with a dark color (dark orange), enabling immediate identification of the most prominent topics in VR/AR research within the context of hospitality. According to Figure 9, the central area of the network is the most significant and contains topics such as “virtual reality,” “augmented reality,” “tourism,” “technology,” “experience,” “impact,” “destination,” “satisfaction,” and “travel.” In contrast, lighter-colored areas (light yellow) indicate topics that received less frequent attention in the literature, including “metaverse” and “hotels,” among others. The fact that the term “hospitality” is highlighted in light orange,

while “tourism” is in dark orange—and the former is also less centrally located in the network than the latter—may suggest a lower concentration of studies on “hospitality” compared to “tourism.” However, as illustrated in the overlaid co-occurrence network of keywords in Figure 10, which depicts the temporal distribution of topics with colors ranging from blue to red, the term “hospitality” began to emerge around 2020. Overall, this figure demonstrates that thematic research directions in VR/AR studies within the hospitality context have scattered from 2019 to 2021. Topics appearing in the most recent studies are represented with a red circle, with the circle’s size indicating the frequency of appearance. Thus, observing the red circles, it is interesting to deduce that more recent articles also focused on the “metaverse” in addition to “virtual reality” and “technology,” which indicates that these technologies are emerging and currently trending topics. Other topics related to these technologies, such as “experiences/visitors experience,” “engagement,” “performance” and “destination image,” are also on the rise.

Figure 9: Keyword co-occurrence density visualization

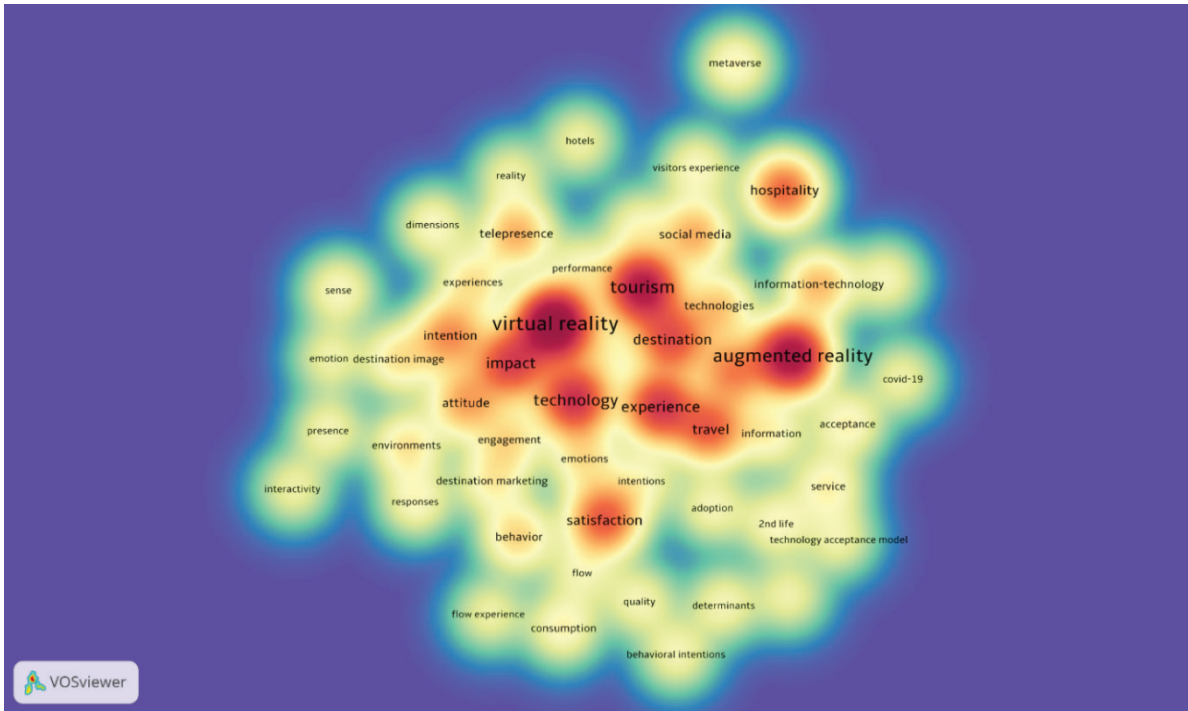
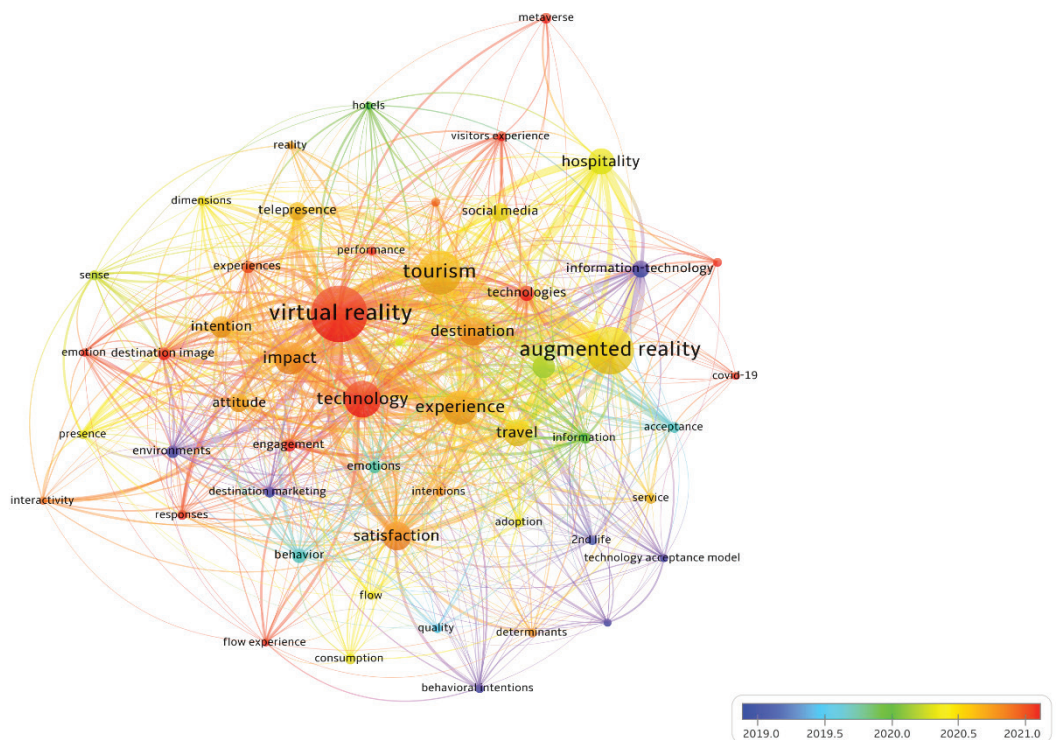


Figure 10: Keyword co-occurrence overlay visualization



## 5. DISCUSSION

This study investigated VR/AR research within the hospitality industry, a context in which immersive technologies are gaining increasing significance due to recent technological developments (Ali, 2022; Flavián et al., 2021; McLean & Barhorst, 2022; Orús et al., 2021; Slevitch et al., 2022). We conducted a bibliometric analysis, selecting and analyzing 213 relevant articles from Web of Science published up to July 2023. First, we performed a descriptive analysis using RStudio to identify the most productive countries, journals, authors, and institutions. We also examined the authors' keywords through a Sankey diagram. Second, we identified the most influential topics using keyword co-occurrence analysis in VOSviewer. This study sought to gain insights into the current state of VR/AR literature addressing related topics, such as potential applications, benefits, and integration challenges of these technologies across different domains of the hospitality industry. The findings offer valuable insights into the latest research developments, with their focus encompassing the state and emerging trends of VR/AR within the hotel sector.

This study identified a substantial increase in the number of scientific articles on VR/AR technologies within the hospitality industry over the past seven years, with 90% of all articles published from 2017 to July 2023. Notably, 2023 appears to be on track to set a record for the peak of scientific production, considering the positive growth trend. In the first half of 2023 alone, 42 articles were published, compared to the previous peak of 49 reached in 2022. This result indicates that there is an ongoing scholarly interest in researching new immersive technologies within the hospitality domain. This result aligns with previous reviews on VR/AR within the overall context of tourism and hospitality, which revealed a dramatic increase in publications since 2009-2010 (Loureiro et al., 2020; Wei, 2019). Interestingly, based on the articles in our database, the earliest study with a specific focus on the hospitality sector was published in 2009, and it argued conceptually for the importance of virtual environment technologies for both individual hospitality businesses and the entire destination network (Breukel & Go, 2009). This suggests that articles published before 2009 may have addressed VR/AR technologies within the broader tourism context, rather than specifically focusing on the hospitality sector. Wei (2019) also supports this perspective, noting that, compared to tourism destinations and attractions, hotels and restaurants have received less attention in the VR/AR literature. However, Wei (2019) also reports the existence of a few sporadic articles published before 2009 in the hospitality context—these were not detected by our Web of Science database search—such as Bray's (2002) study on virtual learning programs in hospitality education and Lee and Oh's (2007) study demonstrating how VR features on a hotel website can help alleviate travel anxiety. Therefore, as our study has demonstrated, VR/AR research within the hospitality sector is more recent than research within tourism as a whole, and it has begun to expand in the last few years. More generally, an increasing number of studies are helping to shape a research field—VR/AR in hospitality and tourism contexts—that is currently in a phase of rapid growth. One possible explanation for this significant development could be attributed to recent technological advancements, coupled with the fact that traditional consumers have only recently begun to embrace VR/AR technologies (Yung & Khoo-Lattimore, 2019), and VR/AR is not only attracting but is also likely to continue attracting new generations of users (Go & Kang, 2023).

Additional findings from this bibliometric study involved mapping the key contributors to the VR/AR research in the hospitality industry, including countries, journals, authors, and institutions, while also identifying prominent topics. The corresponding results are summarized in Figure 11. In terms of publications, China took the top spot, followed by other nations with both single-country and multi-country publications. This demonstrates the widespread interest in and cooperation surrounding research on VR/AR use in the hospitality sector. The most productive authors were found to be tom Dieck and Jung, while the Hong Kong Polytechnic University was the most contributing affiliate institution. The *Journal of Hospitality and Tourism Technology* was the most productive journal.

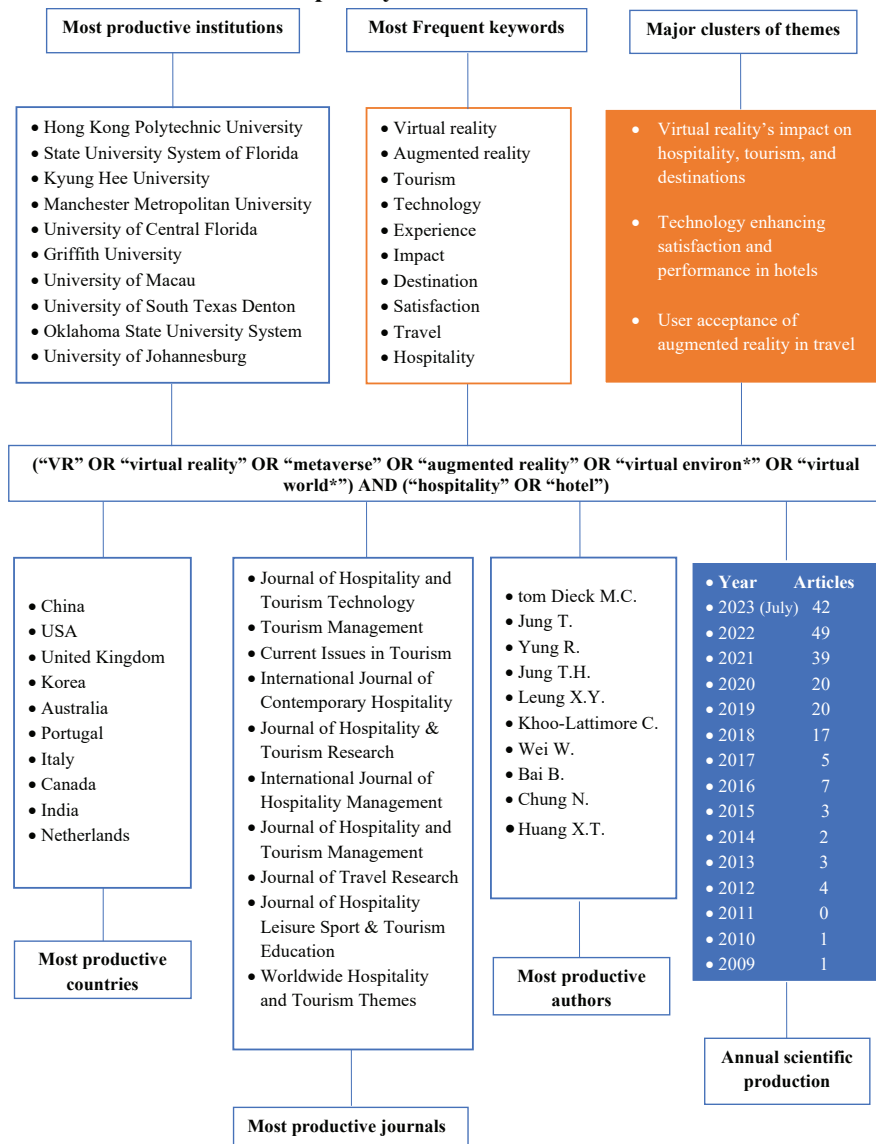
Regarding the prevailing topics and upcoming trends in the literature on VR/AR and hospitality, this study identified three major thematic clusters that are shaping the direction of related research developments. The first major thematic cluster highlights the impact of VR technology on hospitality, tourism, and destinations. As recent literature associated with this cluster has underlined, VR is evolving rapidly, and its current technological capabilities significantly affect both consumers and businesses within the hospitality industry and the broader tourism ecosystem (Buhalis et al. 2019; Çolakoğlu et al., 2023; Flavián et al., 2021; Han & tom Dieck, 2019). Consistently, this study found that the first cluster encompasses several emerging and significant topics, including VR and metaverse technologies, which indicates that these are currently attracting scholarly attention, alongside related discussions involving hospitality services such as performance, customer experiences, and engagement. Existing research seems to demonstrate an awareness of VR's potential to enhance customer experiences by providing immersive environments that enable engagement and entertainment, thereby fostering a positive intention among individuals to visit facilities and destinations (e.g., Flavián et al., 2021; Huang et al., 2016; tom Dieck et al., 2018). Businesses in the hospitality industry can thus strategically gain competitive advantages from innovative VR applications in various business areas, including management, planning, marketing, and training (Guttentag, 2010; Soifer et al., 2021). Some studies have also highlighted how the application of VR technology to hospitality and tourism education can be included among these innovative and advantageous applications, including their contribution to training successful future hospitality business leaders (e.g., Hsu, 2012; Schott, 2017). Our study also noted the frequent presence of keywords such as "tourism" and "destination" within this first cluster, which suggests, in line with Pestek and Sarvan (2021), that VR technology is also emerging as a smart tourism tool that promotes destination images. In this regard, some studies have argued that the sense of presence that VR provides to visitors strongly influences their preference for a destination, thereby stimulating their intention to visit it (e.g., Bigne &

Maturana, 2023; Tussyadiah et al., 2018). VR technology could thus enhance a destination's appeal in the eyes of potential visitors, improving its hospitality image. More recently, Buhalis et al. (2023) discussed VR and metaverse technologies as tools for value co-creation, shaping a smart hospitality system in which businesses and their stakeholders collaborate to maximize collective opportunities for the broader tourism ecosystem. However, despite this vibrant debate, scholars have noted that the quantity of studies on visitors' VR experiences in the hospitality industry is still limited (Çolakoğlu et al., 2023) and have called for studies focusing on user implementation and adoption of VR (Han & tom Dieck, 2019).

The studies in the database that outline the second thematic cluster on VR/AR within the hospitality industry focus on hotels, where innovative technologies contribute to enhancing satisfaction and performance in these business settings. For instance, Cranmer et al. (2020) discussed the potential of AR technology to enhance value in hotel management and operations. In a laboratory experiment, Bogicevic et al. (2021) demonstrated that VR technology contributes to the creation of hotel branding by influencing consumers' behavioral intentions. Other studies have shown that VR influences hotel guests' behavior during the booking process, as this technology provides engaging immersive experiences through virtual tours of hotel rooms and facilities (Israel et al., 2019; Leung et al., 2020; McLean & Barhorst, 2022; Yoon et al., 2021). Some studies have also proven guests' positive emotions and perception of service quality when experiencing a hotel room in VR (Siamionava et al., 2018; Surovaya et al., 2020). VR technology has thus received some attention in the literature as a promotional tool for hotels (e.g., Slevitch et al., 2022). Beyond commercial and marketing purposes, the training capabilities of innovative technologies such as VR to enhance the competencies of hotel management and staff through simulations have also been addressed (Konovalova & Demenev, 2020; Lui & Goel, 2022). More recently, Leung et al. (2023) considered VR as a tool for managing workplace stress in hotels, demonstrating that VR interventions can mitigate the daily emotional fluctuations experienced by frontline hotel staff. Furthermore, Chen (2023) investigated hotel metaverse technology engagement, highlighting that this technology enhances organizational performance and value co-creation for stakeholders, influences customer relationship management, and changes how managers communicate. The new immersive technology applications are changing host-guest relationships in hotel settings (Orús et al., 2021). However, despite the existence of various studies shaping this second thematic cluster, the present study found that the topic of "hotels" remains relatively underexplored within the examined literature. A shortage of studies was also observed concerning hotels that have implemented modern technologies associated with virtual worlds and contents, as existing empirical research has tended to rely on laboratory experiments (e.g., Bogicevic et al., 2021; Leung et al., 2020; McLean & Barhorst, 2022).

The third thematic cluster centers on AR technology and indicates that the majority of related research focuses on user acceptance of AR in travel. This result aligns with the findings of Jingen Liang and Elliot (2021), who examined AR research within the tourism literature. Effectively, studies associated with this cluster in our database primarily explored travelers' perceptions of AR, their interest in experiencing it, and their likelihood to recommend its use (e.g., Aluri, 2017; Lau et al., 2019; Jung et al., 2018; Shin & Jeong, 2021). These studies, however, also discussed related topics in relation to the general context of tourism /hospitality and tourism. For instance, Jung et al. (2018) investigated the effects of cultural differences on AR acceptance as a means to enhance visitors' experience at cultural heritage tourism sites. They also noted that there have been few AR studies specifically conducted within the hospitality industry. Among these, some recent studies have addressed AR-enhanced dining experiences in restaurant settings (Ali, 2022; Batat, 2021). When examining travelers' attitudes AR adoption in a tourism destination, Shin and Jeong (2021) called for future studies to explore AR applications within the hospitality industry and compare them to those in the tourism industry. Nevertheless, as argued by Ali (2022), due to the relatively recent introduction of AR technology in hospitality and tourism—and it is still finding its way into the hospitality industry—studies that investigate how AR enhances visitor experience are limited, with most of the existing research examining users' intention to use AR through theoretical models such as the technology acceptance model (TAM).

Figure 11: Map of VR/AR research in the hospitality domain



## 6. CONCLUSIONS

This bibliometric study provides an overview of the current state of VR/AR research in the hospitality industry through a bibliometric analysis of literature data from the Web of Science database. Previous reviews have explored the research landscape of these technologies within the broader context of tourism or the hospitality and tourism industry as a whole, highlighting that it is a relatively new research field (e.g., Loureiro et al., 2020; Yung & Khoo-Lattimore, 2019; Wei, 2019). Indeed, there is an ongoing and lively debate in this field, and several recent studies have emphasized the significant role that these modern immersive technologies play, particularly in the hospitality sector (e.g., Batat, 2021; Buhalis et al., 2023; Flavián et al., 2021; Orús et al., 2021). This study thus contributes to the ongoing debate by outlining the research trends in this specific sector and identifying related gaps in the literature.

Based on the results, we can conclude that VR/AR studies in the hospitality industry are still in an early stage but are emerging, with further growth expected in the near future. Indeed, the analyses conducted on data related to the 213 articles selected from the Web of Science database unveiled a research activity in its infancy yet brimming with dynamism, involving multiple countries, authors, and institutions worldwide. Compared to tourism destinations and attractions, VR/AR technologies in businesses in the hospitality sector, such as hotels and restaurants, have received less attention—as also noted by Wei (2019)—and only gained scholarly interest more recently. As demonstrated by the current study, however, three major thematic clusters are shaping corresponding directions of VR/AR research in the hospitality sector and have spread between 2019 and 2021. These are: (i) the impact of VR on hospitality, tourism, and destinations; (ii) technology enhancing satisfaction and performance in hotels; and (iii) user acceptance of AR in travel. We have identified and discussed several important topics within each cluster, as well as emerging topics, especially those concerning VR and metaverse technologies.

Overall, this study can offer insight for academics, executives, entrepreneurs, and decision makers in the hospitality sector that may be used as a guide for an understanding of trends, prospective applications, and future directions of VR/AR technologies within this sector. The theoretical implications of this study lie in the support it can provide for the development of future VR/AR-related studies within the specific field of hospitality. It provides prospective scholars with potential research gaps, which, as discussed in the previous section, are diverse and pertain to each of the three identified thematic clusters. In particular, regarding VR-related studies, this research highlights the need for more focus on user implementation and adoption of VR, aligning with the call for further investigation made by Han and tom Dieck (2019). We echo their call, as well as that made by Çolakoğlu et al. (2023) for more research on visitors' VR experiences in the hospitality industry. Similarly, we support the call by Shin and Jeong (2021) for future AR-related studies to explore the application of AR within the hospitality industry. Additionally, we advocate for more empirical studies conducted in real hotel settings that have implemented these new immersive technologies, going beyond laboratory experiments. In a broader sense, future research should delve into opportunities and challenges of new virtual environment-related technologies from the perspective of corporate managers, executives, staff, and property owners, going beyond the customer perspective. Future studies could monitor and analyze their usage practices in hotels, restaurants, and other organizations in the hospitality domain to identify implementation nuances specific to different contexts.

This study also has managerial implications. Its specific focus on discussing VR/AR literature in the hospitality industry can raise awareness of these modern technologies as emerging tools for enhancing the competitiveness and profitability of hotels and other businesses in this sector. This heightened awareness could inspire hospitality practitioners to leverage these technologies for various purposes, such as developing staff skills through virtual environment simulations; promoting virtual tours of hotels' rooms, facilities, and destinations; creating innovative personalized services to attract new generations of visitors; and facilitating relationships between businesses and stakeholders in the hospitality ecosystem. Indeed, innovation is essential for the success of the dynamic and complex businesses in the hospitality sector, which is currently in the process of rebuilding and restarting after the Covid-19 pandemic. Investing in new technologies, including those related to VR/AR, to improve services and overall performance may prove to be a successful strategy for creating sustainable business models.

This study, however, does have some limitations. First, the articles examined were exclusively collected from the Web of Science, which is widely regarded as the leading data source for bibliometric analyses (Forliano et al., 2021; Jabeur et al., 2023). Consequently, articles not present in the Web of Science or solely indexed in other databases, such as Scopus and/or Google Scholar, may have been missed. Another limitation could be related to the search strategy employed in this database, which also captured articles within the broader context of hospitality and tourism. However, because the primary focus of this bibliometric study was on VR/AR research within the hospitality sector, the search query did not include terms such as "tourism" or "destinations," so only some partial trends related to these contexts are reflected in the study results.

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