

Applying virtual reality and augmented reality to the tourism experience: a comparative literature review

287

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Abstract

Purpose – The purpose of this paper is to investigate how previous literature has analyzed the role of augmented reality and virtual reality in the field of tourism, distinguishing between studies focused on one technology or the other as both have characteristics that profoundly differentiate them.

Design/methodology/approach – This study carries out a critical review to assess and synthesize the literature on augmented reality and virtual reality in tourism. Literature searches are conducted using various keywords, resulting in a selection of 84 articles (19 on augmented reality and 65 on virtual reality) from 39 indexed journals.

Findings – The research findings demonstrate an increasing scholarly focus on exploring the application of virtual reality and augmented reality within the realm of tourism. These results highlight a noticeable progression in recent years with respect to different matters, such as methodologies, used theories or considered variables, among others. Based on these results, it is proposed a future research agenda that seeks to establish a cohesive framework and drive the development of both augmented reality and virtual reality research in tourism.

Originality/value – By conducting an individual and comparative review of the literature on the application of augmented reality and virtual reality in tourism, this research helps elucidate the specific lines of research for each technology while providing a better understanding of how each technology can be used to generate effective tourist experiences.

Keywords Augmented reality, Virtual reality, Tourism, Customer experience, Immersive technologies, Literature review

Paper type Literature review

La aplicación de la realidad virtual y la realidad aumentada en la experiencia turística: revisión bibliográfica comparativa

Resumen

Propósito – El objetivo de este artículo es investigar cómo la literatura previa ha analizado el papel de la realidad aumentada y la realidad virtual en el ámbito del turismo, distinguiendo entre estudios

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centrados en una u otra tecnología ya que ambas tienen características que las diferencian profundamente.

Diseño/Metodología/Enfoque – Este estudio realiza una revisión crítica para evaluar y sintetizar la literatura sobre realidad aumentada y realidad virtual en turismo. Se realizan búsquedas de literatura utilizando diversas palabras clave, que dan como resultado la selección de 84 artículos (19 sobre realidad aumentada y 65 sobre realidad virtual) procedentes de 39 revistas indexadas.

Conclusiones – Los resultados de la investigación demuestran que existe un interés creciente en explorar la aplicación de la realidad virtual y la realidad aumentada en el ámbito del turismo. Asimismo, se pone de manifiesto una notable progresión en los últimos años con respecto a diferentes cuestiones, como las metodologías aplicadas, las teorías empleadas o las variables consideradas, entre otras. A partir de estos resultados, se propone una agenda de investigación futura que pretende establecer un marco cohesionado e impulsar el desarrollo de la investigación en el ámbito tanto de la realidad aumentada como de la realidad virtual en turismo.

Originalidad – Al realizar una revisión individual y comparativa de la literatura sobre la aplicación de la realidad aumentada y la realidad virtual en el turismo, esta investigación ayuda a esclarecer las líneas de investigación específicas de cada tecnología a la vez que proporciona una mejor comprensión de cómo cada tecnología puede ser utilizada para generar experiencias turísticas efectivas.

Palabras clave Realidad aumentada, Realidad virtual, Turismo, Experiencia del consumidor, Tecnologías inmersivas, Revisión de literatura

Tipo de papel Revisión de literatura

将虚拟现实和增强现实应用于旅游体验：比较文献综述

摘要

目的 – 本文旨在研究以往的文献是如何分析增强现实和虚拟现实在旅游领域的作用的, 并对侧重于其中一种技术或另一种技术的研究加以区分, 因为这两种技术都有深刻区别于其他技术的特点。

设计/方法/途径 – 本研究通过批判性综述来评估和归纳有关旅游业中增强现实和虚拟现实技术的文献。通过使用各种关键词进行文献检索, 从 39 种索引期刊中筛选出 84 篇文章 (19 篇关于增强现实技术, 65 篇关于虚拟现实技术)。

研究结果 – 研究结果表明, 学术界越来越重视探索虚拟现实和增强现实在旅游业中的应用。这些结果突显了近年来在方法论、采用的理论或考虑的变量等不同方面的明显进步。在这些成果的基础上, 提出了未来的研究议程, 旨在建立一个具有凝聚力的框架, 推动旅游业中增强现实和虚拟现实研究的发展。

独创性 – 本研究通过对增强现实和虚拟现实技术在旅游业中应用的文献进行单独和比较审查, 有助于阐明每种技术的具体研究方向, 同时让人们更好地了解如何使用每种技术来产生有效的旅游体验。

关键词 增强现实, 虚拟现实, 旅游业, 客户体验, 沉浸式技术, 文献综述

文章类型 研究型论文

1. Introduction

The rapid development and widespread use of information and communication technologies (ICTs) have had a profound impact on society. The advancements in communication facilitated by these technologies have created a global era where unlimited information can be transmitted quickly from any location (Buhalis *et al.*, 2019). This technological evolution has also led to the emergence of reality–virtuality technologies, such as augmented reality (AR), virtual reality (VR) and pure mixed reality (PMR), which are transforming the way customers experience both the real and virtual environments (Tom Dieck and Hang, 2022). AR involves overlaying digital information in the real environment. In VR, users are fully immersed in computer-generated environments, providing a completely virtual experience. PMR combines real and digital elements, enabling their coexistence and interaction with the user (Flavián *et al.*, 2019). Recent reports note that the immersive technologies market size is expected

to reach US\$100bn by 2026 (Statista, 2023), which highlights the importance of these technologies for the future development of society.

Tourism, characterized by its intangibility and heterogeneity, benefits greatly from the use of ICTs in enhancing customer experiences (Buhalis *et al.*, 2019). Particularly, the new wave of immersive technologies, such as AR and VR, can help overcome the challenges posed by the intangible nature of tourism products by allowing potential tourists to explore and experience them in novel ways (Guttentag, 2010; Tussyadiah *et al.*, 2018a, 2018b). Being entertained while learning, access to personalized information or to physical areas/historical moments that are not available, among others, are some of the potential benefits of these technologies for tourism (Guttentag, 2010; tom Dieck and Jung, 2018; Flavián *et al.*, 2019b). Moreover, these technologies enable the creation of extra-sensory experiences by seamlessly integrating the real and virtual environments (Petit *et al.*, 2019). The potential of immersive technologies in the tourism industry is undeniable, and further research is needed to effectively implement AR and VR to generate valuable tourism experiences.

However, the existing literature on this topic is still in its early stages, and researchers and practitioners emphasize the importance of studying tourists' experiences with AR and VR technologies (Loureiro *et al.*, 2020; Wei, 2019; Yung and Khoo-Lattimore, 2017). Particularly, given the novelty of this research area and the ongoing advancements, most of the research has been published in recent years, being this literature fragmented without having a common focus. There have been literature reviews attempting to harmonize the existing work to offer common lines of research to be analyzed by the research community (e.g. Fan *et al.* (2022b); Loureiro *et al.*, 2020; Wei, 2019). All these literature reviews have considered AR and VR together, at the same level. However, as both AR and VR have different features that clearly distinguish them (Flavián *et al.*, 2019), the individual and comparative review of the literature on the application of AR or VR in tourism can help to elucidate the specific lines of research for each technology while providing a better understanding of how each technology can be used to generate effective tourist experiences.

Based on this gap, this article follows a critical review process (Snyder, 2019) to analyze individually the literature on AR and VR in the field of tourism, proceeding to make a comparison between both streams of research. Several parameters are considered: evolution in the number of published papers, tourism contexts addressed, research methods employed, stage of the customer journey, used theories and variables included in the models of the papers. Based on this individual and comparative review of AR and VR in tourism, it is proposed a future research agenda that aims to unify and achieve common progress in this nascent research area.

2. Overviews of literature reviews about augmented reality and virtual reality in tourism

Immersive technologies, both AR and VR, have revolutionized the tourism industry, offering unprecedented opportunities for immersive experiences and transforming the way travelers engage with tourism attractions (Buhalis *et al.*, 2019). However, as noted before, despite the growing academic interest and adoption of AR and VR in tourism, the literature is fragmented, and there is a noticeable lack of comprehensive literature reviews that consolidate the existing body of research. With the aim of providing an overview of the existing literature reviews on AR and VR in the tourism field, this section presents the current exceptions based on their

temporal evolution, analyzing their contributions to the understanding and application of AR and VR in the tourism industry.

Beck *et al.* (2019), considering solely the impact of VR in tourism, conducts a state-of-the-art review analysis to contribute to understand VR research in tourism. These authors consider that previous research has not specified the VR system, generating confusion and misunderstanding as the term VR includes systems with different technical capabilities. Based on their levels of immersion, they distinguish between non- (e.g. desktop-based VR), semi- (e.g. multiple projection screens that project content on walls and floor) and fully immersive (complete isolation of the user with the world; e.g. head-mounted displays) VR systems in tourism. The authors explain the different papers on VR research in tourism considering the former taxonomy in an attempt to correctly delineate the terms and associated research. The development of VR devices goes hand in hand with research development: while research before 2013 was mainly based on non-immersive VR, most recent research is focused on full immersive VR.

Yung and Khoo-Lattimore (2017) indicate that there was not known systematic knowledge that emerges from the academic papers on VR and AR in tourism. To that aim, they conducted a systematic quantitative review with 46 papers whose results display that the most selected types of VR/AR are “virtual worlds” and “virtual environments.” Among the tourism context in which VR/AR research has emerged, it can be highlighted marketing, education and conceptual. Categories as food and beverage or MICE remains unexplored. As for the methodologies, conceptual papers and quantitative surveys are clearly the most commonly used. The authors claim for the need of more theory-based research on VR/AR in tourism. Among the exceptions, technology acceptance model (TAM), theory of planned behavior and flow theory are the most applied ones. Based on their review, they propose a model of challenges to VR adoption for tourism.

Wei (2019) considers both AR and VR research in hospitality and tourism. She conducted a literature review of 60 papers published between 2000 and . The findings show that there is a growing trend in the publication of papers in this topic. Most of VR/AR research has been conducted in Europe or Asia, covering contexts such as tourism destinations or cultural heritage sites as museums (lack of research in hotels and restaurants). Based on the reviewed literature, the author proposes a unifying framework of VR/AR user experiences consisting of stimuli (service environment, individual differences, interpersonal factors and presence), dimensions of the VR/AR experience (instrumental, experiential, psychological and social) and consequences (e.g. emotional response, satisfaction, destination image, behavioral intentions). The most used theories are grouped into antecedents-related to VR/AR user experience (e.g. TAM) or process-related theoretical models (e.g. process theory). As for quantitative methodologies, surveys are the most used; while for qualitative methodologies, focus groups and interviews are the most common. Experimental research is beginning to be carried out. Two suggestions for future research are proposed: the need for cross-cultural approach in the studies and more research in events and hospitality settings.

Jingeng Liang and Elliot (2020) focus solely on AR application to tourism. They conducted a literature search, which resulted in 32 selected articles. They showed the evolution of AR tourism research, starting with AR design and development toward more novel topics such as gamification, user experience, satisfaction and behavioral intentions. A conceptual map including the constructs of the reviewed articles is presented. Both qualitative (e.g. focus groups) and quantitative (e.g. field survey) methodologies were used. Based on these results, they propose several future research directions (e.g. gamification, actual behaviors, negative consequences of AR, mixed methods).

Loureiro *et al.* (2020), by using citation network analysis and text-mining techniques, conduct a literature review of 56 articles about VR and AR in tourism. The longitudinal analysis highlights the recent wave (from 2014) of published papers in the selected topic, being this trend more pronounced in recent years. They also show the topics covered by the selected literature: smart cities and cultural heritage, mobile uses for sustainable tourism, tourism destination marketing, experiential and telepresence, AR, among others. Based on the results, Loureiro *et al.* (2020) propose several research questions and four key realms for the future evolution of research on AR and VR in tourism: multisensory experiences, brain-computer interactions, well-being development and use of artificial intelligence in immersive settings.

The most recent literature review is authored by Fan *et al.* (2022b), who conducted the first meta-analysis on AR and VR research in tourism based on 56 papers (65 studies). The authors identify presence as a key construct which affects both value perceptions (e.g. ease of use, enjoyment) and psychological responses (e.g. flow, affective engagement), resulting in consequences (e.g. behavioral intentions/actual behaviors, attachment). Moderating variables (e.g. experience type) are also included in this proposal. The results of the meta-analysis show that most of the hypotheses are supported. Particularly, presence has direct (and indirect) effects on the mediating variables, which affect the responses. Simulation type and social interaction positively moderate (while prior visitation negatively moderate) the relationship of presence and tourism experience. They also propose opportunities for future research: the application of VR/AR to the different stages of the tourism journey (pre-tour, during, post-tour), possible negative effects of immersive technologies, the use of other methods (e.g. sentiment analysis), immersive technologies and sustainability or social interaction.

Considering the scarcity of previous proposals, this research aims to contribute to generating a common framework in which the community of this nascent research area can advance in a uniform manner. Specifically, previous literature reviews have either focused on one of the two technologies (VR: Beck *et al.*, 2019; AR: Jingen Liang and Elliot, 2020), or considered both of them (Fan *et al.*, 2022a, 2022b). However, as previously discussed, the innate characteristics of VR (user immersed in a computer-generated virtual environment; Guttentag, 2010) and AR (virtual information superimposed on the real world; Azuma, 1997) profoundly differentiate these two technologies. Therefore, there is a need for a comparative analysis of how previous literature on AR or VR has been developed in the field of tourism. With this, the aim is to obtain a complete overview of both research fields, displaying their similarities and differences and looking for an integration that will lead to a common roadmap for research on immersive technologies in tourism.

3. Review methodology

Following Snyder (2019), a critical review process was conducted with the aim of assessing, critiquing and synthesizing the literature on AR/VR in tourism in a way that allows for a new theoretical framework. This method highlights problems or disparities in the existing knowledge about a specific area to constructively inform and provide an appropriate focus and ideas for future studies. First, we conducted literature searches with several keywords (“virtual reality,” “augmented reality,” “immersive technologies,” “tourism,” “tourism destination,” “hospitality”) in databases (Scopus and Web of Science). Once the items have been selected, we excluded books, book chapters, reports and conferences. A final set of 84 papers were selected for the final analysis as of March 7, 2023 [AR (19 articles), VR (65 articles)]. Thus, we did not restrict the research to periodicals with the greatest impact on their fields but rather included all the articles from journals indexed by the Web of Science

and Scopus containing the keywords. In the second stage, we carried out the analysis to verify whether the studies already identified were appropriate for the purposes of this research. In this phase, we retained only those articles from English language publications. The third phase of this study involved an individualized and independent analysis of the articles through recourse to a predefined evaluation grid that incorporated the analysis of AR/VR to the tourism experience. This grid was subsequently compared and refined. In the fourth and final phase of our study, we completed content analysis and systematized the 84 articles, and extracted summarized information to the subject in terms of the type of study, analysis, conclusions and similarities among studies to create a critical review and joint conceptual framework that synthesizes variables from both technologies.

4. Results

4.1 Number of papers and journals

Early studies analyzing the impact of AR and VR on tourism began in the 1990s (Cheong, 1995; Williams and Hobson, 1995) (see Figure 1). Theoretical developments discussed the idea of VR as a potential substitute or competitor of real tourism (Hobson and Williams, 1995), while others deem that VR will never replace the feeling of an actual trip (Dewailly, 1999). Despite these theoretical advances, literature on this research topic is scarce in the first decade of the 21st century (Loureiro *et al.*, 2020). Nevertheless, the theoretical work of Guttentag (2010) is the cornerstone for most of the subsequent research conducted in the field. Guttentag (2010) explores the sensory developments and the applications of VR in the tourism industry. He also discusses the idea of VR as a potential substitute of physical tourism, noting that VR can increase the potential tourists' desire of visiting the real tourist attractions.

According to several systematic literature reviews recently conducted, the largest body of research has been published in the past decade, being this trend more pronounced in the past five years (Loureiro *et al.*, 2020; Wei, 2019). Our review shows a similar pattern, with most of the research being published since 2015. When comparing between AR and VR (see Figure 2), the research in 2010–2015 has mainly focused on AR (19 articles; e.g. Chung *et al.*, 2015; Jung *et al.*, 2015). For instance, Jung *et al.* (2015) conducted a field study in which visitors of a tourist attraction used an AR app. Their findings show that some properties of the AR app (content and service quality, personalized service) lead to higher satisfaction and intention to recommend the AR experience. However, recent studies are also focusing on VR (Wei *et al.*, 2023; Aldossary and McLean, 2022), being the most addressed research topic in recent years (55 articles selected). In this way, Wei *et al.* (2023) show that gamification can alleviate fatigue and improve satisfaction levels in a VR tourism experience.

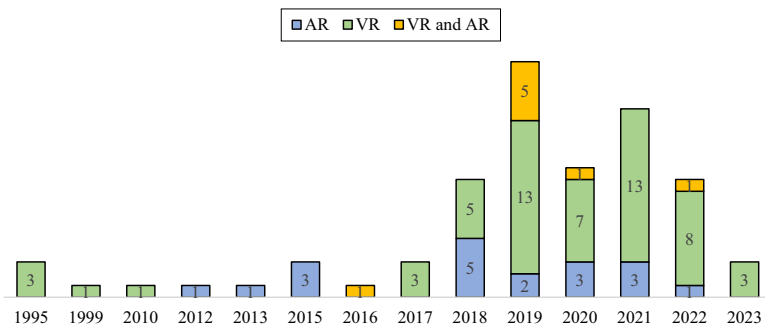


Figure 1.
Number of tourism
AR/VR studies per
year and category



Figure 2.
Word cloud with
tourism context of
AR/VR research

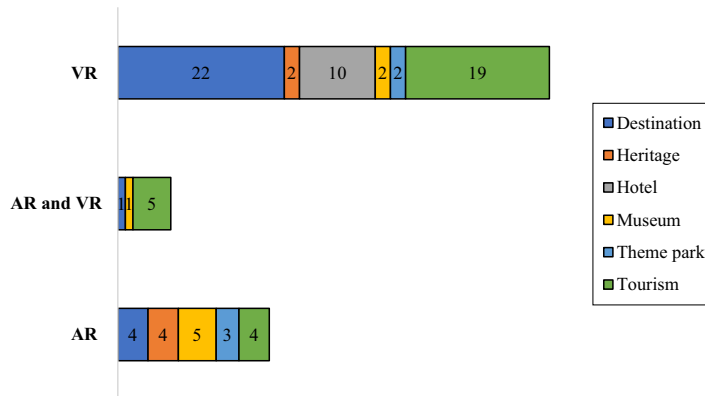
4.2 Tourism context

All selected articles have been classified according to their research context. Figure 2 displays the six most used contexts (destination, memory tourism, hotel, museum, theme parks and tourism – general), highlighting those in larger letters. Tourism (general) has been the most prominent topic in the articles (28), followed by destination (27) and hotels (ten). Figure 3 highlights the total number of articles in each context according to the analyzed technology.

As for AR, the prominent context is museums (five) and the least is theme parks (three), while no research is found for hotels. In a museum setting, Jung *et al.* (2016) identify the factors that promote the adoption of AR in this setting, and tom Dieck *et al.* (2018) explore whether AR can improve the learning experience of museum visitors. Regarding theme parks, Jung *et al.* (2015) analyze how perceived AR quality affects satisfaction and recommendations, Cranmer *et al.* (2021) develop an AR business model and Hu *et al.* (2021) investigate the attributes of AR theatrical performance in theme parks.

The results show that VR articles have mainly focused on destinations (22) and general tourism (19). Some studies analyze the tourist experience by measuring the effect of presence (Tussyadiah *et al.*, 2018a, 2018b), VR pre-experience (Griffin *et al.*, 2017, Orús *et al.*, 2021) or even visitor interactions during a VR experience (Hudson *et al.*, 2019; Lee *et al.*, 2020). In addition, there are studies that focus on certain tourism, such as Wen and Leung (2021) who explore the experiences of young consumers in the purchase of wine and their subsequent

Figure 3.
Evolution of AR/VR
papers according to
context



behaviors, or [Talwar et al. \(2022\)](#), which examines pro-environmental behaviors in terms of tourism. There are also recent articles that consider the context of hotels to explore the role of mental imagery ([Bogicevic et al., 2019](#)), telepresence ([Israel et al., 2019a, 2019b](#)) or the use of VR to mitigate daily negative mood spillover among hotel frontline employees ([Leung et al., 2023](#)).

4.3 Stage

This section analyzes the stage of the customer journey in which the research is developed (pre-experience, on-site experience or post-experience; [Lemon and Verhoef, 2016](#)). [Figure 4](#) shows the evolution of the selected articles over time according to the stage and the used technology (AR, VR, AR and VR).

For AR, two articles focus on the pre-experience stage. [Park and Stangl \(2020\)](#) identified experience-seeking and boredom-susceptibility as essential elements to classifying travel groups regarding AR apps. [Crammer et al. \(2021\)](#) develop a business model considering AR in a theme park context. In the on-site stage, the number of AR articles exceeds VR articles. Studies at this stage begin in 2015 (e.g. discovering the functional properties of the AR system evoke feelings of pleasure and arousal, [Kourouthanassis et al., 2015](#)), and 2018 is the most prolific one. For example, [tom Dieck et al. \(2018\)](#) find that the use of AR HMD helps visitors to see the connections between the pieces of art and personalize their experiences, and [Tussyadiah et al. \(2018b\)](#) find that the perceived enjoyment with AR enhances the overall museum experience. The remaining six articles on AR ([Kounavis et al., 2012](#); [Han et al., 2013](#)) do not consider any stage.

As for VR, most articles have considered the pre-experience stage (40 papers since 2017; see [Figure 4](#)). [Griffin et al. \(2017\)](#) show that VR is more effective than other media (2D video and website) to create more powerful affective destination images and behavioral intentions. Recent years have witnessed more VR research in tourism pre-stage. For example, [Bogicevic et al. \(2019\)](#) explore the role of mental imagery and presence in VR hotel pre-experiences, [Zeng et al. \(2020\)](#) analyze the effect of adding VR to online reviews in a hotel setting, [Lee et al. \(2021\)](#) explore the effects of VR features (vividness and interactivity) on media richness and [Talwar et al. \(2022\)](#) underline the relationship between motivational forces and pro-environmental behaviors. In the on-site stage, the effect of presence in VR tourism is highlighted to generate enjoyable experiences and improve the attitude toward a destination ([Tussyadiah et al., 2018a](#)). Additionally, [Leung et al. \(2023\)](#) note that the hotel frontline employees with high (vs low) levels of trait mindfulness are less likely to be influenced by their negative moods before work when exposed to the VR intervention ([Leung et al., 2023](#)).

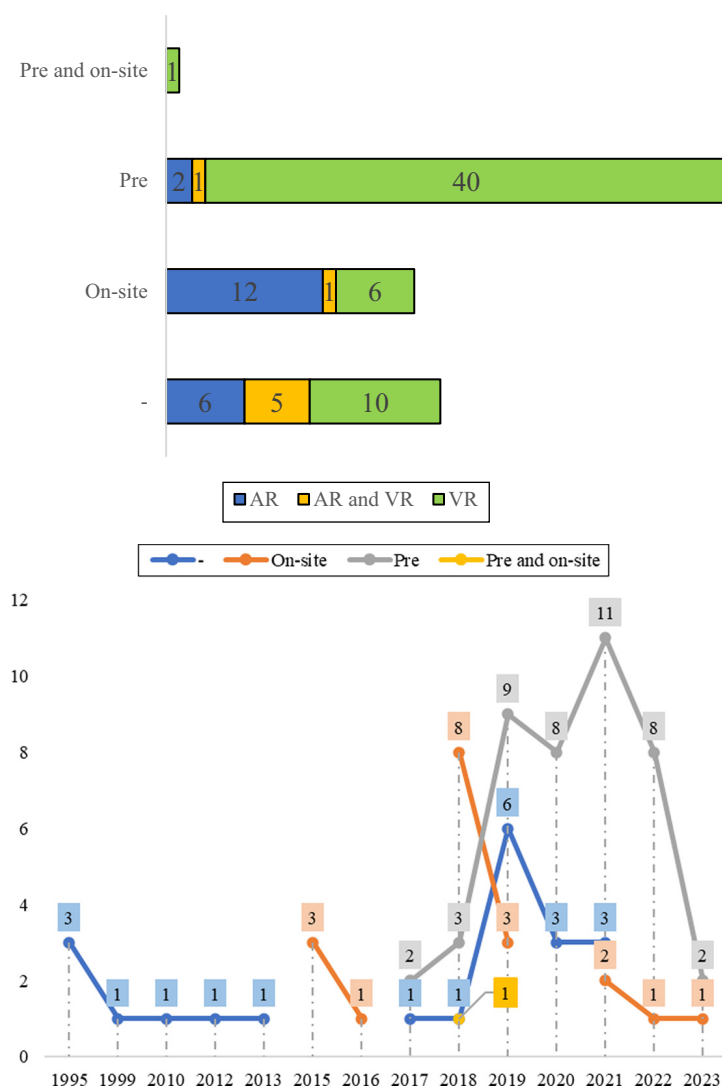


Figure 4. Evolution and number of AR/VR papers according to the stage of the tourism journey

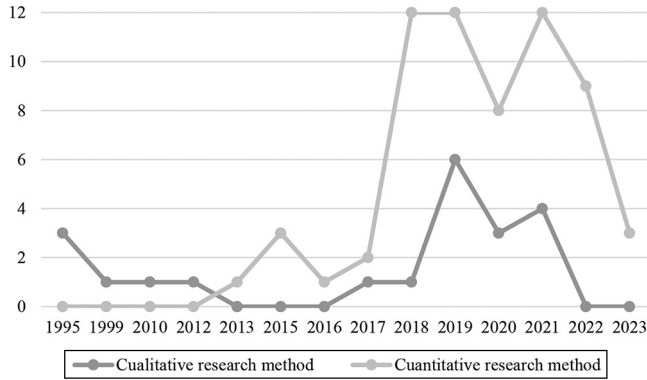
Likewise, [Wagler and Hanus \(2018\)](#) conclude that 360-degree experiences with VR can be considered as a strong analog of real-world tourism experiences.

To sum up, the application of immersive technologies was first analyzed during the tourism experience, but the most recent research is being contextualized in the pre-experience stage; the analysis of AR and VR in tourism post-experiences is still at an early stage ([Wedel et al., 2020](#)), being addressed only at the theoretical level ([Neuburger et al., 2019](#)).

4.4 Research method

Over the years, research on AR and VR tourism has been studied through qualitative and quantitative methodologies (see [Figure 5](#)). In general, there have been less qualitative than

Figure 5.
Evolution of AR/VR
tourism publications
in terms of research
method



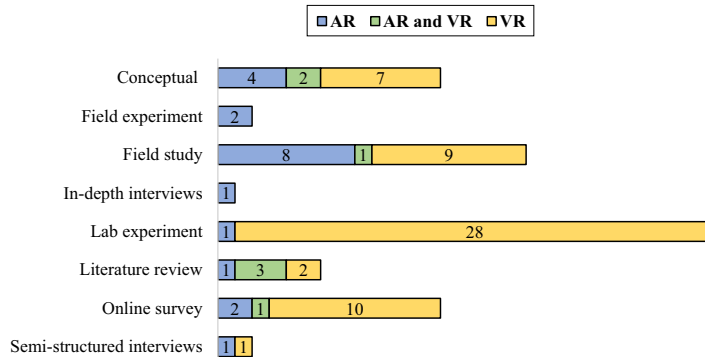
quantitative studies. However, it is since 2013 when more quantitative (compared to qualitative) studies have been published, been this trend more pronounced since 2017 (even doubling the qualitative ones in 2018).

Specifically, research has moved from exploratory studies using mainly qualitative techniques (e.g. in-depth interviews; Han *et al.*, 2013), to recent studies with a more confirmatory focus, which frequently use quantitative techniques (e.g. lab experiments; Israel *et al.*, 2019a, 2019b). As an example of qualitative research, Han *et al.* (2013) conducted in-depth interviews with visitors of a destination who were asked about which features AR apps should have for enhancing their tourism experiences. The results of the thematic analysis performed show that careful design, multi-language functionality, ease of use and personalization in AR apps are highly valued by visitors. Conversely, Willems *et al.* (2019) carried out a lab experiment (quantitative) in which participants could view a destination using static images, 360-degree video using a computer or a VR HMD. The results show that VR, compared to the other formats, generates higher perceptions of vividness, interactivity and presence. Both vividness and interactivity affect sense of presence, which subsequently influences flow, enjoyment and online purchase intentions.

Figure 6 shows the different methodologies used in the 84 articles selected for this study, according to the technology analyzed.

On the one hand, four of them carry out a conceptual methodology to explore how AR creates value for different contexts (tourism, Kounavis *et al.*, 2012; heritage, Bec *et al.*, 2019;

Figure 6.
Number of AR/VR
tourism articles
employing qualitative
and quantitative
methodologies



museum, [Serravalle et al., 2019](#); theme park, [Cranmer et al., 2021](#)). It is worth noting the case study of [Cranmer et al. \(2021\)](#) who develop an AR business model for a small UNESCO visitor attraction. As noted before, [Han et al. \(2013\)](#) explore the elements to create an effective AR travel app through in-depth interviews, while [tom Dieck and Jung \(2018\)](#) analyze the factors that affect users' acceptance of AR by conducting focus groups. Semi-structured interviews are also applied in this context ([Cranmer et al., 2020](#); [Han et al., 2019](#)).

Regarding studies with quantitative methodology, questionnaire has mostly used in field studies (e.g. to explore the antecedents of AR satisfaction, [Chung et al., 2018](#)). In addition, there are studies that contemplate online questionnaires (e.g. to study sensation-seeking in travelers' experiences with AR; [Park and Stangl, 2020](#)) and experiments (e.g. to identify factors that foster AR adoption in museums; [He et al., 2018](#)).

On the other hand, there is a minority of VR articles with qualitative techniques. Among the exceptions, [Martins et al. \(2017\)](#) propose a multisensory VR tourism model and [Bec et al. \(2019\)](#) explore the efficacy of creating tourism experiences in destinations.

However, most studies in this category employ a quantitative methodology. From 2018, experimentation is the most used method (e.g. lab experiment by [Griffin et al., 2017](#); lab and field experiments by [Tussyadiah et al., 2018a](#)). Subsequently, the use of this methodology has increased considerably (e.g. to analyze how the addition of ambient aromas to a VR experience affects digital pre-experiences with a destination, [Flavián et al., 2021a, 2021b](#); to explore the influence of virtual wine tours on the sensory wine experience behaviors of young consumers; [Wen and Leung, 2021](#); to examine how media technologies and users' gender influence the ways in which tourists gather pre-purchase information; [Martínez-Molés et al., 2022](#); to compare two types of VR images in hotel promotions using self-reported and psycho-physiological measures, [Slevitch et al., 2022](#)).

Online questionnaires have also been used in VR research in tourism. [Disztinger et al. \(2017\)](#) find that perceived usefulness, enjoyment, immersion and interest influence behavioral intentions to use VR for travel planning. Another example is the study of [Lee et al. \(2020\)](#) whose results show that content quality, system quality and vividness of telepresence, which affect behavioral intentions to visit the destination displayed in VR.

4.5 Theories

Different theories have been used to study AR and VR in tourism experiences. [Table 1](#) presents the relevant empirical research on AR (six articles) and VR (26 articles) in the context of tourism divided into the main theoretical foundations: models, media, presence, consumer behavior and other theories.

Regarding AR, only six articles are theory-based driven. The TAM is the most used. For instance, [Chung et al. \(2015\)](#) note that perceived usefulness and ease of use of AR affect the intention to use AR and visit a destination. Other theories that have been employed in AR research are the mental imagery theory ([He et al., 2018](#)), the technology mediation theory ([Tussyadiah et al., 2018a](#)), the classic 4E theory ([Hu et al., 2021](#)), the unified theory of acceptance and use of technology (UTAUT, [Ronaghi and Ronaghi, 2022](#)).

VR tourism studies incorporate presence-related theories, which refers to the psychological sense of "being there" in a mediated virtual environment while physically being situated in another, including through the presence theory ([Wei et al., 2019](#)). Related to presence, two VR articles use the presence-emotion-intention framework (PEI), which is a top-to-bottom approach, from the determinants of presence, to how presence impacts emotion and consequently, intentions ([Yung et al., 2021a, 2021c](#)). However, the most used theories in VR tourism research are the TAM and the stimuli-organism-response (SOR) model ([Kim et al., 2021](#)). This last model explains that stimuli are processed by an internal

AR	VR	Theories	Studies
<i>Models</i>			
	1	Attention–interest–evaluation–desire–action model (AIEDA)	Weng <i>et al.</i> (2021)
	1	Extrinsic–intrinsic motivation model	Li and Chen (2019)
	1	Hedonic motivation system adoption model (HMSAM)	Kim and Hall, (2019)
	1	Information system model (IS)	Lee <i>et al.</i> (2020)
	3	SOR model	Flavián <i>et al.</i> (2019); Kim <i>et al.</i> (2021), Schiopu <i>et al.</i> (2022)
2	4	TAM	Chung <i>et al.</i> (2015), Disztinger <i>et al.</i> (2017); tom Dieck and Jung (2018) Israel <i>et al.</i> (2019a); Schiopu <i>et al.</i> (2021); Fan <i>et al.</i> (2022a)
<i>Media</i>			
	1	CATLM	Leung <i>et al.</i> (2022)
	1	Dual coding theory	Zeng <i>et al.</i> (2020)
	1	Media richness theory	Lee <i>et al.</i> (2021)
1		Mental imagery theory	He <i>et al.</i> (2018)
<i>Presence</i>			
	2	Presence theory	Wei <i>et al.</i> (2019), Aldossary and McLean (2022)
	2	PEI framework	Yung <i>et al.</i> (2021a, 2021c)
<i>Consumer behavior</i>			
	1	Theory on consumer learning	Martinez-Molés <i>et al.</i> (2022)
1		UTAUT	Ronaghi and Ronaghi (2022)
	1	Expectancy theory	Talwar <i>et al.</i> (2022)
	1	Self-brand connection	Bogicevic <i>et al.</i> (2021)
	1	Spillover theory	Leung <i>et al.</i> (2023)
	1	Hedonic–utilitarian theory	Israel <i>et al.</i> (2019b)
<i>Other theories</i>			
	1	Construal-level theory (CLT)	Kang (2020)
	1	Optimal–arousal theory	Wei <i>et al.</i> (2023)
	1	Classic theory of 4E	Hu <i>et al.</i> (2021)
	1	Technology mediation theory	Tussyadiah <i>et al.</i> (2018a)
	1	Theory of embodied cognition	Wen and Leung (2021)

Table 1.
Used theories in
AR/VR tourism
research

component, the organism, and this finally leads to the performance (or not) of certain behaviors (Flavián *et al.*, 2019). The remaining articles on VR consider another series of theories and models (e.g. Media Richness Theory; Lee *et al.*, 2021; expectancy theory, Talwar *et al.*, 2022).

As shown in Table 1, a multitude of theories has been applied to both AR and VR tourism research. However, it should be highlighted the TAM is the most used model for this area of research on both technologies (a total of six articles).

4.6 Variables

This section identifies the key concepts applied in the research on AR and VR in tourism. Figure 7 displays the most important antecedents (considering three dimensions: device, content and user) and consequences that have been studied in the previous literature. This gives rise to a new conceptual AR/VR tourism research framework (see Figure 7) that combines both dimensions in a graphic and visual way.



Figure 7. Variables in the AR/VR tourism research

Regarding AR variables, we highlight device variables, where we find effort expectancy, one of the most used (Ronaghi and Ronaghi, 2022; Calderón-Fajardo *et al.*, 2023). Regarding content, personalized service with the AR app has only been studied in the context of AR (Jung *et al.*, 2015). It refers to the ability to provide personalized information, understand the users' needs and preferences, as well as personalized interaction (Jung *et al.*, 2015). In addition, in the context of AR in tourism, it has also been addressed variables related to users' personal perceptions: critical mass (Hsiao and Tang, 2021), ease of imagination (Orús *et al.*, 2021), innovation resistance and social influence (Ronaghi and Ronaghi, 2022) or social interaction (Hudson *et al.*, 2019; Kim *et al.*, 2020a, 2020b). Finally, this study identifies the consequences derived from the use of AR in tourism: such as continuing use intention (Chung *et al.*, 2018), emotional arousal and feeling of belonging (Hu *et al.*, 2021), as well as the willingness to pay more to use this technology in their tourism experiences (He *et al.*, 2018).

As for VR, we identified three unique device variables: functional quality (Wei *et al.*, 2019), product knowledge (Martinez-Molés, 2022) and technology anxiety (Disztinger *et al.*, 2017). Related to content, gamification highlights as a key variable to improve the VR tourism experience (Wei *et al.*, 2023). Perceived coolness (Bogicevic *et al.*, 2021) has also been addressed in previous literature, demonstrating that hotel brands can employ cool technologies (VR) to appeal to hospitality consumers. In addition, there exist several variables regarding users' perceptions: attention allocation (Tussyadiah *et al.*, 2017), flow state (Kim and Hall, 2019; Kim *et al.*, 2020a, 2020b), perceived immersion (Disztinger *et al.*, 2017) or self-location (Kim *et al.*, 2021; Schioppa *et al.*, 2021). Finally, a wide set of consequences derived from VR tourism experiences have been considered (e.g. brand attitude, Lee *et al.*, 2021; intention to recommend the VR experience, Yung *et al.*, 2021c; pro-environmental behavior, Talwar *et al.*, 2022; purchase intention, Wen and Leung, 2021; satisfaction with the experience, Jung *et al.*, 2018b; Aldossary and McLean, 2022).

Similarly, it should be highlighted the variables used with both technologies in the dimensions of device (e.g. perceived usefulness and ease of use [Chung *et al.*, 2015; Kourouthanassis *et al.*, 2015; tom Dieck and Jung, 2018], technology readiness [e.g. Kim *et al.*, 2020a, 2020b]); content (e.g. perceived quality [tom Dieck and Jung, 2018], visual appeal [Chung *et al.*, 2015; Jung *et al.*, 2018a, Marasco *et al.*, 2018; Orús *et al.*, 2021]) and users [enjoyment [e.g. Kim *et al.*, 2021; Fan *et al.*, 2022a]; escapism [Serravalle *et al.*, 2019]). In addition, there are common consequences addressed in both VR and AR research in tourism: attitude toward the technology (Errichiello *et al.*, 2019); intention to visit the tourism product (Marasco *et al.*, 2018; Yung *et al.*, 2021a), nostalgia (Hu *et al.*, 2021) and usage intention (Chung *et al.*, 2015; Errichiello *et al.*, 2019).

5. Conclusions

Recent technologies such as AR and VR are gaining attention in the field of marketing research, especially for services such as tourism. Through AR and VR, it is possible to create different tourism experiences with the aim of providing added value to tourists. This research highlights the recent gap in the literature. Previous literature reviews have considered AR and VR together, at the same level. Nevertheless, AR and VR are two distinct technologies with unique features that set them apart. To gain a comprehensive understanding of their individual potentials and shed light on specific research avenues for each, a literature review examining the application of AR and VR in tourism becomes imperative. Such a review not only delves into the extensive body of literature on each technology but also facilitates comparative analysis, enabling us to discern the respective lines of research of AR and VR in generating impactful and immersive tourist experiences.

Based on that, an AR/VR tourism research framework (Figure 7) is displayed, and a research agenda will be proposed.

Our literature review highlights the increasing importance of AR and VR technologies in tourism research, stressing their potential to change the tourists' experiences. A significant portion of the reviewed studies have been published since 2018, which brings the novelty of this research area and the growing interest. The 84 reviewed articles are classified into six contexts: destination, memory tourism, hotel, museum, theme park and tourism (general). The most commonly studied context for both AR and VR is general tourism, followed by destination, and hotels. Specifically, for AR, museums have received the most attention (Jung *et al.*, 2016; tom Dieck *et al.*, 2018), while for VR destination-related topics have more relevance.

As for the stage of the customer's journey in which the studies are developed, in AR, there are two articles focusing on the pre-experience stage. These studies explore elements such as travel group classification based on experience-seeking and boredom-susceptibility, and the development of a business model considering AR in a theme park (Cranmer *et al.*, 2021; Park and Stangl, 2020). By contrast, most of the AR articles are developed in the onsite stage, starting from 2015, with studies examining the functional properties of AR systems (Kourouthanassis *et al.*, 2015), the use of AR head-mounted displays in art experiences (tom Dieck *et al.*, 2018), or the influence of perceived enjoyment on overall experiences (Han *et al.*, 2013). For VR, most of the articles consider the pre-experience stage, with a total of 40 papers since 2017. These studies investigate topics such as the effectiveness of different media in digital pre-experiences (Griffin *et al.*, 2017), the role of mental imagery and presence in VR hotel pre-experiences (Bogicevic *et al.*, 2019), the effect of adding VR to online reviews (Zeng *et al.*, 2020) and the impact of VR features on media richness (Lee *et al.*, 2021). There is also an increasing number of studies in recent years exploring the relationship between motivational forces and pro-environmental behaviors in VR pre-experiences (Talwar *et al.*, 2022). In terms of onsite experiences, studies have examined the effect of presence in VR tourism experiences (Wei *et al.*, 2019), the influence of social factors on word-of-mouth and willingness to pay (He *et al.*, 2018) and the impact of trait mindfulness on employee experiences with VR interventions (Leung *et al.*, 2023).

Regarding the used methodology, the research on immersive technologies (AR and VR) in tourism has evolved over the past two decades, with a shift from qualitative exploratory studies to more confirmatory studies employing quantitative techniques. Qualitative methods, such as in-depth interviews, have been used to understand visitors' preferences that enhance their tourism experiences (Han *et al.*, 2013) or focus groups (Jung *et al.*, 2018a). More recently, one of the most used methodologies is lab experiments, which have been used to compare different formats (e.g. static images, 360-degree videos, VR) and assess the impact of immersive technologies on perceptions of vividness, interactivity, presence, flow, enjoyment and purchase intentions (Israel *et al.*, 2019a, 2019b; Willems *et al.*, 2019). Specifically, studies on AR have mainly focused on qualitative methods (e.g. in-depth interviews; Han *et al.*, 2013) and conceptual papers (Cranmer *et al.*, 2021) to provide comprehensive overviews for understanding the application of this technology in tourism. On the other hand, VR studies have used different methodologies, with a majority using quantitative methods such as lab experiments (Flavián *et al.*, 2021a, 2021b; Wen and Leung, 2021) and online questionnaires (Lee *et al.*, 2020).

Both AR and VR tourism research articles draw upon a wide variety of theories, but the TAM stands out as the most used model in research on both technologies. TAM is applied in six articles (AR: Chung *et al.* [2015], tom Dieck and Jung [2018], VR: Disztinger *et al.* [2017], Israel *et al.* [2019a], Schioppa *et al.* [2021], Fan *et al.* [2022a]), what highlights its significance

Topic	Reality	Research question
<i>Customer experience</i>	<i>AR</i>	How can negative experiences (e.g. motion sickness, security concerns) with AR affect the global customer experience? How do the different types of AR experiences that can be provided to customers (e.g., location-based AR, marker-based AR, wearable AR devices) influence customer perceptions and satisfaction?
	<i>VR</i>	Are there any customer segments that are more receptive to VR and its potential for enhancing their travel experiences? How does the level of embodiment, immersion and interactivity in VR experiences affect customer perceived value? Are there any differences between customer VR experiences with standalone devices or high-end PC VR devices? How can be created multisensory VR experiences? Is VR effective for generating extra-sensory experiences?
	<i>AR and VR</i>	How can organizations leverage these technologies to create more authentic and realistic customer experiences? How can organizations ensure the responsible and ethical implementation of these technologies to protect customer privacy and well-being?
<i>Customer journey</i>	<i>AR</i>	How does AR impact customers' interactions with the physical environment during their on-site experience? What is the most effective AR-based strategies for personalizing and customizing the customer journey? How does the integration of augmented reality into different touchpoints of the customer journey (e.g. in-store, online, mobile) influence customer behavior and satisfaction?
	<i>VR</i>	How does the use of VR during the customer journey affect customers' post-trip reflections, memories and storytelling? What are the long-term impacts of VR on customers' post-trip sharing, reviews and advocacy? How does the integration of virtual reality with other emerging technologies, such as artificial intelligence or blockchain, enhance the customer journey?
	<i>AR and VR</i>	What are the key moments within the customer journey where immersive technologies can have the most significant impact? Are there any differences in the effectiveness of the realities (AR or VR) depending on the stage of the customer's journey in which they are applied? How can immersive technologies be used to enhance customer decision-making processes during the customer journey in the tourism industry?
<i>Tourism industry</i>	<i>AR</i>	Is AR effective while consumers are traveling (e.g. by train, plane)? How can AR-based gamification techniques be used to engage tourists and enhance their participation in destination activities? How can AR-based applications be used to provide personalized and context-aware recommendations and information to tourists?
	<i>VR</i>	What are the specific applications of VR in different sectors of the tourism industry (e.g. accommodations, attractions, transportation), and how do these applications shape customer experiences? How can VR be applied in meetings, incentives, conferences and exhibitions (MICE) tourism? Can it replace MICE tourism? Can VR be used as a first step toward the development of actual space tourism experiences? Is VR an effective tool in cruise tourism?

Table 2.
Research agenda on
AR and VR in
tourism

(continued)

Table 2.

Topic	Reality	Research question
	<i>AR and VR</i>	<p>Are these technologies effective tools to stop overtourism?</p> <p>How can these technologies be applied to enhance the tourism experiences of individuals with mobility disabilities or other health conditions?</p> <p>How can these technologies be used to facilitate stakeholder collaboration, community engagement and decision-making processes in sustainable tourism development?</p>
<i>Metaverse</i>	<i>AR</i>	<p>What are the implications of combining AR, the metaverse and geolocation for location-based tourism experiences?</p> <p>How can AR and the metaverse be leveraged to create inclusive and accessible tourism experiences?</p> <p>How can augmented reality enhance the storytelling and narrative elements of virtual tourism experiences within the metaverse?</p>
	<i>VR</i>	<p>How can the metaverse and VR technologies contribute to sustainable tourism practices and environmental conservation?</p> <p>How can the integration of VR and metaverse platforms in the tourism industry create immersive virtual tourism experiences?</p> <p>How can VR metaverse platforms facilitate cross-cultural communication and interaction between tourists and locals in virtual tourism destinations?</p>
	<i>AR and VR</i>	<p>What are the synergistic effects and potential challenges in combining these technologies for enhanced tourist experiences?</p> <p>What is the privacy, data security and ethical considerations associated with AR/VR in the metaverse for tourism?</p> <p>How can immersive technologies and the metaverse be effectively harnessed to bridge the gap between pre-visit, onsite and post-visit tourism experiences within the metaverse?</p>

in understanding the applications and impact of AR and VR in tourism experiences. Furthermore, there are different theories that can be grouped according to media (VR: cognitive–affective theory of learning with media [CATLM], [Leung et al., 2022](#); dual coding theory, [Zeng et al., 2020](#); media richness theory, [Lee et al., 2021](#); AR: mental imagery theory, [He et al., 2018](#)), presence (e.g. presence theory [VR], [Wei et al., 2019](#); [Aldossary and McLean, 2022](#)), consumer behavior (e.g. AR: UTAUT, [Ronaghi and Ronaghi, 2022](#); VR: self-brand connection, [Bogicevic et al., 2021](#); hedonic–utilitarian theory, [Israel et al., 2019b](#)) and more specific theories (e.g. Classic theory of 4E [AR; [Hu et al., 2021](#)]; optimal-arousal theory [VR; [Wei et al., 2023](#)]).

Finally, this literature review identifies key variables studied in previous research combining different antecedent dimensions (device, content and user) and the consequences associated to AR, VR or both ([Figure 7](#)). In the context of AR, effort expectancy (device variable) stands out particularly (e.g. [Calderón-Fajardo et al., 2023](#)), while personalized service ([Jung et al., 2015](#)) is the only analyzed variable in the content dimension, focusing on providing personalized information and interaction. For VR, gamification ([Wei et al., 2023](#)) and perceived coolness ([Bogicevic et al., 2021](#)) are key content variables for enhancing VR tourism experiences. In addition, there are multiple variables analyzed for the user experience (e.g. interest [[Lee et al., 2021](#)], flow state [[Kim et al., 2020a, 2020b](#)], sense of presence [[Orús et al., 2021](#)], skepticism [[Disztinger et al., 2017](#)]) and the consequences derived from the use of this technology (e.g. intention to book [[Orús et al., 2021](#)], pleasure [[Leung et al., 2022](#)], pro-environmental behavior [e.g. [Talwar et al., 2022](#)], purchase intention [e.g. [He](#)

et al., 2018]). Literature also highlights variables that are common to both technologies: three device-related variables (perceived usefulness [e.g. Kourouthanassis *et al.*, 2015], technology readiness [e.g. Kim *et al.*, 2020a, 2020b], perceived quality [e.g. tom Dieck and Jung, 2018]), four for content, highlighting visual appeal, Marasco *et al.*, 2018; Orús *et al.*, 2021; and, three for user's experience (enjoyment [e.g. Fan *et al.*, 2022a]; escapism [e.g. Serravalle *et al.*, 2019]; usefulness [e.g. Li and Chen, 2019]). Common consequences include four interesting variables (attitude toward the technology, Errichiello *et al.*, 2019; intention to visit, Yung *et al.*, 2021a; nostalgia, Hu *et al.*, 2021; usage intention, Chung *et al.*, 2015).

Due to the nature of this literature review, this study is not without its limitations. It was not possible to perform a meta-analysis due to the large degree of heterogeneity in the studies included in this review. Apart from the study of Fan *et al.* (2022b), more meta-analyses studies are needed to advance on this topic. Additionally, it is important to identify the possibility of publication selection biases, as the search was limited to English papers available on two databases (Scopus and Web of Science) until a certain date, which may limit the number of potential papers identified and included in this review. Future studies should be conducted to find a consensus in the current literature wave on AR and VR in tourism. Finally, this research has focused solely on AR and VR. However, considering the recent push of the so-called PMR (Flavián *et al.*, 2019), and the upcoming release of PMR devices by big-tech companies such as Apple (Apple Vision Pro), it seems feasible that the future development of immersive technologies will be based on this technology. Thus, it should be analyzed its impact on the tourism field.

6. Research agenda on augmented reality and virtual reality in tourism

This article seeks to bring attention to a topic of growing relevance (AR and VR in tourism) and, based on that, to provide a research agenda to guide and stimulate further research into the introduction of immersive technologies in tourism. This research agenda (Table 2) suggests research questions divided into four blocks (customer experience, customer journey, tourism industry and metaverse) that emerge from the analyzed articles and other recent topics nowadays. By identifying common themes, challenges and opportunities, this research agenda seeks to establish a cohesive framework that promotes collaboration and synergy among researchers, ultimately driving the development and advancement of both AR and VR research in the tourism industry.

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