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Sergio Ibáñez Sánchez

Engaging customers before the trip: experimental analysis of the role of virtual and augmented reality in the creation of tourism pre-experiences

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ENGAGING CUSTOMERS BEFORE THE TRIP: EXPERIMENTAL ANALYSIS OF THE ROLE OF VIRTUAL AND AUGMENTED REALITY IN THE CREATION OF TOURISM PRE-EXPERIENCES

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UNIVERSIDAD DE ZARAGOZA
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UNIVERSIDAD DE ZARAGOZA

Dirección de Marketing e Investigación de Mercados

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Doctoral Thesis

Engaging customers before the trip: experimental analysis of the role of virtual and augmented reality in the creation of tourism pre-experiences

PhD Candidate

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2020

A mis padres, Mª Pilar y Pedro, y a mi hermana, Silvia,

por creer siempre en mí y por ser la base sobre la que se sustentan mis pasos

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AR: Augmented Reality

AV: Augmented Virtuality

CAVE: Cave Automatic Virtual Environment

EPI Cube: Embodiment-Presence-Interactivity Cube

HMD: Head-Mounted Display

HTI: Human-Technology Interaction

ICT: Information and Communication Technology

MR: Mixed Reality

PC: Personal Computer

PMR: Pure Mixed Reality

RE: Real Environment

SM: Smartphone

VE: Virtual Environment

VR: Virtual Reality

XR: Extended Reality

PART I. THE EVOLUTION OF IMMERSIVE TECHNOLOGIES AND THEIR IMPACT ON TOURISM

1. Introduction

1.1. Introduction

During the last decades, we have witnessed the progressive development and dissemination of new Information and Communication Technologies (ICTs) which have profoundly transformed the society where we live (Grewal, Hulland, Kopalle, & Karahanna, 2020). ICTs offer new ways of interaction and facilitate the access to an unprecedented volume of information, which is essential for the political systems, the economic institutions and for us as individuals (Schuelke-Leech, 2018). The advances in communication arising from this technological evolution have resulted in a global era where the possibilities of human communication are unlimited, with the transmission of information in infinite quantities, from any place and with a quickness not seen before (Flavián & Gurrea, 2008, 2009; Fukuda, 2020). These developments have shaped the evolution of our societies, leading to economic and social changes, and shaping not only the daily relationships between people and political, economic and other organizations, but also the relationships between business and customers (Hoyer, Kroschke, Schmitt, Kraume, & Shankar, 2020).

The implementation of ICTs in services (e.g. tourism, education, healthcare, entertainment, banking) is key to achieve an effective digitalization of the tertiary sector of the economy (Buhalis et al., 2019). Given the characteristics of services (intangibility, heterogeneity, and inseparability of production and consumption; Parasuraman, Zeithaml, & Berry, 1985), ICTs are especially relevant in their related industries. In particular, the intangibility and heterogeneity of services mean that products cannot be tested in advance, which makes it difficult to generate realistic expectations and increases the perceived risk involved in the choice (Casaló, Flavián, Guinalíu, & Ekinci, 2015). In this sense, the great amount of information provided with ICTs has contributed to reduce the risk of service decision-making processes (Flavián & Gurrea, 2006; Kim & Mattila, 2011). Overall, ICTs have transformed the consumers' experience with services along their purchase journey, generally grouped into pre-purchase search (recognition of need, search for information, evaluation of alternatives), decision-purchase experience, and post-purchase behavior (Frambach, Roest, & Krishnan, 2007). The digitalization of the tertiary sector is fundamental for the development of a strengthened economic activity and for improving the well-being of the society worldwide (Buhalis et al., 2019; Hoyer et al., 2020).

Among these services, the tourism industry has been dramatically transformed during the last years with the implementation of new technologies (Werthner & Klein, 1999; Xiang, Magnini, & Fesenmaier, 2015). This industry deserves special attention since it is one of the most relevant worldwide, contributing to the 10.3% of the global GDP and being responsible for 1 out of 10 jobs around the world (World Travel & Tourism Council –WTTC–, 2020). Tourism can be considered as "an amalgam of service industries" (Otto & Ritchie, 1996; p. 165) which encompasses a wide variety of intangible and experiential products (e.g. destinations, transportation, accommodations, events) (Guttentag, 2010). This industry has gone hand in hand with the development of new technologies for many decades, embracing ICTs to generate better and innovative experiences (Buhalis & Law, 2008), and revolutionizing the pre-tourism experience, on-site tourism experience and post-tourism experience (Neuhofer, Buhalis, & Ladkin, 2014). Integrating innovative ICTs into tourism experiences can modify conventional experiences and create new ones based on technology-mediated environments, opening a new wave of opportunities and challenges for the effective digitalization of tourism (Gretzel, Fesenmaier, Formica, & O'Leary, 2006; Neuhofer et al., 2014).

The digitalization of all these service-based industries is paramount to strengthen the roots of the tertiary sector of the economy, which is one of the most relevant worldwide, and to protect it from the different threats that can affect this sector dramatically. This fact can be seen these days, as the current COVID-19 pandemic has notoriously affected the multiple industries that constitute the tertiary sector. Beyond the devastating sanitary, economic and social impacts of the COVID-19 pandemic, this crisis is accelerating the development and implementation of ICTs to confront the restrictions derived from the pandemic and achieve economic and social recovery (Gretzel et al., 2020). It is expected that this trend will continue in the future at an even greater pace, and the development of ICTs will favor the synergic management of the customer-business relationship by blurring the boundaries between physical and digital spheres (Krafft, Sajtos, & Haenlein, 2020).

In this context, the current wave of reality-virtuality technologies is changing the way customers experience the real and the virtual environments (Hollebeek, Clark, Andreassen, Sigurdsson, & Smith, 2020; Hoyer et al., 2020; Jessen et al., 2020). Specifically, Virtual Reality (VR), Augmented Reality (AR) and Pure Mixed Reality (PMR) are shaping new environments where real and digital objects are integrated at different levels, resulting in hybrid customer experiences. With AR, the digital information is superimposed over the real environment; in VR, users are immersed into a fully computer-generated environment; in PMR, real and digital elements coexist and interact with each other and with the user (Flavián, Ibáñez-Sánchez, & Orús, 2019a). These immersive technologies are likely to play an essential role in several industries (Berg & Vance, 2017), such as tourism (e.g. Kim, Lee, & Jung, 2020), retail (e.g. Heller, Chylinski, de Ruyter, Mahr, & Keeling, 2019a), marketing (e.g. Wedel, Bigné, & Zhang, 2020), education (e.g. Sahin & Yilmaz, 2020), healthcare (e.g. Maggio et al., 2019) or entertainment (e.g. Lin, Wu, & Tao, 2017). The potential of Extended Reality (XR), the term used to encompass all these realities, is clear since the main digital players of the market (e.g. Facebook, Google, Apple, Microsoft) are investing heavily in them (Investor, 2020), and XR technologies are ranked in the top 10 strategic trends (Gartner, 2018; 2019). The commitment of the industry to standalone devices, which do not require to be connected to other equipment (e.g. computers), together with the gradual drop in end consumer prices in the last years, are putting these technologies in a great position to become widespread. As an example, Oculus Quest 2 (The Verge, 2020), the brand-new standalone VR Head-Mounted Display (HMD) launched by Facebook, has a price of USD299, while its predecessor in 2016 (Oculus Rift) required connection to a powerful computer and had a selling price of USD599 (Oculus, 2016). Recent years have also witnessed the arrival of AR HMDs (e.g. Google Glass Enterprise) and PMR HMDs (e.g. Microsoft HoloLens 2). In addition, recent efforts have been made in the XR industry to overcome the problems associated with the lack of contents available to the general public, reaching a maturity state in which a wide variety of professional contents have been developed (LEK, 2019). These factors contribute to the growth of the XR industry, which is forecasted to grow from USD7.9 billion in 2019 to USD136.9 billion in 2024 (IDC, 2020). The arrival of 5G, the next-gen mobile data technology, can even boost the adoption of these technologies (Forbes, 2019). All these facts support the positive expectations about the future of XR technologies.

Service-based industries can especially benefit from the implementation of XR technologies (Buhalis et al., 2019; Sahin & Yilmaz, 2020). These reality-virtuality technologies significantly affect the customer experience, defined as the "customer's cognitive, emotional, behavioral, sensorial, and social responses to a firm's offerings during the customer's entire purchase journey" (Lemon & Verhoef, 2016; p. 71). Customers have different touchpoints, physical and digital, with companies in the multiple phases of their decision-making process, and these sensory, affective, behavioral and intellectual sub-experiences form the fundamental customer shopping experience

(Brakus, Schmitt, & Zarantonello, 2009). Managing the customer experience is paramount for services (Teixeira et al., 2012) and the integration of XR technologies is especially important since companies are able to offer added value propositions to generate optimal experiences through the combination of physical and digital touchpoints (Hollebeek et al., 2020; Hoyer et al., 2020). If the implementation of previous technological developments meant a breakthrough to tackle the main features of services (Parasuraman et al., 1985), XR technologies can take a large step forward as they can provide customers with experiential, immersive and extra-sensory information in unprecedented ways (Buhalis et al., 2019; Neuburger, Beck, & Egger, 2019; Willems, Brengman, & Van Kerrebroeck, 2019). Specifically, XR technologies offer new types of information and foster users' imagination conveniently throughout the customer journey, enabling enhanced omnichannel experiences (Heller et al., 2020; Hoyer et al., 2020). The use of XR technologies allows consumers to have a more dynamic and autonomous role in their service experiences (Cranmer, tom Dieck, & Fountoulaki, 2020; Rafaeli et al. 2017), leading to higher value perceptions (Hoyer et al., 2020; Neuburger et al., 2019).

XR technologies are being notoriously implemented in tourism and hospitality (e.g. destinations, museums, theme parks, restaurants; Buhalis et al., 2019; Wei, 2019). The use of immersive technologies can help overcome the intangible and experiential nature of tourism products (Guttentag, 2010; Tussyadiah, Wang, Jung, & tom Dieck, 2018), enabling potential tourists to know and experience them in a novel way, compared to traditional media (Loureiro, Guerreiro, & Ali, 2020; Wei, 2019). Although previous technological advances have improved the information available to tourists, the application of XR technologies offers multiple possibilities that are revolutionizing the information available, the tourist's experience, and all the related experiences prior to, and after, the actual purchase and tourist consumption (Neuburger et al., 2019). This is mainly due to the fact that these technologies reduce the barriers between the real and the virtual environments, giving a sense of immersion and improving the realism of digital experiences (Neuburger et al., 2019).

The implementation of AR and VR throughout the tourist purchase journey has many benefits for tourists: they can obtain personalized information (Kounavis, Kasimati, & Zamani, 2012; Yung & Khoo-Lattimore, 2019), be entertained during the experience (Guttentag, 2010; Tussyadiah, Jung, & tom Dieck, 2018), improve their learning processes (Guttentag, 2010; tom Dieck & Jung, 2018), increase their attention and curiosity (Cranmer et al., 2020; Wei, Qi, Zhang, 2019), get more social interaction and connectivity (Kounavis et al., 2012), greater accessibility (Guttentag, 2010) and engagement (Flavián, Ibáñez-Sánchez, & Orús, 2020; Griffin et al., 2017), to name a few. In addition, these technologies have the ability to generate extra-sensory experiences, taking the sensory integration between the real and virtual environments to the next level (Buhalis et al., 2019; Petit, Velasco, & Spence, 2019). Considering all the above, there is no doubt of the potential that immersive technologies have for the tourism industry, and further research is needed in order to achieve an effective implementation of AR and VR to generate valuable tourism experiences.

The interest in addressing this nascent area of research comes from many fields. From the academic perspective, the study of how AR and VR technologies can be effectively applied in the customer journey is aligned with the research priorities set by the Marketing Science Institute (2018-2020; MSI, 2018), regarding the role played by new technologies in customer's experiences in the omnichannel landscape, and the ones proposed for the next years (MSI, 2020), concerning the challenges and opportunities that AR and VR can generate for marketing. From a managerial perspective, several reports acknowledge the potential of these technologies to improve performance and efficiency, enhance the value propositions and improve the user experience (Deloitte, 2019; PwC, 2019a). The study of how immersive technologies affect the tourists' experience is also acknowledged a research priority by politics and governments (Ministry of Economic Affairs and Digital Transformation, 2017). Therefore, all these perspectives agree on the interest that underlies this area of research and the importance of gaining a deeper understanding of the processes that take place in users' experiences with AR and VR technologies, particularly in the tourism industry.

However, the existing literature is currently under development, and researchers and practitioners call for studies to fully understand the (potential) tourists' experiences with AR and VR technologies (Loureiro et al., 2020; Wei, 2019; Yung & Khoo-Lattimore, 2019). In addition, previous research shows a conceptual inconsistency in the use of the terms referring to the different realities (Yung & Khoo-Lattimore, 2019). Furthermore, after an initial stage of theoretical developments (e.g. Cheong, 1995; Hobson & Williams, 1995), the publication of empirical studies within this topic has soared, especially in the last five years (e.g. Bogicevic, Seo, Kandampully, Liu, & Rudd, 2019; Kim, Lee, & Jung, 2020; Tussyadiah, Jung, et al., 2018). Due to the novelty of the research topic and the recent (and potential) advances in the development of XR technologies, further research is needed to comprehend how these technologies can be used to generate effective user experiences, particularly in tourism (Loureiro et al., 2020). There is still a long road to deeply understand the processes underlying the tourism experiences with AR and VR.

1.2. Research objectives and structure

Focusing on users' pre-experiences with tourism products as the research context, the main objective of this doctoral thesis is to analyze the cognitive, affective and behavioral dimensions of the users' experience with immersive technologies.

The main objective is divided into specific objectives that are detailed below. These specific objectives are addressed through an in-depth literature review and the development of several empirical studies.

- **Research objective 1:** *set the conceptual boundaries that define the different realities, technologies, and the customer experiences with immersive technologies.*

Previous research highlights the lack of consensus when defining the components and modalities of technologies in the reality-virtuality continuum (e.g. Milgram & Kishino, 1994; Yung & Khoo-Lattimore, 2019). From a managerial perspective, several HMDs have been confusingly named considering their characteristics (e.g. Windows Mixed Reality; PCWorld, 2017). Therefore, there is no general consensus, both at the academic and business spheres, that establishes the limits between the different realities. This agreement is paramount to lay the foundations of this nascent field of research.

To overcome this lack of consistency in the use of terminologies by researchers and practitioners, this doctoral thesis seeks to clarify the conceptual limits that currently define the different realities. Once these concepts are clarified, these realities are proposed to alter the customer experience throughout all the stages of the purchase journey. In addition, considering the three dimensions of Human-Technology Interaction (HTI), it is proposed a theoretical framework, the Embodiment-Presence-Interactivity (EPI) Cube, that aims to classify all the current and potential reality-virtuality technologies. These theoretical proposals serve as the basis for the empirical studies of this doctoral thesis.

- **Research objective 2:** *analyze the effects of technological embodiment on the pre-experiences with immersive technologies.*

Technological embodiment is regarded as the degree to which a device mediates the users' experience by becoming an extension of their human senses (Ihde, 1990). Despite receiving limited attention, embodiment has been acknowledged as a key factor in the development of user experiences with wearable devices, such as AR/VR HMDs; yet, it has been barely analyzed in empirical studies (Tussyadiah, Jung, et al., 2018). To fill this gap in the literature, this doctoral thesis examines the impact of technological embodiment, with different devices, on the tourists' pre-experiences. Specifically, this doctoral thesis examines how technological embodiment influences users' cognitive and affective states, which subsequently determine their behavioral intentions.

- **Research objective 3:** *analyze the comparative effects of AR and VR in a tourism pre-experience.*

Previous studies mostly consider the individual impact of AR (Chung, Lee, Kim, & Koo, 2018; Cranmer et al., 2020) or VR (e.g. Kim, Lee, & Jung, 2020; Tussyadiah, Wang, et al., 2018) on tourism experiences, and few research analyzes the additive effect of implementing both technologies for improving the visitor experience (e.g. Jung, tom Dieck, Lee, & Chung, 2016). However, the comparison between AR and VR, which is important to understand which reality generates more valuable tourism pre-experiences, has been overlooked (Kim, Lee, & Jung, 2020).

In this way, this doctoral thesis considers the type of content (realistic or digital) and device (HMD or smartphone) to analyze how the levels of perceptual presence (i.e. a continuum ranging from the sense of being in the actual location to the sense of being elsewhere) and technological embodiment elicited by AR and VR technologies affect the user's pre-experience with a tourism product.

- **Research objective 4:** *examine the effects of sensory enrichment in VR tourism pre-experiences.*

Most digital experiences have a strong audiovisual component, and the impact of other sensory stimuli has been regarded to a lesser extent, both in the academic and in the professional spheres (Guttentag, 2010; Petit et al., 2019). Despite the recent advances, the sensorialization of the virtual environment is still a challenge (Petit et al., 2019). The incorporation of touch to VR experiences has received considerable attention in the literature, while smell and taste are less addressed (Baus, Bouchard, & Nolet, 2019). Moreover, the results from previous studies show a lack of consistency regarding the effects of the incorporation of senses to the VR experience.

Therefore, given that the integration of olfactory stimuli into VR research has been less considered than tactile stimulation (Guttentag, 2010), this doctoral thesis focuses on the addition of ambient scents to VR pre-experiences to enrich the multisensory digital experience. The addition of suitable odors to VR experiences represents a further step toward the effective sensorialization of the digital environment. Specifically, the interplay between ambient scents and technological embodiment on the generation of responses toward the tourism product is analyzed.

- **Research objective 5:** *analyze the impact of immersive pre-experiences across different tourism settings.*

The empirical studies conducted are contextualized in different tourism settings (destinations and hotels), and also consider types of tourism that involve different activities. In so doing, the extension and validity of the findings across different tourism settings is pursued, which will offer a more complete picture of how immersive technologies can enhance tourism pre-experiences.

The structure of this doctoral thesis is shown in Figure 1.1. The present chapter introduces the research motivations and the goals of the dissertation. Chapter 2 reviews the specialized literature on immersive technologies in tourism and hospitality. The evolution of research in this field is presented, from the initial stages to the present day, and several gaps in the literature are identified.

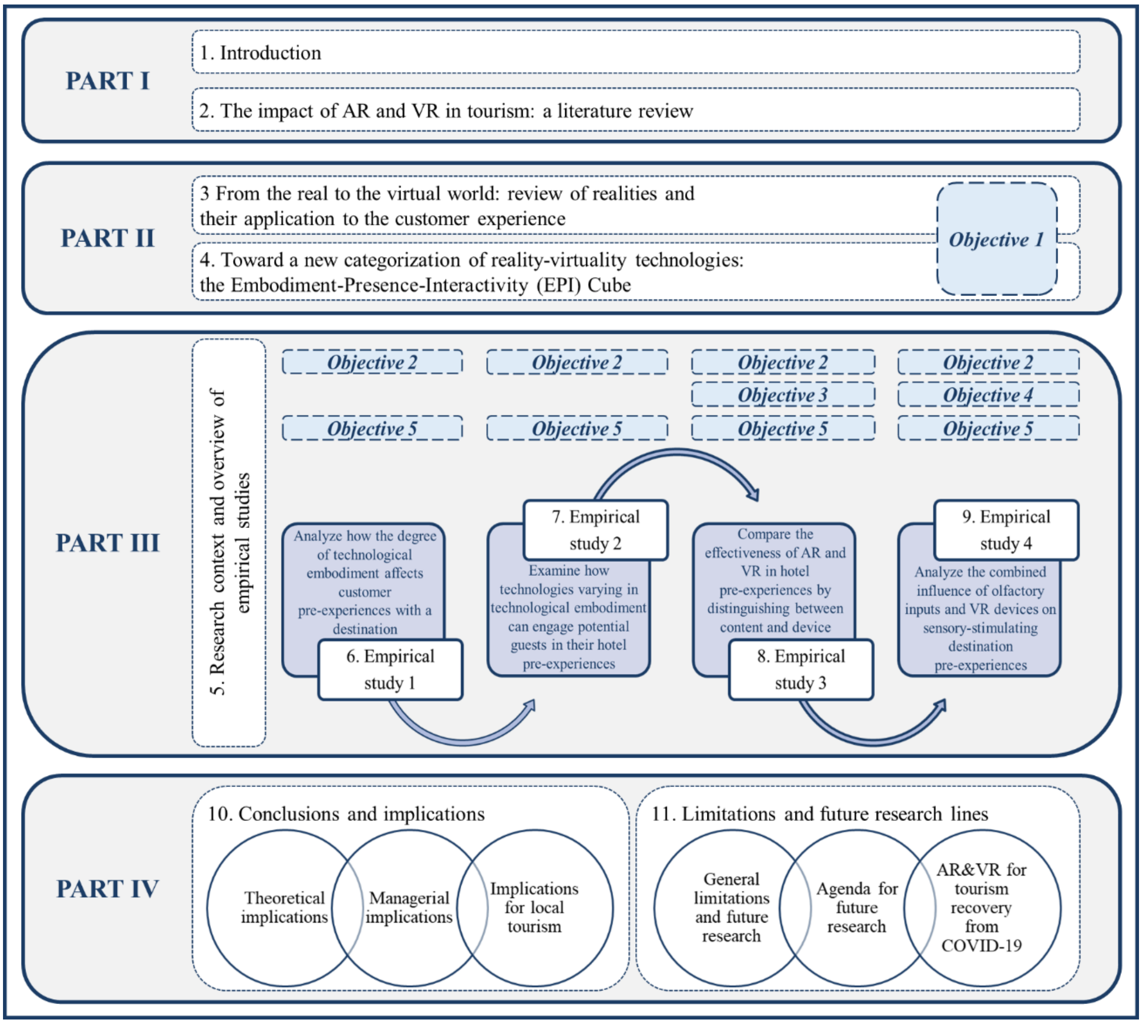
After that, the second part of the dissertation is devoted to the theoretical development. Specifically, chapter 3 provides a new reality-virtuality taxonomy, which tries to clearly set the boundaries between the realities. In addition, it proposes how these realities can affect the customer experience throughout the different stages of the purchase journey. Chapter 4 delves into the basis of this doctoral thesis: the EPI Cube. First, its main dimensions are presented: technological embodiment, perceptual presence and behavioral interactivity. Second, the EPI Cube is explained in detail.

The third part covers the empirical analysis of the doctoral thesis. Chapter 5 presents the research context, the specific research objectives that are addressed in each empirical study, and explains the methodological issues that define the empirical analysis. Next, chapters 6 to 9 are devoted to the four empirical studies of the dissertation. These four chapters analyze the impact of immersive technologies on users' pre-experiences with tourism products.

Finally, the fourth part presents the main conclusions, implications, limitations and future research lines. Specifically, chapter 10 notes the general conclusions derived from the research and highlights the main theoretical and managerial implications.

Chapter 11 details the general limitations of this research and provides an agenda for future research regarding the impact of immersive technologies on the customer experience, ending with a discussion about how these technologies can help the recovery of the tourism industry in the aftermath of the COVID-19 pandemic.

Figure 1.1. Structure of the doctoral thesis



Source: Own elaboration

2. The impact of AR and VR in tourism: a literature review

2.1. Introduction

This chapter provides a literature review regarding the impact of AR and VR technologies on the individuals' experience with tourism products. This review aims to show how previous literature has dealt with this nascent research subject, covering the most important aspects which have been addressed by prior studies. The following section presents how this research stream has evolved from the last decade of the past century to these days, addressing different topics, goals and contexts, as well as highlighting the main findings. The chapter concludes by identifying several gaps in the literature that this doctoral thesis will try to fill.

2.2. Literature review

The literature review is organized in two parts. First, a general discussion of the existing studies in this research area is presented. Second, we point out the main aspects that have been addressed in research focusing on AR and on VR in the tourism literature. At the end of the chapter, we show a table (see Table 2.1) which comprises a total of 56 studies that have been revised. This extensive table offers a summary of the research objectives, the technologies involved, the research contexts, the stage of the consumer's journey (pre-experience, on-site experience or post-experience) analyzed, the research methods, and the main findings of each study.

Early studies analyzing the impact of AR and VR on tourism begun in the 1990s (e.g. Cheong, 1995; Williams & Hobson, 1995). Theoretical developments discussed the idea of VR as a potential substitute or competitor of real tourism (e.g. Hobson & Williams, 1995), while others deem that VR will never replace the feeling of an actual trip (e.g. 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 that has been carried out in the field. Guttentag (2010) explores the sensory developments and the applications of VR in the tourism industry (see Table 2.1). He also discusses the idea of VR as a potential substitute of physical tourism, noting that VR can actually 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 last five years (Loureiro et al., 2020; Wei, 2019). Our review shows a similar pattern, with most of the research being published since 2015 (see Table 2.1).

As for the general trends derived from this literature review, it is worth mentioning that research in 2010-2015 has mainly focused on AR (e.g. Chung, Han, & Joun, 2015; Jung, Chung, & Leue, 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 (e.g. Kim, Lee, & Jung, 2020; Lin, Huang, & Ho, 2020) (see Table 2.1). In this way, Lin et al. (2020) show that visitors, after a VR experience, increase their behavioral intentions to practice slow tourism. The application of immersive technologies was firstly analyzed during the tourism experience (e.g. Jung et al., 2015), but the most recent research is being contextualized in the pre-experience stage, before consuming the tourism product (e.g. Leung, Lyu, & Bai, 2020); 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) (see Table 2.1). For example, in the lab experiment undertaken by Leung et al. (2020) participants (potential guests) could view a hotel commercial using a computer or a VR HMD. Results show that VR produces better immediate results, while for delayed outcomes the results are mixed. Regarding methods, research in the past two decades has also evolved, moving from exploratory studies using mainly qualitative techniques (e.g. in-depth interviews; Han, Jung, & Gibson, 2013), to recent studies with a more confirmatory focus, which frequently employ quantitative techniques (e.g. lab experiments; Israel, Tscheulin, & Zerres, 2019; Israel, Zerres, & Tscheulin, 2019) (see Table 2.1). Han et al. (2013) conduced 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 a careful design, multi-language functionality, ease of use and personalization in AR apps are highly valued by visitors. Willems et al. (2019) carried out a lab experiment 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. As for the research contexts, the study of immersive technologies has been applied to a wide variety of tourism products: early studies focused mostly on destinations (e.g. Han et al., 2013), and further analyses have been applied to certain types of tourism (slow travel tourism; Lin et al., 2020), museums (e.g. He, Wu, & Li, 2018) or the hotel industry (e.g. Leung et al., 2020). He et al. (2018) analyze the factors that promote AR adoption in museums. They performed a lab experiment in which the information type (verbal or visual cues) and virtual presence (high or low) were manipulated. Results show that dynamic verbal cues increase participants' willingness to pay more, and this effect was stronger when a high level of virtual presence was generated in the AR experience. Finally, several literature review studies have been conducted recently, with the aim of giving a general overview of the state of the art, as well as offering future research lines (see Table 2.1). In this way, Loureiro et al. (2020) provide an overview of the AR and VR-related tourism studies network and analyze their evolution over time. They also provide a list with the most relevant topics that have been discussed and suggest some future research avenues: the integration of Brain-Computer Interfaces (BCI; a system that acquires brain signals, interprets them and translates them into outputs like carrying out actions) and AI (Artificial Intelligence) in these experiences or the development of multisensory digital experiences.

In addition, the literature review allows us to identify key issues in the research about AR and VR in the tourist behavior. Regarding the influence of AR, previous studies have identified the antecedents of AR adoption in a tourism setting: perceived usefulness and ease of use, which have traditionally considered in technology acceptance models (Chung et al., 2015; Kourouthanassis, Boletsis, Bardaki, & Chasanidou, 2015; tom Dieck & Jung, 2018), perceived quality of content and of the system, and personalized service with the AR app (Jung et al., 2015; tom Dieck & Jung, 2018) or the visual appeal of the content (Chung et al., 2015; Jung, Lee, Chung, & tom Dieck, 2018) are important to foster the use of AR. Previous research has also analyzed users' perceptions (e.g. Tussyadiah, Jung, et al., 2018) and behavioral intentions (e.g. Chung et al., 2018) derived from the use of AR, as well as the personality traits that make them being more or less willing to accept and use this technology in their tourism experiences (e.g. sensation-seeking; Park & Stangl, 2020). Finally, the wide variety of values that this technology brings to the different stakeholders in the tourism industry has also been explored (e.g. Cranmer et al., 2020; Serravalle, Ferraris, Vrontis, Thrassou, & Christofi, 2019). In this sense, Cranmer et al. (2020) note that tourism stakeholders have identified five values derived from the implementation of AR: marketing (promotion and sales tool), organizational (improve organizational processes, functions and relationships), economic (increase income), tourist (provide enhanced information) and epistemic (promote intellectual curiosity) values.

As for VR, previous literature has considered the antecedents of using VR for travel planning, finding factors (e.g. perceived usefulness, enjoyment, interest, task-technology fit) that positively affect behavioral intentions to use this technology for planning a trip (Disztinger, Schlögl, & Groth, 2017; Israel, Tscheulin, et al., 2019). Another research line is based on analyzing the users' experiences with this technology. Several perceptions have been noted to underlie VR tourism experiences: attention allocation (Tussyadiah, Wang, & Jia, 2017), presence (Tussyadiah et al., 2017; Tussyadiah, Wang, et al., 2018), visual appeal (Marasco, Buonincontri, van Niekerk, Orlowski, & Okumus, 2018), perceived enjoyment (Kim & Hall, 2019; Kim, Lee, & Jung, 2020; Tussyadiah, Wang, et al., 2018), emotional involvement and flow (Kim & Hall, 2019; Kim, Lee, & Jung, 2020), or satisfaction with the experience (Jung, tom Dieck et al., 2018). Research has also shown interest toward the analysis of the effectiveness of VR compared to other traditional promotional tools, such as brochures (e.g. Rainoldi et al., 2018), traditional commercials (e.g. Leung et al., 2020), static images (e.g. Bogicevic et al., 2019; Willems et al., 2019), 2D videos (e.g. Griffin et al., 2017) or even real experiences (Wagler & Hanus, 2018). The interaction between the visual format offered by VR and the written online reviews in tourism pre-experiences has also been explored (Zeng, Cao, Lin, & Xiao, 2020). Additionally, it has been empirically analyzed how the use of VR can decrease the interest in actual tourism (e.g. Deng, Unnava, & Lee, 2019; Li & Chen, 2019). Finally, studies can be found that examine the moderating effect of personality variables in VR tourism experiences (e.g. technology readiness; Kim, Lee, & Preis, 2020).

The 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 studies review has been published since 2018, which brings to light the growing interest in this research field. However, these technologies are still under development, and the end-user's acceptance is rather limited; thus, further research is required to understand its true potential in the user experience. From a theoretical perspective, there is a need to find consensus through a common frame that enables researchers and practitioners to classify the different realities, technologies and experiences with XR technologies. From an analytical perspective, there are several caveats that need further investigation: some of the inherent features of XR technologies (e.g. technological embodiment) have not been properly identified and analyzed. In addition, there is a lack of comparative studies between AR and VR in order to understand which characteristics are the most determinant of the user experience, and which reality (AR or VR) can be more effective. Furthermore, current digital experiences are mainly based on audiovisual stimulation, so there is a long way to go when it comes to the sensory enrichment of these digital experiences, particularly with VR. Finally, while most research has focused on destinations, the application of AR and VR to hospitality settings is rather limited. This doctoral thesis tries to address all these research gaps to contribute to a better understanding of how immersive technologies shape the new realm of customer experiences in tourism.

Table 2.1. Literature review of AR/VR research in tourism

Reference	Objectives	Tech.	Context	Stage	Methodology	Main findings
Cheong (1995)	Analyze the senses involved in VR, VR use in tourism and VR as a substitute for tourism.	VR	Tourism	-	Conceptual	Sight and hearing: main senses involved. Tourists can make better decision with VR. Reasons for (e.g. cheaper) and against (e.g. unable to replace the "feel" of being there) of VR as a tourism substitute.
Hobson & Williams (1995)	Identify the opportunities and challenges of VR for the tourism industry.	VR	Tourism	-	Conceptual	VR is proposed to generate the sensation of being transported to a virtual environment. The future development of VR may make it a substitute of real tourism.
Williams & Hobson (1995)	Reflect on the potential uses of VR in tourism, as well as the idea of VR as a potential substitute of real travels.	VR	Tourism	-	Conceptual	Main uses of VR in tourism: virtual theme parks, sales and promotions tool (pre-travel stage), creation of artificial tourism. As VR evolves, it could completely substitute the actual travel experience, becoming a competitor of the tourism industry.
Dewailly (1999)	Explore VR for sustainable tourism and as potential threat.	VR	Tourism	-	Conceptual	VR is a complement of the real visit, so it will never replace actual tourism. Virtual tourism can add richness to a real experience.
Guttentag (2010)	Determine the main applications and implications of VR for the tourism field.	VR	Tourism	-	Conceptual	Main applications of VR for tourism: planning and management, marketing, entertainment, education, accessibility and heritage preservation. The motivations of tourists for traveling (novelty, social interaction) cannot be replicated by VR, so it is not a substitute.
Kounavis et al. (2012)	Give an overview of the main benefits of AR for tourism.	AR	Tourism	-	Conceptual	Benefits of AR in tourism: personalized information, better exploration of the world, connectivity (sharing information).
Han et al. (2013)	Explore the elements required by users to create an effective AR travel app.	AR	Destination	-	In-depth interviews with visitors	AR has passed the hype stage and can be implemented in the tourism industry. It needs to be carefully designed, including multi-language functionality, ease of use and capability to personalize the app.
Chung et al. (2015)	Examine the elements that affect the use of AR, and how they influence visitors' beliefs, attitudes and future behaviors.	AR	Heritage	On-site	On-site survey	Technological readiness, visual appeal and facilitating conditions are the antecedents of perceived usefulness and ease of use. Both perceived usefulness and ease of use influence the attitude toward AR, which affects the intention to use AR and to visit the destination.
Jung et al. (2015)	Analyze how perceived quality of AR affect tourist satisfaction and recommendation.	AR	Theme park	On-site	Field study (questionnaire)	AR content quality, personalized service quality, and system quality influence satisfaction with the AR experience. AR satisfaction leads to higher intention to recommend the AR.

Kourouthanassis et al. (2015)	Explore the potential of mobile AR for supporting tourists' visits to a destination.	AR	Destination	On-site	Field study (questionnaire)	The functional properties of the AR system evoke feelings of pleasure and arousal. These feelings lead to higher behavioral intentions to use AR.
Jung et al. (2016)	Analyze how the use of AR first, and VR after, affect museum experiences.	AR VR	Museum	On-site	Field study (questionnaire)	Social presence generated in AR and VR experiences improves the visitors' experiences and favors their intention to revisit the museum.
Disztinger et al. (2017)	Examine the factors that contribute to the acceptance of VR for travel planning.	VR	Tourism	Pre	Online survey	Perceived usefulness, enjoyment, immersion and interest about VR lead to higher behavioral intentions to use VR for travel planning.
Griffin et al. (2017)	Compare the effectiveness of different media in a digital pre-experience.	VR	Destination	Pre	Lab experiment (questionnaire)	VR generates higher levels of affective destination image, ad effectiveness, intention to search for information, recommend the destination to others, and share information with others.
Martins et al. (2017)	Propose a multisensory VR tourism model (wine tourism).	VR	Destination	-	Conceptual	Generally, audiovisual senses are stimulated in VR. Proposal of a multisensory wine tourist experience with VR, including vision, audition, olfactory, tactile and gustatory inputs.
Tussyadiah et al. (2017)	Examine the impact of spatial presence in a VR destination preview and its impact on attitude toward the destination.	VR	Destination	Pre	Lab experiment (questionnaire)	Attention allocation influences departure. Spatial presence contributes to a positive change in attitudes toward the destination. Post VR attitude was higher in those using Samsung Gear VR.
Chung et al. (2018)	Analyze the antecedents of AR satisfaction and its effects toward the heritage place.	AR	Heritage	On-site	Field study (questionnaire)	Expectation confirmation with the AR app leads to higher aesthetic experience. Both variables affect perceived advantage and enjoyment. Perceived advantage and aesthetic experience influence AR satisfaction, which lead to higher attitude and behavioral intentions toward the destination.
He et al. (2018)	Identify the factors that foster AR adoption in the context of a museum.	AR	Museum	On-site	Lab experiment (questionnaire)	Compared to visual cues, dynamic verbal cues increase the users' willingness to pay more. Stronger effect when environmental augmentation is applied. Mental imagery is essential in this process.
Jung, Lee, et al. (2018)	Delve into the antecedents of using AR in cultural heritage sites, and explore if there are cultural differences.	AR	Heritage	On-site	Field study (questionnaire)	Aesthetics of the AR experience strongly affects perceived enjoyment. Its effect is also significant for perceived usefulness and perceived ease of use. These variables affect behavioral intentions to use AR. Cultural differences moderate these relationships.

Jung, tom Dieck, et al. (2018)	Explore how effective is the use of VR in a rollercoaster experience.	VR	Theme park	On-site	Field study (questionnaire)	Service quality and entertainment influence satisfaction. Social influence affects word-of-mouth and willingness to pay extra for the VR experience. Effect of satisfaction on word-of-mouth.
Marasco et al. (2018)	Investigate the impact of VR pre-experiences on behavioral intentions toward a heritage site.	VR	Cultural heritage	Pre	Field study (questionnaire)	Perceived visual appeal affects both emotional involvement and behavioral intentions. However, non-significant relationship between emotional involvement and behavioral intentions.
Nayyar et al. (2018)	Review the applications of AR/VR in the tourism and hospitality fields.	AR VR	Tourism	-	Conceptual	Uses of AR/VR in tourism and hospitality: planning and suitable management, entertainment, education, virtual attractions, navigation, booking rooms, exploring the properties (e.g. hotel), AR menus (restaurants), marketing.
Rainoldi et al. (2018)	Compare traditional brochures and VR during the information search and decision processes.	VR	Destination	Pre	Lab experiment (questionnaire)	VR is more effective during the information search process (e.g. provide reliable information, reduce uncertainty) and the decision-making process (e.g. pre-experience the facilities and attractions, be in better position for making decision).
tom Dieck & Jung (2018)	Analyze factors that affect users' acceptance of AR in a tourist destination.	AR	Destination	On-site	Field study (focus groups)	Dimensions for the acceptance of AR (external dimensions): information quality, system quality, costs of use, recommendations, innovativeness, risk, facilitating conditions. Perceptions: perceived usefulness and ease of use.
tom Dieck et al. (2018)	Explore if the use of AR HMDs can enhance the learning experience of museum visitors.	AR	Museum	On-site	Field experiment (semi-structured interviews)	The use of AR HMDs helps visitors to see the connections between the pieces of art and personalize their experiences. However, some drawbacks are shown: lack of visitor-visitor engagement and social acceptability.
Tussyadiah, Jung, et al. (2018)	Analyze the use of wearable AR technologies in a tourism experience.	AR	Museum	On-site	Field study (questionnaire)	Technology embodiment during the experience with the AR HMDs positively affects enjoyment and the improvement of the experience. Perceived enjoyment with AR enhances the overall experience.
Tussyadiah, Wang, et al. (2018)	Analyze the effect of the sense of presence in the VR tourism experience.	VR	City tour and destination	Pre and on-site	Lab experiment and field study (questionnaire)	Perceptions of being present in the virtual environment displayed increase the enjoyment during the VR experience and the liking of the tourism setting. The positive attitude change positively affects visit intentions.
Wagler & Hanus (2018)	Examine the differences between 2D experiences, 360-degree video, and the actual experience in a real destination.	VR	Destination	Pre	Lab experiment (questionnaire)	Both real-world and immersive 360-degree videos scored similarly in terms of presence and emotional engagement. Thus, 360-degree experiences with VR HMDs can be considered as a strong analogue of real-world experiences.

Bec et al. (2019)	Explore how AR/VR can be used for heritage preservation.	AR VR	Heritage	-	Conceptual	Four stages for using AR/VR in heritage preservation for tourism experience: historical facts, contested heritage, integrate historical facts and contested heritage and alternate scenario.
Beck et al. (2019)	Provide a review of the literature which addresses the use of VR in tourism.	VR	Tourism	-	Literature review	The term VR has been used inconsistently. 360-degree videos have limited interactivity. Future research: compare different HMDs and contents, VR in post-travel stages, and social VR.
Bogicevic et al. (2019)	Explore the role of mental imagery and presence in VR hotel pre-experiences.	VR	Hotel	Pre	Lab experiment (questionnaire)	VR HMD enhances mental imagery compared to static and 360-degree content. Elaboration of mental imagery positively affects sense of presence, which subsequently affects tourism experience.
Deng et al. (2019)	Analyze if web-based VR can reduce the intention to actually visit the environment displayed.	VR	Museum	Pre	Lab experiment (questionnaire)	Web-based VR may dissuade users from future consumptions (visiting a museum) compared to traditional websites. Perceived similarity is the mediator. For travel experiences, VR still cannot capture the "essence" of the experience.
Errichiello et al. (2019)	Profile visitors of museums according to their perceptions and attitudes toward VR.	VR	Museum	On-site	Field study (questionnaire)	Three groups according to their attitudes and perceptions toward the VR experience: enthusiasts, moderates and sceptics. Enthusiasts are more involved, have higher usage and sharing intentions.
Han et al. (2019)	Explore the factors that foster the adoption of AR HMD by visitors of a museum.	AR	Museum	On-site	Field experiment (semi-structured interviews)	Usefulness, enjoyment, personal innovativeness, interaction, obtrusiveness, ease of use, risk of use, cost and privacy concerns mediate the effect of acceptability and interaction on adoption.
Hudson et al. (2019)	Examine how social interactions affects visitors' experience during a VR experience.	VR	Destination	On-site	Field study (questionnaire)	Immersion has a positive effect on satisfaction and loyalty. The person-environment interaction help create immersive experiences. Social interaction positively influences satisfaction and loyalty.
Israel, Tscheulin, et al. (2019)	Address user acceptance of VR for immersive hotel presentations.	VR	Hotel	Pre	Lab experiment (questionnaire)	Telepresence and task-technology fit positively affect perceived usefulness. Usefulness directly influences attitude toward using VR for a hotel preview and behavioral intentions to use this technology. The effect of perceived ease of use is non-significant.
Israel, Zerres, et al. (2019)	Investigate the role played by telepresence in hotel-based VR pre-experiences.	VR	Hotel	Pre	Lab experiment (questionnaire)	Telepresence has its greater effect on perceived curiosity, while the impact on usefulness and enjoyment is quite similar. The effect of usefulness is stronger on booking intentions.
Kim & Hall (2019)	Apply the hedonic motivation system adoption model (HMSAM) to VR tourism.	VR	Tourism	Pre	Online survey	Perceived enjoyment (and usefulness to a lesser extent) fosters flow, which directly affects subjective well-being and continued use of VR for tourism activities. The path between perceived usefulness and flow is higher for visitors (compared to non-visitors).

Li & Chen (2019)	Explore if VR inhibits potential tourists of traveling to a destination.	VR	Destination	Pre	On-site survey and field study (questionnaire)	Usefulness and ease of use positively affect behavioral intentions. Perceived enjoyment mediates these effects and directly affects behavioral intentions. VR may decrease real tourism activities.
McFee et al. (2019)	Compare the effects of VR HMDs and computers on destination image.	VR	Destination	Pre	Lab experiment (questionnaire)	Impact of involvement on affective, cognitive and conative destination images is significant for VR. Image formation does not solely depend on content, but also of the device employed.
Neuburger et al. (2019)	Reflect on how AR/VR can be applied throughout all the stages of the tourist journey.	AR VR	Destination	All	Conceptual	AR/VR play a vital role in the planning stage for generating curiosity and inspire potential travelers. On-site: AR can be used for navigation. Post-experience: sharing experiences after the trip.
Serravalle et al. (2019)	Explore how AR creates value among stakeholders.	AR	Museum	-	Conceptual	Values of AR in museums: economic, experiential, social, epistemic, historical and cultural, educational.
Wei (2019)	Analyze the main development in AR/VR research in tourism and hospitality settings.	AR VR	Tourism	-	Literature review	Increasing research about AR/VR in tourism. Most of the research is about destinations and museums. Not much research about hotels and restaurants. Call for cross-cultural research and other contexts (e.g. Food & Beverage).
Wei et al. (2019)	Examine the effectiveness of VR technology application to enhance theme park experience.	VR	Theme park	Pre	Online survey	Both functional and experiential aspects of VR systems influence visitors' virtual experiences. Perceived control is the strongest predictor of presence. Presence leads to higher satisfaction, intention to revisit and intention to recommend.
Willems et al. (2019)	Analyze how VR HMDs affect perceptions and behaviors in tourism experiences.	VR	Destination	Pre	Lab experiment (questionnaire)	VR (compared to still images and 360-degree videos) generates higher interactivity, vividness and presence. Telepresence positively affects flow, enjoyment and purchase intentions.
Yung & Khoo-Lattimore (2019)	Establish the groundwork for academic research on AR/VR. Identify future gaps.	AR VR	Tourism	-	Literature review	Inconsistency in the terminology. Most of research is on virtual worlds (e.g. Second Life). Future gaps: consensus in the terminology, identification of gaps and challenges, and lack of theory-based AR/VR research in tourism.
Cranmer et al. (2020)	Examine the perceived value of AR from the perspective of tourism experts.	AR	Tourism	-	Semi-structured interviews (thematic analysis)	AR tourism-specific value dimensions: marketing, organizational, economic, tourist and epistemic value. Factors detracting the adoption of AR: information overload, heightened expectations.
Jingen Liang & Elliot (2020)	Review the literature about AR in tourism. Analyze current research and future lines.	AR	Tourism	-	Literature review	Five established research realms: user acceptance of AR; user experience, satisfaction and behavioral intentions; AR implementation; gamification and AR; AR design and development. Future research: gamification AR, negative consequences of AR.

Kang (2020)	Explore the effects of VR from the perspective of telepresence and apply the Construal Level Theory (CLT) to a destination.	VR	Destination	Pre	Lab experiment (questionnaire)	VR generates more presence than regular videos. Physical distance does not affect. Telepresence generates higher hypothetical distance, leading to a greater desire to visit the destination. Less perceived risk increases impulse desire.
Kim, Lee, & Jung (2020)	Analyze how VR experiences encourage potential tourists to visit the actual destination.	VR	Destination	Pre	Online survey	Authenticity of the VR experience leads to cognitive and affective responses. These responses affect both the attachment to the VR experience and the intention to visit the real destination.
Kim, Lee, & Preis (2020)	Analyze the effects of VR for tourism-related activities using a theoretically integrated model.	VR	Tourism	Pre	Online survey	Simplicity, benefit, compatibility, informativeness, social interactivity and playfulness affect authentic experience and subjective well-being. The latter has a stronger effect on behavioral intentions. Moderating role of technology readiness.
Lee et al. (2020)	Explore the quality features that makes a VR destination experience effective.	VR	Destination	Pre	Online survey	Content and system quality, as well as vividness, positively affect behavioral intentions. These effects are partly mediated by attitude toward the virtual tour and telepresence.
Leung et al. (2020)	Compare the effectiveness of traditional vs. VR commercials in a hotel context.	VR	Hotel	Pre	Lab experiment (questionnaire)	Hotel commercials with VR generate better immediate advertising effects. Mixed results for delayed effects. It is recommended that VR commercials focus on the immediate effects.
Lin et al. (2020)	Examine the use of VR for the marketing of a sustainable tourism heritage environment.	VR	Heritage	Pre	Field study (questionnaire)	Perceptions of cognitive and affective images are the drivers of slow travel intention. VR has a positive effect on behavioral intentions to engage in slow travel.
Loureiro et al. (2020)	Overview of AR/VR studies in tourism. Present the most important topics and suggest future research lines.	AR VR	Tourism	-	Literature review	Main topics and future research streams: multisensory stimulations, enhanced longitudinal virtual experiences, well-being development, AI embedded in virtual environments. Use of VR to reduce overtourism and to support education in experiences (museums).
Park & Stangl (2020)	Apply the concept of sensation-seeking to comprehend travelers experiences with AR.	AR	Destination	Pre	Online survey	Sensation-seeking can be applied to explain the AR experiences. Experience-seeking and boredom-susceptibility are essential elements to classify travel groups regarding AR apps.
Zeng et al. (2020)	Analyze the effect of adding VR to online reviews in a hotel setting.	VR	Hotel	Pre	Lab experiments (questionnaire)	Positive effects of online review quality, quantity and VR implementation on behavioral intentions. Interaction effects: the joint effect of online reviews and VR is significant only when quality is low and regardless the quantity of online reviews.

Source: Own elaboration

PART II. THEORETICAL DEVELOPMENT

3. From the real to the virtual world: review of realities and their application to the customer experience

3.1. Introduction

Despite the substantial development of XR technologies in recent years evidenced in the first part of this thesis, the boundaries between the different realities (VR, AR, mixed reality –MR–) have not been properly established (Jeon & Choi, 2009; Yung & Khoo-Lattimore, 2019). Specifically, due to the nascent nature of this field, the misuse of the terms referring to the reality-virtuality dimensions has been noted in previous literature, calling for accurately delineate the terminologies, avoid confusion, and make a uniform use in this stream of research (Yung & Khoo-Lattimore, 2019). Similarly, there seems to be no consensus in practitioners' use of these terms when developing and releasing new devices. For instance, the launching of the HMD called Windows Mixed Reality, in which users are completely immersed into a computer-generated environment where they can interact with digital elements (the inherent features of VR), reveals that the misuse of terms occurs also in the professional world (PCWorld, 2017). Thus, recent developments cast doubts on what VR, AR, and MR really mean for both researchers and practitioners.

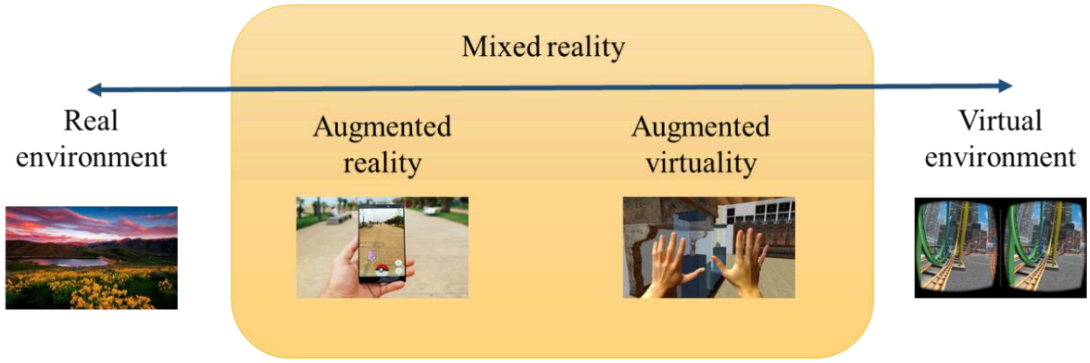
To overcome the aforementioned issues, the goal of this chapter is to provide a clear classification system to standardize the terms used to describe the different realities, which could be useful to maximize the benefits derived from operating with them. Recent technological advances which integrate physical and digital elements at different levels have changed conceptions about the realities. Our proposal creates a pragmatic taxonomy whereby all current and future technological developments would fall within one or other of the proposed reality categories. In addition, once these realities have been clearly delimited, we propose how they can be applied to the customer journey to create technology-enhanced experiences.

3.2. The reality-virtuality continuum

Following Paré, Trudel, Jaana, and Kitsiou (2015), we conducted a critical review with the aim of critically analyzing previous studies that classified realities to reveal weaknesses, inconsistencies or contradictions. This methodology highlights problems or disparities in the existing knowledge about a particular area, to constructively inform and provide an appropriate focus and direction for future studies. We conducted literature searches with keywords *("virtual reality", "augmented reality", "mixed reality", "reality", "virtuality", "taxonomy", "classification"*) in four databases (*ScienceDirect, Scopus, Web of Science, Google Scholar*) to identify studies which classified the different realities. We discovered that previous research had barely addressed the categorization of the different realities, in spite of the need for studies to classify and clarify these terminological issues (Yung & Khoo-Lattimore, 2019). Our proposal aims to address this issue by extending previous classifications to delineate the realities.

Among all the revised taxonomies, the "Reality-Virtuality Continuum" proposed by Milgram and Kishino (1994), has been the starting point for researchers to classify the wide variety of realities. This classification ranges from real to virtual environments at the extremes of the continuum (see Figure 3.1). Real Environments (RE) encompass the reality itself. This includes direct or indirect (through a video display) views of a real scene (Milgram & Kishino, 1994). Virtual Environments (VE) are completely computer-generated environments in which objects that do not actually exist are "displayed" on a device and where users interact in real-time through a technological interface. Between these two extremes, there is a wide variety of realities that involve different combinations of the real and the virtual environment.

Figure 3.1. Reality-Virtuality Continuum



Source: Milgram and Kishino (1994)

Within the category of virtual environments, Virtual Worlds (e.g. Second Life), are continuous virtual environments, open 24/7, which enable users to be represented by avatars so as to create, play and interact in real time with other avatars (Penfold, 2009; Schroeder, 2008). As for Virtual Reality (VR), it is an immersive environment generated by computers in which users can navigate and possibly interact, triggering real-time simulation of their senses, what makes them feel present in the virtual environment displayed (Guttentag, 2010).

Milgram and Kishino (1994) state that, as we move to the right of the continuum, there is an increase in the degree of computer-generated stimuli. The existing realities between these extremes were termed Mixed Reality (MR) environments. Thus, MR was conceived as the different points of the continuum at which real and virtual objects were merged (Milgram & Kishino, 1994; Pan, Cheok, Yang, Zhu, & Shi, 2006; Tamura, Yamamoto, & Katayama, 2001). Consequently, Augmented Reality (AR) and Augmented Virtuality (AV) are part of MR (see Figure 3.1). On the one hand, AR modifies the user´s actual physical surroundings by overlaying virtual elements (images, videos, virtual items; Azuma, 1997; Heller et al., 2020; Javornik, 2016; van Krevelen & Poelman, 2010; Yim, Chu, & Sauer, 2017). The explosion in popularity of AR, thanks to the videogame Pokémon Go, has attracted worldwide attention (Rauschnabel, Rossmann, & tom Dieck, 2017), which highlights its potential to offer memorable experiences to the customer (Chylinski et al., 2020; de Ruyter et al., 2020; Heller, Chylinski, de Ruyter, Mahr, & Keeling, 2019b; Yaoyuneyong, Foster, Johnson, & Johnson, 2016). Less explored is AV, which superimposes real-world elements on virtual environments (Regenbrecht et al., 2004; Tamura et al., 2001). An overview of the definitions for these realities is shown in Table 3.1.

Table 3.1. Definition of the realities and examples of devices

Reality	**Definition**	**Devices**
Virtual Reality (VR)	*"Three dimensional realities implemented with stereo viewing goggles and reality gloves"* (Krueger, 1991; p. 13)	Oculus Rift S Oculus Quest 2 Play Station VR HTC Vive Valve Index Samsung Gear VR Google Cardboard
	"A real or simulated environment in which a perceiver experiences telepresence" (Steuer, 1992; p. 7).	
	"VR is the use of computer graphics systems in combination with various display and interface devices to provide the effect of immersion in the interactive 3D computer-generated environment" (Pan et al., 2006; p. 20).	
	"Use of a computer-generated 3D environment – called a 'virtual environment' (VE) – that one can navigate and possibly interact with, resulting in real-time simulation of one or more of the user's five senses" (Guttentag, 2010; p. 638).	
	An immersive computing technology that incorporates *"a set of technologies that enable people to immersively experience a world beyond reality"* (Berg & Vance, 2017; p.1).	
	"Computer-generated setting in which individuals act in a real-time simulated environment creating artificial locations through an interface that stimulates one or more senses. The digitally generated space is such that users movements are tracked and environs are displayed in synchrony with users' actions" (Innocenti, 2017; p.72).	
	"The application of three-dimensional computer technology to generate a virtual environment within users navigate and interact" (Cowan & Ketron, 2019; p. 1)	
	"A simulated environment in which the perceiver experiences telepresence, which is the extent to which a person feels present in a virtual environment" (Meißner, Pfeiffer, Pfeiffer, & Oppewal, 2019; p. 2).	
Augmented virtuality (AV)	A system that *"enhances or augments the virtual environment (VE) with data from the real world"* (Tamura et al., 2001, p. 64).	Leap Motion; HTC Vive with Bridge, apps via Oculus Rift.
	"AV enhances virtual worlds with real world components or technical aspects" (Regenbrecht et al., 2004; p. 339).	
	"AV deals with predominantly real-world data being added to a computer-generated virtual environment" (Wang & Chen, 2009, p. 151).	

Mixed reality (MR)	*"A particular subset of VR related technologies that involve the merging of real and virtual worlds somewhere along the "virtuality continuum" which connects completely real environments to completely virtual ones"* (Milgram & Kishino, 1994; p. 1322).	Microsoft HoloLens 2 Magic Leap
	"MR is a kind of VR but a broader concept than AR, which augments the real world with synthetic electronic data" (Tamura et al., 2001; p. 64).	
	"MR allows a person to see the real, physical world and objects but also see believable, and even responsive, virtual objects. MR is an attempt to combine the best features of both AR and VR" (Brigham, 2017; p. 174).	
	"MR merges many of the benefits of VR and AR […] Holographic images, three-dimensional objects, and two-dimensional windows may be placed anywhere in the user's visual field, enabling novel interactive experiences with complex data packets" (Tepper et al., 2017, p. 1066).	
Augmented reality (AR)	*"Any system that has the following three characteristics: combines real and virtual, is interactive in real time and is registered in three dimensions"* (Azuma, 1997, p. 356).	Google Glass Enterprise Apps via hand-held devices: Pokémon Go, Ikea Place, etc.
	"A type of VR in which synthetic stimuli are registered with and superimposed on real-world objects; often used to make information otherwise imperceptible to human senses perceptible" (Sherman & Craig, 2003, p. 18)	
	"Superposition of virtual objects (computer generated images, texts, sounds etc.) on the real environment of the user" (Faust et al., 2012, p. 1164).	
	AR is an "interactive technology that modifies physical surroundings with superimposed virtual elements. This virtual layer, placed between the physical environments and the user, can add textual information, images, videos or other virtual items to the person's viewing of physical environment. The devices that enable such superimposition can be smartphones or tablets, wearables (HMDs), fixed interactive screens or projectors" (Javornik, 2016, p. 253).	
	"The practice of displaying digital information over people's real-time view of objects, people, or spaces in the physical world [...]. Augmented digital information may be viewed by users, for example, via smartphone screens, large video installations, or holographic projections" (Scholz & Smith, 2016; p. 160).	
	"AR is a visualization technology, able to introduce more information into the real world, instead of replacing it" (Serravalle et al., 2019, p. 3).	

Source: Own elaboration

Other taxonomies have extended Milgram and Kishino (1994)'s continuum, and describe new realities that have appeared with the advent of more sophisticated technologies. Mann (2002) adds the concept of mediation to the continuum. Mediation is the effect by which some devices are able to modify (not superimpose information) real or virtual environments by altering sensory inputs. In his "reality, virtuality, mediality" taxonomy, four realities are proposed: augmented reality, augmented virtuality, mediated reality and mediated virtuality. The concept of mediated reality/mediated virtuality includes being in the RE/VE, but to incorporate a modulating device (e.g. infrared night vision computer system) to augment or diminish the environment displayed. Schnabel, Wang, Seichter, and Kvan (2007) incorporate new dimensions into the "Reality-Virtuality Continuum": amplified reality (where an amplified object can control the flow of information), mediated reality (in the same way as Mann, 2002) and virtualized reality (similar to 360-degree videos). Jeon and Choi (2009) also add a new sensory dimension to Milgram and Kishino (1994)'s proposal, related to sense of touch (degree of virtuality in touch). Their "visuo-haptic reality-virtuality continuum" encompasses nine environments ranging from the real world (visual and haptic reality) to interactive virtual simulators (visual and haptic virtuality). Raisamo et al. (2019) incorporate the concept of human augmentation to the Milgram and Kishino (1994)'s continuum. Human augmentation is defined as an interdisciplinary field which analyzes the methods, technologies and their applications for improving the sensing, actions, and/or cognitive abilities from human beings (Raisamo et al., 2019). In their continuum, augmented human tools are merged with the different realities to generate more direct and natural user interfaces.

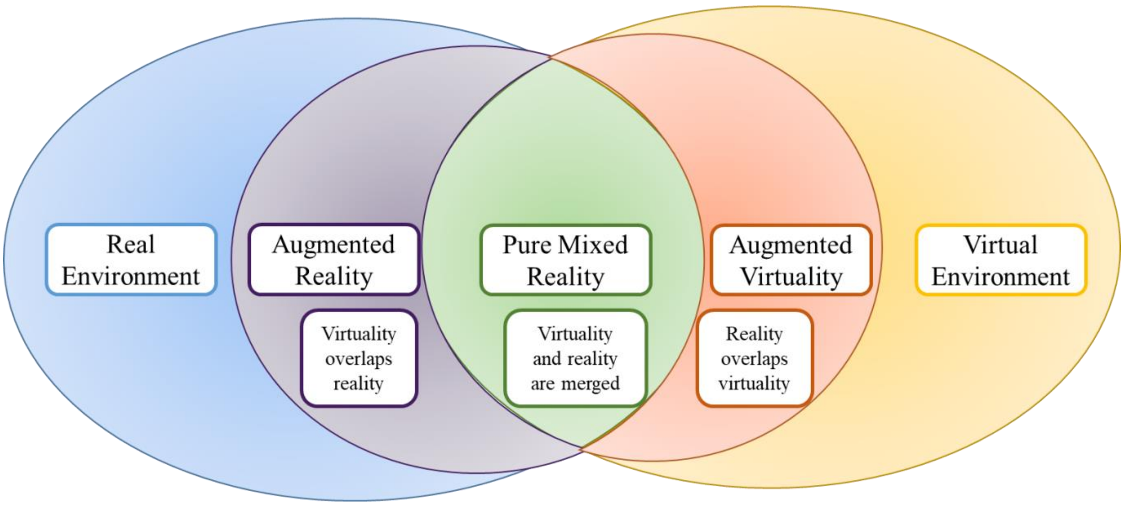
However, previous categorizations built upon the reality-virtuality continuum show limitations as technologies evolve to generate different realities. Mann's (2002) "mediality" proposal consists of accidentally altering the user´s sensory experience (either real or virtual), and AR and AV are still included within MR. Following Mann (2002), Schnabel et al. (2007), add dimensions which are not actually applied in current technologies (e.g. amplified and mediated realities). In addition, technological developments show a clear practical difference between AR, AV and MR; thus, they should be treated separately. Additionally, although the sensory component in Jeon and Choi's (2009) classification may be useful for classifying technological devices, realities and experiences are multisensory and should not be considered as a sum of different, isolated senses (Petit et al., 2019). Finally, Raisamo et al. (2019) incorporate human augmentation to the Milgram and Kishino (1994)'s continuum, which is interesting for providing users with natural interfaces when interacting with the realities; yet, they do not differentiate between the current realities inside the MR space.

As stated before, Milgram and Kishino (1994)'s view of MR included any plane where real and virtual elements were presented together in a single display, thus considering AR and AV as part of MR. Jeon and Choi (2009) note that the terms AR and MR have been used interchangeably in the literature, and Yung and Khoo-Lattimore (2019) draw the attention to clearly delineate the terminology related to VR/AR to avoid current confusions. In the ICT industry, recent launches have been labeled as MR (such as Windows Mixed Reality), but users are placed in a completely digital world, which is the main feature of VR (PCWorld, 2017).

Therefore, there is a need to set clear boundaries between the realities that the current technologies are able to create; particularly those concerning MR. MR must no longer be the broad part of the continuum that includes AR and AV, as noted by Milgram and Kishino (1994). It should be regarded as an independent dimension falling between AR and AV and characterized by the total blend of virtual holograms with the real world.

Thus, we adjust the Reality-Virtuality Continuum proposed by Milgram and Kishino (1994) by differentiating the independent dimension of Pure Mixed Reality (PMR) (see Figure 3.2). The differences between the realities are reflected in Table 3.2.

Figure 3.2. Proposed Reality-Virtuality Continuum



Source: Own elaboration

Digital content in PMR is not superimposed on the RE (as in AR) but virtual objects are rendered so that they are indistinguishable from the physical world. Visual coherence is a basic element of PMR (Collins, Regenbrecht, & Langlotz, 2017). Users can interact with both digital and real objects in real-time and, simultaneously, these objects can interact with each other. This “environment awareness” implies that not only digital objects can act in the real environment, but real objects can also modify the virtual elements, regardless of where the experience is taking place. For instance, in PMR, users would not be able to see a virtual box under a table unless they bent down to look at it; in AR, the box would be overlaid and it would be unnecessary to bend down. Currently, the only technological developments that can truly be considered to be generating PMR experiences are the holographic devices Microsoft HoloLens 2 and Magic Leap, which integrate digital and real objects in a real-time display.

Table 3.2. Summary of differences between the reality-virtuality realities

	RE	AR	PMR	AV	VE
The main environment is the virtual world (V) or the real (R) world.	R	R	R	V	V
Users interact with the virtual (V), real (R) or both (R-V) worlds in real time.	R	R-V	R-V	R-V	V
Digital content is superimposed on the real environment.	-	√	-	-	-
Real content is superimposed on the virtual environment.	-	-	-	√	-
Digital content is merged into the real world so that both digital and real content can interact in real-time.	-	-	√	-	-

Source: Own elaboration

In the light of the previous discussion, we now summarize the different realities of the continuum. The RE is an actual setting where users interact solely with elements of the real world, whereas VE is a completely computer-generated environment where users can interact solely with virtual objects in real-time. Between these extremes, we found technology-mediated realities where physical and virtual worlds are integrated at different levels. AR is characterized by digital content superimposed on the users' real surroundings; AV involves real content superimposed on the user´s virtual environment. Finally, in PMR, users are placed in the real world and digital content is totally integrated into their surroundings, so that they can interact with both digital and real contents, and these elements can also interact.

Once all the realities have been conceptualized, the following subsection proposes how they can be implemented throughout the different stages of the customer journey to add value by providing better, more memorable customer experiences.

3.3. Building technology-enhanced customer experiences

Customer experiences are internal and personal responses of the consumer to any direct or indirect contact with firms (Meyer & Schwager, 2007). Customers have touchpoints with companies throughout the purchase journey, and companies need to effectively manage these "moments of truth" to create memorable and enduring experiences that generate positive cognitive, affective, emotional, social and physical responses (Lemon & Verhoef, 2016; Verhoef et al., 2009).

The importance of customer experience management across customer touchpoints has been stressed by practitioners and researchers. According to Adobe (2018), improving the customer experience is the top priority for businesses, and providing emotionally engaging customer experiences during the customer journey is a marketing research priority according to the MSI (MSI, 2018). As an emerging research area, practice-oriented authors (Rawson, Duncan, & Jones, 2013) and academic authors (Teixeira et al., 2012; Verhoef et al., 2009) advocate effectively managing customer experiences, especially in the service and multichannel marketing domains (Lemon & Verhoef, 2016). In the service landscape, some authors stress the relevance of providing not only an efficient journey but also to design optimal customer experiences (Patrício, Fisk, & Falcão e Cunha, 2008; Teixeira et al., 2012). In the multichannel literature, offering a seamless experience through channel integration is essential to create stronger customer experiences (Brynjolfsson, Hu, & Rahman, 2013; Verhoef, Kannan & Inman, 2015). Both marketing disciplines rely on the role of technologies to design optimal and seamless customer experiences.

The different realities can be considered as channels that mediate customer-firm contacts (Froehle & Roth, 2004) or touchpoints (Payne & Frow, 2004). Therefore, HTI in the different realities can be used to improve customer experiences. The integration of

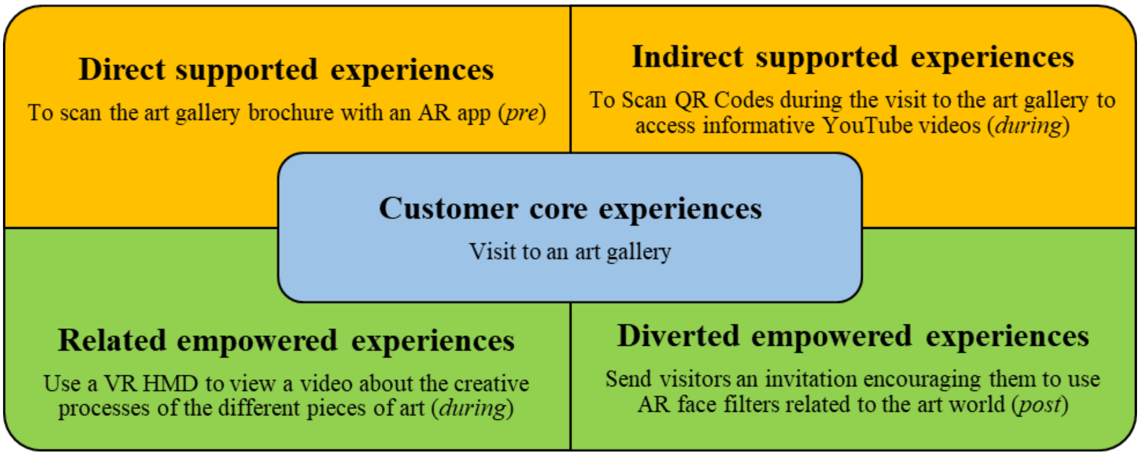
ICTs from the different realities into companies' commercial offers can enhance the experience and increase the value provided to customers (Neuhofer et al., 2014), resulting in technology-enhanced customer experiences.

The "experience hierarchy" proposed by Neuhofer et al. (2014) consists of four main levels of experience: conventional experiences (level 1) are one-directional in essence (companies to customers) and the role of technology is non-existent or limited; in technology-assisted experiences (level 2), technology plays a facilitating role by assisting customers but does not let them interact or co-create their experiences (e.g. Web 1.0); when technologies allow consumers to take an active role and shape their experiences (e.g. Web 2.0), technology-enhanced experiences are offered (level 3). Finally, the fourth and highest level is technology-empowered experiences, where technologies are required for the experiences to happen. Immersive technologies are at this level, offering customers added value derived from high levels of involvement and possibilities for co-creation.

However, the framework proposed by Neuhofer et al. (2014) has shortcomings that this chapter tries to overcome. First, they focus on the technologies of the extremes (real and virtual environments), rather than on intermediate levels where reality and virtuality are mixed at different integration levels. As noted previously, there is a plethora of technologies in the reality-virtuality continuum with great potential to add value to customer experiences. Second, recent technological developments call for a reinterpretation of the different levels of the experience hierarchy, which we build upon the adapted reality-virtuality continuum. Finally, Neuhofer et al. (2014)'s definition of empowered experiences is limited to the use of highly immersive technologies, and this may not always be the case.

Therefore, we follow and extend the experience hierarchy (Neuhofer et al., 2014) by redefining the existing levels and adding new layers based on reality-virtuality technologies. This classification represents a pragmatic guide for the use of technologies linked to the different realities, to design better and more memorable purchase journeys and to reshape the current customer experience landscape. Next, we define the different levels of the technology-enhanced experiences and illustrate how the technologies associated with the realities can support and/or empower the customer experience in a particular industry (i.e. tourism) (see Figure 3.3).

Figure 3.3. Technology-enhanced customer experiences



Source: Own elaboration

First, we define a customer's core experience as the baseline experience, which includes the basic, conventional experience where technology is absent or plays a limited or secondary role. Defining the core experience is paramount for any research and company, since this is the point of departure for building enhanced experiences through reality-virtuality technologies. HTI can be added to these core experiences to create technology-enhanced experiences, resulting in better, more valuable customer experiences.

Once the core experience is properly defined, the technologies related to the reality-virtuality continuum can generate supported experiences. The core experience is supported by technologies either directly or indirectly. In directly supported experiences, technologies assist the customer's core experience by directly acting on the real world. This dimension is an addition to Neuhofer et al. (2014)'s model, since it includes recent advances in AR and PMR technologies which integrate the physical and digital worlds at different levels. On the other hand, indirectly supported experiences involve technologies assisting customers' core experiences in a way that is not integrated with the real world. Due to current technological developments (Web 3.0), it seems unnecessary to distinguish between "technology-assisted experiences" (Web 1.0) and "technology-enhanced experiences" (Web 2.0), as proposed by Neuhofer et al., (2014).

Moving to a different level, empowered experiences involve the technology itself playing a key role in creating new experiences within the customers' core context. In other words, the technology creates a new experience with a singular entity, and this experience can be related or unrelated to the customer's core experience. Contrary to Neuhofer et al. (2014)'s proposal, empowered experiences do not need to be based only on immersive technologies. Specifically, we distinguish between related and diverted empowered experiences. In related empowered experiences, the new experience created by the technology is closely related to what consumers are experiencing, and complements the user's core experience. Finally, in diverted empowered experiences, the technology itself creates a new experience that is not directly related to the user's core experience but influences what they are actually experiencing. The purpose of diverted empowered experiences is to divert consumers from their core experience. Diverted empowered experiences can have either positive or negative effects on the final outcomes of the experience. For instance, a CAVE (Cave Automatic Virtual Environment) can be installed in a museum so that consumers can experience this novel technology. On the positive side, consumers will consequently be attracted to the museum and the potential for visits might greatly increase. Moreover, consumers might develop more positive attitudes toward the museum and generate positive word of mouth (post-purchase behavior). However, the increase in traffic might disturb other visitors who want to view the pieces of art in a peaceful atmosphere, or divert customers from their true purpose (to experience the physical museum).

It must be noted that our proposal does not register situations in which the reality-virtuality technology itself creates new experiences irrespective of the situational context of the user. Pine and Gilmore (1998) stated that the arrival of new technological devices, such as multiplayer games, chat rooms and VR technologies, would generate new experiences. Specifically, technologies have the capacity of creating experiences (technology-generated new experiences); without the technology, the experience would not exist. Almost a century ago, the invention of the television created one of the first technology-generated experiences. Consumers acquired TVs to live that experience and, without a TV, it was not possible to have it. However, over time the consumer got accustomed to the TV and the novelty effect faded; today, watching TV is as a conventional core experience. With this core experience, other technologies are used to support or empower it, creating technology-enhanced core experiences. Therefore, as innovations spread and become widely adopted over time (Diffusion of Innovations Theory; Rogers, 2010), the newness effect of the experience provided by the technology dissipates, and novel technology-generated experiences turn into conventional core experiences. Today, technologies, such as VR HMDs, are creating new experiences by transporting users to remote locations and VE. Nevertheless, the effect of the experiences based on these technologies may diminish as time passes and they become commonplace.

3.3.1. Application of technology-enhanced experiences to the customer journey in tourism

In line with the context of this doctoral thesis, we focus on the tourism industry to illustrate our proposal of technology-enhanced experiences (see Figure 3.3). In this way, the core experience which will serve as a basis on which to build the technology-mediated experiences is a visit to a classic art gallery. We offer examples of technology-mediated experiences throughout the entire customer journey regarding this core experience. In relation to pre-experiences (before actually visiting the gallery), a directly supported pre-experience would consist of scanning the art gallery brochure with an AR app to access additional information, which would be superimposed on the brochure. In an indirectly supported pre-experience, the brochure would include links to information on a website (e.g. history about the art gallery, opinions, videos). A related empowered pre-experience would consist of a 360-degree HMD video that potential visitors could watch at home to plan the visit to the gallery and pre-view the artworks they want to see. Finally, a diverted empowered pre-experience would consist of playing in a virtual world (accessed from the company's website) with historical avatars. Although the company may attract traffic to their website, it may distract potential visitors away from the true purpose of the pre-experience (i.e. obtaining information about the gallery).

In the experience stage (visiting the gallery), a directly supported experience would be the use by visitors of AR HMD to view digital information (history, opinions, etc.) superimposed onto the piece of art they are viewing. In addition, the art gallery might encourage visitors to scan QR codes throughout their visit to access informative YouTube videos (indirectly supported experience). A related empowered experience would be a visit to a CAVE installed in the gallery, showing a video about the creative processes of different pieces of art. Lastly, in a diverted empowered experience, visitors could use VR

HMD to be "transported" to a remote location, just as they enter the gallery, to induce a state of pleasure or relaxation.

As for post-experiences (after visiting the gallery), a directly supported post-experience would consist of inviting visitors to rate the paintings and gallery services (pictures sent by email) through an AR application in which the rating system appears superimposed on their smartphone screens. Encouraging visitors to share their opinions and photographs of their experiences on social networks would represent examples of indirectly supported post-experiences. In a related empowered post-experience, the art gallery might stage a contest in which visitors would record 360-degree videos of their visit to be subsequently uploaded onto YouTube. Finally, a diverted empowered post-experience would consist of an invitation to use AR technologies to take pictures and record videos, with filters and lenses, related to the art world. This post-experience might generate engagement but not necessarily related to the experience of visiting the gallery.

These examples show how the use of technologies linked to the different realities might help researchers and practitioners to reshape the customer experience landscape and to add value in the different stages of the purchase journey. Nevertheless, it should be noted that previous literature (Cheong, 1995; Hobson & Williams, 1995; Williams & Hobson, 1995) suggests that VR might be considered as a substitute for tourism for several reasons (e.g. tailored virtual environments, enjoyable experiences, lower costs, higher convenience). This view can be reinforced in situations where travel is restricted (e.g. current COVID-19 pandemic). However, recent studies highlight the key role that technologies as VR might play in providing potential visitors with a "try-before-you-buy" experience of the destination, which could translate into greater visit intention (Kim, Lee, & Jung, 2020; Marasco et al., 2018; Tussyadiah, Wang, et al., 2018). VR technologies represent pseudo-experiences that cannot induce the same kind of feelings that visiting the real place generates; thus, they should not be considered as a substitute for the real experience but a valuable complement to the customer experience (Guttentag, 2010). In a nutshell, current experiences with immersive technologies still cannot capture the "essence" of the actual experience (Deng et al., 2019), so that these technologies can be used as persuasive tools to promote the interest in the tourism experience displayed, encouraging the development of subsequent positive behaviors (Bogicevic et al., 2019; Tussyadiah, Wang, et al., 2018).

4. Toward a new categorization of reality-virtuality technologies: the Embodiment-Presence-Interactivity (EPI) Cube

4.1. Introduction

In the previous chapter, we have made an effort to clarify the terminological confusion that currently exists in the literature and among practitioners, and to establish clear limits and standardize the use of the terms which describe the different realities. In addition, we have considered how these realities can be applied during the customer journey to provide a valuable customer experience. The following chapter aims to classify the wide variety of technologies associated with the reality-virtuality continuum, according to three dimensions stemming from the HTI.

Dix (2017) states that HTI is the knowledge area focused on the process in which technologies and humans are the main agents, through carrying out actions, which take part in the interaction. Following this approach, our classification of technologies is based on three dimensions that cover the whole spectrum of HTI: a technological dimension (embodiment), a human dimension (perceptual presence), and a behavioral dimension derived from the interaction between technology and the human (interactivity).

Considering these dimensions, we offer a proposal, called the Embodiment-Presence-Interactivity (EPI) Cube, which is an instrument that allows researchers and practitioners to classify all the current and potential reality-virtuality technologies.

4.2. The EPI Cube

In this section we go deeper into the dimensions that constitute the EPI Cube. Afterward, we explain how technologies can be classified according to this proposal.

4.2.1. Embodiment as the technological factor

Recent technological developments have altered the processes of HTI. The theory of technological mediation (Ihde, 1990) aims to explain human-technology mediation processes. This theory analyzes how the technology stands between the humans and the environment around them. The author denotes the existence of four types of relations between human beings, technologies and the world (see Table 4.1):

Table 4.1. Typologies of human-technology mediations

Type of relation	**Definition**	**Examples**
Hermeneutic	Human beings interpret the information provided by the technology. The technology forms a unity with the world, and humans interpret the information provided by the technology to obtain the perception about the world.	*Humans interpret the information of the brain activity provided by MRI.* *Humans interpret the information provided by a thermometer to know the temperature.*
Alterity	Humans interact with technologies as if they were living beings, with the world in the background of this interaction.	*Humans' interaction with robots. Withdrawing money from an ATM.*
Background	Technology is the background (context) of the human experience and action. Here, technologies are the context of the human experience, rather than being experienced themselves.	*The warm air from heating installations. The "beep" sound from a notification of a smartphone.*
Embodiment	Humans form a relationship with a technology (becoming an extension of their human bodies). Both of them as a union (human + technology) interact with the environment.	*Humans speak with other humans through their smartphones. Humans wear a VR HMD to view an alternative reality (e.g. a tourist destination).*

Source: Ihde (1990)

Some of the cutting-edge technological devices are not only smaller and portable, they are also wearable (tom Dieck, Jung, & Han, 2016; Tussyadiah, Jung, et al., 2018) and, in some cases, can be integrated into the human body. These technologies are included in the users' personal space to improve their experiences and extend their sensory, cognitive and motor functions. From a physical perspective, Ihde (1990) establishes this relationship as embodiment, regarded as situations in which technological devices mediate the users' experience and, as a consequence, the technology becomes an extension of the human bodies, helping them to interpret, perceive and interact with their immediate surroundings. The maximum level of technological embodiment can generate a human-technology symbiosis (e.g. implanted devices), leading users to a state where the technology is an unnoticeable part of their bodies (Grewal, Kroschke, Mende, Roggeveen, & Scott, 2020; Tussyadiah, 2014; Verbeek, 2008). As embodiment increases, the technology becomes part of the user´s actions (e.g. information visually displayed is considered as their own vision) and improves their capacities (perceptual skills: vision, etc.). This conceptualization of embodiment differs from others in the HTI domain, which consider embodiment as the users' sense of their own body (e.g. Longo, Schüür, Kammers, Tsakiris, & Haggard, 2008), particularly regarding their capacity to control, own and feel self-located with their virtual counterpart in a digital environment (Aldhous, Hetherington, & Turner, 2017; Liepelt, Dolk, & Hommel, 2017; Nimcharoen, Zollmann, Collins, & Regenbrecht, 2018).

Embodiment has been recently related to user experiences with wearable computing (Tussyadiah, 2014; Tussyadiah, Jung, et al., 2018). Current technologies are increasing the user´s sense of integration between the body and the devices. Therefore, technological embodiment plays a key role in creating immersive experiences due to its ability to involve the human senses (Biocca, 1997). For instance, immersive VR equipment (e.g. VR HMDs, haptic gloves) offers a sense of embodiment since these devices are closer to the human senses (Flavián et al., 2020). Other artifacts, such as AR and PMR HMDs, are expected to revolutionize consumers' behavior by extending their perceptual body, adapting the technological capabilities to the users' skills (Tussyadiah, 2014). Accordingly, technological embodiment involves the integration of the technological devices into the human body and this, as a consequence, will serve to extend the participants' natural abilities by enhancing their motor and perceptual skills, improving their experiences (Tussyadiah, Jung, et al., 2018).

The National Research Council (2012) regards cognitive artifacts as technological systems that serve to complement and improve users' cognitive abilities. They propose a taxonomy based on two dimensions: the "reality-virtuality continuum" (Milgram & Kishino, 1994) and the "mobility continuum". This mobility continuum is related to the degree of integration of the device into the human body (i.e. embodiment). Different levels are proposed, ranging from minimum or no embodiment (e.g. stationary external devices such as desktop computers) to full integration, devices which are implanted in the body (such as microchips or smart contact lenses). In this continuum, technologies can be classified in terms of their level of technological embodiment. However, this continuum does not explicitly identify differences between intermediate levels of embodiment. In this sense, at intermediate levels, we may find portable external devices (e.g. smartphones) and more advanced tools between portable and implanted devices, which are commonly regarded as wearables (e.g. HMDs) (Tussyadiah, Jung, et al., 2018).

Therefore, our proposal further develops the previous classification including a wider variety of technological devices according to their degree of technological embodiment, that is, the degree of contact with the human senses during the experience (see Figure 4.1): internal devices are fitted into the human body (wearables and implanted devices) and external devices are unintegrated in the human body (stationary and portable external devices). Technological embodiment encompasses two important factors discussed in the ICT literature: immersion (Biocca, 1997; Shin, 2017) and sensory stimulation (Biocca, 1997; Tussyadiah, 2014). Higher levels of technological embodiment create a sensation of closeness between the technology and the senses and generate more immersive experiences. Companies must consider the degree of technological embodiment that might be incorporated into their customers' experiences.

Figure 4.1. Technological embodiment continuum

Source: Own elaboration

4.2.2. Presence as the human factor

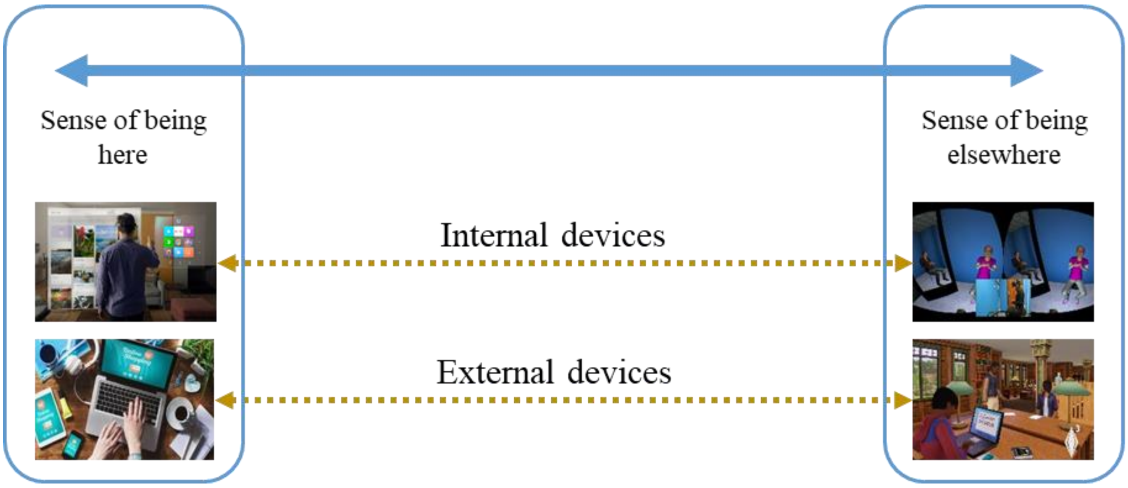
Presence is defined as the user's sensation of being transported to a distinct environment outside the real human body (Biocca, 1997). Presence is regarded as a psychological stage (not related to a specific technology) and the medium is simply the way to arrive at that stage (Thornson, Goldiez, & Le, 2009). Presence can be triggered by reading a book, listening to a song, watching a movie or playing a videogame (Coelho, Tichon, Hine, Wallis, & Riva, 2006). Although the medium is relevant in inducing presence, the user´s psychological interpretation of what is in front of him/her is key to developing a sense of presence (Baños et al., 2004). This psychological approach has been previously adopted in the literature (Heeter, 1992; Lee, 2004; Lombard & Ditton, 1997). Lombard and Ditton (1997) state that perceptual presence has a subjective nature, given that it depends on different sensory, cognitive and affective processes. Presence is related to transportation (Biocca, 1997) in the sense that users' consciousness is being transported to an alternative place, completely different from where they actually are, and they feel and act as if they were in a real place (Sanchez-Vives & Slater, 2005).

Thus, we concur with previous research and consider the technological quality of the media as immersion (as a part of technological embodiment) and the psychological perception of the user as the sense of presence (Slater, 2003; Thornson et al., 2009). In this way, media characteristics are antecedents of presence (Coelho et al., 2006). For instance, presence can be provoked by a sensation of "place illusion" generated inside a virtual environment (Slater, 2009). VR systems can generate responses in the virtual environment regarding users' positions and actions (tracking), show images, synchronize audio, and provide haptic information, depending on their location and orientation (Sherman & Craig, 2003).

This proposal regards perceptual presence as a continuum ranging from the sense of being in the actual location to the sense of being elsewhere. At this point, we must note different presence sub-continuums depending on the level of technological embodiment of the devices (see Figure 4.2). As previously stated, immersion is an antecedent of presence, and is dependent on the technology's capabilities. Thus, internal and external devices can generate different levels of immersion (Slater, 2009). Specifically, internal devices can transport and immerse users into distant locations (virtual or physical, real or digital) to a greater extent than external devices, due to their highly immersive capacity and to their sensory attachment. External devices (e.g. computer screens, smartphones) set boundaries between the physical and virtual world due to their interfaces and they require users to make an extra mental effort to feel themselves elsewhere. The content displayed in these devices has to be immersive and engaging enough to increase the sense of presence in that location by decreasing the users' awareness of their surroundings

(Takatalo, Häkkinen, Kaistinen, & Nyman, 2010). Therefore, although low levels of presence (the feeling of "being here") can be perceived with both internally and externally embodied technologies, the high level of presence ("being elsewhere") can be much greater with internal than with external devices.

Figure 4.2. Perceptual presence continuum



Source: Own elaboration

4.2.3. Interactivity as the behavioral factor

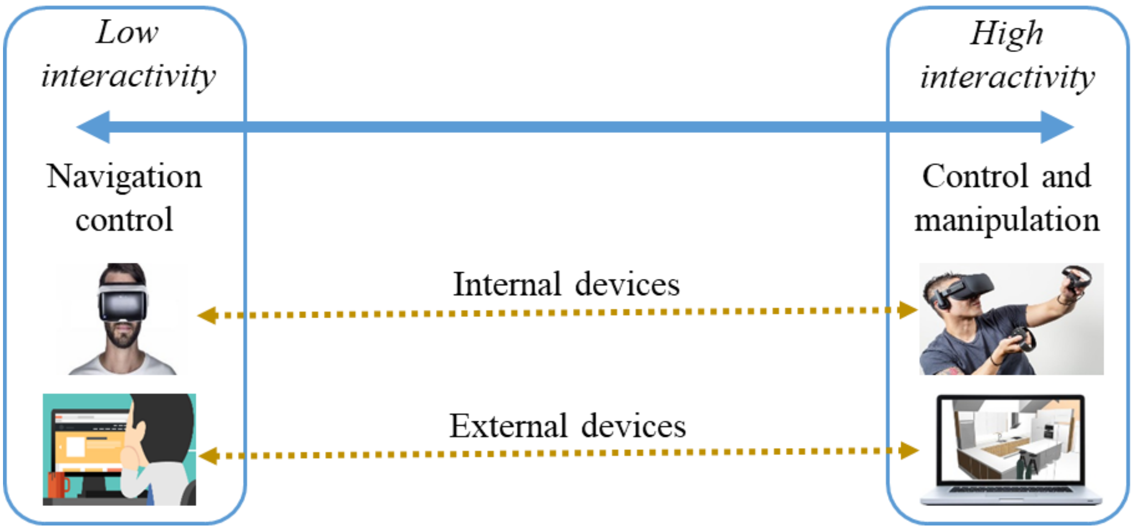
Interactivity is defined as the users' capacity to modify and receive feedback to their actions in the reality where the experience is taking place (Carrozzino & Bergamasco, 2010; Muhanna, 2015). We focus on what Hoffman and Novak (1996) called human-machine interactivity, where the participants interact with the mediated environment and it responds according to their actions. Steuer (1992) described interactivity as the "extent to which users can participate in modifying the form and content of a mediated environment in real time" (p. 14). Thus, interactivity is a behavioral factor in that users have the ability to control and manipulate the environment that is in front of them (Sohn, 2011).

This behavioral approach regards interactivity as a dynamic process based on the interaction between two main agents: users and technologies. Consequently, this perspective implies the integration of both technological and perceptual standpoints (Domagk, Schwartz, & Plass, 2010). As for the technological perspective, the structuralist or mechanistic approach (Mollen & Wilson, 2010) considers interactivity as the response to the attributes of the technology and proposes that it can be enhanced through the development of these technologies. Some elements, like joysticks or more sophisticated haptic devices (e.g. gloves, suits) enable users to modify the state of what is before their eyes, by actions such as grabbing or moving objects (Slater, 2009). As for the perceptual perspective (McMillan & Hwang, 2002; Wu, 1999), interactivity is referred to as the user's psychological state during the interaction with the technological tool, which is not only related to the actual interactive capabilities of the medium, but also to the situational characteristics (Sohn, 2011). Wu (1999) determines that perceived interactivity is based on two dimensions: "internally based self-efficacy" (perceived control with respect to where users are and where they are going in the technological system) and "externally-based system efficacy" (how responsive a system is to the participants' actions). Therefore, for HTI to occur, behavioral interactivity is the core process in which the two agents interact in order to behave in a certain way in the environment (Dix, 2009).

Different media offer varying levels of interactivity and, therefore, the interactivity continuum cannot be categorized as dichotomous (Fortin & Dholakia, 2005). Instead, there is a continuum ranging from low behavioral interactivity (navigation control) to high interactivity (capacity to control and modify the environment) (Bowman & Hodges, 1999; Muhanna, 2015). In addition, the fact that every typology of technology has a different space for possible user actions must be taken into consideration (Janlert & Stolterman, 2016). Thus, we distinguish interactivity between internal and external embodied technologies (Bailenson et al., 2008) (see Figure 4.3). Internal technological tools, such as HMDs or gloves, provide direct and sensory-based levels of interactivity due to their greater capacity for behavioral tracking (gestures, movements and gazes).

In our case, the approach will be based on Bowman and Hodges (1999) study about interactivity in immersive environments. Viewpoint motion control (or travel) is the basic level of interactivity and is founded on the idea that users' visual orientation and location change as a result of their movements. The maximum level of behavioral interactivity is based on the concept of manipulation in the sense of being able to modify the position, orientation, or some features (e.g. shape, scale) of previously selected objects. On the other hand, external devices, such as computers or smartphones, provide an indirect interactivity through clicking and pressing keys that transform these actions into activities shown on the screen. In this case, the control stage is related to the navigability in the media (changing the "content" that is displayed), while manipulation is the ability to change the features (shape, position, state, etc.) of previously selected content (changing the "form"; Steuer, 1992).

Figure 4.3. Behavioral interactivity continuum

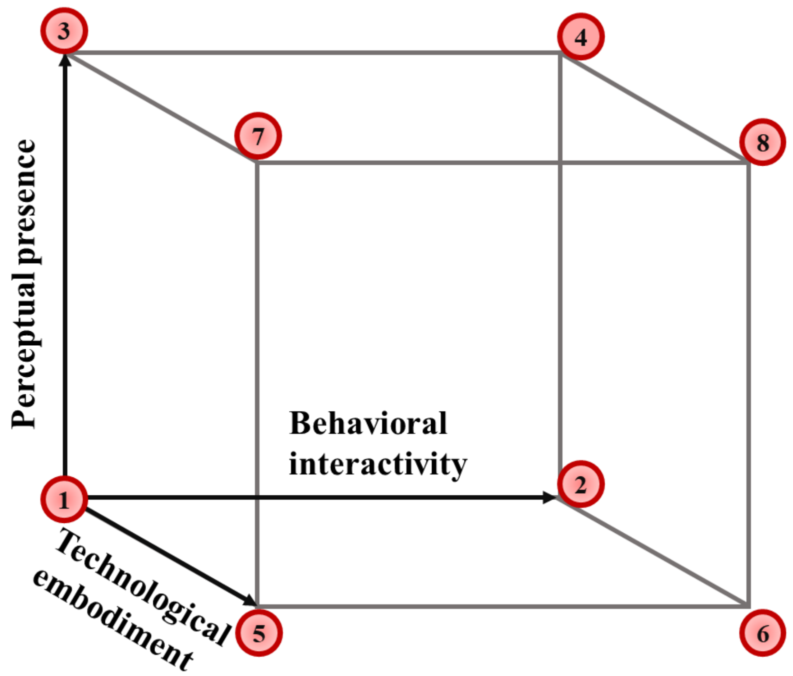


Source: Own elaboration

4.3. Classification of technologies according to the EPI Cube

Based on the integration of variables stemming from the technological and psychological disciplines, which cover all the factors involved in a HTI process, the Embodiment-Presence-Interactivity, or EPI Cube, is proposed (see Figure 4.4). A wide variety of existing technologies is placed on the different faces of, and inside, the cube, in accordance with their positions relative to the corresponding factors. In addition, potential technological advances can be placed in the cube according to these criteria.

Figure 4.4. The EPI Cube and associated extreme examples of technologies



Vertex	Radical examples of technologies
1	Computer Web 1.0.
2	Website online simulators
3	Video Wall
4	Virtual Worlds (Second Life)
5	Augmented reality HMD
6	Mixed reality HMD (Holographic devices)
7	360-degree video HMD (fixed position)
8	Virtual reality HMD with haptic devices

Source: Own elaboration

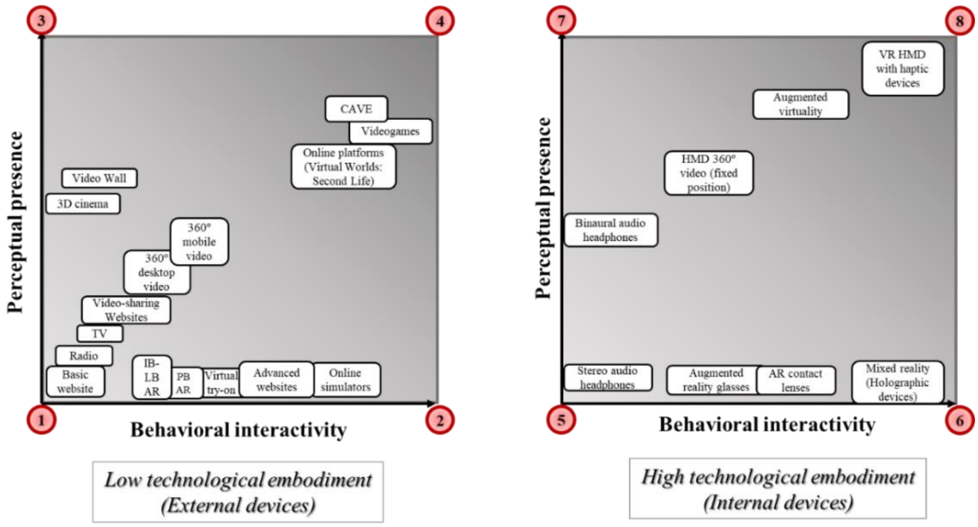
Vertices of the EPI Cube represent radical examples of technologies in their corresponding situation (see Figure 4.4). External devices are placed in vertices 1 to 4. In vertex 1, we highlight computer 1.0 websites and traditional media (TV, radio) as radical examples of technologies unintegrated in the body, where users feel themselves in the actual location and they can only control the content displayed (not modify it). Vertex 2 is similar to vertex 1, but users can also manipulate the environment (e.g. website online simulators, such as Ikea Planner, allow users to modify the form and shape of displayed content). In vertex 3, we find external devices with a low degree of behavioral interactivity (control only of displayed content) and through which users may feel they are in a place other than where they actually are (high levels of presence). Video Wall or 3D cinema can be considered as radical examples of these technologies. Finally, vertex 4 offers high levels of behavioral interactivity, where users can also manipulate the content. Examples of this are videogames and virtual worlds (e.g. Second Life), where users can freely manipulate the virtual environment and the content is engaging enough to make them forget their immediate surroundings (Takatalo et al., 2010). Users can establish their virtual identity in these virtual platforms by creating avatars, which are designed according to their desires and expectations (Belk, 2013, 2014, 2016). Although some real life features persist in this process, some other private elements, such as thoughts, emotions or hidden/idealized aspirations, seem also to be reflected in their virtual profiles (Belk, 2013; Koles & Nagy, 2012).

Internal devices are placed in vertices 5 to 8. In vertex 5 we find technologies that fit into the human body, that allow participants to control (not modify) content and make them remain in their immediate, real surroundings. AR HMD (such as Google Glass Enterprise) are in this vertex, since users can control only the digital content overlaying a real scene (not manipulate its position or size). PMR HMD (holographic devices) are one radical example of vertex 6, as they allow users to modify the form of the content displayed and to interact with these virtual elements that they are viewing in their actual location. Vertex 7 involves internal technologies through which users can control only content, but they feel they are elsewhere. When interacting with 360-degree HMD videos, users are placed in a fixed position and can feel as if they are in a different location, but they cannot modify the form or the position of the elements in that location. Finally, in vertex 8 the level of behavioral interactivity is high. For instance, users wearing VR HMDs, and some haptic suits that track their movements, are able to move through the virtual environment and change the shape and position of the digital objects.

Figures 4.5, 4.6 and 4.7 show how a total of 24 different technologies which are contained within the EPI Cube. Specifically, in each figure, two dimensions of the EPI Cube are crossed in the X and Y axes, while the third dimension is held constant. In this way, technologies are arranged according to: the levels of behavioral interactivity (X) and perceptual presence (Y), for low (see Figure 4.5a) and high (see Figure 4.5b) levels of technological embodiment; the levels of technological embodiment (X) and perceptual presence (Y), for low (see Figure 4.6a) and high (see Figure 4.6b) levels of behavioral interactivity; and the levels of technological embodiment (X) and behavioral interactivity (Y), for low (see Figure 4.7a) and high (see Figure 4.7b) levels of perceptual presence.

Figure 4.5. Technologies placed on the faces of the EPI Cube

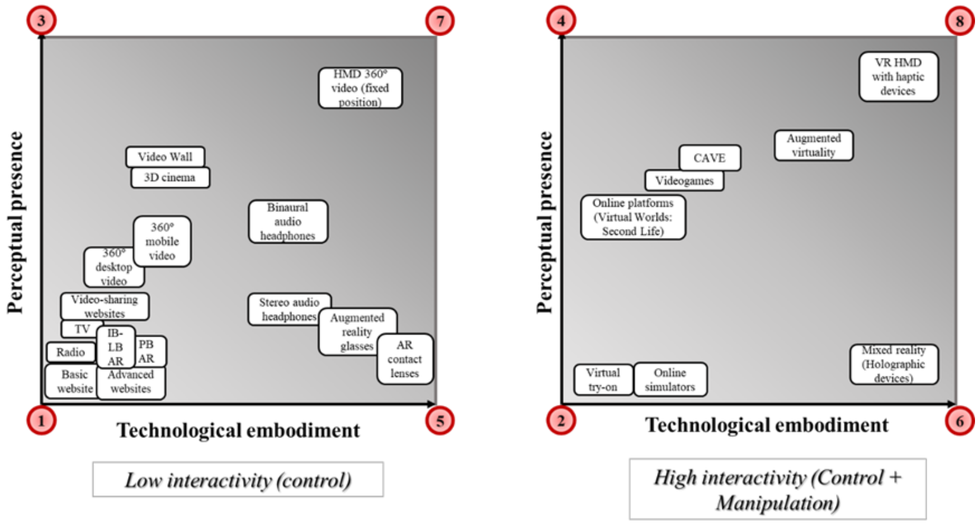
(Extreme levels of technological embodiment)



Source: Own elaboration

Figure 4.6. Technologies placed on the faces of the EPI Cube

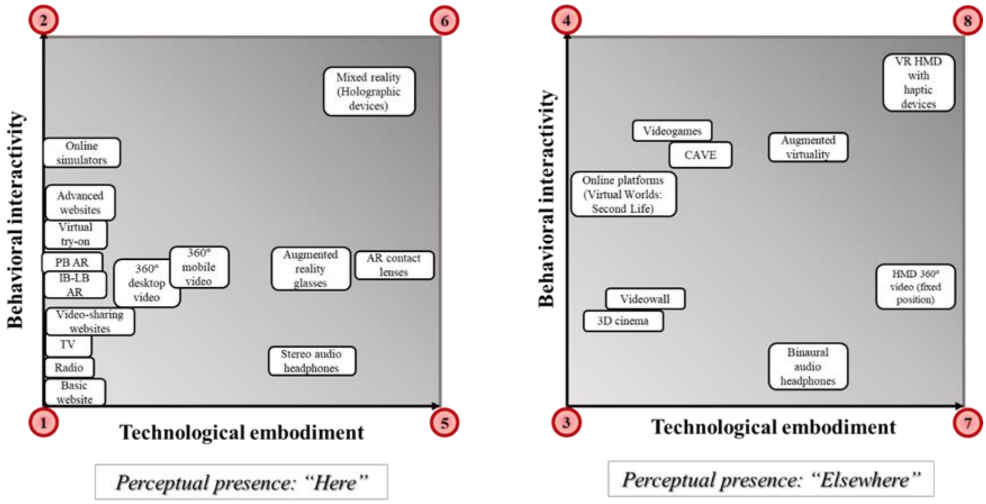
(Extreme levels of behavioral interactivity)



Source: Own elaboration

Figure 4.7. Technologies placed on the faces of the EPI Cube

(Extreme levels of perceptual presence)



Source: Own elaboration

At this point, several clarifications should be made. First, AR hand-held systems (e.g. smartphones, tablets) can be classified as image-based and location-based systems (Cheng & Tsai, 2013; Wojciechowski & Cellary, 2013). Image-based (IB) AR technologies use image recognition techniques to detect particular signals in the real environment (marker-based AR: artificial markers as QR codes or 2D labels; marker-less AR: natural markers of real objects or landscapes) to locate the virtual contents. Location-based (LB) AR technologies are based on geolocation information (GPS, digital compass and accelerometer) and show different computer-generated information according to the users' location. In addition, projection-based (PB) AR technologies do not need real object recognition to display digital content on the real location (e.g. Ikea Place). This last typology is more interactive than other AR technologies, as it allows users to manipulate content, while the others only display a picture or a video over the marker and, generally, their interactivity level in this regard is more limited (see Figures 4.5 and 4.7). Second, playing a 360-degree video on a smartphone may generate a higher sense of presence than on a desktop computer (see Figures 4.5 and 4.6), since its gyroscope function allow users to control what is being displayed by turning the device, thus creating a sense of harmony between their position and the content. On a computer screen, the user can only control the content by clicking on an arrow, which is not as natural. Finally, binaural audio is different from stereo audio because it tries to generate a 3D sensation, imitating how human ears interpret sounds (see Figures 4.5 and 4.6).

The EPI Cube offers an integrated framework for a more complete taxonomy of existing (and potentially new) reality-virtuality technologies, which allows researchers to better understand their impact on the customer experience. In addition, the EPI Cube is a practical tool for managers, which can help them select the most appropriate technologies with which to design added value propositions for consumers.

PART III. EMPIRICAL ANALYSIS

5. Research context and overview of empirical studies

5.1. Introduction

This chapter presents an overview of the empirical research undertaken in this doctoral thesis. The empirical studies aim to address the research objectives, proposed in the introduction, regarding the gaps identified in the previous literature about the impact of immersive technologies on user experience, specifically in the tourism industry. The results will allow us to significantly advance in this nascent research field.

To this aim, this chapter introduces the specific context in which the empirical studies take place (tourism pre-experiences), as well as the dimensions of the EPI cube analyzed. Additionally, a detailed overview of the studies is presented, together with the specific research questions that each study aims to answer. The last part of the chapter outlines the methodological and analytical issues of the empirical research.

5.2. Research context

The empirical part of the doctoral thesis focuses on the pre-experience stage of the customer journey (Lemon & Verhoef, 2016). For experiential products (products whose characteristics and performance cannot be assessed without a physical interaction; Nelson, 1970), such as tourism, AR and VR can revolutionize their promotion and selling (Cranmer et al., 2020; Guttentag, 2010). The intangibility of tourism means that potential customers are not able to test the products in advance (Yung & Khoo-Lattimore, 2019). Therefore, potential tourists perform exhaustive information searches to overcome the complexity of making the most suitable decision (Gursoy, Bonn, & Chi, 2010; Gursoy & McCleary, 2004). While direct product experience is considered the best way to evaluate these products (Hyun & O'Keefe, 2012), when this is not possible, consumers demand for convenient ways of pre-screening how a product will perform to improve their customer journey (Manis & Choi, 2019). The immersive nature of AR and VR position these technologies in an advantageous position to generate valuable pre-experiences with a tourism product (Loureiro et al., 2020). The potential of VR lies in its ability to place customers in the environments they are considering visiting (Yung & Khoo-Lattimore, 2019). The feeling of presence in that environment through the sensory experience provided with VR allows potential tourists to better overcome the inherent intangibility of tourism (compared to traditional technologies) and make a better evaluation of the tourism product (Bogicevic et al., 2019; Guttentag, 2010). Similarly, AR can be used by potential tourists in their pre-experience stage as a way of gathering relevant information that helps them evaluate the product they are assessing (e.g. view a virtual representation of a hotel room instead of several pictures) and make the most suitable decision (Cranmer et al., 2020).

Therefore, immersive technologies are especially important in the pre-experience stage of the customer journey since they allow potential tourists to obtain valuable "try-before-you-buy experiences" that resemble how it would be to stay in the real environment (Bogicevic et al., 2019; Chung et al., 2015; Kim, Lee, & Jung, 2020; Marasco et al., 2018; Tussyadiah, Wang, et al., 2018). Specifically, these technologies provide potential tourists with richer perceptions by immersing them in the virtual environment, where they can obtain valuable "experiential information", which empowers them before making the final decision (Buhalis et al., 2019; Neuburger et al., 2019; Willems et al., 2019).

In these digital tourism pre-experiences, consumers can preview the experiences (Tussyadiah, Wang, et al., 2018), but it is assumed that they cannot modify the product. For example, a potential visitor of a destination can preview the different points of interest, but s/he cannot modify the position of the tourist attractions. In the same way, a potential guest in a hotel can preview different rooms or facilities, but cannot choose the color of the curtains or the position of the bed. In addition, previous research has noted that the transformational interactivity is not yet well developed in immersive technologies (Kang, 2020). Thus, we keep the level of behavioral interactivity constant at a low level (control over the navigation with no capacity of modifying the surrounding environment) and focus on the technological and the human dimensions of the EPI cube (technological embodiment and perceptual presence, respectively) to examine the impact of the immersive technologies during the tourism pre-experience.

Technological embodiment has received little attention in the study about immersive technologies in tourism (Tussyadiah, Jung, et al., 2018). Despite this, the devices associated to this dimension (wearables as AR/VR HMDs) bring to light the relevance that the integration of the devices into the human senses has in the way potential tourists can perceive a tourism product with these technologies (Flavián et al., 2019a; Tussyadiah, Jung, et al., 2018). When tourists use these embodied devices, they are often unaware of their presence after some time, becoming the means by which tourists can perceive the environment displayed. The embodiment of wearable devices improves the tourists' skills, then increasing the possibilities of engagement with the tourism product displayed, generating an overall positive experience (Tussyadiah, Jung, et al., 2018). Then, when these embodied technologies are applied in the pre-experience stage, they may mean a positive shift in the predisposition of potential tourists toward the product shown.

Generating a sense of presence in the environment displayed is essential for the development of effective digital pre-experiences in the tourism industry (Hyun & O'Keefe, 2012). Consequently, placing customers in a virtual environment that resembles the real tourism product to be consumed can help to overcome its intangible nature, allowing potential tourists to make appropriate decisions due to the information they have been provided (Buhalis et al., 2019). Immersive technologies, especially VR, are particularly suited for generating presence in virtual environments (Bogicevic et al., 2019; Lee, Lee, Jeong, & Oh, 2020). Therefore, the presence elicited by these technologies can inspire and engage customers in their pre-experiences with tourism products since they can “have a taste” of how the real tourism experience would be (Beck, Rainoldi, & Egger, 2019; Neuburger et al., 2019; Tussyadiah, Wang, et al., 2018).

5.3. Overview of empirical studies and research questions

Once the first research objective of the doctoral thesis (establish the conceptual boundaries between the different realities, technologies and the customer experiences with immersive technologies) has been addressed in chapters 3 and 4, this section presents an overview of the empirical studies that are carried out in order to answer the remaining goals and research questions. The Table 5.1 shows an overview of the research questions that are addressed in the empirical part of the doctoral thesis.

The first two empirical studies deal with an overlooked topic in the previous literature about digital tourism pre-experiences with immersive technologies: the role of technological embodiment (Tussyadiah, Jung, et al., 2018). The concept of technological embodiment is empirically validated and its immediate effects proposed in section 4.2.1 (immersion and sensory stimulation) are analyzed, as well as its impact on the emotional reactions derived from the experience with the technology. Furthermore, the effect of technological embodiment on potential tourists’ engagement and behavioral intentions is examined. The mediating roles of immersion, sensory stimulation, and emotional reactions, in the relationship between technological embodiment and behavioral intentions are analyzed. Additionally, two tourism settings (destinations and hotels) are explored to further validate the proposed relationships across different contexts.

Table 5.1. Overview of research questions addressed in the empirical studies

Chapter(s)	Specific Research Questions
Chapters 6 and 7	▪ What is the role of technological embodiment on digital tourism pre-experiences? (RO2) ▪ How can embodied technologies engage potential tourists at the psychological and the behavioral level? (RO2) ▪ What is the role of sensory and emotional factors? (RO2) ▪ Are there differences between distinct tourism products (e.g. type of tourism, hotels)? (RO5)
Chapter 8	▪ Which reality (AR vs. VR) is more effective for showing a hotel pre-experience? (RO3) ▪ What is the importance of the content (presence) and the device (technological embodiment) employed with these realities to generate better hospitality pre-experiences? (RO2) (RO3) ▪ Are there differences in the sense of presence felt depending on the content displayed? (RO3) ▪ What is the role of imagination in this process? (RO2)
Chapter 9	▪ Does the addition of an olfactory stimulus improve the VR pre-experiences with a destination? (RO4) ▪ What is the effect of olfaction and VR on affective and conative destination images? (RO4) ▪ What are the features of scents that should be considered for the generation of superior multisensory digital experiences? (RO4) ▪ What is the role of technological embodiment and imagination in this process? (RO2)

Source: Own elaboration; **RO:** Research Objective.

These research questions are addressed in chapters 6 and 7. Particularly, following the Stimulus-Organism-Response model (Mehrabian & Rusell, 1974), chapter 6 analyzes how technological embodiment directly influences potential visitors' engagement and behavioral intentions toward a destination. This study also examines the mediating role of immersion and sensory stimulation in the effects of technological embodiment on engagement and behavioral intentions. In addition, it explores the moderating role of the type of tourism (active versus passive) in the relationships proposed. In the study (n = 202), the participants have a pre-experience with a destination, using devices with varying degrees of technological embodiment (desktop computer –PC–, smartphone, or VR HMD) and in a different type of tourism (active or passive). The participants' perceptions of perceived embodiment, immersion, sensory stimulation, engagement and their intentions to visit the destination, are measured.

With the aim of extending the findings about the impact of technological embodiment on the user's tourism pre-experiences, chapter 7 addresses the role played by this variable in engaging potential guests of a hotel. Specifically, this study considers how devices with different levels of technological embodiment generate emotional reactions. In addition, the direct and indirect (through emotional reactions) influences of technological embodiment on psychological and behavioral engagement are examined. In the study, participants (n = 141) view a 360-degree video of a hotel room with a device that varied in the level of technological embodiment (desktop PC, smartphone, or VR HMD), and reported their perceptions of embodiment, emotional reactions, psychological engagement, and behavioral engagement.

The results of chapters 6 and 7 emphasize the importance of considering the perceptions of technological embodiment when analyzing the impact of VR technologies on potential tourists' pre-experiences with destinations and hospitality products. By considering the mediating role of sensory and emotional dimensions, these studies also delve into the affective route underlying the use of VR (Van Kerrebroeck, Brengman, & Willems, 2017a).

Chapter 8 addresses the dimension of perceptual presence (elicited by the content), together with technological embodiment (produced by the device), to compare the effectiveness of AR and VR on tourism pre-experiences. In chapters 6 and 7, the affective route of VR is investigated. In chapter 8, we aim to complement this view by analyzing the cognitive route (perceptions of visual appeal and ease of imagination) that underlie customer experiences with immersive technologies. The study examines the impact of the contents and the devices, resulting in AR and VR experiences, on the perceptions of visual appeal, ease of imagining the real experience in the hotel, and booking intentions. The mediating role of visual appeal and ease of imagination is also analyzed. In the study, participants (n = 206) have a pre-experience with a hotel room with different devices (smartphone or VR HMD) and contents (digital or realistic). In addition to measuring their perceptions of technological embodiment and presence, their perceptions of visual appeal, the ease with which they could imagine the real hotel room, and their intentions to book the room are measured. The results of the study are useful for disentangling which reality (AR or VR) is more effective for enhancing a digital tourism pre-experience. This research also stresses the importance of considering both the type of device and content in AR and VR experiences (Beck et al., 2019; Li & Chen, 2019). By considering perceptual presence, together with technological embodiment, we show that these dimensions of the EPI Cube are valid for analyzing technology-enhanced experiences.

Finally, chapter 9 addresses the process of sensorialization of the digital experiences (Petit et al., 2019). The incorporation of the senses is essential for enhancing these experiences in virtual environments (Spence & Gallace, 2011). However, previous research has mainly focused on the audiovisual stimuli, particularly with VR, and the incorporation of the other sensory inputs has been considered to a lesser extent (Guttentag, 2010; Petit et al., 2019). In view of this situation, chapter 9 goes a step further in the integration of other senses into VR experiences to achieve the generation of effective multisensory digital experiences. Specifically, the study analyzes how the addition of an olfactory stimulus affects the VR pre-experience with a destination. We delve into the characteristics that an ambient scent should have to improve these immersive experiences. The study considers pleasant scents that can be congruent (or non-congruent) with the destination displayed. The effect of multisensory VR experiences on sensory stimulation is analyzed. Furthermore, the effect of sensory stimulation on affective and conative destination images, both directly and indirectly through ease of imagination, is examined. The participants (n = 263) are exposed to a pre-experience with a destination, in which the level of technological embodiment (desktop PC or HMD) and the ambient scent (no scent, pleasant and non-congruent scent, pleasant and congruent scent) were manipulated. The variables under study included technological embodiment, sensory stimulation, ease of imagination, and affective and conative destination images. The findings seek to reinforce the cognitive route underlying the experiences with immersive technologies, and contribute to an effective sensorialization of digital experiences.

5.3.1. Methodological and analytical issues of the empirical research

All the studies conducted in this doctoral thesis follow the same methodology, which consists of the combination of experimentation with questionnaires as the measurement instruments. The suitability of experimentation to set cause-effect relationships represents the main advantage of this methodology (Viglia & Dolnicar, 2020). Experimentation as a research technique has been widely used in marketing (e.g. Peracchio & Meyers-Levy, 1997; Weathers, Sharma, & Wood, 2007) and tourism (e.g. Babakhani, Ritchie, & Dolnicar, 2017; Wu, Shen, Fan, & Mattila, 2017). Recently, it has been also applied to the study of immersive technologies (e.g. Bogicevic et al., 2019; He et al., 2018; Kang, 2020; Leung et al., 2020).

Specifically, the four studies are conducted through laboratory experiments, where the researchers are in (nearly) full control over the conditions that configure the different experimental scenarios (Kirk, 2012). Thus, one or several independent variables (X) can be manipulated to examine their influence on one or several dependent variables (Y), while controlling the effect of confounding variables (Malhotra, 2004). This type of experiments is especially useful for analyzing the psychological processes underlying the change in a dependent variable (Viglia & Dolnicar, 2020). The design of the laboratory experiments was between-subjects in all cases. In between-subjects designs, participants are randomly assigned to one experimental condition, obtaining only one measure of each dependent variable (Tabachnick & Fidell, 2007). Compared to within-subject design (in which all the manipulations are shown to the participant), between-subjects design avoids the possible learning effects as a consequence of being exposed multiple times to different manipulations (Viglia & Dolnicar, 2020).

As for the samples' characteristics, participants of the experiments were college students who were recruited from the University of Zaragoza (Spain) and received a course credit for their participation. College students are a valid and homogeneous group regarding education levels and age (Flavián, Gurrea, & Orús, 2016). Previous research about users' experiences with immersive technologies has employed student samples (Kang, 2020; Suh & Prophet, 2018). Besides of the convenience of the sample, students are considered the leading users group of emerging technologies (Parboteeah, Valacich, & Wells, 2009) and seem to be especially interested in immersive technologies (Cognizant, 2019; Commscope, 2017). The Table 5.2 shows the socio-demographic and psychographic information of the samples of the four studies, consisting of the participants' gender and age, and several control questions regarding their previous experience with the destinations and the technologies employed, their preferences for different types of tourism and hotel attributes, and their degree of technological innovativeness. In the questionnaires, scales previously validated in the literature were used to measure most of the variables. The Appendix A contains the full list of items used in each study, together with the references from which the scales were obtained.

Table 5.2. Sample's characteristics of the experiments

	Chapter 6	Chapter 7	Chapter 8	Chapter 9
Demographics				
N *(total)*	196	141	206	263
Gender *(%)*				
Female	60.2	61.7	65.0	60.1
Male	39.8	38.3	35.0	39.9
Age *(mean, std. dev.)*	22.1 (1.81)	20.6 (1.53)	20.7 (0.69)	21.8 (1.95)
Control questions				
Previous experience in the destination *(%)*				
Not visited and I do not plan to	1.5	4.3	2.9	2.7
Not visited but I would like to	77.0	55.3	59.2	67.3
Visited and I would not visit again	0.0	4.3	2.4	0.0
Visited and I would visit again	21.5	36.1	35.5	30.0
Preference for type of tourism *(from 1 = "I do not like it at all", to 7 = "I like it very much"; mean, std. dev.)*				
City tourism	6.1 (1.07)	6.1 (1.10)	6.20 (1.03)	5.9 (1.29)
*Adventure (sports)/Nature tourism**	4.5 (1.89)	NA	NA	5.8 (1.17)
Importance of hotel aspects *(from 1 = "Not important", to 7 "Very important"; mean, std. dev.)*				
Room	NA	5.8 (1.26)	5.9 (1.14)	NA
Reception	NA	4.2 (1.22)	4.2 (1.34)	NA
Services (e.g. gym)	NA	3.9 (1.78)	3.8 (1.75)	NA
Location	NA	6.5 (0.68)	6.4 (0.70)	NA
Restaurant	NA	4.0 (1.78)	3.9 (1.70)	NA
Value for money	NA	6.6 (0.65)	6.5 (0.69)	NA
Previous experience with technology *(from 1 = "I have never used it/watch them on this device", to 7 = "I am very used to use it/watch them on this device"; mean)*				
PC -360-degree videos-	2.8 (2.08)	2.4 (1.77)	2.6 (1.87)	2.9 (2.07)
Smartphone -360-degre videos-	4.2 (2.11)	3.5 (1.70)	3.8 (1.75)	4.5 (1.95)
VR HMD -360-degree videos-	1.9 (1.66)	1.7 (1.15)	1.9 (1.41)	2.3 (1.72)
AR with smartphones	NA	2.3 (1.55)	2.4 (1.67)	NA
AR HMD	NA	NA	1.4 (1.04)	NA
Technology innovativeness (from 1 = "Strongly disagree", to 7 = "Strongly agree"; adapted from Bruner & Kumar, 2007; Thakur, Angriawan, & Summey, 2016)				
Mean (std. dev.)	3.2 (1.33)	2.7 (1.13)	2.51 (1.09)	3.2 (1.35)

Source: Own elaboration

Notes: * Participants were asked about their preferences toward adventure (sports) tourism in chapter 6, whereas preferences toward nature tourism were asked in chapter 9; NA: Not asked.

The scales were validated through a two-step procedure in all the studies. First, Exploratory Factor Analyses (EFA) were performed. The scales' unidimensionality was assessed by means of a principal component analysis (Hair, Babin, Anderson, & Black, 2018). Unidimensionality allows us to calculate the average of the items that constitute each construct. When this is the case, a single variable to represent each theoretical construct can be used (Anderson & Gerbing, 1988). Separate factorial analyses, with principal components and Varimax rotation, were conducted to determine if any eigenvalues were higher than 1. The Kaiser-Meyer-Olkin (KMO) test and Bartlett test of sphericity confirmed the adequacy of the principal components method to determine the unidimensionality of the scales. Furthermore, the factorial loadings were required to be greater than 0.5, with a significant total explained variance (Hair et al., 2018).

Second, Confirmatory Factor Analyses (CFA) with SmartPLS 3 (Hair et al., 2018; Ringle, Wende, & Becker, 2015) were carried out. We verified that all the loadings from the items were higher than the recommended value of 0.7 (Henseler, Ringle, & Sinkovics, 2009). In addition, we checked that the Cronbach's Alphas were higher than the cut-off of 0.7 (Bagozzi & Yin, 1988) and that composite reliabilities were higher than the recommended value of 0.65 (Steenkamp & Geyskens, 2006), proving their internal consistency. After that, we corroborated that the values of the average variance extracted (AVE) were higher to the benchmark of 0.5 to confirm the convergent validity (Fornell & Larcker, 1981). Finally, to establish discriminant validity, we verified that the value of the square root of the AVE was higher than the correlations among the constructs (Fornell & Larcker, 1981) and the values of the Heterotrait-Monotrait (HTMT) ratio (Henseler, Ringle, & Sarstedt, 2015) were lower than 0.90 (Gold, Malhotra, & Segars, 2001).

Once the scales were validated, the average of the items were calculated to obtain the scales of each construct. Several statistical techniques were used to test the specific hypotheses of the studies. All the analyses were carried out with the software SPSS v26. Specifically, analyses of variance were conducted in order to examine the differences between the dependent variables depending on the experimental conditions: multiple analysis of variance (MANOVA), multivariate analysis of covariance (MANCOVA), univariate analysis of variance (ANOVA) and univariate analysis of covariance (ANCOVA). These tests were used to examine the differences between the dependent variable (ANOVA; ANCOVA if control variables are included as covariates) or a set of correlated dependent variables (MANOVA or MANCOVA) depending on the experimental conditions. We also applied independent samples t-test to determine if there were differences in the mean of two groups depending on the experimental manipulation.

Finally, we used the PROCESS macro (PROCESS Macro, 2020) to estimate total, direct and indirect effects. PROCESS is a simple, user-friendly modeling system that uses Ordinary Least Squares regression procedures (Hayes, 2018). Similar to other techniques which rely on Maximum Likelihood procedures (e.g. Structural Equation Modeling –SEM–), PROCESS estimates indirect effects and does not require separate tests to assess the significance of the mediation effect. However, unlike SEM, PROCESS can be used with smaller samples with irregular sampling distributions, given that it uses bootstrapping methods to estimate indirect effects (Hayes, Montoya, & Rockwood, 2017). By using bootstrap confidence intervals, the inferences are likely to be more accurate and the test has higher power than when using ordinary methods; Hayes 2018). Hayes et al. (2017) argue that both methods are equally valid for mediation models, and produce similar results for observed variables (as is our case; the scales are formed by the average of the items). PROCESS allows researchers to analyze direct, indirect, and total effects simultaneously and does not require subgroup analysis (Hayes, 2018). This modeling tool is freely available for SPSS, SAS, and R statistical packages.

6. The affective route of virtual reality (I): effects on engagement and behavioral intentions toward destinations

6.1. Introduction

The development of new technologies characterized by high degrees of portability and embodiment has brought VR to a new level. As mentioned in the introduction, the advances in the field of VR, particularly the arrival of standalone devices (e.g. Oculus Quest 2) which do not require to be connected to a powerful PC, the progressive decrease in the price of these devices and the enhancement in the quality of the contents offered, have undoubtedly led to a considerable improvement in the user's VR experience, fostering a higher adoption (Pearce, 2020). However, the growth in the adoption of VR seems to be slower and more irregular than expected (Road to VR, 2019). Thus, understanding how these technologies support, empower, or create new experiences, is challenge that must be addressed by researchers and practitioners (Flavián et al., 2019a).

The particular features of tourism, considered as a service-intense industry in which the products offered cannot be tested in advance (Guttentag, 2010; Neuhofer et al., 2014) make it an ideal industry in which to implement VR technologies and analyze their impact. In fact, users have shown high interest in the use of VR devices in the travel and adventure field (Greenlight, 2016). Users perceive that VR adds value to their travel decision-making processes, so they are willing to use this technology at a travel agency as well as to book vacations based on in-store VR experiences (YouGov, 2016). As for tourism marketers, they are striving to find innovative ways to attract potential customers to their destinations (Pike & Page, 2014). The use of VR devices can help them to design and deliver optimal customer experiences (Berg & Vance, 2017). More specifically, embodied VR devices have great potential to affect tourists' behaviors, especially in the pre-purchase stage of the customer journey (Bogicevic et al., 2019; Guttentag, 2010; Lee et al., 2020; Marasco et al., 2018; Tussyadiah, Wang, et al., 2018). Embodied VR devices can be said to be in direct contact with the human senses and can mediate the potential customers' experiences within a virtual environment, giving them the ability to explore virtually, and thereby assess, specific destinations (which cannot be pre-tested). Consequently, the consumer can make more confidently-held decisions in relation to visiting that destination (Marasco et al., 2018).

Most studies about the implementation of VR technology in the tourism field focus on its antecedents (e.g. Disztinger et al., 2017; Gibson & O'Rawe, 2017; Israel, Tscheulin, et al., 2019), its influence on decision-making process (e.g. Lee et al., 2020; Marasco, et al., 2018; Tussyadiah, Wang, et al., 2018) or the benefits of its application (e.g. Barnes, 2016; Guttentag, 2010). However, the influence of technological embodiment, which is one of the main features of VR technologies (Tussyadiah, Jung, et al., 2018), has not been empirically analyzed.

This chapter analyzes how the degree of technological embodiment affects the customer pre-experience with a destination. Based on the Stimulus-Organism-Response (S-O-R) paradigm (Donovan & Rossiter, 1982; Mehrabian & Rusell, 1974), we propose that the level of embodiment (stimulus) affects users' perceptions of immersion and sensory stimulation (organism), which ultimately determine their experience in terms of engagement and behavioral intentions toward a destination (response). By better understanding the processes through which technological embodiment enhances customer experiences, tourism managers will be able to create superior and memorable experiences by offering their customers high value propositions, especially in the pre-experience stage of the customer journey.

6.2. Theoretical development and hypotheses

The Stimulus-Organism-Response (S-O-R) paradigm is rooted in classic Stimulus-Response theory (classical conditioning; Pavlov, 1902), which posits that, after being shown a specific stimulus, subjects carry out a paired response. The classic conditioning model was extended by Mehrabian and Russell (1974) and Donovan and Rossiter (1982) to the S-O-R paradigm. Stimuli are the specific factors that arouse the organismic processes of the individual (Eroglu, Machleit, & Davis, 2001). Through the processing of these stimuli, internal processes are generated (organism). Eventually, this finally leads to responses, such as approach or avoidance behaviors (Donovan & Rossiter, 1982). Thus, the S-O-R model proposes that stimuli cause organismic reactions, which lead to the performance (or not, as the case may be) of certain actions. The organism mediates the influence of a particular stimulus on the response. The S-O-R model has previously been used in online shopping environments (e.g. Eroglu et al., 2001; Ettis, 2017; Mummalaneni, 2005). In virtual environments, stimuli are the sensory cues presented to the shopper, who processes these stimuli (organism) and, consequently, responds by buying (or not) a particular product (Eroglu et al., 2001).

6.2.1. Stimulus: technological embodiment

As stated in section 4.2.1 of this doctoral thesis, the theory of technological mediation (Ihde, 1990) describes embodiment as a situation in which a technological device mediates the users' experiences and, consequently, the technology becomes an extension of their bodies and helps them to interpret, perceive and interact with their immediate environment. Following the EPI cube developed in chapter 4, VR HMDs are highly embodied technologies, while smartphones and desktop PCs are in medium and low levels of embodiment, respectively. Recently developed wearable technologies have been compared to embodied technologies (Tussyadiah, 2014; Tussyadiah, Jung, et al., 2018), since they reinforce the user´s sense of integration between the body and the technology. Therefore, devices with different levels of technological embodiment are the stimuli that are proposed to affect the organism components (immersion and sensory stimulation) and responses (engagement and behavioral intentions).

6.2.2. Organism: immersion and sensory stimulation

Immersion is an individual experience, defined as the "psychological state characterized by perceiving oneself to be enveloped by, included in, and interacting with an environment that provides a continuous stream of stimuli and experiences" (Witmer & Singer, 1998, p. 227). This is related to the concept of "mental immersion", defined by Sherman and Craig (2003) as the state of being deeply involved in an experience with the suspension of disbelief. These authors state that physical immersion, in which the technological stimulus creates the sensation that the body has entered into the virtual environment, may have an important effect on mental immersion.

Cutting-edge technologies characterized by a high degree of immersion can generate experiences in which users feel as if they are actually part of the virtual environment (Tussyadiah, Wang, et al., 2018). Furthermore, as the efficacy of traditional media is decreasing (Fransen, Verlegh, Kirmani, & Smit, 2015), marketers are continually on the lookout for more effective formats as VR (Wedel et al., 2020). Embodied devices provide customers with a higher sense of closeness between the virtual environment and their senses, thus creating more immersive experiences than portable or external technologies (Biocca, 1997; Flavián et al., 2019a). In addition, high embodied technologies create a greater sense of immersion in the virtual environment by matching their users' body movements with the information displayed (Witmer & Singer, 1998). Hence:

H_1: High vs. medium vs. low levels of technological embodiment have a positive effect on users' perceived immersion.

According to Krishna (2012), sensory marketing aims to engage the customers' senses, resulting in changes in their perceptions, judgments and subsequent behaviors. Consumers experience their surroundings through their senses, so sensory information and the related subjective experiences are key in human action and cognition (Krishna & Schwarz, 2014). Experiential products (such as tourism) need to provide vicarious experiences with sensory information to create an attractive destination (Hyun & O'Keefe, 2012). VR technologies generate virtual environments where users obtain information directly through the stimulation of their senses, which provides them with a realistic representation of the simulated environment (Petit et al., 2019; Slater & Usoh, 1993). Sensorial richness is regarded as one of the variables that influences virtual experiences (Steuer, 1992), and VR offers elements that generate sensory stimulation (Cheong, 1995; Lin et al., 2020; Petit et al., 2019).

Sight is the sense most often stimulated by HMDs (Guttentag, 2010). Audio is also important (Jung, tom Dieck, Moorhouse, & tom Dieck, 2017) and is widely used in realistic virtual environments (Gutiérrez, Vexo, & Thalmann, 2008). For tourism, these two senses are regarded as paramount (Guttentag, 2010). In addition, haptic devices (e.g. gloves or haptic suits) can be implemented in VR experiences to trigger tactile sensations. Finally, recent advances have been made regarding the addition of olfactory and gustatory senses to virtual environments (Gutiérrez et al., 2008; Petit et al., 2019).

Embodied technologies as VR HMDs have the potential to create extensive multisensory experiences, which might result in better consumer responses (Petit et al., 2019; Willems et al., 2019). Specifically, high embodied technologies use effectors (e.g. HMDs, haptic devices), which stimulate the receptors of the perceptual human senses (Latta & Oberg, 1994). Therefore, devices with higher levels of technological embodiment generate stronger sensorial stimuli, resulting in more stimulating sensorial experiences (Biocca, 1997; Flavián et al., 2019a; Tussyadiah, 2014), than non-embodied devices. Thus:

H_2: High vs. medium vs. low levels of technological embodiment have a positive effect on users' sensory stimulation.

6.2.3. Response: engagement and behavioral intentions

User engagement is defined as the quality of the experience characterized by the depth of the users' cognitive, temporal, affective and behavioral investment when they are interacting in the digital environment (O'Brien, 2016). The underlying processes of user engagement in virtual environments are receiving great attention from both researchers and managers (O'Brien, 2016).

For tourism marketing, providing users with VR experiences (as they resemble direct experiences to a great extent) is expected to be more effective than giving them indirect experiences, favoring engagement with the real destination (Hyun & O'Keefe, 2012). High embodied devices as VR HMDs have great potential to engage tourists (Bec et al., 2019; Tussyadiah, Jung, et al., 2018). Previous research has shown that advertising destinations using embodied VR devices is more engaging than with other, traditional formats (Griffin et al., 2017). In the same way, watching videos through highly embodied devices (e.g. VR HMDs) generates more engagement than watching them on a flat screen (Nielsen, 2016). VR experiences generate customer engagement by creating emotional connections with the destination depicted (Barnes, 2016). Therefore, we propose that devices with high levels of technological embodiment will generate more engagement than devices with medium and low levels of embodiment:

H_3: High vs. medium vs. low levels of technological embodiment have a positive effect on users' engagement.

Behavioral intentions are the main antecedents of actual customer behaviors (Ajzen, 1991). Intentions reflect the eagerness of users to carry out particular behaviors.

Previous research has shown that there is a relationship between intentions and actual behaviors (Casaló, Flavián, & Ibáñez-Sánchez, 2017a; Venkatesh & Davis, 2000).

Previous studies also show that VR technologies can provide "try-before-you-buy" experiences, which create a destination image in the mind of potential visitors, leading to positive behavioral intentions (Marasco et al., 2018; Tussyadiah, Wang, et al., 2018). In fact, the study of the marketing opportunities that VR technologies offer, in terms of their influence on potential visitors' decisions whether or not to visit a destination, is a growing research topic (Griffin et al., 2017; Loureiro et al., 2020; Marasco et al., 2018).

The impact of high embodied technologies on consumer behavior has been highlighted by previous literature. Kim, Lee and Jung (2020) stress the potential of VR to enhance the behavioral intentions toward visiting a destination. Griffin et al. (2017) state that embodied devices, in comparison to less embodied technologies, generate greater willingness to seek out further information, and to share it, about a destination. Tussyadiah, Wang, et al. (2018) also reveal the persuasive power of embodied devices (VR) in tourism marketing. Therefore, we propose that devices with high levels of technological embodiment will have a positive impact on behavioral intentions. Thus:

H_4: High vs. medium vs. low levels of technological embodiment have a positive effect on users' behavioral intentions toward the destination.

6.2.4. Mediation effects

Following the S-O-R framework (Donovan & Rossiter, 1982; Mehrabian & Rusell, 1974), we propose that immersion and sensory stimulation are the organismic components that may mediate the relationship between the stimulus (devices with different levels of technological embodiment) and the responses (engagement and behavioral intentions). On the one hand, high embodied technologies play a key role in providing immersive experiences that, as a result, generate a perception of engagement while users are in the virtual environment (Jennett et al., 2008; Sherman & Craig, 2003). On the other hand, one of the main advantages of embodied technologies for tourism marketing is that they provide potential tourists with sensory cues, which is key for the industry (Barnes, 2016; Flavián et al., 2019a; Guttentag, 2010). As a consequence, a sense of engagement in the virtual experience can be generated (Barnes, 2016). Therefore, both organismic components (immersion and sensory stimulation) may mediate the influence of devices with different levels of technological embodiment on users' engagement:

H_5: The levels of (a) immersion and (b) sensory stimulation mediate the effect of high vs. medium vs. low levels of technological embodiment on users' engagement.

Taking into account the particular features of the tourism industry (service domain and intangibility; Casaló, Flavián, & Guinalíu, 2010; Hyun & O'Keefer, 2012), providing potential visitors with a realistic "try-before-you-buy" experience can influence travel decision-making (Jang, 2005; Tussyadiah, Wang, & Jia, 2016). In this way, immersive technologies help potential visitors to virtually experience the actual destination before going there (Marasco et al., 2018; Tussyadiah, Wang, et al., 2018). Previous research shows that the immersive capacity of VR devices can have a positive impact on subsequent behavior (Hudson, Matson-Barkat, Pallamin, & Jegou, 2019; Jung et al., 2017). Thus, high levels of immersion generated by embodied technologies may lead to favorable behavioral intentions toward a destination. In a similar vein, sensory cues can significantly influence the consumer's intention to visit a destination (Ghosh & Sarkar, 2016). Potential tourists can better evaluate and make better travel decisions if they are provided with useful and relevant information (Mendes-Filho, Mills, Tan, & Milne, 2017). Direct experiences can be simulated through the sensory power of high embodied technologies (VR HMDs), which will result in more positive behaviors (Huang, Backman, Backman, & Chang, 2016). Therefore:

H_6: The levels of (a) immersion and (b) sensory stimulation mediate the effect of high vs. medium vs. low levels of technological embodiment on users' behavioral intentions toward the destination.

6.2.5. Moderation effect: active/passive tourism

Previous studies reveal several motivations for tourism travel, such as leisure, escapism, novelty and pleasure seeking (Guttentag, 2010; Kim, Chua, Lee, Boo, & Han, 2016; Kim & Prideaux, 2005). Tourists perform different activities during their stays to meet their own particular needs. In this sense, tourism activities can be classified according to the degree of physical energy that is expended (Pizam & Fleischer, 2005). Specifically, active (or dynamic) tourism encompasses activities in which tourists expend significant physical energy; these may include fast-moving, outdoor activities (vigorous sports, nature or adventure; Vohnout et al., 2014). Activities such as rafting or hiking can be considered as active tourism. On the other hand, passive (or static) tourism includes activities where the tourist does not expend significant amounts of physical energy. These activities are slow-paced, well planned and organized in advance, so they involve no risk. City based activities (e.g. shopping, attending the opera, ballet and theater) are often regarded as passive tourism.

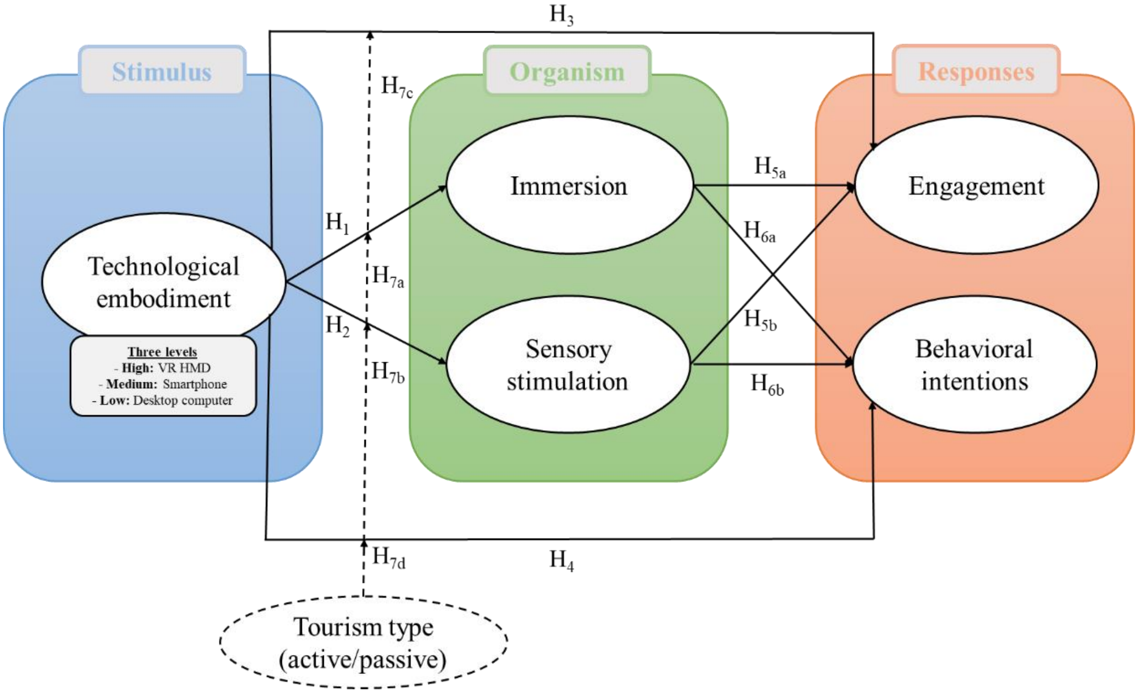
According to the cognitive fit theory (Vessey, 1991), when users are presented with a particular task, the correspondence between the task and the format in which the relevant information is displayed results in superior task performance. Similarly, resource-matching theory (Peracchio & Meyers-Levy, 1997) suggests that the persuasiveness of a particular item of information is higher when the resources allocated to process it match that required to perform the related task. Therefore, the fit between the technology used to view a particular message and the features of the content displayed in the message is critical (task-technology fit; Goodhue & Thompson, 1995), especially taking into account that tourism services cannot be pre-tested by the consumers (Guttentag, 2010).

As technological embodiment is related to the extent that a device is integrated into the body, highly embodied devices (i.e. VR HMDs) will allow users to perceive more naturally the fast-paced movements, greater dynamism and energy that featured active tourism activities. A greater correspondence between the active tourism video and the technological device used strengthens users' perceptions (Goodhue & Thompson, 1995). However, for passive tourism activities videos (compared to active tourism) the role of embodiment is not substantial due to its main characteristics (e.g. slow-paced movements, less energetic activities). Additionally, embodied VR devices turn potential tourists into active participants since they can freely and naturally explore the virtual environment from a first-person perspective (Cho, Wang, & Fesenmaier, 2002; Israel, Zerres, et al., 2019), what reinforces their role in active tourism videos. Therefore, given the characteristics of active tourism, embodied devices (VR HMDs) help to create a close match between users' actual movements and the ones in the virtual environment (Slater, 2009), what help potential travelers to better explore virtually the destination and strengthening their perceptions. Therefore:

H_7: The type of tourism (active/passive) moderates the effects of high vs. medium vs. low levels of technological embodiment on (a) immersion, (b) sensory stimulation, (c) engagement and (d) behavioral intentions; the effects of technological embodiment will be stronger for active tourism than for passive tourism.

Figure 6.1 shows the research model and related hypotheses.

Figure 6.1. Research model



6.3. Methodology

6.3.1. Participants, procedure and measurements

The data to test the hypotheses were collected from a lab experiment. The sample consisted of 202 participants (socio-demographic information appears in Table 5.2), who took part in a 3 (technological embodiment: low vs medium vs high) × 2 (type of tourism: passive vs active) between-subjects factorial design.

The context of the experiment was a 360-degree tourism-related video as a pre-experience of a potential destination. First, the participants were gathered in one room and given a brief introduction about the study. Specifically, they were told that they were going to have a virtual pre-experience with a destination and they had to answer related to it. At this point, the participants received a brochure with several pages containing the questionnaires. We used random procedures (different colored stickers) to hand out the brochures. In the first page, participants answered a series of control questions (a summary of the results from these control questions is shown in Table 5.2).

Second, participants were directed to different experimental rooms, according to their assignment to the experimental condition (colored sticker). Each color corresponded to the viewing of a 360-degree video of a destination with a device with three levels of embodiment: low (desktop PC), medium (smartphone –SM–) and high (VR HMD). Participants entered individually into the room and, after some instructions they watched the video with the corresponding device. Regarding the type of tourism, participants in the passive tourism condition watched a video of a gondola ride in Venice. The video showed a quiet ride along the canals of the city in a sunny day; the viewer was placed on the gondola, plowed through the calm waters of the canals in a slow-paced way. In the active tourism video, participants watched a video of a whitewater rafting in the Grand Canyon. In this video, the viewer was placed on a boat on a sunny day in the middle of nature; in this case, they sailed down through the rapids of a river, so that a great movement was generated in a fast-moving way. The original videos were modified to keep the duration and sound quality constant. After viewing the video, the participants completed the main questionnaire which includes the variables considered in the study (see Appendix A.1).

6.4. Results

Before analyzing the data, the first control question allowed us to screen out those participants who had already visited the target destination (Venice or the Grand Canyon) and would not visit it again. The resulting pre-experience and behavioral intentions of these participants might remain unaltered regardless of the experimental treatment, adding noise to the analysis. Thus, the final sample consisted of 196 participants (60.2% female; mean age = 22.10). Cell sizes ranged from 30 to 36 participants.

6.4.1. Manipulation checks

Once the scales were validated following the procedures described in section 5.3.1, mean values were calculated to obtain the scales that were used in the analysis. To check the manipulation of technological embodiment, we carried out a one-way ANOVA with device type as the independent variable with SPSS v26. As expected, technological embodiment was higher in the case of VR HMDs (M = 5.58, SD = 1.55) than with SMs (M = 4.30, SD = 1.12) and desktop PCs (M = 2.89, SD = 1.01), and these differences were significant ($F_{(2,195)}$ = 104.014, $p < 0.001$). The post-hoc Tukey tests revealed significant differences between desktop PCs and SMs (p = 0.000), desktop PCs and VR HMDs (p = 0.000) and SMs and VR HMDs (p = 0.000). In addition, the Grand Canyon video was perceived as significantly more active (M = 5.32; SD = 1.68) than the Venice video (M = 4.38, SD = 1.49; $t_{(194)}$ = 4.126, $p < 0.001$). Also, participants correctly classified the Venice video as city tourism and the Grand Canyon video as nature/sports tourism ($\chi^2_{(2)}$ = 196.000, $p < 0.001$).

6.4.2. Direct and moderation effects

The descriptive statistics per each experimental cell and treatment are shown in Table 6.1. We carried out a multivariate analysis of variance, which is appropriate since the correlations between the dependent variables were significant (*Pearson's r*s > 0.281; Hair et al., 2018). We included the participants' previous experience in the destination (1 = yes, 0 = no), preference for the type of tourism displayed in their condition (city or adventure sports), their previous experience with 360-degree videos in the device they used in their condition (desktop PC, SM, or VR HMD), and their degree of technological innovativeness as covariates. The MANCOVA revealed a significant multivariate effect of the type of device (*Wilk's* λ = 0.469, $F_{(8, 374)}$ = 21.024, $p < 0.001$; *partial* η^2 = 0.315;

power = 1.000). Type of tourism did not have a significant multivariate effect (p = 0.934). However, the interaction term was significant at the multivariate level (*Wilk's* λ = 0.895, $F_{(8, 374)}$ = 2.597, p < 0.05; *partial* η^2 = 0.054; *power* = 0.921). Regarding the control variables, the MANCOVA showed a significant multivariate effect of the participants' previous experience in the destination (*Wilk's* λ = 0.945, $F_{(4, 183)}$ = 2.679, p < 0.05; *partial* η^2 = 0.055; *power* = 0.737). Their preference for the type of tourism (p = 0.741), their previous experience with the technology (p = 0.074) and their degree of technological innovativeness (p = 0.524) had no significant effects.

Table 6.1. Descriptive statistics per experimental cell

		Immersion	Sensory stimulation	Engagement	Behavioral intentions
Device	**Type of tourism**	**M *(SD)***	**M *(SD)***	**M *(SD)***	**M *(SD)***
PC	**Passive**	3.35 *(1.405)*	3.96 *(1.197)*	4.16 *(1.280)*	4.44 *(1.616)*
	Active	2.62 *(1.277)*	3.50 *(1.427)*	3.82 *(1.385)*	4.18 *(1.729)*
	Total	3.02 *(1.387)*	3.75 *(1.316)*	4.00 *(1.329)*	4.33 *(1.661)*
SM	**Passive**	4.11 *(1.420)*	4.57 *(1.260)*	5.08 *(1.203)*	5.03 *(1.438)*
	Active	4.01 *(1.168)*	4.58 *(1.151)*	4.85 *(1.033)*	4.95 *(1.340)*
	Total	4.06 *(1.287)*	4.58 *(1.195)*	4.95 *(1.116)*	4.99 *(1.377)*
VR HMD	**Passive**	5.47 *(1.123)*	5.30 *(0.695)*	5.78 *(0.947)*	4.89 *(1.348)*
	Active	6.46 *(0.649)*	6.18 *(0.723)*	6 46 *(0.677)*	5.31 *(1.426)*
	Total	5.99 *(1.026)*	5.76 *(0.831)*	6.14 *(0.879)*	5.11 *(1.395)*
Total	**Passive**	4.28 *(1.585)*	4.59 *(1.208)*	4.97 *(1.332)*	4.77 *(1.486)*
	Active	4.49 *(1.917)*	4.84 *(1.569)*	5.12 *(1.514)*	4.85 *(1.555)*
	Total	4.38 *(1.758)*	4.71 *(1.402)*	5.04 *(1.424)*	4.81 *(1.518)*

Overall, we observed gradual increases in all the dependent variables as the degree of technological embodiment increases (see Table 6.1). The results for the univariate effects are shown in Table 6.2. Specifically, the type of device was found to positively affect the levels of immersion and sensory stimulation. The effects were significant and strong. The post-hoc Tukey test indicated that both variables were higher for participants in the VR HMD condition than those in the SM condition (see Table 6.1; ps < 0.001) and those in the desktop PC condition (see Table 6.1; *p*s < 0.001). The differences between SM and desktop PC conditions were also significant (see Table 6.1; *p*s < 0.001). Thus, hypotheses H_1 and H_2 were supported. None of the covariates had a significant influence on immersion or sensory stimulation (see Table 6.2).

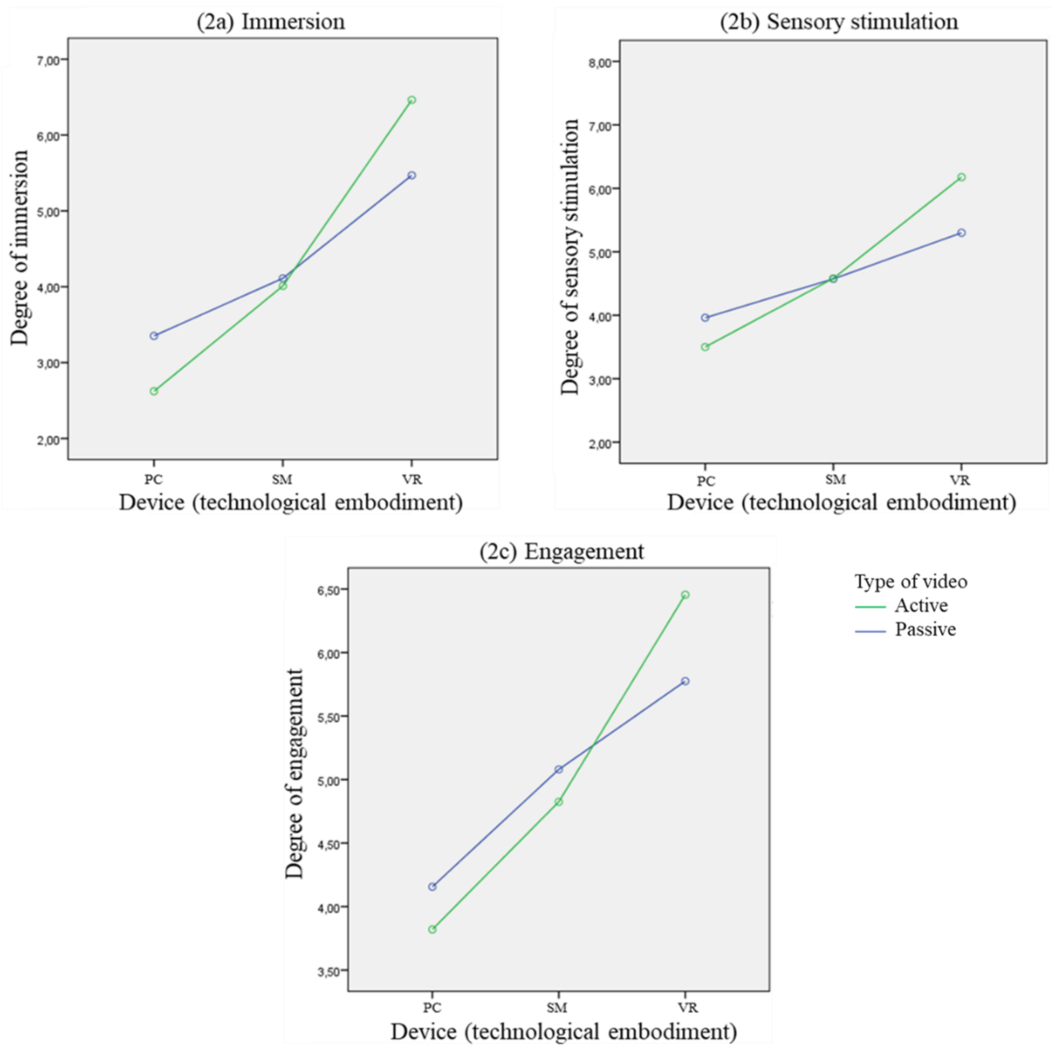
Table 6.2. Results of the univariate effects

	Immersion		**Sensory stimulation**		**Engagement**		**Behavioral intentions**	
Variable	$F_{(2, 195)}$	***Sign.***	$F_{(2, 195)}$	***Sign.***	$F_{(2, 195)}$	***Sign.***	$F_{(2, 195)}$	***Sign.***
Experience in the destination	1.461	0.228	2.853	0.093	0.001	0.980	4.001	0.047
Pref. for the type of tourism	0.083	0.774	0.125	0.724	0.034	0.853	1.646	0.201
Experience with the technology	0.026	0.873	1.309	0.254	0.313	0.577	2.802	0.096
Technological innovativeness	1.810	0.180	1.014	0.315	2.136	0.146	1.456	0.229
Device	98.827	0.000	56.428	0.000	57.436	0.000	6.411	0.002
Type of tourism	0.181	0.671	0.014	0.905	0.050	0.823	0.061	0.805
Device × type of tourism	9.211	0.000	6.408	0.002	4.572	0.012	0.955	0.387

Regarding the influence of embodiment on engagement, we found a significant strong effect (see Table 6.2). The high level of technological embodiment (VR HMD) was found to positively affect the participants' engagement (see Table 6.1). The post-hoc Tukey test indicated that all differences between conditions were significant (all *p*s < 0.001), thus supporting H_3. The effect of the type of device on behavioral intentions was also significant, although the effect size was medium (see Table 6.2); however, the difference between SMs and VR HMDs was not significant (see Table 6.1; $p = 0.751$). Therefore, H_4 was partly supported. The control variables did not affect engagement and behavioral intentions, except for a small, significant impact of the previous experience in the destination on behavioral intentions (see Table 6.2). Specifically, behavioral intentions were higher for participants who had not been in the destination previously (n = 154; $M = 4.91$, $SD = 1.449$) than for those who had already been in the destination (n = 42; $M = 4.44$, $SD = 1.715$).

Type of tourism had no direct effects on the dependent variables (see Table 6.1 and Table 6.2). However, significant interaction effects were found for immersion, sensory stimulation and engagement (see Table 6.2). The effect sizes were medium for immersion and sensory stimulation, and small for engagement. Figure 6.2 shows these interaction effects. Specifically, we observed that the effects of high embodied technologies on immersion (see Figure 6.2a), sensory stimulation (see Figure 6.2b) and engagement (see Figure 6.2c) were stronger for the active tourism video than for the passive tourism video. The interaction between technological embodiment and tourism type on behavioral intentions was not significant (p = 0.400). Altogether, the results support H_{7a}, H_{7b} and H_{7c}, yet H_{7d} must be rejected.

Figure 6.2. Interaction effects



6.4.3. Mediation effects

We used the PROCESS macro v3.1 for SPSS v26 (Hayes, 2018) to test the mediating role of the organismic components (immersion and sensory stimulation) in the relationship between the stimulus (technological device) and the participants' responses (engagement and behavioral intentions).

We ran two separate models for each response variable (model 4 with parallel mediators). As the independent variable was an ordinal multicategorical variable with three levels, sequential coding was used (Hayes, 2018). Thus, two dummy variables (X1: 1 = SM and VR HMD, 0 = desktop PC; X2: 1 = VR HMD, 0 = otherwise) were included in each model. The participants' previous experience in the destination and with the technology, their preference for the type of tourism displayed in the video, and their degree of technological innovativeness were also included as covariates.

The results of the mediation model on engagement are displayed in Table 6.3. The results of the effects of the device on immersion and sensory stimulation replicated those found in the MANCOVA. When the organismic variables were included in the model, the direct effects of technological embodiment became non-significant. Both immersion and sensory stimulation had significant effects on engagement. The bootstrap results for the indirect effects revealed mediation for both organismic variables, given that the zero value was not included in the 95% confidence intervals (see Table 6.3). Therefore, H_{5a} and H_{5b} were supported. Regarding the control variables, we found that participants who had already been in the destination reported higher levels of engagement. However, the total effect was not significant, and no other effects were found (see Table 6.3).

Table 6.3. Results of the analysis of the mediation model on engagement

Predictor	Coeff.	SE	*t*	*p*	LLCI	ULCI
Immersion						
Constant	3.398	0.40	8.587	0.000	2.617	4.179
X1 (desktop PC vs. otherwise)	1.011	0.22	4.515	0.000	0.569	1.452
X2 (VR HMD vs. otherwise)	1.951	0.23	8.364	0.000	1.491	2.411
Experience in the destination	-0.245	0.23	-1.082	0.281	-0.692	0.202
Pref. for the type of tourism	-0.015	0.055	-0.278	0.781	-0.123	0.092
Experience with the technology	0.003	0.045	0.074	0.941	-0.086	0.093
Technological innovativeness	-0.076	0.067	-1.125	0.262	-0.208	0.057
Model Summary	**R^2 = 0.512; $F_{(6, 189)}$ = 33.513, p < 0.001**					
Sensory stimulation						
Constant	3.783	0.36	10.600	0.000	3.077	4.489
X1 (desktop PC vs. otherwise)	0.753	0.20	3.721	0.000	0.354	1.153
X2 (VR HMD vs. otherwise)	1.306	0.21	6.192	0.000	0.890	1.723
Experience in the destination	-0.387	0.20	-1.886	0.061	-0.791	0.018
Pref. for the type of tourism	0.010	0.05	0.196	0.845	-0.088	0.107
Experience with the technology	0.055	0.04	1.336	0.183	-0.026	0.135
Technological innovativeness	-0.049	0.06	-0.801	0.424	-0.169	0.071
Model Summary	**$F_{(6, 189)}$ = 19.090, p < 0.001**					
Engagement						
Constant	1.277	0.28	4.531	0.000	0.721	1.833
X1 (desktop PC vs. otherwise)	0.267	0.13	2.015	0.045	0.005	0.528
X2 (VR HMD vs. otherwise)	-0.065	0.15	-0.425	0.671	-0.368	0.237
Immersion	0.237	0.06	4.266	0.000	0.127	0.347
Sensory stimulation	0.589	0.06	9.582	0.000	0.468	0.710
Experience in the destination	0.263	0.13	2.047	0.042	0.009	0.516
Pref. for the type of tourism	-0.002	0.03	-0.069	0.945	-0.063	0.058
Experience with the technology	-0.049	0.02	-1.915	0.057	-0.099	0.002
Technological innovativeness	-0.032	0.04	-0.847	0.398	-0.107	0.043
Model Summary	**R^2 = 0.770; $F_{(8, 187)}$ = 78.299, p < 0.001**					
TOTAL EFFECT MODEL: Engagement						
Constant	4.310	0.36	12.008	0.000	3.602	5.018
X1 (desktop PC vs. otherwise)	0.950	0.20	4.480	0.000	0.550	1.351
X2 (VR HMD vs. otherwise)	1.167	0.21	5.513	0.000	0.749	1.584
Experience in the destination	-0.023	0.21	-0.111	0.912	-0.428	0.383
Pref. for the type of tourism	0.000	0.05	-0.001	0.999	-0.098	0.098
Experience with the technology	-0.016	0.04	-0.391	0.696	-0.097	0.065
Technological innovativeness	-0.080	0.06	-1.290	0.198	-0.199	0.042

Model Summary	**$R^2 = 0.393$; $F_{(6, 189)} = 20.399$, $p < 0.001$**					
Relative total effects of X on Y	***Effect***	**SE**	***t***	***p***	**LLCI**	**ULCI**
X1 (desktop PC vs. otherwise)	0.950	0.20	4.679	0.000	0.550	1.351
X2 (VR HMD vs. otherwise)	1.167	0.21	5.513	0.000	0.749	1.584
Omnibus test of total effect of X on Y	**R^2 change = 0.359** **$F_{(2, 189)} = 55.922$, $p < 0.001$**					
Relative indirect effects of X on Y	***Effect***	**BootSE**	**BootLLCI**		**BootULCI**	
Embodiment → Immersion → Engagement						
X1 (desktop PC vs. otherwise)	0.240	0.09	0.091		0.450	
X2 (VR HMD vs. otherwise)	0.463	0.12	0.232		0.706	
Bootstrap results for indirect effects	***Effect***	**BootSE**	**BootLLCI**		**BootULCI**	
Embodiment → Sensory stimulation → Engagement						
X1 (desktop PC vs. otherwise)	0.311	0.09	0.130		0.486	
X2 (VR HMD vs. otherwise)	0.540	0.11	0.336		0.764	

Note: n = 196. Confidence interval calculated at 95% of significance. Bootstrap sample size = 5,000. BootLLCI: lower limit confidence interval; BootULCI: upper limit confidence interval.

The same analysis was conducted for behavioral intentions (see Table 6.4). In this case, the mediation model followed a similar pattern, yet with some remarkable differences. The direct effect of the device on behavioral intentions disappeared when the mediators were included in the regression. Nevertheless, immersion had no significant effect on behavioral intentions; only sensory stimulation had. The significance of the indirect effects revealed that sensory stimulation mediated the effect of technological embodiment (low versus medium + high) on behavioral intentions. Support for H_{6b} is found; H_{6a} must be rejected. The control variables did not have direct effects (see Table 6.4). In the total effects model, the results replicated those found in the MANCOVA (negative effect of previous experience in the destination on behavioral intentions). However, the explanatory power of the model was low, suggesting than the mediator (sensory stimulation) has a more powerful effect on behavioral intentions than the type of device.

Table 6.4. Results of the analysis of the mediation model on behavioral intentions

Predictor	**Coeff.**	**SE**	***t***	***p***	**LLCI**	**ULCI**
Behavioral intentions						
Constant	2.154	0.55	3.932	0.000	1.073	3.235
X1 (desktop PC vs. otherwise)	0.248	0.26	0.962	0.338	-0.261	0.756
X2 (VR HMD vs. otherwise)	-0.165	0.30	-0.552	0.581	-0.753	0.424
Immersion	-0.132	0.11	-1.219	0.224	-0.345	0.081
Sensory stimulation	0.594	0.12	4.971	0.000	0.358	0.830
Experience in the destination	-0.368	0.25	-1.472	0.143	-0.860	0.125
Pref. for the type of tourism	0.086	0.06	1.440	0.151	-0.032	0.203
Experience with the technology	0.061	0.05	1.232	0.219	-0.037	0.159
Technological innovativeness	-0.074	0.07	-0.999	0.319	-0.219	0.072
Model Summary	**R^2 = 0.234; $F_{(8, 187)}$ = 7.158, $p < 0.001$**					
TOTAL EFFECTS MODEL: Behavioral intentions						
Constant	3.953	0.47	8.481	0.000	3.034	4.873
X1 (desktop PC vs. otherwise)	0.562	0.26	2.131	0.034	0.042	1.082
X2 (VR HMD vs. otherwise)	0.354	0.27	1.288	0.199	-0.188	0.896
Experience in the destination	-0.565	0.27	-2.115	0.036	-1.091	-0.038
Pref. for the type of tourism	0.094	0.06	1.456	0.147	-0.033	0.220
Experience with the technology	0.093	0.05	1.751	0.082	-0.019	0.198
Technological innovativeness	-0.093	0.08	-1.168	0.244	-0.249	0.064
Model Summary	**R^2 = 0.098; $F_{(6, 189)}$ = 3.424, $p < 0.05$**					
Relative total effects of X on Y	***Effect***	**SE**	***t***	***p***	**LLCI**	**ULCI**
X1 (desktop PC vs. otherwise)	0.562	0.26	2.131	0.034	0.042	1.082
X2 (VR HMD vs. otherwise)	0.354	0.27	1.288	0.199	-0.188	0.896
Omnibus test of total effect of X on Y	**R^2 change = 0.061** **$F(2, 189)$ = 6.396, $p < 0.01$**					
Relative indirect effects of X on Y	**Effect**	**BootSE**	**BootLLCI**		**BootULCI**	
Embodiment → Immersion → Behavioral intentions						
X1 (desktop PC vs. otherwise)	-0.133	0.12	-0.382		0.074	
X2 (VR HMD vs. otherwise)	-0.257	0.21	-0.691		0.145	
Bootstrap results for indirect effects	**Effect**	**BootSE**	**BootLLCI**		**BootULCI**	
Embodiment → Sensory stimulation → Behavioral intentions						
X1 (desktop PC vs. otherwise)	0.447	0.16	0.171		0.771	
X2 (VR HMD vs. otherwise)	0.776	0.19	0.452		1.185	

Note: n = 196. Confidence interval calculated at 95% of significance. Bootstrap sample size = 5,000. BootLLCI: lower limit confidence interval; BootULCI: upper limit confidence interval.

6.5. Discussion and implications

VR technologies allow potential tourists to have realistic "try-before-you-buy" experiences that help them make better travel decisions (Bogicevic et al., 2019; Jang, 2005; Tussyadiah et al., 2016). Specifically, embodied VR devices are in close contact with the human senses, mediate users' experiences, create immersive and sensory-stimulating experiences that improve tourists' information search processes and, thus, help them make final decisions (Flavián et al., 2019a; Huang et al., 2016). This chapter uses the S-O-R model to provide a better understanding of the impact of this particular feature of VR devices on tourists' responses.

Table 6.5 shows a summary of the results obtained in the hypotheses testing. First, in line with previous notions, the results of the analysis show that technologies with high levels of embodiment (VR HMDs) produced higher levels of immersion and sensory stimulation than technologies with medium and low levels of embodiment (Biocca, 1997; Shin, 2017; Tussyadiah, 2014). Furthermore, embodied technologies improve user engagement with the pre-experience of the destination. This finding highlights the role of embodied VR technologies for the tourism industry in terms of engaging tourists (Griffin et al., 2017). Finally, we found partial support for the effect of technological embodiment on behavioral intentions. Although there are clear differences between VR HMDs, smartphones and desktop PCs, it appears that medium levels of technological embodiment may be enough to increase the potential tourist's behavioral intentions toward the destination. This could be due to the fact that tourists are accustomed to using their smartphones during all the stages of their touristic experiences (Wang, Park, & Fesenmaier, 2012). In the pre-experience stage, tourists are determined to fulfill their informational needs (Lu, Gursoy, & Lu, 2016) and, therefore, they may be more concerned about the usefulness of the information for decision-making than about the integration of the technology with their senses.

Table 6.5. Summary of the results

Hypothesis	Support
H_1: Technological embodiment → (+) Immersion	Yes
H_2: Technological embodiment → (+) Sensory stimulation	Yes
H_3: Technological embodiment → (+) Engagement	Yes
H_4: Technological embodiment → (+) Behavioral intentions	Partly
H_{5a}: Technological embodiment → Immersion → Engagement (mediation)	Yes
H_{5b}: Technological embodiment → Sensory stimulation → Engagement (mediation)	Yes
H_{6a}: Technological embodiment → Immersion → Behavioral intentions (mediation)	No
H_{6b}: Technological embodiment → Sensory stimulation → Behavioral intentions (mediation)	Yes
H_{7a}: The type of tourism × Technological embodiment → Immersion (moderation)	Yes
H_{7b}: The type of tourism × Technological embodiment → Sensory stimulation (moderation)	Yes
H_{7c}: The type of tourism × Technological embodiment → Engagement (moderation)	Yes
H_{7d}: The type of tourism × Technological embodiment → Behavioral intentions (moderation)	No

Furthermore, the results reveal that the particular features of the type of tourism moderate the effects of technological embodiment. Active tourism content is better perceived with embodied VR devices (high technological embodiment) in comparison to less embodied devices. We found that active tourism videos viewed through VR HMDs stimulate more immersive and sensorial experiences, and higher perceptions of engagement, than passive tourism videos viewed through VR HMDs. Watching passive tourism videos through low embodied devices may be, at the very least, equally as effective as using high embodied devices. This may be explained by the matching of the users' real movements and their actions in the virtual environment, facilitated by embodied VR technologies (Slater, 2009). This leads the potential tourist to have active involvement in the virtual environment which provides him or her with a better pre-experience of the destination (Cho et al., 2002). Our results are in line with the cognitive fit theory (Vessey, 1991). However, this moderating effect was not significant for behavioral intentions. These antecedents of actual behaviors (Ajzen, 1991) can be influenced by the type of tourism, while the rest of the variables are more related to the experience itself.

Finally, the results confirm mediation in the relationship between technological embodiment and engagement through the two organismic variables: immersion and sensory stimulation. The immersive and sensory power provided by highly embodied technologies drive perceptions of engagement with the virtual destination (Barnes, 2016; Jennett et al., 2008). In addition, sensory stimulation mediates the effect of high technological embodiment on behavioral intentions. As previously stated, sensory cues can impact on the users' senses and influence their behaviors through emotions, memories, perceptions and preferences (Krishna, 2012). In tourism, this effect can be even stronger due to its particular features (Guttentag, 2010). Our findings confirm that embodied VR devices provide extensive sensory information (Petit et al., 2019), so their use in the tourism industry can lead to positive behavioral intentions. Yet, the mediating effect of immersion is not significant. This might be because immersion appeals to experiential processes and not their outcomes (Chen & Chen, 2010). Thus, sensory cues may be more important than perceptions of immersion for inducing certain behaviors.

6.5.1. Theoretical and managerial implications

At the theoretical level, this chapter contributes to the body of knowledge about the application of VR technologies in the pre-experience stage of travelers' decision-making processes. VR devices can differ from smartphones and stationary PCs in several dimensions. This chapter examines the role embodiment as one of the main differentiating features of these technologies, and proposes a measurement instrument of perceived technological embodiment. Our findings stress that technological embodiment must be taken into consideration in the study of VR customer experiences. In addition, we contribute to the call for empirical research regarding the use of VR devices in tourism marketing (Griffin et al., 2017), particularly with destinations, since most of the previous literature is mainly focused on virtual worlds (e.g. Second Life; Tussyadiah, Wang, et al., 2018).

At the managerial level, destination marketers can give tourists more effective promotional messages using embodied VR devices, integrating immersive and sensory experiences into their communication strategies to provide positive potential outcomes (Huang et al., 2016; Willems et al., 2019). This chapter sheds light on the psychological-technological processes that managers must take into account when presenting visual information to potential tourists that may affect their virtual travel experiences (Choi, Hickerson, & Lee, 2018) and increase their likelihood of visiting the destination. Travel agencies can use embodied VR technologies to offer vicarious experiences that help potential visitors to make travel decisions, especially in the case of active tourism offers. These embodied technologies can generate superior, memorable experiences that will be perceived as high value propositions by potential customers, particularly in the pre-experience stage of their customer journey. Therefore, investing in this emerging technology and the creation of attractive and suitable content may help companies to overcome the decreasing efficacy of traditional media (Belanche, Flavián, & Pérez-Rueda, 2017; Fransen et al., 2015).

6.5.2. Limitations and future research lines

Beyond the general limitations of the research conducted in the doctoral thesis (which will be discussed in chapter 11), this study has several specific limitations that may serve as bases for future research. First, although several features may serve to characterize these technologies, we focused on one of the main differentiating factors of

VR devices (i.e. technological embodiment) to compare their effectiveness with less embodied devices. However, future research should consider additional physical variables in which these devices differ (e.g. weight, screen size). Additionally, we focused on active/passive tourism as a moderator of the proposed relationships. However, other types of tourism (e.g. cultural, relaxing) may moderate these effects.

Furthermore, we have taken into account several control variables (previous experience with the destination, preference for the type of tourism, previous experience with the technology, degree of technological innovativeness). However, as the newness effect of VR HMDs dissipates over time (Diffusion of Innovations Theory; Rogers, 2010), users can become bored or even abandon these technologies once the initial excitement is overcome. Therefore, future studies should consider variables to reflect on the potential downsides of VR technologies (e.g. skepticism toward new technologies, novelty-seeking tendency). In addition, future studies could analyze the role that personality traits (e.g. capacity to imagine, personal involvement) play in these relationships, since previous research has shown that individual characteristics can alter the impact of VR technologies (Disztinger et al., 2017; Kim, Lee, & Preis, 2020). Finally, this study offers a first step in the validation of a scale that measures effectively the level of technological embodiment perceived by users. Future studies are needed to develop and confirm scales for the more precise measurement of technological embodiment.

7. The affective route of virtual reality (II): effects on emotions and engagement in hospitality

7.1. Introduction

Previous sections have highlighted the dramatic changes that recent technological developments are having on consumers' experiences, especially in tourism and hospitality (Buhalis et al., 2019; Hudson et al., 2019). Among them, VR is positioned as an important technology for providing such high value propositions in tourism (Lee et al., 2020; Yung & Khoo-Lattimore, 2019). VR is a disruptive technological trend with the potential to transform the travel industry and the overall tourism experience (SimpleView, 2019). Focusing on the hotel industry, a recent report has shown that 66% of potential guests note that viewing hotel tours with VR would help them in their booking processes (Oracle, 2017). Additionally, hotels offering VR tours are seeing a 135% increase in the revenues, and most of the largest hotel chains have launched VR pre-experiences as part of their marketing strategy (PwC, 2019b). All this data reinforces the potential of VR in the future of the industry.

Previous research has called for further analysis of the use of VR in hospitality settings (Wei, 2019). As can be observed in Table 2.1, the literature analyzing the impact of VR in tourism has focused on destinations (e.g. Lin et al., 2020; Tussyadiah, Wang, et al., 2018), museums (e.g. Errichiello, Micera, Atzeni, & Del Chiappa, 2019), heritage sites (e.g. Marasco et al., 2018) or theme parks (e.g. Wei et al., 2019). However, little empirical research has analyzed the effectiveness of VR in the hotel industry (Bogicevic et al., 2019). Camilleri (2018) argues that accommodation is a fundamental element in any travel or tourism decision, whereas attractions (e.g. museums and heritage sites) are considered ancillary products; tourist experiences with hotels usually last longer, entail higher financial commitment and, in some cases, include a wider range of activities than other products. Therefore, selecting a good hotel involves higher uncertainty and perceived risk (Sun, 2014). In addition, hotel experiences are dominated by instrumental value (Prebensen & Rosengren, 2016). Hence, the information search stage can be especially important; it can add value to the overall purchase journey, indeed, even more than tourism activities dominated by hedonic value (e.g. viewing a tourist attraction).

VR technologies can be applied to engage consumers during all the stages of the customer journey (Bec et al., 2019; Flavián et al., 2019a) and offer valuable hospitality experiences. In the pre-experience stage, VR can inspire potential guests by conveying a realistic preview of how the real experience with hotel facilities would be (Neuburger et al., 2019). Additionally, VR can be implemented during the experience stage of the journey (Errichiello et al., 2019), for instance by offering information about tourism activities in an immersive way, or as a way of escapism while guests are resting in their rooms. Finally, consumers can record 360-degree videos of their own experiences in the hotel and share them with others who could view them with VR to be inspired in their pre-experiences. For potential guests of a hotel, VR can be especially useful to get a preview of the hotel facilities (e.g. room) as a “try-before-you-buy” experience (Bogicevic et al., 2019; Kim & Hardin, 2010; Wagler & Hanus, 2018). This realistic experience empowers them in their decision-making processes (Binkhorst & Den Dekker, 2009).

Although technological embodiment is one of the main features of VR HMDs (Tussyadiah, Jung, et al., 2018), previous research has not empirically analyzed the mechanisms through which technological embodiment affects the customer experience in the hotel industry. In addition, the role of engagement has been emphasized in previous theoretical proposals about VR in tourism and hospitality, but there is a paucity of empirical studies in this emerging topic (e.g. Bec et al., 2019; Hollebeek et al., 2020; Loureiro et al., 2020). This chapter analyzes the affective process by which technologies with different levels of embodiment (VR HMD, smartphone, and desktop PC; Flavián et al., 2019a) can be effective for the pre-experience stage with a hotel. Specifically, we examine the impact of technological embodiment on emotional reactions and its subsequent effects on psychological and behavioral engagement. This study aims to extend the results obtained in the previous chapter, regarding the effectiveness of high embodied devices (e.g. VR HMDs), to the hospitality dimension of the tourism industry (i.e. hotels). Results from this study extend those of the previous chapter regarding the affective processes that underlie the use of embodied devices, particularly in the hospitality sector. Managerially, this research shows how hotel services' providers (e.g. hotel websites, travel agencies, booking websites) can create emotional and engaging ways of promoting their products through offering high-value VR-based propositions.

7.2. Theoretical development and hypotheses

7.2.1. The impact of VR on technological embodiment and emotions

As noted in previous sections, the theory of technological mediation (Ihde, 1990) aims to explain these human-technology mediation processes. This theory considers embodiment as states in which users' experiences are mediated by technologies, and these devices become intertwined with their own bodies and allow users to perceive, interpret and interact with their immediate environment (Tussyadiah, Jung, et al., 2018). Following this approach, the EPI Cube (see section 4) differentiates external devices (detached from the human body) from internal devices (fitted into human senses). Considering stationary external devices (e.g. desktop PC) as the lowest level of technological embodiment, portable external devices (e.g. smartphone) are placed in the medium-low part of the continuum, and wearables (e.g. VR HMD), which are more attached into the users' bodies, occupy a medium-high position. Despite these theoretical conceptualizations, there is a lack of empirical research that directly considers the degree of integration of the technology with the human senses, and its subsequent impact on the user experience (Flavián et al., 2019b). Thus, the first hypothesis aims to further confirm empirically this conceptual taxonomy, extending it to the hospitality context. Thus, it is expected that users will perceive VR HMD devices (high embodiment) as more embodied than smartphones (medium) and desktop PCs (low). In addition, smartphones are expected to be perceived as more embodied than desktop PCs:

H_1: VR HMDs generate higher perceptions of technological embodiment than smartphones and desktop PCs, and smartphones generate higher perceptions of technological embodiment than desktop PCs.

Emotions can be defined as states or feelings that arise as reactions to experiences (Mehrabian & Rusell, 1974; Poels & Dewitte, 2019). In this study, emotional reactions are related to the sense of feeling positive emotions (delight, excitement, pleasure and arousal; Laros & Steenkamp, 2005). Experiencing positive emotions is paramount for generating satisfactory experiences with hospitality products (e.g. Lo, Wu, & Tsai, 2015), even in the pre-consumption encounters with service providers (Wang & Beise-Zee, 2013). Thus, designing pre-experiences that foster potential guests' positive emotions can establish an initial bond with the company and develop a competitive advantage. In this way, as VR HMDs are more embodied to human senses, they may generate intense emotional processes through immersive and sensory experiences (Petit et al., 2019). In addition, embodied technologies (VR HMDs) are able to generate higher emotional states than less embodied devices (Kim, Lee, & Jung, 2020; Lin et al., 2020) as these technologies allow for a better transfer of emotions while experiencing the virtual environment (Van Kerrebroeck et al., 2017a). Therefore, we expect a linear relationship between technological embodiment and emotional reactions. Specifically, embodied VR (high embodiment) devices will produce more positive emotions than smartphones (medium) and desktop PCs (low), and smartphones (medium embodiment) will generate more positive emotions than desktop PCs (low). Formally:

H_2: High vs. medium, and medium vs. low, levels of technological embodiment have a positive effect on emotional reactions.

7.2.2. The impact of technological embodiment and emotions on engagement

Customer engagement has received considerable attention in the hospitality literature as a way to improve the customer experience (e.g. Bilro, Loureiro, & Guerreiro, 2019; Harrigan, Evers, Miles, & Daly, 2017; Li, Cui, & Peng, 2017; Romero, 2017). In the specific context of VR technologies, Wei (2019) carried out a literature review and identified engagement as one key experiential dimension of VR/AR-related experiences in tourism and hospitality. However, empirical research about the influence of VR on engagement in tourism is scarce (for exceptions, Flavián, Ibáñez-Sánchez, & Orús, 2019b; Wagler & Hanus, 2018; Willems et al., 2019), and there are no studies analyzing the impact of VR in potential guests' engagement with a prospect hotel. This study focuses on the generation of engagement at early stages of the customer journey, before the actual experience with the hotel or brand takes place. In this way, O'Brien, Cains and Hall (2018) define user engagement as the quality of an experience featured by the user's cognitive, temporal, affective and behavioral investment when interacting in a virtual environment. The conceptualization of user engagement differs slightly from other forms of engagement, such as customer brand engagement or customer engagement (Harrigan et al., 2017; Hollebeek, Srivastava, & Chen, 2019).

User engagement can be analyzed from a psychological and a behavioral point of view (Fang, Zhao, Wen, & Wang, 2017; Romero, 2017). On the one hand, psychological engagement occurs through interactive customer experiences with a focal object (e.g. a VR pre-experience with a hospitality service provider) (Brodie, Hollebeek, Jurić, & Ilić, 2011). Bowden (2009) defined engagement as a psychological process that leads to customer return and loyalty. O'Brien et al. (2018) adopted an attribute-based user engagement in human-computer interactions to develop a multidimensional scale including factors related to focused attention (i.e. feeling absorbed in the interaction), aesthetic appeal (i.e. the attractiveness and visual appeal of the interface), and reward (i.e. the degree of perceived interest and success of the interaction). On the other hand, behavioral engagement refers to the user's behavioral manifestations toward a focal object (e.g. brand, service provider) that go beyond purchase (Van Doorn et al., 2010). These behavioral manifestations include word-of-mouth, assistance and recommendations to other individuals (Romero, 2017; Van Doorn et al., 2010). This study adopts this double perspective to analyze the impact of technological embodiment on user's pre-experience with a prospect hotel.

Regarding psychological engagement, previous theoretical developments have emphasized the potential of VR technologies to increase engagement in tourism and hospitality (Barnes, 2016; Bec et al., 2019), and have called for research on this topic (Loureiro et al., 2020). As a few empirical exceptions, Griffin et al. (2017) found that VR devices (high embodiment) are more effective at promoting a destination by engaging potential tourists, than 2D videos and websites (less embodied devices). Wagler and Hanus (2018) compared 360-degree video VR experiences to real-world experiences and showed similar levels of engagement. Willems et al. (2019) examined enjoyment, flow and purchase intentions as antecedents of engagement, and found that VR experiences are more effective than static images and 360-degree videos with a laptop. Flavián et al. (2019b) analyzed the process by which embodied devices (VR HMDs) generated engagement in a pre-experience with a destination, through immersion and sensory stimulation. However, these empirical studies were focused on destinations, and only

Flavián et al. (2019b) directly measured the impact of technological devices on psychological engagement. Due to the lack of research on this topic, there is a need to delve into the impact of technological embodiment on psychological engagement in a hotel setting to generalize the results to the tourism industry. Thus, this study proposes that, as the degree of technological embodiment increases, the psychological process by which the user becomes engaged in the hotel pre-experience will be favored. The integration between the technology and the human body may lead users to feel absorbed in the interaction (Tussyadiah, Jung, et al., 2018), perceive the content as highly appealing (Van Kerrebroeck, Brengman, & Willems, 2017b), and evaluate the experience as interesting and worthwhile (Tussyadiah, Wang, et al., 2018; Wagler & Hanus, 2018).

This study operationalizes behavioral engagement as the users' intention to recommend the hotel (Berezina, Bilgihan, Cobanoglu, & Okumus, 2015; Getty & Thompson, 1995). Taking into account that behavioral intentions can be considered as the main antecedent of actual behaviors (Ajzen, 1991), the intentions to recommend consists of the generation of positive word of mouth that introduces a particular product to others (Casaló, Flavián, & Ibáñez-Sánchez, 2017b). Intention to recommend is considered a key customer engagement behavior (Van Doorn et al., 2010), especially in tourism and hospitality (Bilro et al., 2019; Prayag, Hosany, & Odeh, 2013; Romero, 2017). Recommendations are one of the most preferred and influential sources of travel information and decision-making (Belanche, Casaló, Flavián, & Guinalíu, 2019; Berezina et al., 2015), given that hospitality products are difficult to evaluate before trying them out (Bilro et al., 2019). In this sense, experiences with embodied VR HMDs are useful in tourism since they allow potential tourists to have "try-before-you-buy" experiences, improving information diagnosticity by creating a realistic image in their minds and fostering behavioral intentions (Tussyadiah, Wang, et al., 2018). In other tourism contexts, such as destinations or museums, VR HMDs have been shown to generate greater intentions to share the experience on social media and recommend the displayed information to friends and family (Errichiello et al., 2019; Griffin et al., 2017). These effects can be extrapolated to the hospitality context.

Therefore, we expect that, compared to less embodied devices (smartphones and desktop PCs), pre-experiences with highly embodied devices (VR HMDs) will result in higher levels of psychological and behavioral engagement. Similarly, medium levels of technological embodiment (smartphones) will produce more positive effects than low levels of embodiment (desktop PCs):

> *H_3: High vs. medium, and medium vs. low, levels of technological embodiment have a positive effect on (a) psychological engagement and (b) behavioral engagement.*

Additionally, this study attempts to establish relationships between the former variables to understand how experiences with VR HMDs influence engagement through the affective route. Specifically, users can experience a sense of psychological engagement (Mollen & Wilson, 2010) and develop higher intentions to recommend a product (i.e. behavioral engagement; Prayag et al., 2013) when they have emotionally stimulating experiences. Previous research has established that when customers feel an intense emotion while having tourism experiences online, their degree of engagement increases (Bilro et al., 2019; Yeh, Wang, Li, & Lin, 2017). In technology-mediated environments, users who feel positive emotions with VR in museums also show favorable intentions to share their experience through online reviews and social media (Errichiello et al., 2019). With destination pre-experiences, positive emotions and emotional involvement lead to favorable behavioral engagement (Huang, Backman, Backman, & Moore, 2013). Therefore, as embodied VR devices are able to stimulate consumers' emotions (Kim, Lee, & Jung, 2020; Riva et al., 2007), we expect emotional reactions to mediate the impact of VR technologies on psychological and behavioral engagement:

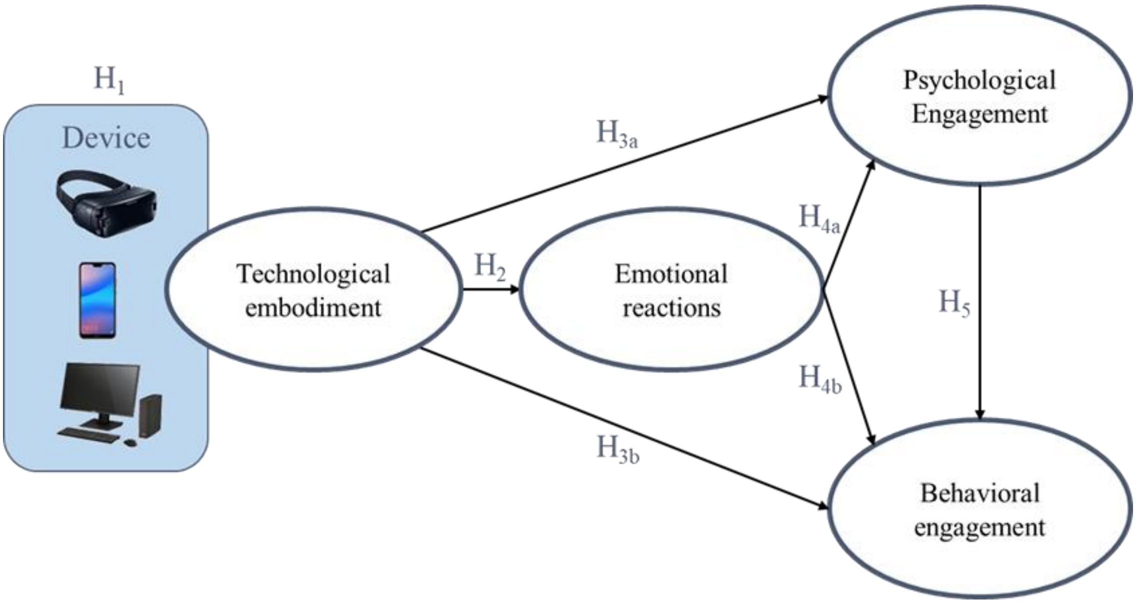
H_4: Emotional reactions mediates the effect of high vs. medium, and medium vs. low, levels of technological embodiment on users' (a) psychological engagement and (b) behavioral engagement.

Finally, high levels of psychological engagement positively influence behavioral engagement (i.e. intention to recommend; Fang et al., 2017; Van Doorn et al., 2010). When users are psychologically engaged with the content they view, they are prone to finally recommend that content to others (Oh & Sundar, 2016). This also occurs in hospitality services; companies that provide engaging experiences increase customers' willingness to recommend those experiences to others (Bilro et al, 2019). Furthermore, the effect of psychological engagement on behavioral engagement can be even stronger when users view the content with embodied VR devices (Wagler & Hanus, 2018). Therefore, if embodied VR devices are able to generate higher states of psychological engagement than less embodied devices, it is expected that users will be more willing to recommend the product displayed with the technology (Griffin et al., 2017). Thus:

H_5: Psychological engagement mediates the effect of high vs. medium, and medium vs. low, levels of technological embodiment on users' behavioral engagement.

Figure 7.1 graphically shows the research model and related hypotheses.

Figure 7.1. Research model



7.3. Methodology

Data to test the hypotheses was collected from a lab experiment. The participants (n = 141; see Table 5.2 for socio-demographic information) were asked to imagine that they were planning to visit Venice and they were looking for an accommodation. In the experiment, participants had a pre-experience of a real hotel room by watching a 360-degree video with technologies with varying degrees of technological embodiment. First, the participants were welcomed in one room where the researchers gave them a brief introduction about the study (context and instructions). After that, they answered a first questionnaire to gather information about several control variables (see Table 5.2).

Second, the participants were randomly assigned to the experimental treatment: a pre-experience with a hotel room with a device, which varied in the level of technological embodiment: low (desktop PC), medium (smartphone –SM–), or high (VR HMD). They were then directed to different rooms according to their experimental condition (47 participants per scenario, exceeding the recommended values proposed by Seltman, 2018). With the assigned device, all the participants watched the same 360-degree video about a hotel room. The video showed some of the habitual parts of a hotel room (e.g. bed, desk, bathroom). After watching the content, they answered the second part of the questionnaire which included scales previously validated in the literature adapted to the context of study (see Appendix A.2).

7.4. Analysis and results

Once the scales were validated (see section 5.3.1), the average values of the items were calculated to obtain the scales that were used in the analysis. We conducted one-way ANOVA with the different devices as the independent factor. The descriptive statistics and the results of the ANOVA are shown in Table 7.1. We found significant effects of the experimental treatment on all the variables. Post-hoc HSD Tukey tests allowed us to verify the significance of the differences between conditions: participants in the VR condition perceived a higher degree of technological embodiment than participants in the other conditions, and those in the SM group perceived higher embodiment than those in the PC group (see Table 7.1). Thus, H_1 was supported.

Table 7.1. Descriptive statistics and results of the ANOVA

	VR		SM		PC		$F_{(2, 138)}$ (sign.)	Sign. Diff.*
	Mean	***SD***	**Mean**	***SD***	**Mean**	***SD***		
Technological embodiment	5.63	*0.99*	4.09	*1.15*	2.84	*1.31*	67.948 (0.000)	1-2; 1-3; 2-3
Emotional reactions	5.66	*1.02*	4.62	*1.09*	3.74	*1.04*	39.267 (0.000)	1-2; 1-3; 2-3
Psychological engagement	6.03	*0.68*	4.84	*1.03*	4.06	*1.05*	52.732 (0.000)	1-2; 1-3; 2-3
Behavioral engagement	5.43	*0.94*	4.54	*1.20*	4.07	*1.30*	16.408 (0.000)	1-2; 1-3

Note: F values correspond to the Brown-Forsythe test.

* Post-hoc Tukey tests. Experimental conditions: 1= VR condition; 2 = SM condition; 3 = Desktop PC condition. Differences significant at 95% level.

The analysis showed that in the VR condition (compared to SM and PC), participants reported significantly higher levels of emotional reactions, psychological and behavioral engagement. Furthermore, watching the 360-degree video with a SM lead to significantly higher positive emotions and psychological engagement than watching it with a desktop PC; however, the difference between both devices on the intention to recommend the hotel was not significant (see Table 7.1). Altogether, we found support for H_2 and H_{3a}, whereas H_{3b} can be only partly supported. Nevertheless, the VR HMD was more effective for fostering behavioral engagement.

Taking into account the specific features of our research model (non-recursive model with one multicategorical independent variable, one dependent variable and a causal path analysis with serial mediation), we ran a causal path model (model 6) with the PROCESS macro v3.1 for SPSS v26 (Hayes, 2018) to analyze the mediating effects of emotions (H_4) and psychological engagement (H_5) in the relationship between the type of device and behavioral engagement. Sequential coding was used to operationalize the multicategorical independent variable (Hayes, 2018). Two dummy variables (X1: 1 = SM and VR, 0 = desktop PC; X2: 1 = VR, 0 = desktop PC and SM) were used to test the model. We included the control variables related to the destination (preference for city tourism and previous experience in Venice) and the technology (previous experience with the device and technological innovativeness) in the model. Table 7.2 shows the results of the analysis. Regarding control variables, we found a significant positive effect of the participants' previous experience with the destination on emotions and intention to recommend, and an overall negative effect of technological innovativeness on emotional reactions, and both psychological and behavioral engagement. No other effects were significant (see Table 7.2).

Table 7.2. Results of the analysis of the mediation model on behavioral engagement

Predictor	Coeff.	SE	*t*	*p*	LLCI	ULCI
Emotional reactions						
Constant	3.574	0.53	6.724	0.000	2.523	4.625
X1 (desktop PC vs. otherwise)	0.936	0.21	4.381	0.000	0.514	1.359
X2 (VR vs. otherwise)	0.945	0.23	4.151	0.000	0.495	1.396
Preference for city tourism	0.119	0.08	1.548	0.124	-0.033	0.271
Experience in the destination	0.532	0.18	2.910	0.004	0.171	0.893
Experience with the device	-0.047	0.05	-0.867	0.388	-0.155	0.061
Technological innovativeness	-0.209	0.07	-3.187	0.002	-0.339	-0.079
Model Summary	**$R^2 = 0.446$; $F_{(6, 134)} = 17.987$, $p < 0.001$**					
Psychological engagement						
Constant	2.283	0.39	5.787	0.000	1.503	3.064
X1 (desktop PC vs. otherwise)	0.198	0.15	1.348	0.000	-0.092	0.488
X2 (VR vs. otherwise)	0.601	0.16	3.927	0.000	0.303	0.917
Emotional reactions	0.616	0.06	11.107	0.000	0.506	0.726
Preference for city tourism	-0.044	0.05	-0.885	0.378	-0.142	0.054
Experience in the destination	0.104	0.12	0.858	0.392	-0.136	0.343
Experience with the device	0.032	0.04	0.912	0.363	-0.038	0.102
Technological innovativeness	-0.121	0.04	-2.764	0.007	-0.208	-0.034
Model Summary	**$R^2 = 0.746$; $F_{(7, 133)} = 55.824$, $p < 0.001$**					
Behavioral engagement						
Constant	1.792	0.68	2.623	0.009	0.441	3.143
X1 (desktop PC vs. otherwise)	0.114	0.23	0.499	0.618	-0.338	0.566
X2 (VR vs. otherwise)	0.269	0.25	1.059	0.291	-0.233	0.771
Emotional reactions	-0.107	0.12	-0.899	0.370	-0.343	0.129
Psychological engagement	0.589	0.13	4.394	0.000	0.324	0.855
Preference for city tourism	0.075	0.08	0.971	0.333	-0.078	0.228
Experience in the destination	0.622	0.19	3.316	0.001	0.251	0.994
Experience with the device	-0.014	0.05	-0.249	0.803	-0.122	0.094
Technological innovativeness	-0.122	0.07	-1.748	0.083	-0.259	0.016
Model Summary	**$R^2 = 0.044$; $F_{(8, 132)} = 12.958$, $p < 0.001$**					
TOTAL EFFECT MODEL: Behavioral engagement						
Constant	4.053	0.58	7.021	0.000	2.911	5.194
X1 (desktop PC vs. otherwise)	0.471	0.23	2.027	0.045	0.012	0.929
X2 (VR vs. otherwise)	0.871	0.25	3.519	0.001	0.381	1.359
Preference for city tourism	0.079	0.08	0.952	0.343	-0.086	0.244
Experience in the destination	0.819	0.19	4.129	0.000	0.427	1.212
Experience with the device	-0.007	0.06	-0.115	0.909	-0.124	0.111

Technological innovativeness	-0.247	0.07	-3.454	0.001	-0.388	-0.105
Model Summary	**R^2 = 0.320; $F_{(6, 134)}$ = 10.519, p < 0.001**					
Relative total effects of X on Y	***Effect***	**SE**	***t***	***p***	**LLCI**	**ULCI**
X1 (desktop PC vs. otherwise)	0.471	0.23	2.027	0.045	0.012	0.929
X2 (VR vs. otherwise)	0.871	0.25	3.519	0.001	0.381	1.359
Omnibus test of total effect of X on Y	**R^2 change = 0.179; $F_{(2, 134)}$ = 17.711, p < 0.001**					
Relative indirect effects of X on Y	***Effect***	**BootSE**	**BootLLCI**		**BootULCI**	
T. Embodiment → Emotional reactions → Behavioral engagement						
X1 (desktop PC vs. otherwise)	-0.100	0.13	-0.340		0.183	
X2 (VR vs. otherwise)	-0.101	0.14	-0.369		0.199	
Bootstrap results for indirect effects	***Effect***	**BootSE**	**BootLLCI**		**BootULCI**	
T. Embodiment → Psychological engagement → Behavioral engagement						
X1 (desktop PC vs. otherwise)	0.117	0.09	-0.068		0.319	
X2 (VR vs. otherwise)	0.359	0.16	0.096		0.704	
T. Embodiment → Emotional reactions → Psychological engagement → Behavioral engagement						
X1 (desktop PC vs. otherwise)	0.339	0.11	0.143		0.587	
X2 (VR vs. otherwise)	0.343	0.13	0.130		0.643	

Note: n = 141. Confidence interval calculated at 95% of significance. Bootstrap sample size = 5,000. BootLLCI: lower limit confidence interval; BootULCI: upper limit confidence interval.

After controlling for these variables, the direct effect of the device on behavioral engagement disappeared when the mediators were included in the model. Results showed that emotional reactions positively influenced psychological engagement, and the direct effect of the device on psychological engagement remained significant. Additionally, psychological engagement had a significant influence on the intention to recommend, whereas the effects of the device and emotions were not significant. According to the results of a bootstrap analysis with 5,000 subsamples for testing the significance of indirect effects (see Table 7.2), the paths Device – Emotional reactions – Psychological engagement – Behavioral engagement and Device – Psychological engagement – Behavioral engagement were significant. Therefore, H_{4a} and H_5 were supported, while H_{4b} must be rejected.

7.5. Discussion and conclusions

VR devices appear as an ideal technology for offering try-before-you-buy experiences in tourism and hospitality, allowing potential guests to obtain valuable information from immersive experiences that helps them make better decisions (Bogicevic et al., 2019; Loureiro et al., 2020). However, little empirical research has analyzed the role of embodied VR in the hotel industry (Wei, 2019). This study aims at offering a better understanding of the underlying affective processes that occur with embodied VR devices to engage potential guests in their hotel pre-experiences.

Table 7.3 shows a summary of the results obtained in the hypothesis testing. Our findings revealed that, as the degree of contact and integration of the technological device with the human body increases, the perceptions of technological embodiment are enhanced. Specifically, VR devices produced the highest perception of embodiment, compared to smartphones and desktop PCs, and smartphones also produced higher perceptions of embodiment than stationary devices. These results empirically confirm the different levels of technological embodiment proposed by previous conceptualizations (Flavián et al., 2019a; National Research Council, 2012).

Table 7.3. Summary of the results

Hypothesis	Support
H_1: Type of device → Technological embodiment	Yes
H_2: Technological embodiment → (+) Emotional reactions	Yes
H_{3a}: Technological embodiment → (+) Psychological engagement	Yes
H_{3b}: Technological embodiment → (+) Behavioral engagement	Partly
H_{4a}: Technol. embodiment → Emotional reactions → Psychol. engagement (mediation)	Yes
H_{4b}: Technol. embodiment → Emotional reactions → Behavioral engagement (mediation)	No
H_5: Technol. embodiment → Psychol. engagement → Behavioral engagement (mediation)	Yes

The analysis showed that the level of technological embodiment has a strong, positive impact on the users' pre-experiences. Specifically, VR devices generated more positive emotions than less embodied devices. This may be due to the immersive and sensorially enriching capacities of embodied VR devices (Petit et al., 2019). VR has been identified as an effective tool to induce feelings (e.g. relaxation; Riva et al., 2007), and can generate pleasant experiences that help overcome negative situations (Van Kerrebroeck et al., 2017a). In tourism, Kim, Lee and Jung (2020) revealed the importance of emotional involvement for a wide variety of tourism experiences with VR (e.g. overseas or domestic travels, recreation, leisure activities). However, previous research did not directly measure the particular emotions that are aroused after the VR experience, in comparison with other devices, nor did they analyze the emotional impact of VR on hospitality settings. Our study measures the potential guests' specific emotional reactions after their digital hotel pre-experience with different embodied devices, finding more positive emotions as the degree of technological embodiment increases.

Embodied VR technologies had a positive impact on psychological and behavioral engagement. Despite being identified as one of the key dimensions in tourism experiences with VR (Wei, 2019), previous research in this context has been mainly theoretical (e.g. Bec et al., 2019). The few empirical exceptions (Flavián et al., 2019b; Wagler & Hanus, 2018; Willems et al., 2019) are focused on destinations. By adopting a double perspective of engagement (Fang et al., 2017; Romero, 2017), this study shows that technological embodiment has a positive influence on psychological and behavioral engagement after a digital pre-experience with a hotel. Among the considered devices, VR HMDs are able to generate the highest levels of engagement.

Finally, the causal path analysis indicated that the emotional reactions partly mediated the effect of technological embodiment on psychological engagement.

Experiences with high embodied devices can generate high levels of engagement due to a higher emotional connection with the content displayed (Barnes, 2016). However, our results showed that emotions did not directly mediate the effect of the device on the intention to recommend the hotel, but this effect was established indirectly through psychological engagement. Marasco et al. (2018) state that emotional involvement by itself is not enough to generate higher behavioral intentions toward a destination, pointing that there are indirect variables that affect this relationship. Our findings indicate that users may need to be psychologically engaged in the virtual experience to generate a stronger connection with the focal object, driving them to recommend the hotel to others. Results also confirmed the mediating effect of psychological engagement in the relationship between the device and behavioral engagement. Therefore, in line with Choi et al. (2018), users need to become psychologically engaged with the virtual experience to increase their behavioral intentions to recommend the content, particularly with embodied devices. These results extend those obtained in the previous chapter and offer further knowledge about the affective route underlying VR experiences.

7.5.1. Theoretical and managerial implications

As for theoretical implications, this study contributes to the still scarce research regarding the effectiveness of VR in the hotel industry (Wei, 2019). Hotels, in comparison to other tourism products, represent a key element of any travel or tourism experience; consumers derive mainly utilitarian value from their experiences with hotels (Camilleri, 2008; Prebensen & Rosengren, 2016). New developments in VR technologies serve to offer more realistic vicarious experiences that help overcome the high risk of making purchase decisions in this highly intangible context (Bogicevic et al., 2019). This research contributes to a better understanding of the affective route that leads to the effective use of these VR devices. Potential guests can obtain superior value propositions in their pre-experiences with hotels thanks to embodied VR devices. In addition, our findings empirically confirm the importance of considering technological embodiment in VR tourism experiences to generate effective customer pre-experiences. In chapter 6, we found that technological embodiment positively affects perceived immersion and sensory stimulation. This chapter shows that high levels of integration between the technology and human senses foster the emotional reactions that arise during digital pre-experiences with hotels.

Furthermore, although engagement is considered as a key variable for analyzing VR in tourism and hospitality (Wei, 2019), it has been mostly addressed at a conceptual level (e.g. Bec et al., 2019; Hollebeek et al., 2020; Loureiro et al., 2020). We contribute to this flourishing topic by empirically analyzing the impact of VR on engagement from a double perspective, i.e. psychological and behavioral (Fang et al., 2017; Romero, 2017). In addition, we consider this variable at the early stages of the customer experience, before actually interacting with the product, service or brand (Harrigan et al., 2017; Hollebeek et al., 2019). Our findings show that embodied VR favors psychological and behavioral engagement, and that a positive relationship exists between them. Thus, these results (hotel industry) complement those from the previous chapter's study (destinations), allowing us to further validate the importance that technological embodiment from a device has in driving engagement in tourism digital pre-experiences. In addition, both psychological and behavioral engagement should be considered in future research when analyzing how VR can be implemented in tourism and hospitality pre-experiences. Finally, behavioral engagement has been operationalized by means of the intention to recommend the hotel. Prior research has proposed the relationship between positive emotions and intentions to share VR experiences in tourism (Errichiello et al., 2019). We take a step forward by empirically confirming this relationship in the context of a hotel VR pre-experience, both directly and indirectly through psychological engagement.

Regarding managerial implications, as marketers are striving for finding new ways of promoting their products in an emotional way (Hays, Page, & Buhalis, 2013; Poels & Dewitte, 2006, 2019), they should consider the impact of embodied VR devices (Hoyer et al., 2020). These technologies are able to generate emotionally stimulating and psychologically engaging experiences which, in turn, lead to favorable behavioral engagement (i.e. intention to recommend). Hotel managers should take into account the contents that their potential guests can view with embodied VR devices to generate these experiences. Thus, they should be involved in the process of content creation to ensure certain requirements (e.g. high-quality recording and editing, interactivity, sensory inputs; Cowan & Ketron, 2019), which will enhance emotional reactions and levels of psychological and behavioral engagement. Importantly, potential guests' engagement with the hotel may occur even before having the real experience. For instance, users' emotions can be aroused by generating gamification experiences with VR in which potential guests can interact with the different spaces of the hotel. Consequently, users may feel psychologically engaged with the experience which, in turn, leads them to recommend the hotel displayed. As previous research has noted (Bilro et al., 2019; Errichiello et al., 2019), electronic word of mouth (eWOM) is a powerful tool for tourism and hospitality companies to generate competitive advantages since it helps potential tourists in their decision-making processes.

By displaying engaging contents with VR technologies, hotel managers could create memorable and effective pre-experiences that can be included in their communication strategies. In fact, although research has not paid much attention to the application of VR in the hotel industry, several hotel chains (e.g. Best Western Hotel &

Resorts; Best Western, 2016) are using this technology to offer information of their hotel rooms, which reinforces the potential of this technology in the hospitality industry. Hotel managers and booking webpages may use VR to provide their customers with realistic pre-experiences to get a clear and vivid impression of what the real experience would be (Zeng et al., 2020). Similarly, travel agencies could incorporate this technology in their stores to offer added-value services through which the potential guests could easily imagine the hotel in which they are planning to stay. As a result, by using embodied VR devices, potential guests will be given the opportunity to experience the room by themselves, obtaining more information than just with a mere description or a regular video, and empowering them to make their final decisions.

7.5.2. Limitations and future research lines

Besides the general limitations that are presented in chapter 11, this particular study presents a series of limitations that must be addressed in future research. First, the stimulus under analysis was one single room from a hotel chain which was viewed with different devices. Moreover, one single city (Venice) was used as stimulus. In this way, it would be interesting to use different stimuli (e.g. rooms with different categories, such as low-cost, standard, premium), from different hotel categories (e.g. hostel versus four-star hotel), or from different destinations (e.g. cities versus rural areas) and compare the effectiveness of the different technologies in potential guests' responses (e.g. intention to upgrade the room category; Hotel Technology News, 2019). Furthermore, emotional reactions and psychological engagement have been measured with self-reported measures. In this way, it would be interesting to gather both self-reported and neurophysiological measures of these constructs (Suh & Prophet, 2018).

Finally, our analysis of the control variables showed that having been in the destination had a positive impact on emotions and behavioral engagement. This may be due to the fact that users may take their previous experience and memories into account when recommending the hotel. In addition, a negative effect of technological innovativeness on all the variables was found. It seems that, when the novelty effect of the device fades, technological innovators may get used to their use (Rogers, 2010), so their effect may be reduced as technologies become commonplace (Flavián et al., 2019a). Future research should delve into these issues and include more personality traits (e.g. immersive tendency, capacity to imagine) to obtain a more complete understanding about the effectiveness of VR experiences.

8. The cognitive route of virtual and augmented reality: comparative analysis of content and device in hotel pre-experiences

8.1. Introduction

Once the concept of technological embodiment has been empirically validated and its impact on digital pre-experiences with different tourism products (destinations, hotels) has been verified, the next step of the doctoral thesis consists of comparing the effectiveness of AR and VR. This chapter considers the degree of presence elicited by the content viewed, together with the technological embodiment of the device employed, to achieve this goal.

As previously stated, the hospitality industry has been especially immersed in the new technological wave to offer superior added-value propositions (Buhalis et al., 2019). In this way, AR and VR can play an important role in the development of the industry. If the potential of VR for the hospitality industry has been highlighted in the previous chapter, AR has also been acknowledged as a powerful tool to deliver technology-enhanced pre-experiences. For instance, AR can be implemented in promotional brochures to show potential guests the accommodation and amenities of the prospective hotel they are planning to book (e.g. Radisson Hotel Group; Soluis, 2018). By overlaying a digital representation over the brochure, this information can be provided in an innovative way, helping them better evaluate how their stay in the hotel will be and resulting in high booking rates (Hospitalitytech, 2019). Thus, XR technologies empower potential guests by allowing them to virtually sample the hotel services before experiencing them in real life (Buhalis et al., 2019; Loureiro et al., 2020), acting as effective tools for information dissemination (Yung & Khoo-Lattimore, 2019). In view of the potential importance of these technologies in the hospitality industry, researchers and practitioners need to better understand how consumers respond to the experiences with AR and VR to effectively address the current challenges and develop added value service propositions.

Despite the relevance of AR and VR technologies in the hospitality industry, there is a lack of research that empirically analyzes and compares their effectiveness. Recently, few studies have addressed the implementation of VR in the hotel industry. These studies have analyzed the effectiveness of watching hotel-related contents with VR HMDs (Israel, Tscheulin, et al., 2019); others have compared viewing similar contents with VR HMDs versus other devices (Bogicevic et al., 2019; Flavián et al., 2020; Leung et al., 2020). Previous research has also confirmed the combined effect of textual online reviews and VR, which promotes booking intention (Zeng et al., 2020). However, previous tourism literature has mostly considered these technologies as a whole and do not differentiate between the content displayed and the device used (Marasco et al., 2018; Tussyadiah, Wang, et al., 2018). The effects of the message (contents), along with the medium (devices), in XR hotel experiences, is an unexplored research area (Li & Chen, 2019; Suh & Prophet, 2018).

With the aim filling these gaps, this study analyzes the effects of the type of content (realistic or digital), together with the use of different devices (HMDs or smartphones), on consumer's XR hotel pre-experiences. Following the EPI Cube (see chapter 4), the levels of technological embodiment resulting from using different devices (Ihde, 1990), and the perceptions of presence elicited by different contents (Witmer & Singer, 1998) in the XR experiences are examined. In addition, we analyze the influence of the type of content and device on the perceptions of visual appeal, ease of imagination, and booking intention. The results of this study contribute to a better understanding of cognitive route that underlies users' experiences with XR technologies. Managerially, the separate and comparative analysis of the type of content and its interplay with the device used in the XR experiences will allow hotel providers to generate better value propositions to their potential customers.

8.2. Theoretical development and hypotheses

In the same line that the previous chapters of the doctoral thesis, this study is grounded in the EPI Cube developed in chapter 4. The cube classifies technologies according to three HTI factors: technological embodiment, perceptual presence, and behavioral interactivity. All the technologies of the EPI Cube can be used in potential touchpoints with customers to offer added-value propositions (Neuhofer et al., 2014). In the context of this study (hospitality digital pre-experiences), potential guests can get a preview of the hotel facilities (e.g. the room) using XR technologies, but they cannot modify the form/shape of the product shown (e.g. they cannot change the position or the shape of the bed). Consequently, the level of interactivity in the experience with the technology remains still limited to the control of the navigation in the environment displayed (ability to navigate but not to modify the environment; Flavián et al., 2019a). Therefore, for this study we keep low the level of behavioral interactivity, and we focus on the technological (embodiment) and human (perceptual presence) dimensions of the EPI Cube to examine the impact of the type of device and content on XR hospitality pre-experiences.

Technological embodiment has been previously defined as states in which the technologies mediate users' experiences by becoming integrated with their body, enabling them to perceive, understand and interact with their immediate environment (Tussyadiah, Jung, et al., 2018). In the previous chapters, the existence of this variable and its influence on tourism pre-experiences has been empirically validated. The first hypothesis is a replication of previous results that confirm that HMDs generate higher perceptions of embodiment than smartphones:

H_1: HMDs (versus smartphones) will have a positive impact on the perceptions of technological embodiment.

According to section 4.2.2, presence is defined as the users' subjective sensation of being transported to a different environment (Biocca, 1997). Previous research has analyzed the role of technologies to induce presence states (e.g. Lee et al., 2020; Slater, 2009). Several factors, including media form and content, are important to develop a sense of presence in a technology-mediated environment (Steuer, 1992; Thornson et al., 2009; Witmer & Singer, 1998). Similar to embodiment, presence is regarded as a continuum ranging from low to high levels (Flavián et al., 2019a). At the lowest level, the user feels like s/he is "here", where the actual experience is taking place (physical environment). At the highest level, the user feels like s/he is "elsewhere", wherever the experience is transporting the individual (digital environment).

We expect that differences in the content of XR pre-experiences will affect the users' perceived presence. These days, technological advances allow users to interact with many different types of contents, from cartoons and fantasy worlds to hyper-realistic contents. Several authors stress that one of the components of presence is the similarity of the content to the real world (Lombard & Ditton, 1997; Schubert, Friedmann, & Regenbrecht, 1999). Realistic contents can lead to a state of perceptual presence (Slater, 2003). Specifically, 360-degree videos, rather than being digitally constructed, are usually filmed in the real world and display actual situations (Martínez-Navarro, Bigné, Guixeres, Alcañiz, & Torrecilla, 2019). Consequently, this type of content takes users to real environments (Wagler & Hanus, 2018), and may lead to higher perceptions of presence than digital content, as users may sense that they are placed in real locations (Willems et al., 2019). Therefore, we expect that if the content showed resembles the real world, users' sense of presence will be enhanced. Thus:

H_2: Viewing realistic (versus digital) contents will have a positive impact on the perceptions of presence.

Once the differences between the device and content are hypothesized, this study analyzes the effects of these configurations of XR technologies on users' hotel pre-experiences. Given the lack of research about the type of contents in XR experiences (Beck et al., 2019; Li & Chen, 2019), we focus on its effect on users' experiences. After that, we make propositions about its interaction with the type of device used. Specifically, we first consider the visual appeal of the content shown with the device, which represents the users' evaluation of the XR experience (de Ruyter et al., 2020; Marasco et al., 2018). Second, ease of imagination is a subjective experience regarding the assessment of how XR technologies facilitate users' imagination about how the actual experience would be (Bogicevic et al., 2019). Finally, according to the Theory of Planned Behavior (Ajzen, 1991), behavioral intentions (e.g. booking intention) represent a strong signal of how potential customers will behave.

Visual appeal is the exhibition of visual elements in the content that serve to improve the presentation of the information systems (Liu, Li, & Hu, 2013). Actual-like contents add more visual richness to the experience than digital contents (Wagler & Hanus, 2018), making the content more visually appealing for users. Additionally, new technological devices characterized by a high degree of embodiment are able to provide users with more stimulating sensorial experiences (Biocca, 1997; Petit et al., 2019; Tussyadiah, 2014) due to their closeness with human senses. This results in a strengthening of the visual appeal of the experience with the content viewed (Van Kerrebroeck et al., 2017b) whose main component is naturally visual (Guttentag, 2010). Thus, realistic contents are expected to lead to higher perceptions of visual appeal than digital contents, and this effect will be stronger when embodied devices are used:

H_{3a}: Viewing realistic (versus digital) contents will have a positive impact on the perceptions of visual appeal.

H_{3b}: The effect of realistic (versus digital) contents on the perceptions of visual appeal will be stronger with embodied (versus non-embodied) devices.

Ease of imagination is a metacognitive experience consisting of how easily users perceive that a good/service is and how it will perform, which serves them to evaluate the experience and make consumption decisions (Orús, Gurrea, & Flavián, 2017). Realistic contents allow users to more easily generate a mental pre-view of the environment displayed, compared to animated or digital contents. This may support them in their planning and facilitate their decision-making processes (Huang et al., 2016). Additionally, embodied technologies enrich customers' imagination with the content viewed, helping them to create a better image about how the real experience would be (Loureiro, Guerreiro, Eloy, Langaro, & Panchapakesan, 2019; Tussyadiah et al., 2017). In this way, embodied technologies can help overcome the problems of transmitting intangible experiences, facilitating the potential customers' creation of an image of the actual experience (Tussyadiah, Wang, et al., 2018). Therefore, realistic contents are expected to foster users' ease of imagination to a greater extent than digital ones, and this effect will be stronger when embodied devices are applied:

H_{4a}: Viewing realistic (versus digital) contents will have a positive impact on the ease of imagination.

H_{4b}: The effect of realistic (versus digital) contents on the ease of imagination will be stronger with embodied (versus non-embodied) devices.

By offering a simulation of how the actual experience would be with contents that resemble the real world, potential customers may feel in a better position to make their decisions (Wagler & Hanus, 2018), leading to higher purchasing intentions compared to less realistic contents. Realistic contents may transport the users to the real experience, obtaining more realistic pre-experiences than with digital contents. Additionally, previous studies have stressed the persuasive power of embodied devices when viewing contents to increase behavioral intentions in tourism settings (Bogicevic et al., 2019; Jung et al., 2017; Lee et al., 2020; Tussyadiah, Wang, et al., 2018). These devices provide potential customers with compelling “try-before-you-buy” experiences, resulting in favorable behavioral intentions after watching the content (Marasco et al., 2018; Tussyadiah, Wang, et al., 2018). Hence, displaying realistic content is expected to lead to higher booking intentions, and this effect will be higher when embodied devices are utilized:

H_{5a}: Viewing realistic (versus digital) contents will have a positive impact on booking intentions.

H_{5b}: The effect of realistic (versus digital) contents on booking intentions will be stronger when the experience takes place with embodied (versus non-embodied) devices.

Finally, previous research has shown that the perceived visual appeal of the content leads to an increase in behavioral intentions (Chung et al., 2015). By viewing more aesthetic contents (as actual contents; Wagler & Hanus, 2018), users feel more willing to engage in positive behaviors (Marasco et al., 2018). In addition, the ease with which customers imagine a product and how it performs influences their behavioral intentions (Alter & Oppenheimer, 2009; Orús et al., 2017). In this way, consumers process the realistic contents by using their imagination, creating mental images more easily that help them to tangibilize the experience (Cowan & Ketron, 2019), which determines their subsequent behavior (Petrova & Cialdini, 2008). Thus, both visual appeal and ease of imagination are expected to mediate the impact of realistic (compared to digital) contents on booking intentions. Furthermore, these effects will be strengthened by the use of embodied devices since they intensify the sensory and cognitive processes on online experiences (Kim, Lee, & Jung, 2020; Petit et al., 2019):

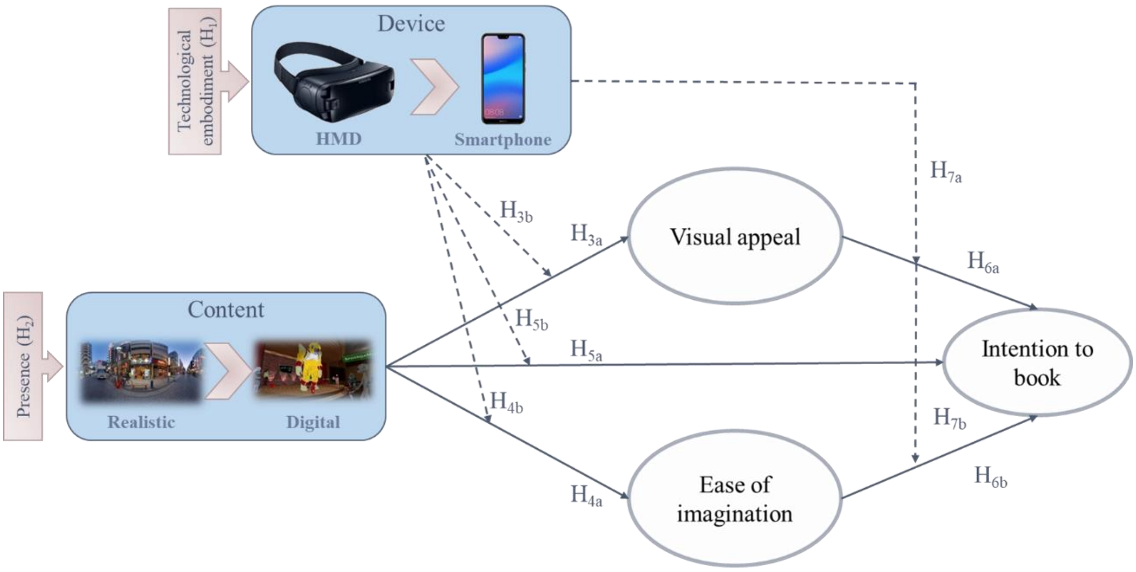
H_6: The effect of viewing realistic (versus digital) contents on booking intentions will be mediated by (a) visual appeal and (b) ease of imagination.

H_{7a}: The mediating effect of visual appeal in the relationship between realistic (versus digital) contents on booking intentions will be stronger with embodied (versus non-embodied) devices.

H_{7b}: The mediating effect of ease of imagination in the relationship between realistic (versus digital) contents on booking intentions will be stronger with embodied (versus non-embodied) devices.

Figure 8.1 shows the research model and the proposed hypotheses.

Figure 8.1. Research model

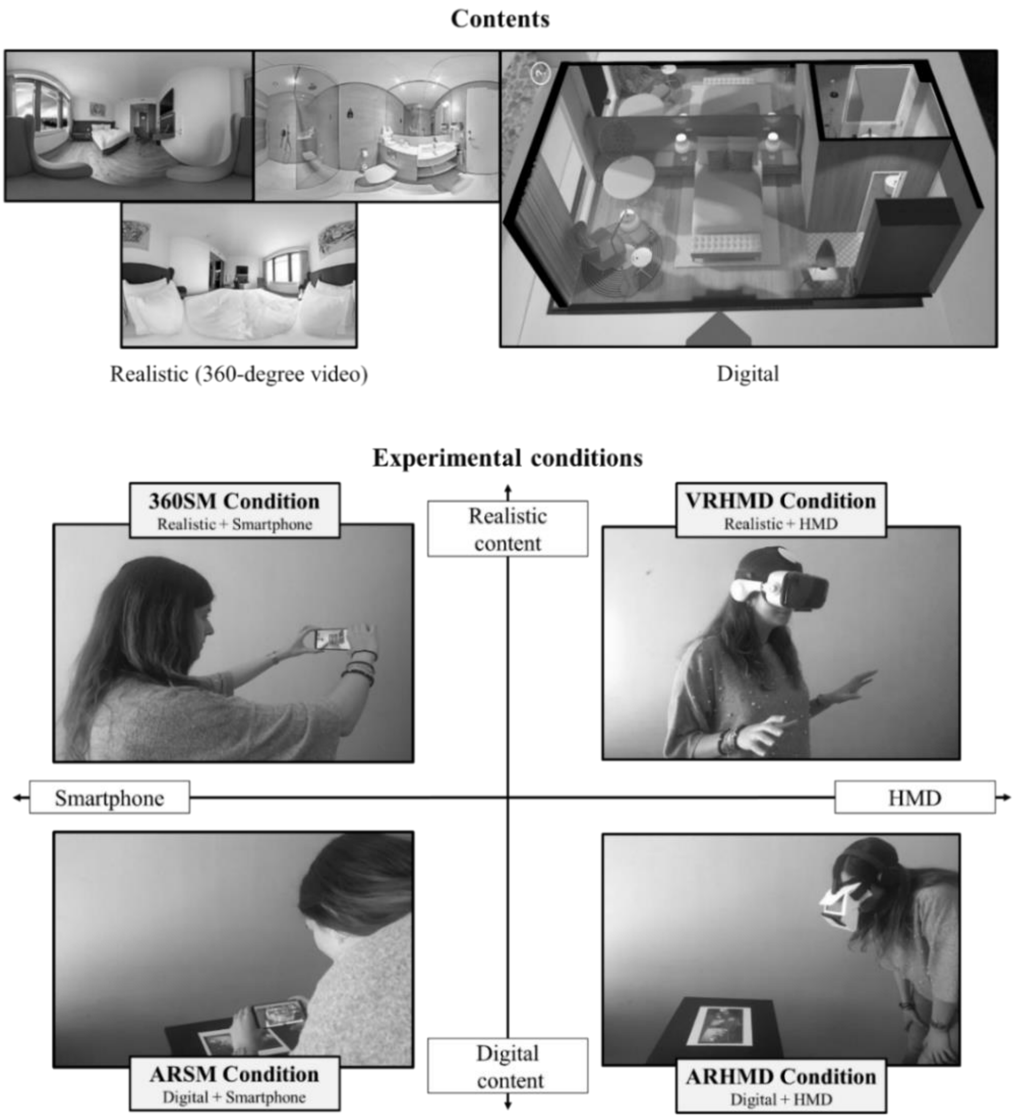


8.3. Methodology

A lab experiment was carried out to test the hypotheses. The participants (n = 206; see socio-demographic information in Table 5.2) were instructed to imagine that they were going to visit a specific city (Venice) and were about to choose an accommodation. The procedure was similar as in the previous studies. After introducing the context of the study and gathering the participants' information about the control variables (see section 5.3.1), they were told that they were going to watch information about a hotel room from a well-known chain. The name of the chain was not displayed to avoid brand preference biases. After watching the hotel room information, the participants answered the second part of the questionnaire containing the main variables of the study (see Appendix A.3), and their socio-demographic information.

The experimental manipulation was introduced in the digital pre-experience with the hotel room. Specifically, participants were randomly assigned to one of the experimental conditions in a 2 × 2 factorial design, where they viewed the hotel room with different combinations of contents (realistic vs. digital) and devices (HMD vs. smartphone –SM–). Regarding the manipulation of content (see Figure 8.2), in the realistic content condition, participants watched a 360-degree video showing the different parts of a hotel room (bedroom with desk and closet, bathroom) from different perspectives and angles. The video was manipulated to keep the duration constant (45 seconds), add background music, and control for extraneous factors (e.g. people appearing in the scenes were removed). In the digital content condition, participants viewed a virtual representation of a hotel room similar to the one that was used in the realistic content condition. This digital representation of the room was superimposed over a printed marker that was previously recognized by an app (see Figure 8.2). Participants had the same time (45 seconds) to explore the different parts (bedroom with desk and closet, bathroom) by moving around the virtual representation of the room, and the same background music as in the realistic content condition was played in the room while the participant was having the experience. As for the manipulation of the device, participants could view these contents with either a HMD or a SM. These devices have been acknowledged as the most used in experiences with XR technologies (Tussyadiah, Wang, et al., 2018). All the materials belonged to the research group to keep the environmental factors constant (e.g. screen sizes, quality of graphics). The different combinations of contents and devices resulted in four experimental conditions (see Figure 8.2). In the "VRHMD Condition", participants (n = 51) watched a 360-degree video of the room (realistic content) with a HMD. In the "360SM Condition", participants (n = 52) viewed the same 360-degree video with a SM. In the "ARHMD Condition" (n = 50), the digital representation of the hotel room was displayed with a HMD. Finally, in the "ARSM Condition" (n = 53), the same digital content could be viewed by means of a SM.

Figure 8.2. Contents and experimental conditions



8.4. Analysis and results

The scales were validated following the standard procedures of Hair et al. (2018). Once this process was undertaken, the average values were calculated and the resulting scales were examined through independent t-tests with the experimental treatment as the independent factor. First, perceived technological embodiment was significantly higher for participants in the HMD condition (M = 5.13, SD = 1.389), compared to the participants in the SM condition (M = 4.32, SD = 1.291; $t_{(204)}$ = 4.310, $p < 0.001$). Second, perceptual presence was significantly higher when participants viewed realistic contents (M = 5.17, SD = 1.398), compared to digital contents (M = 3.54, SD = 1.481; $t_{(204)}$ = 8.104, $p < 0.001$). Thus, support for H_1 and H_2 was found. The type of device (HDM greater than SM) determined the differences in the perceived technological embodiment. Additionally, the content viewed (realistic greater than digital) produced significant differences on perceptual presence.

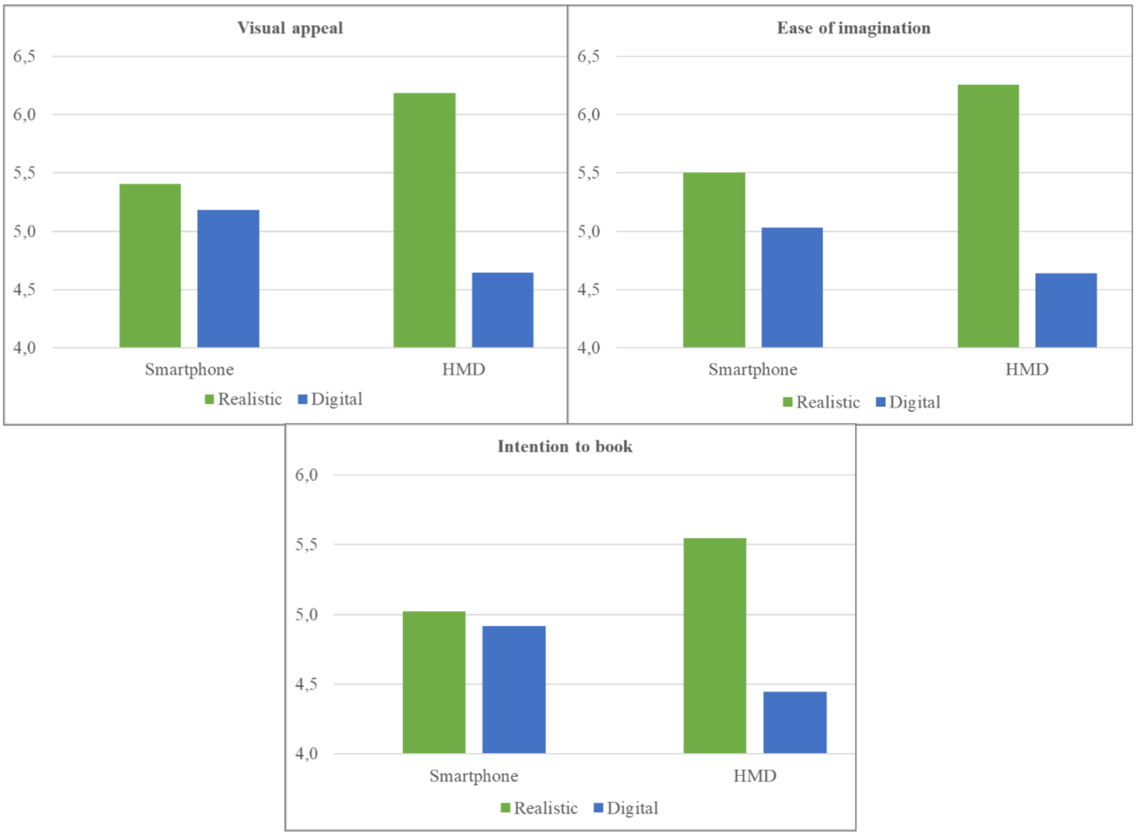
To test hypotheses H_3 to H_5, we conducted a 2 (device: HMD vs. SM) × 2 (content: realistic vs. digital) multivariate analysis of variance (MANOVA). This analysis examines several dependent variables simultaneously and it is recommended when the dependent variables are correlated (*Pearson's r*s ranged from 0.569 to 0.732, all *p*s < 0.001) (Hair et al., 2018). Results showed significant multivariate effects for the type of content (*Wilks's* λ = 0.825; $F_{(3, 200)}$ = 14.141, $p < 0.001$) and the content × device interaction (*Wilks's* λ = 0.909; $F_{(3, 200)}$ = 6.635, $p < 0.001$). However, the multivariate direct effect of the device was non-significant (p = 0.711).

The descriptive data of the direct effects, as well as the results of the univariate ANOVAs for each dependent variable are reported in Table 8.1. In this way, the type of content significantly influenced the perceptions of visual appeal, ease of imagination and intentions to book (see Table 8.1). Moreover, the interaction effect between content and device was significant for visual appeal ($F_{(1, 205)} = 18.926$, $p < 0.001$), ease of imagination ($F_{(1, 205)} = 11.327$, $p < 0.001$) and intentions to book ($F_{(1, 205)} = 9.484$, $p < 0.01$). The Figure 8.3 shows that viewing realistic contents using HMDs (compared to SMs) generated the highest perceptions and intentions to book. Altogether, H_3, H_4 and H_5 were supported.

Table 8.1. Descriptive data and results of the ANOVA for direct effects

		Visual appeal			**Ease of imagination**			**Intention to book**		
		M	***SD***	$F_{(1, 205)}$	***M***	***SD***	$F_{(1, 205)}$	***M***	***SD***	$F_{(1, 205)}$
Content	**Realistic**	5.79	0.903	33.823*	5.87	1.025	37.414*	5.28	1.109	13.696*
	Digital	4.92	1.319		4.84	1.445		4.69	1.261	
Device	**SM**	5.29	1.101	0.649	5.26	1.310	1.139	4.97	1.172	0.032
	HMD	5.42	1.312		5.46	1.395		5.00	1.276	
Total		5.35	1.208		5.36	1.352		4.98	1.221	

Figure 8.3. Content × device interaction effects



The macro PROCESS v3.3 (Hayes, 2018) was used to test H_6 and H_7. The participants' previous experience with the destination (1 = yes, 0 = no) and with the technology used in their corresponding condition, as well as the importance they attached to the room in order to book a hotel for accommodation (see Appendix A.3), were included in the model as covariates. The results of the parallel mediation model appear on Table 8.2. The direct effect of the content (1 = realistic, 0 = digital) on the participants' intentions to book disappeared when visual appeal and ease of imagination were included in the model, which had significant influences on intention to book. In fact, the explanatory capacity of the model increased to a great extent when the mediators were included in the model, compared to the total effects model (see Table 8.2). The results of the bootstrap analysis with 5,000 subsamples confirmed the mediation of visual appeal and ease of imagination in the relationship between content and the intention to book. H_{6a} and H_{6b} were thus supported. Although the effect of ease of imagination was higher than that of visual appeal, the contrast between the two mediating effects was not significant (*effect* = -0.051, *bootSE* = 0.19, *bootstrap 95% confidence interval* [-0.432, 0.325]). Both mediators were equally important. Regarding the control variables, only the importance attached to the room for booking a hotel had positive effects on booking intentions (see Table 8.2).

Table 8.2. Results of the analysis of the mediation model on intention to book

Predictor	**Coeff.**	**SE**	***t***	***p***	**LLCI**	**ULCI**
Visual Appeal						
Constant	4.479	0.45	9.981	0.000	3.594	5.364
Content	0.899	0.16	5.486	0.000	0.576	1.222
Experience in the destination	0.224	0.16	1.382	0.169	-0.096	0.544
Experience with the device	-0.026	0.05	-0.530	0.596	-0.121	0.069
Importance of room quality for booking	0.068	0.69	0.986	0.325	-0.068	0.205
Model Summary		**R^2 = 0.144; $F_{(4, 201)}$ = 8.421, p < 0.001**				
Ease of imagination						
Constant	4.175	0.49	8.453	0.000	3.201	5.149
Content	1.081	0.18	5.997	0.000	0.726	1.437
Experience in the destination	0.340	0.18	1.904	0.058	-0.012	0.692
Experience with the device	-0.040	0.05	-0.762	0.447	-0.145	0.064
Importance of room quality for booking	0.103	0.08	1.352	0.178	-0.047	0.254
Model Summary		**R^2 = 0.172; $F_{(4, 201)}$ = 10.458, p < 0.001**				
Intention to book						
Constant	0.807	0.47	1.716	0.088	-0.120	1.735
Content	0.019	0.15	0.126	0.899	-0.281	0.319
Visual Appeal	0.311	0.08	3.789	0.000	0.149	0.473
Ease of imagination	0.305	0.07	4.093	0.000	0.158	0.452
Experience in the destination	0.133	0.14	0.958	0.339	-0.141	0.408
Experience with the device	0.010	0.04	0.245	0.807	-0.071	0.091
Importance of room quality for booking	0.135	0.06	2.173	0.024	0.018	0.251
Model Summary		**R^2 = 0.401; $F_{(6, 199)}$ = 22.182, p < 0.001**				
TOTAL EFFECT MODEL: Intention to book						
Constant	3.434	0.46	7.493	0.000	2.559	4.388
Content	0.629	0.17	3.714	0.000	0.295	0.962
Experience in the destination	0.307	0.17	1.830	0.069	-0.024	0.637
Experience with the device	-0.010	0.05	-0.206	0.837	-0.109	0.088
Importance of room quality for booking	0.187	0.07	2.615	0.009	0.046	0.329
Model Summary		**R^2 = 0.106; $F_{(4, 201)}$ = 5.942, p < 0.001**				
Indirect effects of X on Y	***Effect***	**BootSE**	**BootLLCI**		**BootULCI**	
Experience → Visual Appeal → Intention to book						
Content	0.279	0.11	0.082		0.518	
Experience → Ease of imagination → Intention to book						
Content	0.329	0.12	0.123		0.578	

Note*:* n = 206. Confidence interval calculated at 95% of significance. Bootstrap sample size = 5,000. BootLLCI: lower limit confidence interval; BootULCI: upper limit confidence interval.

To test H_7, a moderated mediation model was conducted (model 8; Hayes, 2018) in which the mediating role of visual appeal and ease of imagination was proposed to be moderated by the type of device. The results of this model confirmed moderated mediation for visual appeal (*index* = 0.395, 95% *bootstrap confidence interval* [0.078, 0.789]) and ease of imagination (*index* = 0.354, 95% *bootstrap confidence interval* [0.094, 0.697]). Specifically, the mediating effects were stronger when the participants used HMDs than when they used SMs, in both cases (visual appeal: $effect_{HMD} = 0.454$, $effect_{SM} = 0.059$; ease of imagination: $effect_{HMD} = 0.495$, $effect_{SM} = 0.142$). Thus, we found support for $H7_a$ and $H7_b$.

Finally, we ran the same parallel mediation model to analyze the effects of the VRHMD condition (versus otherwise) on the intention to book. The direct effect of the VRHMD condition on the intention to book disappeared ($p = 0.653$) when both mediators where included in the model. Visual appeal (*coeff.* = 0.305, $se = 0.08$; $t = 3.678$, $p < 0.01$) and ease of imagination (*coeff.* = 0.302, $se = 0.07$; $t = 4.075$, $p < 0.01$) had significant impacts on the participants' intention to book. The bootstrap analysis (5,000 subsamples) showed that both visual appeal (*effect* = 0.354, *BootSE* = 0.14, *95% bootstrap confidence interval* [0.103, 0.645]) and ease of imagination (*effect* = 0.379, *BootSE* = 0.12, *95% bootstrap confidence interval* [0.141, 0.631]) mediated the relationship between using VRHMD (compared to other conditions) and the intention to book. These results show that watching realistic contents with HMDs lead to the most effective pre-experience.

8.5. Discussion

Table 8.3 shows a summary of the results obtained in the hypothesis testing. First, the results of the analysis showed that the type of content and device affected the components of HTI (Dix, 2017). Devices with a higher degree of integration with the human body (HMD) were perceived as more embodied than devices less integrated into the senses (smartphone). This result further supports the technological dimension of the EPI Cube (Flavián et al., 2019a). In addition, viewing realistic contents provoked a higher sense of presence than digital contents. This result is contrary to the findings of Martínez-Navarro et al. (2019), who noted that there were no differences in terms of presence between realistic and computer-generated contents in VR experiences. This different finding may be due to the research context, given that Martínez-Navarro et al. (2019) focused on a more tangible industry (retailing). Hospitality services are featured by a high degree of intangibility (Parasuraman et al., 1985); thus, it seems that the realism of the contents is critical to increase the level of perceptual presence. Our results highlight the importance of providing customers with realistic contents in online hotel pre-experiences. In fact, our results align with Wagler and Hanus (2018), who found that watching a 360-degree video of a tourism product generated the same presence reactions as the real physical experience. Therefore, it is essential to create realistic contents to induce users' sense of "being there" instead of "being here" (Lee et al., 2020).

Table 8.3. Summary of the results

Hypothesis	Support
H_1: Type of device → Technological embodiment	Yes
H_2: Type of content → Presence	Yes
H_{3a}: Type of content → Visual appeal	Yes
H_{3b}: Realistic content × embodied device → Visual appeal (moderation)	Yes
H_{4a}: Type of content → Ease of imagination	Yes
H_{4b}: Realistic content × embodied device → Ease of imagination (moderation)	Yes
H_{5a}: Type of content → Booking intention	Yes
H_{5b}: Realistic content × embodied device → Booking intention (moderation)	Yes
H_{6a}: Realistic content → visual appeal → booking intention (mediation)	Yes
H_{6b}: Realistic content → ease of imagination → booking intention (mediation)	Yes
H_{7a}: (Realistic content → visual appeal → booking intention) × embodied device (moderated mediation)	Yes
H_{7b}: (Realistic content → ease of imagination → booking intention) × embodied device (moderated mediation)	Yes

Second, the analysis revealed that the content of the HTI influenced the users' evaluation of the hotel pre-experience, their subjective experience and their booking intentions. Specifically, compared to digital contents, realistic contents improved the visual appeal of the experience and facilitated imaginations about how the real experience would be. Presence-inducing contents add richness to the experience, which enhance the visual appeal of hospitality pre-experiences (Wagler & Hanus, 2018). This type of contents also allows users to view the real experience more clearly, supporting their decision-making processes (Huang et al., 2016). Importantly, these effects were stronger when embodied devices were used. When participants watched realistic contents with HMDs, their perceptions of visual appeal and their ease of imagining the actual experience were the highest, compared to the rest of experimental conditions. Previous research has found positive effects of using HMDs on perceptions of visual appeal about the content showed (Van Kerrebroeck et al., 2017a), so the use of these embodied devices enable users to obtain powerful visual experiences (Petit et al., 2019). In addition, using HMD with realistic contents allow customers to have more powerful "try-before-you-buy" experiences (Tussyadiah, Wang, et al., 2018), facilitating their imaginations about how the real experience would be (Bogicevic et al., 2019). Our findings confirm the superiority of realistic contents with HMDs compared to digital contents and smartphones.

Furthermore, viewing realistic (compared to digital) contents favored the participants' booking intentions. The similarity of the contents with the actual environment puts customers in a better position to make their decision (Wagler & Hanus, 2018). This effect was strengthened by using embodied devices, which is in line with previous propositions (Kim, Lee, & Jung, 2020; Tussyadiah, Wang, et al., 2018). Finally, the analysis showed that the effect of watching realistic (vs. digital) contents on booking intention was mediated by visual appeal and ease of imagination. These results reinforce the idea that the visual attractiveness of the content serves to promote positive behavioral intentions (Marasco et al., 2018), and that realistic contents help consumers to easily imagine the real experience, affecting their decisions (Bogicevic et al., 2019). We extend previous findings by showing that using embodied devices to view realistic content are more powerful than non-embodied devices.

8.6. Conclusions and implications

Despite the increasing relevance of XR technologies in hospitality, few studies have analyzed and compared their influence on potential guests' pre-experiences (Bogicevic et al., 2019). Previous authors have also noted the need for the device/content distinction when analyzing the effectiveness of XR technologies (Li & Chen, 2019). This study contributes to the literature by examining the comparative effects of AR and VR technologies in hotel pre-experiences, considering the impact of the content displayed, along with the device used. Specifically, the levels of embodiment and presence elicited by different types of devices and contents, respectively, of XR technologies are analyzed. Furthermore, we examine the main effects of the type of content, and its interaction with the type of device, on a hotel pre-experience in terms of visual appeal, ease of imagination and booking intentions.

Taking into account the results of the empirical study, AR is posited as an effective tool for showing tourist attractions (e.g. Chung et al., 2015); yet, it may not be so effective for tangibilizing hospitality service offers. For this purpose, using realistic contents with devices highly integrated with the human body (VR HMDs) seem to generate better results. Focusing on this technology, VR hardware and VR content are two separate dimensions that serve to create successful VR experiences (Manis & Choi, 2019). This study stresses the combination of contents close to reality with embodied devices to generate successful XR experiences.

This study also gives insights into the cognitive route underlying the experiences with immersive technologies. The perceptions of visual appeal and ease of imagination have been shown to play a mediating role in the experiences with these technologies. Thus, these results complement those obtained in the previous chapters which have delved into the affective route.

8.6.1. Managerial implications

This study offers ways to help practitioners improve potential guests' pre-experiences with a hotel. First, our findings show that using contents that resemble the real world (360-degree videos) places customers in the environments displayed more effectively, empowering them in their booking decisions. Unlike tangible industries (e.g. retail), where the type of content seems not be so important for eliciting a higher sense of "being there" (Martínez-Navarro et al., 2019), for hospitality services it is essential to offer realistic previews to generate this perception. These 360-degree videos may even resemble real-world experiences (Wagler & Hanus, 2018). Therefore, it is advisable for hotel managers to use this type of format (360-degree videos) which may be cheaper to produce than digital animations or applications, and it is gaining great popularity among customers (Martínez-Navarro et al., 2019).

Service designers and developers must choose the combination of contents and devices that better fits their potential customers' needs to offer technology-enhanced experiences (Flavián et al., 2019a). Our results highlight that when hotel managers use realistic contents (360-degree videos) to present their products, embodied devices (HMDs) are the most effective devices for transmitting this information (VR condition). In this sense, "try-before-you-buy" experiences with realistic contents and embodied devices (VR) foster visually appealing perceptions of the information, and help consumers to easily imagine how the real experience would be (Loureiro et al., 2019). Both factors generate favorable booking intentions. This combination empowers the customer experience by creating a new experience (VR with HMDs) which is related to his or her current goals (i.e. looking for information about the hotel) (Flavián et al., 2019a). Good practices in this regard can be already found in the hotel industry (e.g. Shangri-La Hotels and Resorts; Shangri-La, 2020). Companies may integrate this type of VR experiences in online channels (e.g. webpages, smartphone apps) and physical outlets (e.g. travel agencies, stands in shopping malls), as well as combining them with other formats (e.g. textual online reviews; Zeng et al., 2020), to generate superior value propositions.

In case of using digital content (AR), high embodied devices seemed not to perform very well. Thus, hotel managers may encourage the use of less embodied technologies, such as smartphones, to generate better pre-experiences with their products. This combination of content-device can be considered a directly supported experience (Flavián et al., 2019a), given that the technological experience offers a direct assistance to the customer's goals at this stage of the journey (information search). In AR experiences, it seems that embodied devices (HMDs) are not as effective as smartphones. The reason may be that customers are widely used to using their smartphones throughout their purchase journeys (Orús, Gurrea, & Ibáñez-Sánchez, 2019), particularly with AR (Park & Stangl, 2020), but the process of AR HMD adoption is still in its early stages and may generate negative reactions (Rauschnabel, He, & Ro, 2018). Additionally, it should be noted that while AR may be effective in situations when the focus of the experience is the physical environment (Chung et al., 2015), it may not be as effective when the focus is on the digital information itself. In this latter case, the real environment may distract the consumer from the main experience (i.e. viewing the digital content), thus diminishing the value of the experience as a whole.

8.6.2. Limitations and future research lines

Aside from the general limitations (discussed later in chapter 11), this study has some specific limitations that open the way for future research lines. In the experiment, participants viewed either realistic/digital content of a hotel room. The utilitarian character of a room, compared to other parts of a hotel which can be considered as hedonic (e.g. restaurant, spa), can influence the effectiveness of the pre-experience with these technologies. Thus, as these elements are also highly valued by consumers, it would be worthwhile to analyze how the preview with AR or VR of these hedonic elements, compared to hotel rooms, can be effective in fostering booking intentions.

In addition, we manipulated the videos so that the staff members were removed to ensure that it was similar to the other experimental conditions. Nevertheless, future research should explore how the presence of staff or other guests can affect these pre-experiences. Finally, the results show that using VR HMDs with real contents generates more effective pre-experiences with a hotel room that increase the subsequent booking intentions. However, it remains unexplored how these technologies can be applied during the stay in the hotel, in which AR can serve to provide extra digital information superimposed on the real world (e.g. opening hours) and as a navigation tool in the hotel, while VR can be useful to provide relaxing and escapism experiences when resting in the room. Therefore, the consideration (individually and jointly) of these realities in a hotel experience is interesting to achieve their effective implementation.

9. Toward an effective sensorialization of digital experiences: the impact of aroma-content congruence on virtual reality experiences with destinations

9.1. Introduction

Thus far, our empirical analysis has delved into the validation of technological embodiment and presence as two main dimensions of HTI. We have paid special attention to embodiment, which has been shown to affect potential tourists' behavioral intentions through both affective and cognitive mechanisms. The comparative effects of VR and AR have also been examined. The last empirical study seeks to take one step further in the sensorialization of the digital experiences with immersive technologies, which represents a challenge for XR researchers and practitioners (Loureiro et al., 2020).

Achieving multisensory digital experiences is the holy grail of HTI. Recent developments (e.g. Teslasuit Gloves, 2019) try to achieve the "sensorialization" of the digital environment by stimulating the human senses in ways similar to their stimulation in the real world. Despite the efforts made by researchers and practitioners to deliver multisensory digital experiences, there is still a long way to go before this goal is accomplished (Petit et al., 2019). In fact, providing multisensory experiences in digital environments is one of the future priorities in technology development (Gartner, 2019; Guinalíu, Hernández-Ortega, & Franco, 2019; Spence, 2019). However, current digital experiences are mainly based on audiovisual stimulation, including to a less extent other sensory stimulation (Petit et al., 2019). Considering that virtual environments are becoming increasingly important in the customer purchase journey (Lemon & Verhoef, 2016; Neuhofer et al., 2014), the integration of a wider range of senses to generate holistic experiences may increase the value delivered to consumers (Spence & Gallace, 2011).

Sensory-enabling technologies represent a first step toward the sensorialization of the digital world (Petit et al., 2019). These technologies deliver sensory inputs to customers while they are interacting in digital environments. When virtual environments stimulate sensory inputs, users feel as if they are inside the digital world and more easily process information (Bogicevic et al., 2019; Cowan & Ketron, 2019). According to Petit et al. (2019), VR has a sensorial character, which differentiates it from other technologies (Willems et al., 2019). VR HMDs enable users to obtain multisensory information directly through the stimulation of their senses (Flavián et al., 2019b). However, as with other related technologies, current VR experiences stimulate mainly sight and hearing (Guttentag, 2010), and the role of other sensory stimuli has been less explored (Serrano, Baños, & Botella, 2016). Adding other sensory cues (e.g. scents, haptics) can generate realistic and immersive experiences (Meißner et al., 2019; Obrist, Gatti, Maggioni, Vi, & Velasco, 2017; Roschk & Hosseinpour, 2020). Therefore, it is interesting to understand how VR technologies can be combined with other sensory inputs to enrich multisensory digital experiences (Loureiro et al., 2020).

Adding scent generates enhanced experiences in multisensory digital environments (Raisamo et al., 2019). However, there is a lack of studies analyzing the integration of scents in VR experiences and their impact in digital service consumption contexts (Roschk & Hosseinpour, 2020; Serrano et al., 2016). Following an imagery fluency approach (Petrova & Cialdini, 2008), this chapter analyzes the combined influence of olfactory inputs and VR devices on sensory-stimulating pre-experiences in the context of a tourist destination. In addition, despite being one of the most important aspects of scent, congruity is regarded as an unexplored research area in digital environments (Errajaa, Legoherel, & Daucé, 2018). Thus, it is examined how scent-content congruity may moderate the influence of the multisensory pre-experience on affective and conative destination image. Combining multiple sensory stimuli is important for creating a consistent sensory destination identity; and a consistent sensory destination identity will, in turn, provide competitive advantage (Agapito, 2020; Agapito, Mendes, & Valle, 2013). Our findings aim to contribute to a better understanding of how multiple sensory inputs can deliver holistic digital experiences which will favor cognitive processes and behavioral reactions (Nibbe & Orth, 2017).

9.2. Theoretical development and hypotheses

9.2.1. Sensorialization of the digital environment

Real-world experiences are multisensory in nature (Citrin, Stem Jr, Spangenberg, & Clark, 2003; Petit et al., 2019). A wide variety of sensory inputs are simultaneously integrated in real-world experiences, and these eventually determine individuals' judgements and behaviors (Krishna, 2012; Spence & Gallace, 2011). The same applies to consumers in purchasing environments (Motoki, Saito, Nouchi, Kawahima, & Suqiura, 2019; Sunaga, Park, & Spence, 2016). This emphasizes the importance of achieving the optimum integration of sensory inputs in the customer experience, particularly with regard to the consistency between the different sensory stimuli (Helmefalk & Hultén, 2017; Krishna, 2012; Lwin, Morrin, & Krishna, 2010; Spence, Puccinelli, Grewal, & Roggeveen, 2014; Velasco, Woods, Petit, Cheok, & Spence, 2016). As customers seek multisensory experiences in their purchase journeys (Meißner et al., 2019), one might wonder if these sensory effects are equivalent in digital environments, where today's consumers increasingly undertake a significant percentage of their commercial transactions (Statista, 2019).

Traditionally, HTI in digital environments have relied heavily on the senses of sight and hearing (Guttentag, 2010; Spence, Obrist, Velasco, & Ranasinghe, 2017) as, hitherto, the use of tactile, olfactory and gustatory stimuli has been rather limited (Gallace & Spence, 2014; Narumi, Nishizaka, Kajinami, Tanikawa, & Hirose, 2011). Consequently, digital environments may inhibit customer experiences due to their limited capacity to provide wider sensory inputs (Petit et al., 2019). With the aim of overcoming this challenge, recent technological developments seek to communicate haptic, olfactory and even gustatory information (Petit et al., 2019; Spence et al., 2017; Velasco, Obrist, Petit, & Spence, 2018). In fact, the integration of different sensory inputs provides customers with multisensory experiences resembling real-life experiences (Petit et al., 2019), and customers perceive them as natural, immersive and engaging (Meißner et al., 2019). Considering the natural lack of multisensory interaction in digital environments, the challenge for researchers and practitioners is, using the latest technological developments, to apply a wider spectrum of sensory inputs, thus extending the audiovisual domain, to more effectively connect the real and digital worlds (Petit, Cheok, Spence, Velasco, & Karunanayaka, 2015; Petit et al., 2019).

9.2.2. Sensory-enabling technologies: virtual reality

Recent developments in HTI have taken further steps toward the achievement of the sensorialization of the digital environment (Petit et al., 2019). The integration of the senses in online experiences is paramount for facilitating multisensory interactive experiences (Spence & Gallace, 2011; Yoganathan, Osburg, & Akhtar, 2019). Sensory-enabling technologies provide sensory inputs in digital shopping environments which serve as proxies for the sensory experiences that customers might enjoy in physical environments (Petit et al., 2019). The multisensory experiences provided by sensory-enabling technologies can potentially reduce the psychological distance in online consumption (Petit et al., 2019) by helping customers to envision how their future consumption experience might turn out, which represents one of the main challenges for online purchasing (Heller et al., 2019a). This can be done by providing customers with some of the sensory properties of products (e.g. texture, odor or taste) which cannot be transmitted through traditional channels (Petit et al., 2019). The implementation of sensory-enabling technologies will be especially important for services (e.g. tourism), as they can overcome the intangibility of the sector (Lee et al., 2020; Tussyadiah, Wang, et al., 2018). Sensory-enabling technologies can empower potential customers in their service decision-making processes by providing multisensory experiences that act as previews of real experiences (Buhalis et al., 2019).

VR is a key sensory-enabling technology that immerses users in a three-dimensional environment where their senses are stimulated (Guttentag, 2010). Consumers demand richer sensorial experiences, using technologies such as VR, that can augment their perceptual abilities, transform their immediate reality and create symbiotic human-technology relationships (Buhalis et al., 2019). Previous VR research has noted its sensory enriching potential in service contexts (e.g. Kim, Lee, & Jung, 2020; Marasco et al., 2018; Martins, Gonçalves, Branco, Barbosa, Melo, & Bessa, 2017; Tussyadiah, Wang, et al., 2018).

Similar to other related technologies, VR research has mainly involved the use of audiovisual elements (Guttentag, 2010). However, recent attempts have been made to incorporate other senses into VR experiences. The Table 9.1 shows a summary of the empirical studies conducted in the last 5 years that have analyzed the addition of tactile, olfactory and/or gustatory stimuli to VR service experiences.

Table 9.1. Multisensory VR research in services

Reference	Objectives	Context	Methodology	Findings	Involved senses (apart from audiovisual)		
					Touch	Smell	Taste
Alaraj et al. (2015)	Development of a new haptic-based VR simulator for neurosurgical training.	Training	Residents tested a VR aneurysm clipping simulator with haptic feedback and evaluated their perceptions.	Residents perceived that this system was useful in preparing them for real-life surgeries and it resembled how the real surgery would be.	✓		
Covarrubias et al. (2015)	Design a multisensory VR system, based on exercises where interactions with objects happen through gestures and scents, for upper-limb rehabilitation.	Health	Two tests: within-subjects designs (15 healthy users in one study; 2 patients in the other study), who use the VR system with and without HMD. Self-reported measures before and after the experiences	Participants preferred stereoscopic vision (versus PC), gained confidence in the use of gestures over time, and appreciated odors in terms of pleasantness and congruence.	✓	✓	
Serrano et al. (2016)	Analyze how a mood-induction procedure implemented with multisensory VR can induce to relaxation and generate presence.	Wellness	Lab experiment. Participants were exposed to a VR experience including (or not) olfactory and touch stimuli (together or individually).	All the groups scored high in the level of relaxation. When touch was stimulated, relaxation and sense of presence were higher.	✓	✓	
Shapira et al. (2016)	To test TactileVR, a VR system in which users can interact with physical objects which are represented in the virtual environment.	Entertainment	Lab experiment. Children used this system and evaluated their experience after performing some tasks.	Children took instantly to this system, getting used to interacting and performing certain tasks with it. High satisfaction with the system.	✓		

Baus & Bouchard (2017)	Explore if the exposure to an olfactory stimuli affects perceived presence, sense of reality and realism in VR.	HCI; Real Estate	Lab experiment. Participants were exposed to either a pleasant, unpleasant or ambient scent (control) in the VR experience.	Unpleasant odors generate higher levels of presence than pleasant ones.		✓
Ranasinghe et al. (2017)	Analyze if the addition of thermal and wind stimuli provided by Ambiotherm helps enhance perceptions of presence in a VR experience.	HCI; Entertainment	Lab experiment. Participants were randomly assigned to a VR experience including (or not) the thermal and wind stimuli.	The addition of wind and thermal stimuli significantly enhances sensory and realism factors, which contribute to an enhancement of the sense of presence.	✓	
Butt et al. (2018)	Explore if the use of a VR HMD with wearable gloves can improve the learning from nurses in a VR game-based training experience.	Training	Lab experiment. Two groups: one was learning the procedure in reality, and the other with VR and wearable gloves.	VR elicited higher usability, engagement, enjoyment and focus on the task. They also completed the task more times than the other group.	✓	
Ranasinghe et al. (2018)	Design a multisensory wearable VR HMD system.	Entertainment	Experiment within-subjects condition. Participants were exposed to a VR journey through the four seasons where the corresponding olfactory and haptic (thermal and wind) stimuli were added.	Results showed that the addition of any sensory modality enhance users' sense of presence in a VR experience and the combination of them further increased this effect.	✓	✓
Baus et al. (2019)	Analyze if visual/scent concordance affect users' perceptions in VR experiences.	HCI; Real Estate	Lab experiment. Participants were exposed to either a pleasant (and congruent scent), unpleasant (and inconsistent) or ambient scent (control) in the VR experience.	Pleasant odors congruent with the virtual environment shown generate higher sense of reality. No effect on sense of presence nor realism. Visual/olfactory concordance facilitates scent detection.		✓
Edwards et al. (2019)	To test how adding haptic stimulation to a VR system improve the learning process of chemistry.	Education	Lab experiment. Participants could build molecules interacting with the bonds and atoms available.	This systems supports participants' high engagement, motivation, interest and organic chemistry learning.	✓	

Huang et al. (2019)	Study if watching the simulation of actual tea color in VR influenced participants' evaluation of the tea taste.	Food & beverage	Lab experiment. Participants tasted an actual tea sample after watching the simulation of the tea color with VR.	The visual representation of VR and the gustatory cues from the real world influence participants' taste perceptions from the actual drink when colors are previously selected by them.			✓
Liu et al. (2019)	Explore how the congruency between the visual, auditory and olfactory cues in a virtual environment affect perceptions of cold brewed coffees.	Food & beverage	Within-subjects lab experiment. Participants were exposed to different combinations of visual, auditory and olfactory cues in the immersive tasting conditions.	Olfactory cues were less recalled than the rest of stimuli. Participants spent more time evaluating the coffees when all the sensory cues were congruent.		✓	✓
Chen et al. (2020)	Assess the combined effect of taste-congruent/incongruent visual cues displayed with VR in beverage perceptions.	Food & beverage	Within-subjects lab experiment. Participants tasted the same beverage while using a VR HMD which displayed different environments.	Perceived sweetness of the beverage was higher when a sweet-congruent VR environment was displayed.			✓
Hopf et al. (2020)	Analyze how the joint addition of olfactory and tactile stimuli can result in better VR experiences with a destination.	Tourism	Lab experiment. Olfactory and haptic inputs were simultaneously added to the experimental group experience when they watched the video of a destination with VR.	Presence is not enhanced in multisensory VR experiences. Immersion and intention to recommend the destination are higher in multisensory VR.	✓	✓	
Jung et al. (2020)	To explore the impact of simultaneously delivered multiple sensory feedback on a VR perceptual-cognitive task.	HCI; Entertainment	Within-subjects lab experiment. Participants were exposed to several virtual environments (vision and audio) which included (or not) additional tactile (wind blowing, floor vibration) and olfactory stimuli.	Multi-sensory VR led to superior states of presence in the virtual environment and user preference. However, not including additional sensory inputs resulted in higher confidence levels for the task.	✓	✓	

Source: Own elaboration

As can be observed, empirical research has focused on a variety of services, including entertainment, hospitality, education or health recovery. As for the involved senses, the incorporation of touch to VR experiences is the most analyzed multisensory integration, while smell and taste are less addressed. Overall, the results from these studies show a lack of consistency regarding the effects of the incorporation of senses to the VR experience. While several studies show positive effects (e.g. Jung, Wood, Hoermann, Abhayawardhana, & Lindeman, 2020; Ranasinghe, Jain, Karwita, Tolley, & Do, 2017; Ranasinghe et al., 2018), others do not find such effect (Baus et al., 2019; Hopf, Scholl, Neuhofer, & Egger, 2020). In the specific context of this study (tourism), the only empirical evidence showed that the addition of olfactory and tactile inputs in a VR experience with a destination did not result in higher presence in the destination displayed (Hopf et al., 2020). However, the authors analyzed the joint effect of both sensory stimuli (smell and touch), without considering the individual effect of each sense. As two manipulations were introduced simultaneously, the resulting output cannot be assigned to one or the other (Viglia & Dolnicar, 2020). Therefore, given that the integration of olfactory stimuli into VR research has been less considered than tactile stimulation (Baus et al., 2019; Guttentag, 2010), this study focuses specifically on the addition of this sensory input. The addition of suitable odors to VR experiences represents a further step toward the effective sensorialization of the digital environment.

9.2.3. The role of scent in VR experiences

Since the first attempts of incorporating scents into audiovisual and immersive experiences (Smell-O-Vision, Laube, 1959; Sensorama, Heilig, 1962), there has been an increasing interest in the development of digital scent delivery devices; several companies have attempted to market their devices, with more or less success (oPhone, Digital Trends, 2014; Scentee, Tech in Asia, 2014; iSmell, The Hustle, 2018). Examples of current developments can be found at Olorama (Olorama, 2020), Aroma Shooter (Aroma Shooter, 2020), Portable USB Aroma Diffusers (Soehne, 2020) or Feelreal (Feelreal, 2020). Academic research has also made efforts to integrate olfactory stimuli in digital immersive experiences (e.g. Covarrubias et al., 2015; Dinh, Walker, Song, Kobayashi, & Hodges, 1999; Herrera & McMahan, 2014; Maggioni, Cobden, Dmitrenko, Hornbæk, & Obrist, 2020; Ranasinghe et al., 2018).

Despite the great interest, several limitations still exist to generate a successful digital scent delivery system that can be incorporated into VR experiences. First, some of these sophisticated devices have to be worn during the immersive experience, adding discomfort and disturbing the users from the main experience (Jung et al., 2020; Ranasinghe et al., 2018). Furthermore, there is no standard device, mainly due to complex designs, the difficulty with scents' storing-mixing-delivery mechanisms, lack of affordability and availability for the general public (Herrera & McMahan, 2014; Serrano et al., 2016). For all these reasons, the digitalization of scents in digital experiences remains a challenge.

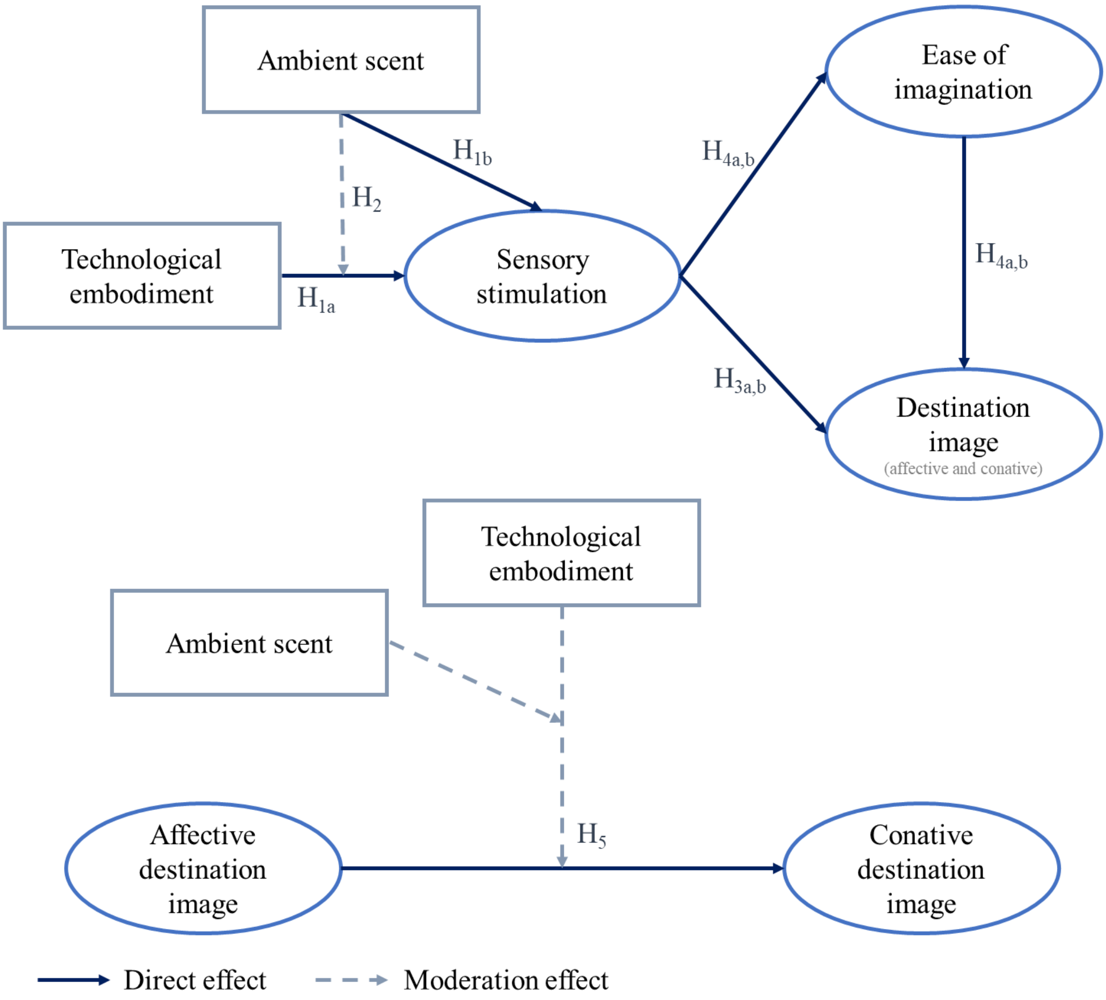
With the aim of delivering scents in immersive experiences in a more naturalistic and subtle way, the use of ambient scents is the simplest application of digitizing this chemical sense (Spence et al. 2017). Ambient scent refers to an aroma that does not emanate from a specific object, but is present in the environment (Spangenberg, Crowley, & Henderson, 1996). Compared to object-specific scents, the implementation of ambient scents is particularly interesting for retailers and service providers because it can enhance customers' overall impressions about an experience (Chebat & Michon, 2003; Mattila & Wirtz, 2001). The introduction of ambient scents in digital experiences can serve as a way of augmenting the other senses in digital experiences (Spence et al., 2017). Users can be placed in a realistic digital environment where, even though they may not be able to report the existence of a scent, its mere presence can affect their evaluations and decisions (Li, Moallem, Paller, & Gottfried, 2007; Maggioni et al., 2020; Uchida, Kepecs, & Mainen, 2006). Therefore, the integration of ambient scents is interesting for VR, as it can help to generate favorable experiences that might foster the user's connection with the virtual environment (Cowan & Ketron, 2019; Raisamo et al., 2019).

However, it remains unclear which features of olfactory stimuli can help to enrich the overall VR service experience. The few empirical exceptions (see Table 9.1) show a lack of consensus about the effectiveness of incorporating ambient scents in VR experiences, or did not consider the specific features of scents that can be added to affect the multisensory digital experience (Baus et al., 2019; Baus & Bouchard, 2017; Hopf et al., 2020; Serrano et al., 2016). Thus, there is a need to better understand the role of olfactory stimuli, particularly regarding the features of ambient scents, in customers' VR experiences (Roschk & Hosseinpour, 2020; Serrano et al. 2016).

9.2.4. Hypotheses development

Figure 9.1 shows graphically the proposed relationships regarding the influence of technologies and scents on digital experiences. Specifically, in the context of a destination pre-experience (Beerli-Palacio & Martín-Santana, 2018), the present study analyzes the effect of the interplay between scent inputs and audiovisual digital experiences with different technologies on users' sensory stimulation (i.e. the activation of users' senses as a consequence of the sensory information delivered in an experience; Flavián et al., 2019b), and its subsequent influence on affective and conative destination images. The mediating role of ease of imagination on this relationship is also explored.

Figure 9.1. Ambient scent and embodiment influences on the multisensory digital experience



The first hypothesis seeks to confirm the influence of the device on the perceptions of technological embodiment and its effect on sensory stimulation. As internal devices (e.g. VR HMDs) use effectors which stimulate the receptors of the perceptual human senses (Latta & Oberg, 1994), they are able to generate superior levels of sensory stimulation than external devices (e.g. desktop PC) (Flavián et al., 2019b). In addition, scents are processed in the primeval areas of the brain, so they are perceived with low cognitive effort (Bone & Ellen, 1999; Herz & Engen, 1996). This can help scents to be directly processed, along with other sensory inputs, in customers' experiences. It has been shown that adding odors to the customer experience produces holistic experiences which engage the human senses (Nibbe & Orth, 2017). In digital environments, sensory augmentation (e.g. odors) can help develop enhanced sensory experiences (Buhalis et al., 2019). Therefore, our first hypothesis repeats previous findings that showed that higher degrees of technology-human body integration in the digital experience, and the addition of scents to the digital experience, have positive effects on sensory stimulation:

H_{1a}: The use of embodied (vs. non-embodied) technologies in a digital experience will have a positive influence on users' sensory stimulation.

H_{1b}: The presence (vs. absence) of a pleasant ambient scent in a digital experience will have a positive influence on users' sensory stimulation.

Congruency is the degree to which different cues fit with each other in a particular environment (Helmefalk & Hultén, 2017). Sensory congruency has been defined as the existing fit between the characteristics of the different sensory stimuli of an experience (Krishna, 2012). Congruent sensory cues, specifically scents, can generate favorable multisensory experiences (Roschk & Hosseinpour, 2020; Roschk, Loureiro, & Breitsohl, 2017). The underlying reasons for this are explained by the theory of cognitive balance (Heider, 1958) and the theory of processing fluency (Herrmann, Zidansek, Sprott, & Spangenberg, 2013; Schwarz, 2004). According to the theory of cognitive balance (Heider, 1958), harmonious or balanced (compared to unbalanced) situations generate favorable reactions in individuals. The theory of processing fluency (Herrmann et al., 2013; Schwarz, 2004) argues that congruent stimuli (versus incongruent stimuli) help individuals more easily process information, which generates positive reactions. The mere presence of a pleasant scent may not be enough to generate better multisensory experiences, but congruency between stimuli is critical in determining the multisensory effectiveness of experiences (Spangenberg, Grohmann, & Sprott, 2005). Therefore, congruency is an important aspect in the cross-modal effects between different sensory inputs that foster the positive effects of aromas in experiences (Spence, 2011). Formally:

H_2: The effect of embodiment on sensory stimulation will be higher for an ambient scent congruent (vs. non-congruent) with the audiovisual content of a digital experience.

The mental image that potential visitors have of a destination is a critical factor when they make travel decisions (Baloglu & McCleary, 1999; Beerli-Palacio & Martín-Santana, 2018; Bogicevic et al., 2019; Hosany, Ekinci, & Uysal, 2007). The present study examines the distinction between affective and conative destination images. Affective destination image represents the feelings and emotions felt toward a destination (Hosany, Ekinci, & Uysal, 2006; Lin, Morais, Kerstetter, & Hou, 2007; Pike & Ryan, 2004). The concept of conative destination image is closely linked to the idea of behavioral intentions toward that destination (Hyun & O'Keefe, 2012). Therefore, it can be considered as the main antecedent of how potential tourists will actually behave in the future (Pike & Ryan, 2004). Multisensory experiences in digital environments enrich the experiences of the potential tourist, and promote the affective side of the destinations depicted (Ghosh & Sarkar, 2016). In addition, previous research has found that sensory stimulation has a positive influence on behavioral intentions toward a destination (Flavián et al., 2019b). Thus, sensory inputs can affect potential tourists' senses, and promote positive behaviors through emotions, memories, perceptions, and preferences (Krishna, 2012). Therefore:

H_3: Sensory stimulation will have a positive influence on (a) the affective image and (b) the conative image of a destination.

We propose that ease of imagination is the mechanism through which sensory stimulation affects users' perceptions of the image. As stated in the previous chapter, ease of imagination refers to the ease with which consumers can create a mental image about how a product might perform (Orús et al., 2017). These imaginative processes are undertaken through sensory representations of ideas, feelings and experiences with objects which, as a result, influence their subsequent evaluations and behavioral intentions (Walters, Sparks, & Herington, 2007). The imagery accessibility approach (Alter & Oppenheimer, 2009; Petrova & Cialdini, 2008) suggests that the ease with which consumers imagine products or consumption situations is an informational cue that influences evaluations and behavioral intentions. This metacognitive experience helps them evaluate the alternatives and make their final decisions (Orús et al., 2017). This may be especially important in a service context, given that the intangible nature of services leads consumers to infer how experiences might unfold. This mental representation is sometimes the most important available source on which to base a judgement, acting as a “try-before-you-buy” experience (Guttentag, 2010). When a high number of sensory inputs are stimulated, the enriched sensory information helps users better imagine how actual experiences will be (Wei et al., 2019). Thus, as shown in chapter 8, VR experiences favor users’ imaginative processes by evoking concrete mental representations of the simulated environments (Cowan & Ketron, 2019). Furthermore, the addition of a suitable scent can also favor imaginative processes, helping users to envision how the real experience will unfold and facilitating their decision making processes (Goldkuhl & Styvén, 2007). Consequently, when sensorially stimulated, individuals may be expected to easily envisage the destination, and this metacognitive experience will determine their perceived affective and conative images (Ghosh & Sarkar, 2016). Thus:

H_4: Ease of imagination mediates the impact of sensory stimulation on (a) the affective image and (b) the conative image of destinations.

Finally, previous research has found a positive relationship between the affective and conative images of destinations (Agapito, Valle, & Mendes, 2013; Hyun & O'Keefe, 2012). We propose that this link may be affected by the characteristics of the multisensory experience. As embodied VR technologies are considered to be sensory-enabling technologies (Petit et al., 2019), they can reinforce the mental representation of destinations and, thus, foster the relationship between the affective and conative images of destinations (Griffin et al., 2017). In addition, we expect that this effect will be stronger when the scent is congruent with the destination. Following the theory of cognitive balance (Heider, 1958) and the theory of processing fluency (Herrmann et al., 2013; Schwarz, 2004), when there is a match between the different stimuli (i.e. scent and destination displayed), users will more easily process information and their reactions will be more positive. Therefore, in a VR experience, when the scent dissipated is congruent with the displayed content, the link between the affective and the conative image may be strengthened:

> *H_5: The effect of the affective image on the conative image is stronger when the experience involves embodied (vs. non-embodied) technologies and congruent (vs. non-congruent) scents.*

9.3. Methodology

The hypotheses were tested in a laboratory experiment. The sample consisted of 263 participants (see the sample's socio-demographic characteristics in Table 5.2), who were randomly assigned to one of the 2 (technological embodiment: low –desktop PC– vs. high –VR HMD–) × 3 (scent: no scent vs. pleasant and non-congruent –P– vs. pleasant and congruent –P+C–) between-subjects conditions, in a factorial design. Cell sizes ranged from 39 to 48 participants.

In the experiment the participants were instructed to imagine that they were thinking about visiting a particular destination. In order to avoid biases derived from previous experiences or tourism preferences, two destinations were chosen as the stimuli for the experiment, and randomly assigned to the participants: Venice (Italy) and the Cliffs of Moher (Ireland). After answering the questions regarding the control variables (see Table 5.2), they were randomly assigned to one of the six experimental conditions. Depending on the condition, they viewed a 360-degree video of the destination through a different device (desktop PC vs. VR HMD) in a room with different types of scents (no scent vs. pleasant and non-congruent vs. pleasant and congruent). The original videos were modified to keep duration (90 seconds) and sound quality constant. The lab rooms were perfumed with ambient scents when required by the experimental condition.

After undergoing their pre-experience with the destination, the participants moved on to another room where they answered the questionnaire about the variables under study (see Appendix A.4). Before gathering the participants' demographic information, we asked them to indicate whether they noticed any scent in the experimental room (yes vs. no), and to rate any scent in terms of pleasantness, intensity, familiarity and congruency (Errajaa et al., 2018).

9.3.1. Olfactory stimuli

Following the procedures of Serrano et al. (2016), ceramic diffusers with a small-unscented candle, water, and essence oil of a particular scent, were used to perfume the lab rooms. Current technological developments offer sophisticated devices (e.g. collars, masks, tubes) that allow the user (or the researcher) to have a high degree of control over the olfactory inputs provided (Noguchi, Sugimoto, Bannai, & Okada, 2011; Ranasinghe et al., 2018). However, as previously stated, most of these methods require wearing special devices which introduce additional nuisances that may disturb the user from the immersive experience (Jung et al., 2020), and may be invasive and/or uncomfortable (Ohtsu, Sato, Bannai, & Okada, 2009; Ranasinghe et al., 2018). These devices often require complex designs, can be expensive, or are not available for the general public

(Herrera & McMahan, 2014). In addition, these sophisticated devices can be useful when the task involves using several scents (Lai, 2015; Ranasinghe et al., 2018) or when olfactory stimulation is object-based (Covarrubias et al., 2015; Dinh et al., 1999; Mochizuki et al., 2004). In our experiment, we used one ambient scent to enrich the multisensory experience, given that the videos showed a scene in an open environment where the user did not interact with any specific object. Also, our purpose was not to make the scent manipulation highly explicit to the participants, but to place them in a realistic situation where the scents are subtly perceived. In this way, using ceramic diffusers is a natural, non-invasive, simple and ecological procedure to spread ambient scent (Serrano et al., 2016; Yanagida, 2012).

Two scents were sprayed into the experimental rooms. To avoid possible problems derived from mixing odors in the environment (Lai, 2015), each scent was displayed in one single room. The scent was carefully controlled to ensure that it was uniformly distributed in the rooms (Morrison, Gan, Dubelaar, & Oppewal, 2011). Each experimental room had a surface of 25 m^2. Three ceramic diffusers were equidistantly spaced within the room, in hidden positions from the participant's perspective. Although the pre-experience with the destination was relatively short in duration (90 seconds), scent habituation could be an issue, which occurs when the scent is emitted in the air over a continuous period and causes human adaptation due to a decrease in the sensory nerve activity (Noguchi et al., 2011; Ohtsu et al., 2009). To prevent participants' adaptation, the researchers poured a drop of essence oil in the ceramic diffusers at the middle (45 seconds) of the participants' pre-experience with the destination.

The scents were selected to be similar in terms of pleasantness, but dissimilar in terms of their congruence with the destination (Errajaa et al., 2018). For the safety and allergic concerns, the aromas were chosen from the products available at a specialized company (Lai, 2015). Given the commercial offer of the company, coffee was chosen for Venice and grass for the Cliffs of Moher. After verifying that the scents were correctly identified by five individuals independent of the research project, we carried out an online pre-test to confirm the stimuli (see Appendix B). The results from the pre-test confirmed the suitability of the scents for the main experiment.

9.3.2. Manipulation checks

To validate the scales, regular procedures were performed (see section 5.3.1). Once the scales were validated, the average values of the items were calculated and the resulting scales were used to perform the analyses. We controlled for possible differences in the variables under study depending on type of destination and scent. No significant differences were found, so the data from both destinations (Venice and the Cliffs of Moher) were merged. Thus, the digital experience with Venice together with a grass scent represented the "pleasant" condition (P), whereas the coffee scent accounted for the "pleasant and congruent" condition (P+C); the opposite was applied to the digital experience with the Cliffs of Moher: the coffee scent was the "pleasant" condition (P), while the grass scent represented the "pleasant and congruent" condition (P+C).

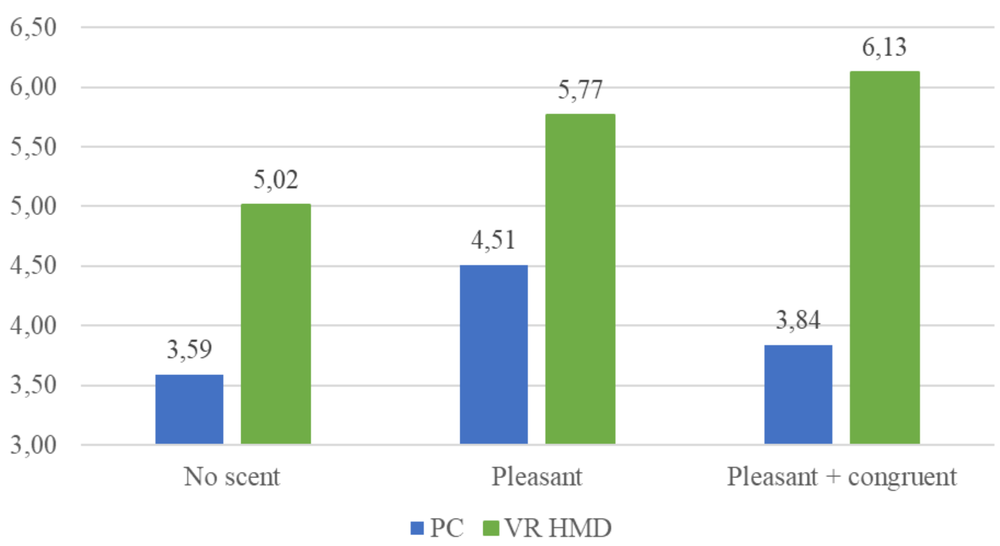
Independent t-tests were carried out to check the manipulations. The results showed that technological embodiment was significantly higher for participants in the VR HMD condition (M = 5.37, SD = 1.01) than in the desktop PC condition (M = 3.09, SD = 1.29; $t_{(261)}$ = 15.929, $p < 0.001$). In addition, both scents were similar in terms of pleasantness (M_P = 5.29, SD_P = 1.35; M_{P+C} = 5.31, SD_{P+C} = 1.44; p = 0.935), intensity (M_P = 5.44, SD_P = 1.48; M_{P+C} = 5.51, SD_{P+C} = 1.36; p = 0.734), and familiarity (M_P = 4.64, SD_P = 1.58; M_{P+C} = 4.85, SD_{P+C} = 1.67; p = 0.408). However, the degree of congruity of the scents with the destinations differed significantly, being higher for the pleasant + congruent scent than for the pleasant scent (M_P = 3.35, SD_P = 1.66; M_{P+C} = 5.23, SD_{P+C} =

1.51; $t_{(171)} = 7.759$, $p < 0.001$). These results confirmed that the manipulations were correctly executed and perceived by the participants.

9.3.3. Hypotheses testing

H_1 and H_2 were tested through a univariate ANOVA with sensory stimulation as the dependent variable and the experimental treatments as the independent factors. The ANOVA results revealed that sensory stimulation was significantly higher for participants in the VR HMD condition ($M = 5.62$, $SD = 1.00$) than in the desktop PC condition ($M = 3.97$, $SD = 1.38$; $F_{(1, 262)} = 139.480$, $p < 0.001$). In addition, the presence of a pleasant ambient scent significantly influenced the participants' sensory stimulation ($F_{(2, 262)} = 13.571$, $p < 0.001$). With no scent, sensory stimulation was lower ($M = 4.30$, $SD = 1.37$) than with a pleasant scent ($M_P = 5.18$, $SD_P = 1.38$; $M_{P+C} = 4.90$, $SD_{P+C} = 1.50$). The post-hoc HSD Tukey test showed that the difference between the scents was not significant ($p = 0.230$). Thus, H_{1a} and H_{1b} were supported. Furthermore, the embodiment × scent interaction was significant ($F_{(2, 262)} = 5.043$, $p < 0.01$). As can be observed in Figure 9.2, the effect of embodiment on sensory stimulation was stronger when the scent was congruent with the destination, which supports H_2.

Figure 9.2. Embodiment × scent interaction on sensory stimulation



The macro PROCESS v3.1 for SPSS v26 was used to test H_3 and H_4. We designed a customized model based on the conceptual diagram showed in Figure 9.1. Two separate conditional process models were ran, using perceived affective image and conative image as the dependent variables, respectively. The device (VR HMD = 1; desktop PC = 0) was included as the independent variable; sensory stimulation and ease of imagination were the mediators. The scent manipulation was included as the moderator. Taking into account that the moderator was a multi-categorical variable, two dummy variables were created (W1: 1 = presence of scent, 0 = no scent; W2: 1 = pleasant + congruent scent; 0 = otherwise). The participants' previous experience with the destination, with 360-degree videos, and with VR, and their preferences for the types of tourism displayed on the videos, were included as covariates.

Table 9.2 shows the results of the analyses. First, the regression on sensory stimulation replicated the results of the ANOVA regarding the direct and interaction effects of the experimental treatments. In support of H_3, sensory stimulation positively influenced affective image (H_{3a}) and conative image (H_{3b}) (see Table 9.2).

Regarding H_4, the analysis revealed a direct impact of sensory stimulation on the ease of imagination. Ease of imagination had a significant, positive effect on affective image and conative image (see Table 9.2). Importantly, the bootstrap results for the indirect effects of the VR HMD on affective image and conative image, through sensory stimulation and ease of imagination, were significant for the three scent conditions, given that the zero value was not included in the 95% confidence intervals (see Table 9.2). The path VR HMD → sensory stimulation → ease of imagination → destination image was significant, thus supporting mediation and H_4. Interestingly, the index of moderated mediation of W2 (pleasant + congruent scent vs. otherwise) was significant for both affective image (*index* = 0.231, *95% bootstrap confidence interval with 5,000 samples*

[0.072, 0.418]) and conative image (*index* = 0.337, *95% bootstrap confidence interval* [0.101, 0.586]), revealing that the serial mediation was stronger when the scent was pleasant and congruent with the destination, compared to the other conditions.

Table 9.2. Results of the conditional process models on destination image

Predictor	Coeff.	SE	*t*	*p*	LLCI	ULCI
Sensory stimulation						
Constant	3.228	0.398	8.122	0.000	2.445	4.010
Device (VR HMD vs. desktop PC)	1.434	0.239	6.004	0.000	0.964	1.905
W1 (Scent: yes vs. no)	0.961	0.245	3.921	0.001	0.480	1.443
W2 (P+C aroma vs. otherwise)	-0.607	0.245	-2.896	0.014	-1.089	-0.123
Interaction: Device × W1	-0.162	0.342	-0.471	0.638	-0.836	0.513
Interaction: Device × W2	1.010	0.350	2.896	0.004	0.323	1.698
Prev. exp. destination	0.297	0.158	1.883	0.061	-0.014	0.607
Preference type of tourism	0.043	0.060	0.709	0.478	-0.076	0.160
Prev. exp. 360-degree videos	0.041	0.061	0.675	0.500	-0.078	0.161
Prev. exp. VR	-0.321	0.211	-1.518	0.130	-0.737	0.095
Model Summary	**$R^2 = 0.422; F_{(9, 253)} = 20.510, p < 0.001$**					
Ease of imagination						
Constant	1.705	0.363	4.700	0.000	0.991	2.420
Device (VR HMD vs. desktop PC)	0.124	0.150	0.868	0.392	-0.161	0.410
Sensory stimulation	0.523	0.050	10.557	0.000	0.426	0.621
Prev. exp. destination	0.028	0.132	0.215	0.832	-0.231	0.288
Preference type of tourism	0.163	0.051	3.215	0.002	0.063	0.263
Prev. exp. 360-degree videos	0.041	0.051	0.806	0.421	-0.059	0.142
Prev. exp. VR	0.138	0.178	0.774	0.439	-0.213	0.488
Model Summary	**$R^2 = 0.437; F_{(6, 256)} = 33.113, p < 0.001$**					
Affective image						
Constant	1.395	0.350	3.994	0.000	0.707	2.083
Device (VR HMD vs. desktop PC)	-0.140	0.134	-1.045	0.297	-0.404	0.124
Sensory stimulation	0.262	0.055	4.778	0.000	0.154	0.370
Ease of imagination	0.438	0.058	7.578	0.000	0.323	0.551
Prev. exp. destination	-0.171	0.122	-1.407	0.161	-0.411	0.069
Preference type of tourism	0.078	0.048	1.624	0.106	-0.017	0.172
Prev. exp. 360-degree videos	0.030	0.047	0.642	0.521	-0.063	0.124
Prev. exp. VR	-0.038	0.165	-0.232	0.817	-0.362	0.286
Model Summary	**$R^2 = 0.473; F_{(7, 255)} = 32.706, p < 0.001$**					

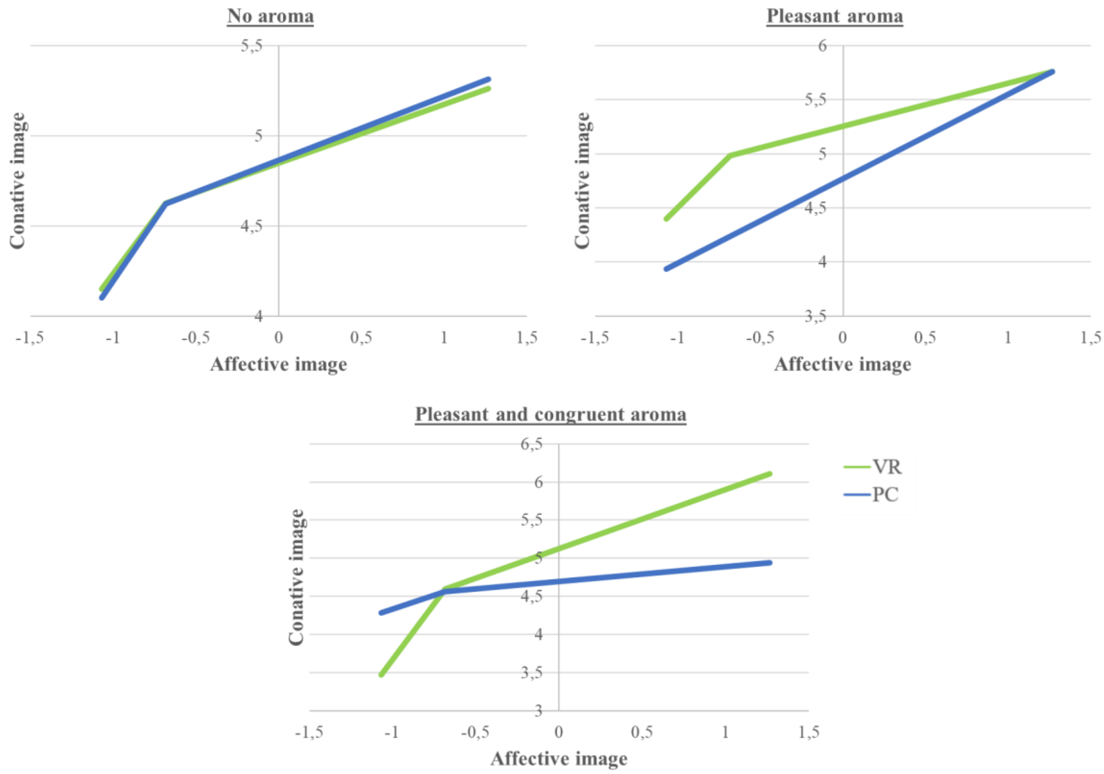
Conative image						
Constant	0.363	0.384	0.952	0.342	-0.390	1.121
Device (VR HMD vs. desktop PC)	-0.294	0.147	-1.999	0.047	-0.585	-0.004
Sensory stimulation	0.170	0.060	2.822	0.005	0.051	0.289
Ease of imagination	0.637	0.063	10.039	0.000	0.512	0.762
Prev. exp. destination	-0.182	0.134	-1.357	0.176	-0.445	0.082
Preference type of tourism	0.040	0.053	0.762	0.447	-0.064	0.144
Prev. exp. 360-degree videos	0.123	0.052	2.356	0.019	0.020	0.225
Prev. exp. VR	-0.316	0.181	-1.748	0.082	-0.672	0.040
Model Summary			**R^2 = 0.494; $F_{(7, 255)}$ = 35.564, p < 0.001**			

Bootstrap results for indirect effects	***Effect***	**BootSE**	**BootLLCI**	**BootULCI**
Device → Sensory stimulation → Ease of imagination → Affective image				
No scent	0.328	0.087	0.183	0.521
Pleasant scent	0.291	0.092	0.145	0.499
Pleasant + Congruent scent	0.523	0.110	0.334	0.762
Device → Sensory stimulation → Ease of imagination → Conative image				
No scent	0.478	0.115	0.280	0.721
Pleasant scent	0.424	0.124	0.216	0.702
Pleasant + Congruent scent	0.761	0.139	0.514	1.052

Note: n = 263. Confidence interval calculated at 95% significance. Bootstrap sample size = 5,000. BootLLCI: lower limit confidence interval; BootULCI: upper limit confidence interval.

To test H_5 (bottom of Figure 9.1) a moderation model was executed in which it was proposed that the relationship between affective and conative image was moderated by the two manipulations (Model 3; Hayes, 2018). After controlling for the effects of the covariates, the three-way interaction was significant (*coeff.* = 1.074, $t_{(247)}$ = 3.174, p < 0.01). Figure 9.3 shows the link between both destination images corresponding to the desktop PC vs. VR HMD scenarios in each of the three scent conditions. The relationship was stronger, and the differences between desktop PC and VR more evident, when the digital experience was accompanied by a congruent scent, compared to the other conditions. These results support H_5.

Figure 9.3. Embodiment × scent interaction on the link between affective and conative destination image



9.4. Discussion and implications

Table 9.3 shows a summary of the results obtained in the hypothesis testing. Embodied devices (VR HMDs) generate higher sensory stimulation than external devices (desktop PCs). The degree of integration between the device and the human senses may explain why VR technologies are able to deliver sensory information effectively (Flavián et al., 2019b). This finding further reinforces the utility of considering technological embodiment when analyzing the effects of VR on multisensory digital experiences. Pleasant ambient scents improve sensory stimulation, as the number of senses involved in the digital experience increases. Moreover, this study shows that the congruency between a pleasant scent and the displayed content can generate a better multisensory digital experience, compared to pleasant but non-congruent scents. This is in line with the theories of cognitive balance (Heider, 1958) and processing fluency (Herrmann et al., 2013; Schwarz, 2004), and with previous research about the effect of scents in offline consumption environments (see Roschk & Hosseinpour, 2020 for a review). We have extended this finding to digital experiences with VR technologies.

Table 9.3. Summary of the results

Hypothesis	Support
H_{1a}: Technological embodiment → (+) Sensory stimulation	Yes
H_{1b}: Pleasant ambient scent → (+) Sensory stimulation	Yes
H_{2}: Technological embodiment × Congruent ambient scent → Sensory stimulation	Yes
H_{3a}: Sensory stimulation → (+) Affective image	Yes
H_{3b}: Sensory stimulation → (+) Conative image	Yes
H_{4a}: Sensory stimulation → Ease of imagination → Affective image (mediation)	Yes
H_{4b}: Sensory stimulation → Ease of imagination → Conative image (mediation)	Yes
H_{5}: (Affective image → Conative image) × embodiment × congruent scent (moderation)	Yes

Furthermore, digital experiences with enhanced multisensory stimulation improve the affective and conative images of destinations. For a tourist destination, it is important to produce multisensory digital experiences that will generate positive affective and conative reactions (Flavián et al., 2019b, 2020; Ghosh & Sarkar, 2016). We found that ease of imagination mediates the impact of sensory stimulation on the affective and conative images of a destination. Embodied technologies stimulate the users' senses, and this stimulation helps them better imagine how the actual product or experience will turn out (Neuburger et al. 2019). The resulting mental representation favors affective and conative reactions toward the displayed environment (Bogicevic et al., 2019). These results reinforce the cognitive route that underlies VR experiences. Interestingly, these effects are strengthened by the presence of a congruent ambient scent. Therefore, the addition of a new sensory input (i.e. scent), especially if it is congruent with the content displayed, is important in the facilitation of the consumer's mental imagery process (Ghosh & Sarkar, 2016) and for generating positive outcomes in the digital experience. Nevertheless, it should be noted that the mediation was partial, and sensory stimulation still had a direct effect on destination image. Increasing sensory stimulation, in itself, influences users' affective and behavioral responses toward a destination (Ghosh & Sarkar, 2016).

Finally, in line with previous research (Agapito, Valle, et al., 2013; Hyun & O'Keefe, 2012), the results confirmed the positive effect between affective and conative destination image. When a VR experience is accompanied by a congruent ambient scent, compared to other devices (desktop PCs), or other olfactory cues (non-congruent scent, or no scent), the relationship between affective and conative images is significantly reinforced. Therefore, our findings show an additive effect of VR and congruent olfactory inputs in strengthening the link between the destination images in digital experiences. In this way, a persuasive sensory destination identity can be offered to potential tourists that can affect their subsequent affective and conative reactions (Agapito, 2020; Agapito, Mendes, et al., 2013).

9.4.1. Managerial implications

The findings of this study can help service providers generate effective multisensory digital experiences. Adding pleasant and congruent ambient scents that complement the audiovisual stimuli in VR promotes affective and behavioral reactions toward a destination. As previous research has noted, spraying scents is the simplest way to digitize them (Spence et al., 2017). Therefore, destination managers can use olfactory inputs to enhance the multisensory experience provided by VR. In this sense, ambient scents can be spread through ceramic diffusers as a non-invasive and ecological procedure (Serrano et al., 2016). Given the difficulty in generating vicarious experiences in tourism experiences (Tussyadiah, Wang, et al., 2018), combining congruent olfactory stimuli with VR may help create effective multisensory digital experiences. By firing the users' imagination, the gap between virtual and real-world experiences can be reduced, favoring affective and behavioral reactions. Special events (e.g. tourism fairs) and travel agencies may benefit from these findings and develop a competitive advantage by providing potential consumers with superior added value propositions. However, this is not a simple task. Using scents in closed, public spaces (e.g. exhibition centers, travel agencies) can be troublesome since the scents can be mixed with other odors in the environment; this may cause confusion in the user, who may not be able to differentiate between the odors. Also, the ventilation system of these spaces may spread out the scents into the whole environment, making users habituated to the scent before having the VR interaction and causing air contamination issues (Lai, 2015). A possible solution to address these challenges could be using an isolated cabin for the entire multisensory experience.

Similarly, tourism managers might use other sophisticated devices (e.g. Aroma Shooter, 2020; Olorama, 2020) to enhance the effectiveness of the olfactory stimuli in their VR experiences. The application of pleasant and congruent scents in multisensory VR experiences represents a new level in sensory stimulation for these nascent technologies. In line with previous findings in offline environments (Morrison et al., 2011; Spangenberg et al., 2005), digital experiences can also benefit from the application of multisensory stimuli, and appropriate scents can intensify the positive reactions that customers have in digital environments.

Nevertheless, if congruency is the key to the generation of better multisensory digital experiences, the question for managers is what represents a congruent scent for their specific service experience? Recently, Nespresso has launched a new line of coffee capsules inspired by Italian cities and landmarks (e.g. Ispirazione Venezia; Nespresso, 2020). Marriott International sprays scents matching the destinations offered in its travel program in the vicinity of advertisements displayed in public places (e.g. coconut aroma for Greece; MobileMarketing, 2020). Thus, if companies wish to use olfactory sensory inputs in their commercial offerings, to obtain the best results they should identify the scents congruent with their products. In a nutshell, although a pleasant scent can improve the multisensory digital experience, congruency is key to fostering positive customer reactions.

9.5. Limitations and future research lines

This study has several limitations that can be overcome by future studies (see chapter 11 for the overall limitations involved in all the empirical studies). First, a number of issues regarding the olfactory stimulation of the multisensory experience in the experiment have to be noted. This study has focused on the use of ambient scents, vaporized through simple and ecological devices (ceramic diffusers; Yanagida, 2012) in order to introduce the manipulation subtly and provide the participants with a natural, no-invasive experience. However, as previously mentioned, technological developments offer highly effective methods and devices to enrich the olfactory component of VR experiences (Ranasinghe et al., 2018). These methods allow users to interact with the odors in the virtual environment, being more reactive to the users' actions (e.g. coffee scent is vaporized when the user approaches a coffee machine; Dinh et al., 1999), can be focused on specific objects (e.g. fruits with different odors according to their shape; Mochizuki et al., 2004), and can prevent scent habituation (Ohtsu et al., 2009). Future research could investigate the comparative effects of these methods on the user's multisensory VR experiences. In addition, we have analyzed the positive side of pleasant scents, both congruent and non-congruent with the displayed content, in the digital experience. Future research should also explore the negative side of pleasantness and congruency. For instance, the consumer may encounter a situation in which a congruent scent may be unpleasant. In fact, the participants of the pre-test reported stagnant water from the canals as a scent associated with Venice (Appendix B). Thus, it would be interesting to compare the resulting multisensory digital experience with the same situation and a pleasant but non-congruent scent (e.g. vanilla).

In a similar vein, while this study has analyzed the pleasantness dimension of scents, future studies should incorporate the arousal dimension into the examination of olfactory stimulation on the multisensory digital experiences (Chebat & Michon, 2003; Maggioni et al., 2020; Roschk & Hosseinpour, 2020). Although the manipulation of both dimensions independently (pleasure and arousal) may be difficult to achieve (Spangenberg et al., 1996), it would be useful to keep congruity constant and compare whether a relaxing or an arousing aroma (e.g. lavender versus grapefruit; Mattila & Wirtz, 2001) influences the ease of imagination and destination images. Other characteristics of ambient scents, such as intensity (Chebat & Michon, 2003; Maggioni et al., 2020; Spangenberg et al., 1996), would also be worth investigating.

Finally, previous research has suggested that the stimulation of multiple senses may, in fact, have a detrimental effect on consumer experiences (Malhotra, 1984; Petit et al., 2019). Too much sensory stimulation may cause sensory overload and, thus, induce a negative experience in the customer (Malhotra, 1984; Petit et al., 2019). There is a dearth of research into sensory overload (Krishna, 2012), thus it would be interesting to examine the balance between different sensory stimuli; the results of this further research might provide superior experiences (Cowan & Ketron, 2019; Petit et al., 2019).

PART IV. CONCLUSIONS, IMPLICATIONS, LIMITATIONS AND FUTURE RESEARCH

10. Conclusions and implications

10.1. Introduction

The current wave of reality-virtuality technologies is changing the ways customers experience the real and virtual environments. Thanks to the development of the so called XR technologies, the boundaries between the physical and the virtual realms are blurring and integrating with each other at different levels. Immersive technologies are being increasingly implemented by companies for shaping customers' experiences. Recent years have witnessed a great development for these XR technologies, both in the devices (e.g. standalone devices which do not require being connected to a computer) and the contents launched which, together with a gradual decrease in the prices of the technology, have contributed to a large growth in the adoption of these XR technologies. In fact, these (and potential) advances that make these technologies more affordable to end users and the arrival of 5G support the expansion of the XR industry, which is forecasted to grow from USD7.9 billion in 2019 to USD136.9 billion in 2024 (IDC, 2020).

Specifically, AR and VR are revolutionizing the ways in which potential tourists perceive and experience tourism products and services (Loureiro et al., 2020), such as destinations, theme parks or cultural heritage sites (Wei, 2019). Immersive technologies can be especially useful in tourism settings, due to the intangibility and heterogeneity of this industry. These technologies act as innovative tools that improve the tourist experience throughout all the stages of their journey (Flavián et al., 2019a). For tourists, AR and VR can encourage their pre-travel curiosity and inspire them through the information provided, as well as provide them with valuable "try-before-you-buy" experiences (Neuburger et al., 2019; Tussyadiah, Wang, et al., 2018). These technologies can also be used in the on-site stage of the journey; visitors can get information or be entertained during their experiences (Chung et al., 2018; Neuburger et al., 2019). Finally, they can be used at the post-experience stage; tourists can record and share their experience with others, who may subsequently become inspired for their next trip (Neuburger et al., 2019).

The interest in this nascent area is evident from academia (MSI, 2020), practitioners (Deloitte, 2019), and even policy makers (Ministry of Economic Affairs and Digital Transformation, 2017). As a matter of fact, the literature review carried out in chapter 2 reveals that a large part of the research about AR and VR in tourism has been developed since 2018, which shows the importance and novelty of this research topic. Additionally, it is shown the evolution of the literature, which currently tends to analyze both AR and VR equally, evolving toward quantitative techniques (from initial exploratory analyses) and applying the research to a greater variety of tourism settings. However, the existing literature is currently under development, and there is a need for theoretical and empirical advances to fully understand the potential of AR and VR technologies to refine and redefine the customer experience.

Focusing on the tourist's pre-experience stage of the purchase journey as the research context, this doctoral thesis aims to analyze the cognitive, affective and behavioral dimensions of the users' experiences with AR and VR technologies. These technologies can be used to overcome the inherent features of tourism in the pre-experience stage (intangible service-based industry; Guttentag, 2010; Neuhofer et al., 2014). Their application at this stage prior to the purchase decision is relevant because immersive technologies provide potential tourists with rich and experiential information, allowing them to better evaluate the tourism product, which places them in an advantageous position to make appropriate decisions (Neuburger et al., 2019; Willems et al., 2019).

Next, the general research conclusions are presented, summarizing the main results of the empirical studies according to the research objectives. After that, the theoretical contributions of the dissertation are highlighted. Finally, recommendations for technological developers, services providers, and managers, are offered. Overall, the findings of this doctoral thesis may help researchers and practitioners to be conceptually consistent in their technological developments, which should be oriented toward the improvement of the customer experience.

10.2. General research conclusions

The first research objective of the dissertation is to set the conceptual boundaries that define the existing realities, examine how these realities affect the customer experience through the purchase journey, and to provide a framework based on different dimensions of HTI to classify the reality-virtuality technologies. Previous research has highlighted the inconsistencies in the conceptualization of the different realities (Jeon & Choi, 2009; Yung & Khoo-Lattimore, 2019). The misuse of the terms referring to the realities is also recurrent in the ICT industry (e.g. Windows Mixed Reality; PCWorld, 2017). In this way, chapter 3 has sought to overcome these terminological inconsistencies by developing a theoretical framework which delimits the features that distinguish the different realities. Taking Milgram and Kishino's (1994) reality-virtuality continuum as the basis, our aim has been to update this framework by considering the latest technological developments, and offer a uniform and accurate use of the terminology when referring to all the levels at which the real and the virtual environments are intertwined.

This refined continuum has been shown in Figure 3.2, and Table 3.2 has outlined the main features that define the different realities. As a summary, in real environments users are in a real setting interacting solely with real world elements, while in virtual environments, users are in a completely computer-generated world where they interact solely with virtual objects. Within virtual environments, VR is defined as an immersive environment generated by computers in which users can navigate and possibly interact. In-between real and virtual environments, we can find three different levels of real-digital integration: AR, which superimposes digital elements over the actual view of the user; augmented virtuality, which superimposes real elements over the virtual environment viewed by the user; and PMR, which merges reality and virtuality in such a way that both digital and real elements are totally integrated into the environment and interact between them.

This chapter has also addressed how these realities can be implemented throughout the different stages of the customer journey, particularly in the tourism industry. With this we have attempted to improve previous classifications regarding the application of ICTs to tourism experiences that only considered the extremes (real and virtual environments) of the reality-virtuality continuum (Neuhofer et al., 2014). In this way, it is emphasized the importance of defining the core experience, i.e. the basic, conventional experience in which technology is absent or plays a limited or secondary role. Once this core experience is identified, technologies related to the different realities can either support (directly and indirectly) or create a new experience (that empowers the core experience or leads to a diversion). We show examples of how to create technology-enhanced customer experiences using reality-virtuality technologies in order to offer memorable experiences with greater added value.

Finally, Chapter 4 has proposed a framework, the EPI Cube, which aims to classify all the existing and potential reality-virtuality technologies. This has been done by considering three dimensions that comprise the elements of HTI: a technological factor, a human factor, and a third element that arises from the interaction between the technological and the human elements. In this way, technological embodiment is defined as situations where the technology mediates users' experiences by becoming an extension of their human bodies, allowing them to interpret, perceive and interact with the surroundings (Ihde, 1990). In addition, perceptual presence refers to users' subjective sensation of being transported to a different environment (Biocca, 1997). Finally, behavioral interactivity is considered as the users' capacity to modify (the form and the content) and receive feedback to their actions (e.g. movements, voice commands) in the reality where an experience is taking place (Carrozzino & Bergamasco, 2010; Steuer 1992). This framework is suitable for classifying all the existing and potential reality-virtuality technologies according to their positions relative to the corresponding dimensions.

Considering the EPI Cube as the cornerstone of the dissertation, the second research objective has sought to empirically analyze the effects of the first dimension of the EPI Cube: the degree of technological embodiment. Despite its relevance, this variable has been barely considered by the previous literature about ICT implementation, particularly in tourism experiences with immersive technologies (Tussyadiah, Jung, et al., 2018). Therefore, all the empirical studies have analyzed, to a higher or a lesser extent, the impact of technological embodiment on potential tourists' digital pre-experiences with a tourism product (destinations and hotels). The results of these studies have confirmed that technological embodiment is an important variable to be considered for engaging and driving potential tourists' behavioral intentions.

Specifically, chapters 6 and 7 have examined the affective route that underlies the experiences with embodied technologies. We have considered the sensory stimulation and the emotional reactions derived from the use of embodied technologies, which serve to engage potential tourists and foster their behavioral intentions toward the tourism product. As for chapters 8 and 9, the results show the importance of technological embodiment in generating cognitive states (perceptions of visual appeal, ease of imagination) that lead to favorable behavioral responses.

The third research objective is to compare the effectiveness of AR and VR. To accomplish this goal, chapter 8 has considered the human dimension proposed in the EPI Cube (i.e. perceptual presence), together with technological embodiment. Given the lack of studies that individually analyze the effectiveness of devices and contents with AR and VR technologies (Li & Chen, 2019; Suh & Prophet, 2018), this chapter has compared them by analyzing the levels of technological embodiment provoked by different devices (HMD or smartphone), and the perceptions of presence elicited by different contents (realistic or digital). The different device-content configurations that lead to perceptions of visual appeal, ease of imagination, and behavioral intentions, have also been examined. The results of the analysis have confirmed the effects of different devices on technological embodiment, and have shown that realistic contents elicit higher presence than digital contents. Compared to digital content, viewing realistic content is perceived as more visually appealing, facilitates imaginations of the hotel experience, and fosters intentions to book in the hotel. In addition, visual appeal and ease of imagining mediate the impact of realistic content on hotel booking intentions. Interestingly, all these effects have been found to be stronger when embodied devices are applied. Thus, this research has confirmed that the use of VR HMDs along with realistic contents can generate better pre-experiences than other combinations of devices and contents.

With the fourth research objective, we try to contribute into one of the main challenges that are being currently faced in the field of HTI: the development of multisensory digital experiences (Petit et al., 2019). Most of the previous research on immersive technologies has focused mainly on audiovisual stimuli (Guttentag, 2010). However, real-world experiences are constructed by the stimulation of all our senses

(Citrin et al., 2003; Petit et al., 2019). The chapter 9 has explored how the addition of odors can improve VR experiences. Specifically, we have analyzed how the addition of ambient scent to experiences, with technologies varying in their levels of technological embodiment, influences the affective and conative responses toward a destination, and the role played by ease of imagination in this process. The results have confirmed that adding pleasant scents which are congruent with the destination strengthens the effects of embodied VR HMD experiences. Sensory stimulation is enhanced, which directly (and indirectly through ease of imagination) influence affective and behavioral reactions. Furthermore, these enriched multisensory experiences reinforce the link between the affective and conative destination images. The results have allowed us to take a step further toward the effective sensorialization of digital environments (Petit et al., 2019): the incorporation aromas, not only pleasant but also congruent with the content shown in the VR experience, is effective for improving digital pre-experiences in the tourism industry.

The last research objective is to examine the impact of immersive pre-experiences across different tourism settings. This objective has been addressed throughout the empirical analysis. Specifically, chapters 6 and 9 have used destinations as the research context. In the study carried out in chapter 6, the results have revealed that embodied VR devices can be more effective for promoting active tourism than passive tourism activities, since perceived immersion, sensory stimulation, and engagement, were favored. However, viewing passive tourism videos through low embodied devices may be, at the very least, equally as effective as using high embodied devices. In the study developed in chapter 9, we have found that there are aromas that are more easily identified and associated with certain destinations, compared to other aromas. In addition, chapters 7 and 8 have been focused on pre-experiences with hotels. Overall, the results in the hotel's context have replicated those obtained for destinations, especially regarding the validity of technological embodiment as a key construct in XR experiences and its influence on sensory stimulation, engagement, ease of imagination and behavioral intentions.

To sum up, this doctoral thesis offers a series of general conclusions regarding the impact of AR and VR in tourism pre-experiences. First, the role played by technological embodiment for engaging customers during their tourism pre-experiences should be highlighted. Importantly, sensory and emotional reactions need to be considered as mediating variables with this type of experiences, particularly when promoting behavioral intentions among potential tourists. According to Farah, Ramadan, and Harb (2019), the effectiveness of immersive technologies reaches its peak when the user is at an engagement state. Thus, it is necessary to appeal to the senses and emotions to foster potential tourists' behavioral intentions.

In addition, the cognitive states resulting from the customers' experiences with these technologies (perceived visual appeal of the contents, ease of imagining how the experience would be) are important to induce positive behavioral intentions. The use of VR HMDs accompanied by realistic contents has been proved to be the best device-content combination to generate better tourism pre-experiences. While implementing AR during the on-site stage of the customer journey can be effective (e.g. Chung et al., 2015), it may be less so for pre-experiences, in which the main focus of potential tourists is to gather information as close to the real experience as possible, in order to make the most appropriate decision (Gursoy et al., 2010; Gursoy & McCleary, 2004). For this purpose, VR better drives customers' behavioral intentions.

Finally, incorporating additional sensory inputs (i.e. olfactory stimuli) to a VR destination pre-experience can generate positive affective and conative reactions. To achieve this sensory enrichment, the input (i.e. ambient scent) has to be pleasant, but especially congruent with the content (destination) displayed. The higher the sensory stimulation, the easier the users' imagination about the destination, and the better the responses toward it. This multisensory experience also reinforces the link between the affective and the conative perceived images, leading attitudes to be stable and predictive of behavioral intentions.

10.3. Theoretical implications

This doctoral thesis offers a series of theoretical contributions that may be useful for obtaining a greater understanding of tourism pre-experiences with AR and VR technologies. First, the review of studies carried out in chapter 2 gives an overview of how the literature about this nascent research line has evolved over the past 25 years. Research goals, contexts, stages of the purchase journey, methods, and main findings are summarized. In the same way as this extensive review has allowed us to identify the research gaps that have been addressed in this dissertation, it could help researchers and practitioners to know the state of the art on the use of AR and VR in the tourism field.

Second, given the lack of consensus in the academic (Jeon & Choi, 2009) and managerial (PCWorld, 2017) fields about the conceptual boundaries between the different realities, the relevant literature is reviewed to clearly define and establish the boundaries between them, especially those that differentiate PMR from AR and augmented virtuality. The refinement of the reality-virtuality continuum (Milgram & Kishino, 1994) represents a key theoretical contribution of the dissertation (see chapter 3). Contrary to previous proposals, we note that all the realities are independent from each other and the main features that characterize them are outlined (see Table 3.2), so that all future technologies will fall into one or other of the categories of the proposed continuum of realities. In the same line, we extend Neuhofer et al. (2014)'s experience hierarchy framework by proposing how the different technologies associated to the realities can affect the customer experience along the purchase journey. Customer experience management is a hot topic in marketing research and practice (Lemon & Verhoef, 2016) and XR technologies can play a key role in adding value to the customer experience throughout the different stages of their journey.

The EPI Cube is the third theoretical contribution that dissertation offers. The EPI Cube aims at classifying all the existing (and potential) technologies based on these realities. The three axes of the cube stem from three main components of the HTI process (Dix, 2017): technological embodiment, perceptual presence, and behavioral interactivity. Technologies are placed along the different faces of, and inside, the cube, in accordance with their positions relative to the corresponding factors. In this doctoral thesis, we have empirically tested the role played by two of the dimensions of the EPI Cube, technological embodiment and perceptual presence, in the context of a tourism pre-experience with immersive technologies.

Fourth, the results of the empirical analysis stress the importance of considering the degree of technological embodiment in research on tourism digital pre-experiences, which has barely considered by previous literature (Tussyadiah, Jung, et al., 2018). Our studies have shown that highly embodied devices (VR HMDs) are able to enhance the perceptions and responses toward tourism products (destinations and hotels), compared to less embodied devices. Sensory stimulation and emotional reactions are important aspects to be considered for generating an affective route that leads to engage potential tourists and foster their behavioral intentions toward the tourism product after their immersive pre-experiences (chapters 6 and 7). Furthermore, the significant role of perceived visual appeal, and the ease of imagining how the actual experience would be, highlight the importance of considering the cognitive route to explain users' behavioral intentions after immersive pre-experiences (chapters 8 and 9).

The fifth theoretical contribution is related to the comparison between AR and VR in tourism digital pre-experiences, which has been overlooked by prior research (Kim, Lee, & Jung, 2020). This dissertation contributes to the previous literature by considering the impact of the content displayed and the device employed, whose combination can generate different XR experiences (Li & Chen, 2019). In addition, the empirical analysis has further validated the EPI by including the second dimension: perceptual presence. The results highlight the importance of displaying realistic contents, along with embodied devices (HMDs) to foster behavioral intentions in a hospitality setting. Thus, VR has been found to be more effective than AR for showing tourism pre-experiences.

Finally, this doctoral thesis contributes to the emerging literature on multisensory digital experiences with immersive technologies (e.g. Loureiro et al., 2020). Specifically, the addition of ambient scents to VR experiences can enhance the users' interaction with these technologies; however, previous literature has not yet agreed on what type of odors are the most effective (e.g. Baus et al., 2019; Baus & Bouchard, 2017; Hopf et al., 2020; Serrano et al., 2016). Following a congruency approach, we have shown that using pleasant scents, which are congruent with the destination displayed in the VR experience, can improve sensory stimulation and facilitate the users' imagination about how the real experience would be, which subsequently affect the affective and conative reactions toward a destination. The addition of pleasant and congruent scents to VR experiences can generate attitudes more stable and predictive of behavior. In a nutshell, the findings contribute to an effective sensorialization of the virtual environments (Petit et al., 2019).

10.4. Managerial implications

This doctoral thesis also offers several managerial implications. The updated version of the reality-virtuality continuum (see Figure 3.2 and Table 3.2) can serve to overcome the inconsistency in the use of the terms regarding the realities by practitioners. The launch of "Windows Mixed Reality", a HMD which immerse users into a completely computer-generated environment, allowing them to interact only with digital elements (main features of VR), illustrates that the ICT industry is confusing the terms referred to the realities (PCWorld, 2017). This dissertation makes a clear distinction between the realities, allowing companies to accurately name their products and describe the associated experiences.

In addition, we encourage managers and service providers to clearly identify the core experiences that are going to be enhanced with reality-virtuality technologies. This technological enhancement can be carried out in multiple ways: to support (directly or indirectly) or to empower the core experience by creating a new experience that can be related or unrelated to it. If service providers are capable of identifying the core experiences of their business, their technological investments to enhance these experiences will be better oriented. For instance, in the pre-purchase stage of the journey, the consumer may be interested in acquiring valuable information to make the best purchase decision; in this situation, using a diverted empowered experience may not be the best way of technologically enhancing his or her experience; however, a diverted empowered experience may be valuable to avoid unwanted circumstance that may occur in a purchase experience (e.g. to lessen the negative impact of waiting times).

Furthermore, the EPI Cube is a valuable tool that managers can use to choose the most suitable technology for their marketing strategy, design customer experiences, and thus achieve their strategic and business goals. For instance, if a company wants customers to be transported to another location but there is no need for them to manipulate the environment, they can employ technologies in Vertices 3 and 7 of the EPI Cube (e.g. VideoWall, VR HMD 360-degree video in a fixed position). The cube offers three dimensions that technological developers can take as a reference to focus their designs, depending on the technological capabilities and the core customer experience that needs to be enhanced.

Tourism managers should consider the degree of integration between the devices and the human senses (i.e. technological embodiment) when implementing their promotional actions. Using VR with embodied devices (HMDs) can boost potential tourists' engagement with the tourism products since the early stages of the purchase journey (pre-experience). The use of these embodied devices (VR HMDs), coupled with the growing interest from the general public (Greenlight, 2016), can be a source of competitive advantage for tourism companies. Travel agencies can also implement VR HMD experiences to better promote tourism products (e.g. travel to destinations, hotel bookings) as these technologies have been shown to be more effective in engaging and driving behavioral intentions than less embodied devices. In a similar way, booking websites (e.g. Booking, TripAdvisor) and the branded websites (e.g. destinations, hotels, restaurants) would benefit from incorporating 360-degree contents and encouraging tourists to use embodied devices as VR HMDs to view them, combined (or not) with textual reviews, so they can obtain better pre-experiences (Zeng et al., 2020). Special tourism events (e.g. fairs, exhibitions) would also generate richer and immersive experiences among the attendees by displaying promotional contents using VR HMDs.

Furthermore, if the use of embodied devices appears to be key, the kind of contents that are displayed seems, at the very least, equally important. Our results encourage tourism managers to use realistic contents, which can be more effective than digital contents, to provide potential tourists with powerful “try-before-you-buy” experiences that empower them to make the most suitable decisions. In this sense, 360-degree videos, a format that is increasingly popular, and is easier and cheaper to produce than other digital creations (Martínez-Navarro et al., 2019), take the potential tourist to the locations virtually, being a closer analogue to the real experience (Wagler & Hanus, 2018). Therefore, it is highly recommended that tourism companies use this format, accompanied by embodied devices (VR), to promote the pre-experiences with the tourism products.

Finally, we suggest that tourism managers should incorporate sensory stimuli into the provision of VR experiences. The sensory experience provided with embodied VR HMDs, mainly based on audiovisual stimuli (Guttentag, 2010), becomes even more powerful when it is complemented with other sensory stimuli (Neuburger et al., 2019). In this dissertation, we have considered the potential of ambient scents, which can be easily implemented to enrich VR experiences. However, managers should take into account that not every scent can be adequate for enhancing VR experiences; they need to design a multisensory experience in which all sensory stimuli complement each other (Martins et al., 2017). In particular, the use of pleasant scents, congruent with the content displayed, is recommended for the effective incorporation of olfactory stimuli in destination pre-experiences with VR. Practitioners should conduct studies to identify the aromas that are congruent with their tourism products to take a step forward the sensorialization of virtual environments, transmitting more effectively the sensory identity of their products (Agapito, 2020).

10.4.1. Implications for the development of local tourism (Aragón, Spain)

As previously noted, understanding the user's experiences with XR technologies is important not only for the academic and managerial perspectives, but also from a political standpoint. Specifically, the use of immersive technologies can be effective for the digitalization of services, and national, regional, and local governments are encouraging research projects and facilitating the conditions for the development of these technologies (CEOE, 2018). This commitment is especially important in regions where the services sector has a strong weight in the economy and the society. In this way, the tourism industry represents a strategic sector of great importance in the region of Aragón (Spain): 8% of the GDP and 10% of the employment depends directly on tourism (Aragón Turismo, 2020). Then, the results of this doctoral thesis can be useful for the development of added-value tourism propositions that generate interest and attract potential tourists to the region.

Specifically, Aragón can benefit from the results of this dissertation in four important ways. First, VR HMD experiences can be used to attract potential tourists. The immersive and sensory nature of these technologies may drive potential tourists' subsequent behaviors. Our results have shown that the use of these devices is especially effective for active tourism, featured by fast-paced activities which involve greater dynamism and energy. Considering the diversity of tourism typologies in the region (from cultural and heritage tourism to snow tourism, including other typologies such as gastronomic, adventure or nature tourism), our results can be beneficial to promote certain types of tourism (e.g. skiing in the Pyrenees, hiking in the Maestrazgo). Nevertheless, passive tourism activities (e.g. walking through the historic patrimony of Zaragoza) can also benefit from VR experiences, even with less embodied devices. Second, our results encourage public authorities to invest in the creation of high quality realistic contents

(360-degree videos), which will help potential visitors to better imagine the actual experience. In fact, the regional government has already made efforts in this direction by creating 360-degree content to showcase tourism experiences (e.g. Castle of Montearagón), so they should encourage potential tourists to view these contents using embodied VR HMDs to generate better pre-experiences. Third, when promoting the attractions of Aragón in special events and tourism fairs (e.g. Fitur in Madrid-Spain, ITB Berlin-Germany, IPW United States), effective multisensory experiences can be created by adding pleasant and congruent (with the content displayed) scents to VR experiences, what will result in better affective and conative reactions. Fourth, the accommodations of the region (e.g. hotels, holiday cottages) can benefit from showing their facilities through VR HMDs and realistic contents, obtaining a competitive advantage by providing powerful "try-before-you-buy" experiences.

11. Research limitations and future research lines

11.1. Introduction

The last chapter of this doctoral thesis is devoted to present the limitations and future research lines. First, the general limitations of the empirical studies are outlined, given that all the studies have followed similar techniques, designs, samples and procedures. This list of general limitations opens avenues for further studies. Second, an agenda for future research is proposed, which hopefully will stimulate research in this emerging area. Finally, considering the current pandemic (COVID-19) we are facing and its catastrophic sanitary, economic and social consequences, we explore how XR technologies can be helpful to cope with the situation, paying special attention to the tourism industry which is being severely affected.

11.2. General limitations and future research lines

The four empirical studies carried out in the doctoral thesis have a section with specific limitations and future research of each study. However, the research techniques and designs, the samples, and the procedures, were similar in all the studies. Therefore, this section outlines the general limitations derived from these methods, and suggests ideas for further studies to address them.

First, all the experimental studies were conducted in an artificial, laboratory setting. This method may overcome most of the limitations of one-off cross-sectional data from a survey research with no randomization, and lab experiments ensure a higher degree of control and internal validity than other types of experiments (Malhotra, 2004; Tabachnick & Fidell, 2007). However, future efforts should be made in order to increase external validity and thus the veracity and believability of our findings. One way of achieving this is through increasing the realism of the experiment (Morales, Amir & Lee, 2017). Field experiments, natural experiments and quasi-experiments, which are carried out in real settings with actual (or prospective) consumers have the potential to increase the external validity of the effects found in these studies. Another way of improving the veracity of the findings is to use behavioral measures, instead of self-reported measures, as dependent variables (Morales et al., 2017; Viglia & Dolnicar, 2020). Although this may be difficult to accomplish in some cases (e.g. ease of imagination), future studies may employ neuroscience techniques to capture the sensory stimulation of participants (e.g. eye tracking for visual stimulation) and ask about the participants' actual choice (involving some kind of trade off or real consequence) instead of just behavioral intentions.

Second, the studies used convenience samples of college students. As noted in chapter 5, student population is an interesting target group for this research context (Cognizant, 2019; Commscope, 2017) and it has been widely used in previous studies analyzing users' experiences with immersive technologies (Kang, 2020; Suh & Prophet, 2018). However, previous research has noted that socio-demographic characteristics (e.g. age, educational level) may influence attitudes and perceptions toward immersive experiences (Errichiello et al., 2019). Thus, future research should perform studies with representative samples (broader set of ages and profiles) to compare these results across different types of individuals and increase external validity.

Third, this doctoral thesis is focused on the technological and the human dimensions of the EPI Cube, namely technological embodiment and perceptual presence. The results show that embodied devices and presence-inducing contents are able to generate enhanced tourists' perceptions and responses after a digital pre-experience. However, the behavioral dimension of the EPI Cube, i.e. interactivity, has been kept constant at low levels in all the studies (Flavián et al., 2019a). Future research is needed to examine the role played by behavioral interactivity in tourism pre-experiences with immersive technologies, both individually and in combination with the rest of dimensions of the EPI Cube. In this, a holistic view of the impact of immersive technologies on the user experience will be provided.

Fourth, we have considered AR and VR to analyze tourism pre-experiences. The reason is that these technologies are increasingly adopted by users, particularly in the tourism industry (Wei, 2019). However, last years have witnessed the launch of PMR HMDs (e.g. Microsoft HoloLens 2, Magic Leap), in which users are placed in the real environment and digital contents are integrated into their actual surroundings. A full interaction between human, physical, and digital elements can be achieved (Flavián et al., 2019a). Although the adoption of PMR is still slow (mainly due to high costs and lack of contents, as it was the case with AR and VR), it is expected that this promising technology will have an important role in the future. Thus, following the EPI Cube and the hierarchy of technology-enhanced experiences, future research should analyze how PMR can be implemented for the enhancement of tourism experiences along the purchase journey, and compare their effects with other reality-virtuality technologies.

Fifth, the empirical studies have focused on the use of immersive technologies in the pre-experience stage of customer journey (Lemon & Verhoef, 2016). As these technologies can be applied to all the stages of the journey (Flavián et al., 2019a; Neuburger et al., 2019), it would be interesting to analyze the effects of these technologies in later stages (experience stage, post-experience stage) to obtain a global picture of how these technologies can be implemented throughout the customer journey to enhance the overall experience.

Finally, the immersive technologies tested in our studies have focused on the audiovisual stimulation, even though the last study incorporated olfactory stimuli to the VR experience. The choice of olfactory stimuli has been based on the fact that the integration of scents into VR experiences has been less considered than other sensory stimuli (see Table 9.1). In this way, future research should go a step further by including additional sensory inputs (e.g. tactile and gustatory stimuli) to empirically verify the effectiveness of providing multisensory digital experiences with immersive technologies (Martins et al., 2017).

11.3. Agenda for future research

This section provides an agenda with several questions, in different domains, with the aim of stimulating research in this hot topic. In this way, several research questions are formulated that are expected to be addressed in the future to advance in the current knowledge about the impact of reality-virtuality technologies in the customer experience.

The first set of questions refers to the different realities that have been established in chapter 3. Focusing on AR, PMR and VR, future research might address the following questions:

- Do customers perceive the integrated realities (e.g. AR, PMR) in the same way?
- What is the future of AR and PMR for driving customer behavior? Will augmented virtuality reach the same state of adoption as AR? What about PMR?
- How do the realities affect the customer's purchase journey? Are there any differences in the effectiveness of the realities depending on the stage of the customer's journey in which they are applied?
- In which industries are the realities more suitable? Which differences are there between industries that commercialize tangible or intangible products?

This doctoral thesis has analyzed the underlying processes that take place in customers' experiences with immersive technologies. However, due to the recent nature of the matter, there is room for additional research in this area, such as:

- What is the effect of behavioral interactivity in these experiences? Which dimension of the EPI Cube influences HTI processes the most? Are the influences context-dependent?
- What is the effect of social experiences on the use of these technologies? Does the sense of social presence enhance the experiences with these technologies?
- How do users' characteristics (e.g. previous experiences, demographic and personality variables) affect users' experiences with these technologies?
- What is the effect of the passage of time on the customer experience with these technologies? What is the effect of novelty in the experience?
- While we have mostly focused on the positive side of applying reality-virtuality technologies to experiences, how can negative experiences (e.g. motion sickness, security concerns) with these technologies affect the global customer experience?
- Taking into account the recent advances in Brain-Computer Interfaces (BCI) and nanotechnologies (e.g. Neurable), how can the addition of these elements alter AR and VR experiences? And what about the integration of AI (e.g. virtual personal assistants) in these experiences?
- How does the level of intrusiveness of embodied technologies affect their development and the customer's experience?

The tourism industry is the context in which this research is settled. Despite the increasing literature about the impact of AR and VR in this sector, there are several questions that remain unanswered. Specifically, the following research questions can be posed:

- How can these technologies be implemented to enhance customers' experiences in the food and beverage industry (e.g. restaurants)? Are these technologies suitable for offering festivals and concerts?

- How can immersive technologies be applied in meetings, incentives, conferences and exhibitions (MICE) tourism? Can these technologies replace MICE tourism?
- Is the implementation of these technologies effective while consumers are traveling (e.g. train, plane)?
- While most of the research has focused on tourism pre and on-site experiences, what is the effect of using these technologies in tourism post-experiences?
- Can immersive technologies be used as a first step toward the development of actual space tourism experiences?
- Are these technologies effective tools to stop overtourism?
- How can these technologies be applied to enhance the tourism experiences of individuals with mobility disabilities or other health conditions?

Finally, this dissertation has delved into the sensorialization of digital experiences. Specifically, immersive technologies are well positioned to further advance in this research line. However, there is a still a long way to go to generate digital multisensory experiences that resemble those of the real world. Thus, several questions are proposed to continue advancing in this research area:

- What is the role of tactile and gustatory stimulation in immersive experiences? What is the relative importance of the different sensory stimuli in immersive experiences?
- What kind of cross-modal effects between the sensory inputs (e.g. temperature and sound) are more effective to enhance immersive experiences?
- How accurate should the sensory stimuli added to the digital experiences be to generate similar effects to the real world experiences?
- Can sensory stimulation generate users' physical and/or mental overload? How would this affect the overall experience?

11.3.1. Future research line: AR and VR for the recovery of tourism in the age of COVID-19

The COVID-19 pandemic has generated an unprecedented global crisis which has severely impacted the political, social and economic systems (Gretzel et al. 2020). The tourism industry has not been immune to this crisis. In fact, it has been one of the most affected by this global pandemic. Citizens all around the world have witnessed travel restrictions, lockdown conditions, lock of the national borders and the shutdown of airports to prevent the spread of the virus (UNWTO, 2020). This pandemic has shown the vulnerability of the tourism industry (Gössling, Scott, & Hall, 2020), an industry in which the personal mobility, location connectivity and the possibility to access destinations are essential (Kwok & Koh, 2020). As a consequence, the tourism industry is projected to lose between $910 billion to $1.2 trillion, and 100-120 million direct jobs (UNWTO, 2020).

Despite this serious situation, both industry and academia are advocating for considering this crisis as an opportunity to transform the tourism sector (Sigala, 2020). Technological solutions are needed to overcome this situation and transform the industry (e.g. Gretzel et al. 2020; Sigala, 2020). AI, chatbots, robots, XR technologies, in-room technologies and digital payments are just some examples of these technologies (Sigala, 2020).

Specifically, the use of XR technologies can serve to redesign the tourist journey to overcome the current travel restrictions and guarantee the social distancing. While tourists will continue seeking diverse travel experiences to fulfill their desires of escapism and hedonism, companies should provide them with novel experiences for ensuring their current and future surveillance as a source of competitive advantage (Kwok & Koh, 2020). During the last months, users can access VR contents to get a preview of several tourism products (e.g. the museum VR tours provided by Google Arts & Culture). The use of VR has also established new opportunities for enjoying these products (e.g. Vappu Eve VR concert attracted 1.4 million viewers worldwide; Forbes, 2020). VR allows potential travelers to feel present elsewhere while being safe at home (Yung & Khoo-Lattimore, 2019). The results of this doctoral thesis stress that having a pre-view of a tourism product using VR HMDs can drive subsequent behavior. Thus, the use of this technology can engage them and foster their desire to actually visit the destination after the COVID-19 pandemic.

Furthermore, AR can also be implemented as a gamification tool during the visit to a destination or a museum, allowing travelers to see the different places while avoiding overcrowded areas at the main tourist attractions (e.g. Teruel GO). AR can also provide tourists with superimposed digital information over the real world to give extra information about the main tourist attractions, as if they were in a guided tour (tom Dieck & Jung, 2018), and can be used to avoid the risk of physical contact with menus in restaurants (e.g. Kabaq).

Therefore, the development and implementation of XR technologies in tourism can be accelerated in the COVID-19 era since these tools can be useful to cope with the sanitary and social distance conditions. XR technologies can offer tourists safer experiences by avoiding physical contact and overcrowded areas during their on-site tourism experiences. Finally, as this dissertation has shown, these technologies can provide potential tourists with enriched immersive pre-experiences, which may favor their visiting intentions once the pandemic is over, which hopefully will arrive sooner than later.

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Note: *The access to the websites included in this doctoral thesis has been guaranteed until October 2020.*

APPENDIX A. MEASUREMENTS

Appendix A.1. Measurements scales of Chapter 6

Please rate from 1 (strongly disagree) to 7 (strongly agree) the extent to which you agree with the following sentences / regarding your experience with (experimental condition; EC).

Technological innovativeness *(Bruner & Kumar, 2007; Thakur, Angriawan, & Summey, 2016)*			
I get a kick out of buying new high tech items before most other people know they exist.			
It is cool to be the first to own high tech products.			
I get a thrill out of being the first to purchase a high technology item.			
Being the first to buy new technology devices is very important to me.			
I want to own the newest technological products.			
When I see a new technology in the store (web), I often buy it because it is new.			
Technological embodiment *(own development)*			
The (EC) technology is nearly integrated into my body.			
The (EC) technology is in direct contact with my senses.			
The (EC) technology becomes part of my actions.			
The (EC) technology is an extension of my body.			
Immersion *(Fornerino, Helme-Guizon, & Gotteland, 2008)*			
The technology created a new world that suddenly disappeared at the end of the experience.			
During the experience with the technology, I was unaware of my real surroundings.			
The technology made me forget about the realities of the world outside.			
Sensory stimulation *(Witmer & Singer, 1998)*			
During the (EC) experience, the visual aspects of the virtual environment involve me.			
During the (EC) experience, the auditory aspects of the virtual environment involve me.			
During the (EC) experience, I was able to actively survey or search the environment using vision.			
During the (EC) experience, my sense of moving around inside the virtual environment was compelling.			
Engagement *(O'Brien, Cairns, & Hall, 2018; O'Brien & Toms, 2010)*			
I was absorbed in the (EC) experience.			
Using (EC) in the experience was worthwhile.			
My (EC) experience was rewarding.			
The time I spent using (EC) just slipped away.			
I felt interested in this (EC) experience.			
Behavioral intentions *(Bigné, Sánchez, & Sánchez, 2001; Huang, Backman, Backman, & Moore, 2013)*			
After the (EC) experience, I want to find out more information about the destination.			
After the (EC) experience, I will try to visit the destination in person in the future.			
Type of tourism			
I consider that this video is related to…	City tourism □	Nature tourism □	Sports tourism □
The approach of this video is… Passive 1 2 3 4 5 6 7 Active (lower leading role, more static) (higher leading role, more motion)			

Appendix A.2. Measurements scales of Chapter 7

The items for measuring the variable "technological innovativeness" can be found in Appendix A.1.

Please rate from 1 (strongly disagree) to 7 (strongly agree) the extent to which you agree with the following sentences regarding your hotel experience with (experimental condition; EC).

Technological embodiment *(Flavián, Ibáñez-Sánchez, & Orús, 2019b)*	
The (EC) technology is nearly integrated into my body.	
The (EC) technology becomes part of my actions.	
The (EC) technology is an extension of my body.	
Emotional reactions *(Bigné, Andreu, & Gnoth, 2005)*	
During the (EC) experience, I have felt…	
Disappointed (1)	Delighted (7)
Calm (1)	Excited (7)
Dissatisfied (1)	Very pleased (7)
Unaroused (1)	Aroused (7)
Psychological engagement *(O'Brien, Cairns, & Hall, 2018)*	
I lost myself in the (EC) experience.	
I was absorbed in the (EC) experience.	
The time I spent in the (EC) experience just slipped away.	
The (EC) experiences was attractive.	
The (EC) experience was aesthetically appealing.	
The (EC) experience appealed to my senses.	
Using the (EC) in the experience was worthwhile.	
My experience with the (EC) was rewarding.	
I felt interested in the (EC) experience	
Behavioral engagement *(Algesheimer, Dholakia, & Herrmann, 2005; Casaló, Flavián, & Ibáñez-Sánchez, 2017b)*	
After the (EC) experience, I would be willing to recommend the hotel to those planning to visit Venice.	
I would likely recommend the hotel to friends and relatives interested in vising Venice after the (EC) experience.	
I would seldom miss an opportunity to tell others interested in vising Venice about the hotel after the (EC) experience.	
I would probably say positive things about the hotel after the (EC) experience.	

Appendix A.3. Measurements scales of Chapter 8

The items for measuring the variable "technological innovativeness" can be found in Appendix A.1.

Indicate from 1 (strongly disagree) to 7 (strongly agree) the extent to which you agree with the following sentences regarding your hotel experience with (experimental condition; EC).

Technological embodiment *(Flavián, Ibáñez-Sánchez, & Orús, 2019b)*
The (EC) technology was nearly integrated into my body.
The (EC) technology became part of my actions.
The (EC) technology was an extension of my body.
Presence *(Slater, Usoh, & Steed, 1994; Usoh, Catena, Arman, & Slater, 2000)*
In the (EC) generated world, I had a sense of “being there”.
During the time of the (EC) experience, I often thought that I was actually in the virtual world.
There were times during the (EC) experience when I felt that the virtual world became my reality.
During the (EC) experience, I often thought that I was really standing in the virtual world.
Visual appeal *(Chung, Han,& Joun, 2015; Oh, Fiore, & Jeoung, 2007)*
The (EC) experience has generated an attractive environment.
The environment as seen in the (EC) experience is visually appealing.
The (EC) experience has generated an animated environment.
Ease of imagination *(Nowlis, Mandel, & McCabe, 2004; Orús, Gurrea, & Flavián, 2017)*
After the (EC) experience…
…, it is easy for me to imagine how the hotel would be.
…, it is easy for me to picture myself in the hotel.
…, it is easy for me to picture myself enjoying the hotel.
Intention to book the hotel room *(Casaló, Flavián, & Guinalíu, 2010; Chiang & Jang, 2007)*
After watching the content in the (EC)…
…, if I intended to visit the destination, my desire to book at this hotel would be high.
…, if I intended to visit the destination, the possibility of booking at this hotel would be high.
…, if I intended to visit the destination, it is likely that I would book at this hotel.

Appendix A.4. Measurements scales of Chapter 9

The items for measuring the variable "technological innovativeness" can be found in Appendix A.1.

Please rate from 1 (strongly disagree) to 7 (strongly agree) the extent to which you agree with the following sentences regarding your (destination) experience (experimental condition; EC).

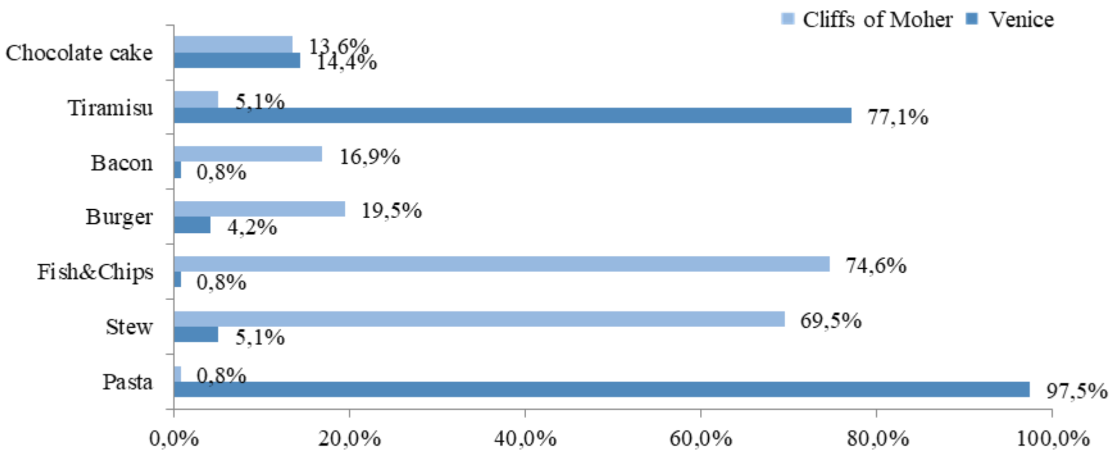
Technological embodiment *(Flavián, Ibáñez-Sánchez, & Orús, 2019b)*	
The (EC) technology is nearly integrated into my body.	
The (EC) technology is in direct contact with my senses.	
The (EC) technology becomes part of my actions.	
The (EC) technology is an extension of my body.	
Sensory stimulation *(Witmer & Singer, 1998*)	
During the (EC) experience, the visual aspects of the virtual environment involve me.	
During the (EC) experience, the auditory aspects of the virtual environment involve me.	
The (EC) experience has stimulated my sense of sight.	
The (EC) experience has stimulated my sense of hearing.	
During the (EC) experience, my senses have been activated.	
Ease of imagination *(Nowlis, Mandel, & McCabe, 2004; Orús, Gurrea, & Flavián, 2017)*	
After the (EC) experience…	
…, it is easy for me to imagine how the destination would be.	
…, it is easy for me to picture myself in the destination.	
…, it is easy for me to picture myself enjoying the destination.	
…, it is easy for me to fantasize about the destination.	
Affective destination image *(San Martín & Del Bosque, 2008)*	
The destination shown in the video is…	
Sleepy (1)	Arousing (7)
Gloomy (1)	Exciting (7)
Unpleasant (1)	Pleasant(7)
Conative destination image *(Bigné, Sánchez, & Sánchez, 2001)*	
After the (EC) experience, I want to find out more information about the destination.	
After the (EC) experience, I will try to visit the destination in person in the future.	
After the (EC) experience, I am willing to recommend the destination.	

APPENDIX B. PRE-TEST FOR CHAPTER 9

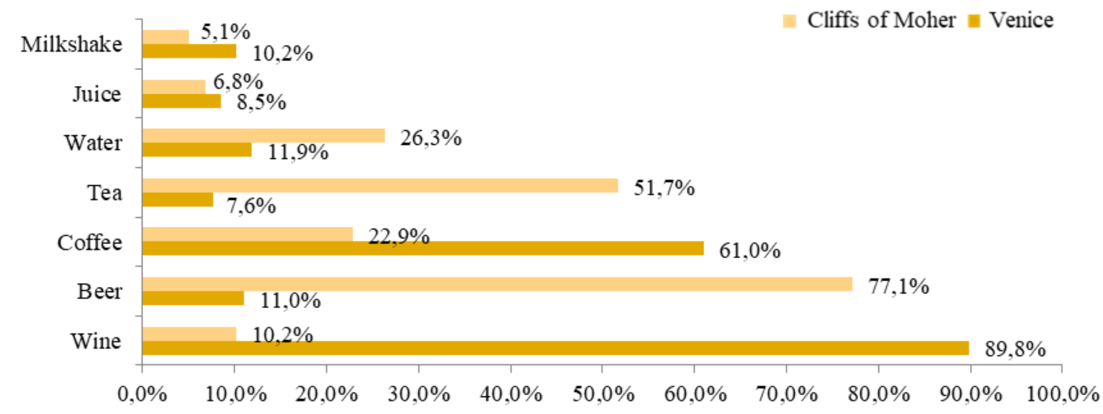
An online pre-test was conducted to ensure that the olfactory manipulations were appropriate for use in the main experiment of chapter 9. Participants (n = 118) were recruited through a market research agency. The characteristics of the sample were: 53.8% male, mean age = 23.72 (*standard deviation = 3.03*), and 55% possessed a college degree. Regarding their previous experiences with the destinations, 25.7% of participants had been to Venice, whereas 6.8% had visited the Cliffs of Moher. In addition, we asked the participants about their liking of coffee and nature in general, using a 7-point scale (from 1 = I don't like it at all, to 7 = I like it very much). The mean values were 5.17 for coffee (*std. dev. = 1.90*), and 6.15 for nature (*std. dev. = 0.90*). All these questions were asked at the end of the survey.

The survey contained several questions, using qualitative and quantitative approaches and different measurements (close-ended and open-ended questions). First, the participants were asked to associate different objects to either Venice or Cliffs of Moher. The objects were displayed in three categories: food, drinks and elements from the environment. Participants had to choose the two most representative objects for each destination in each category. The following graphs show the main results:

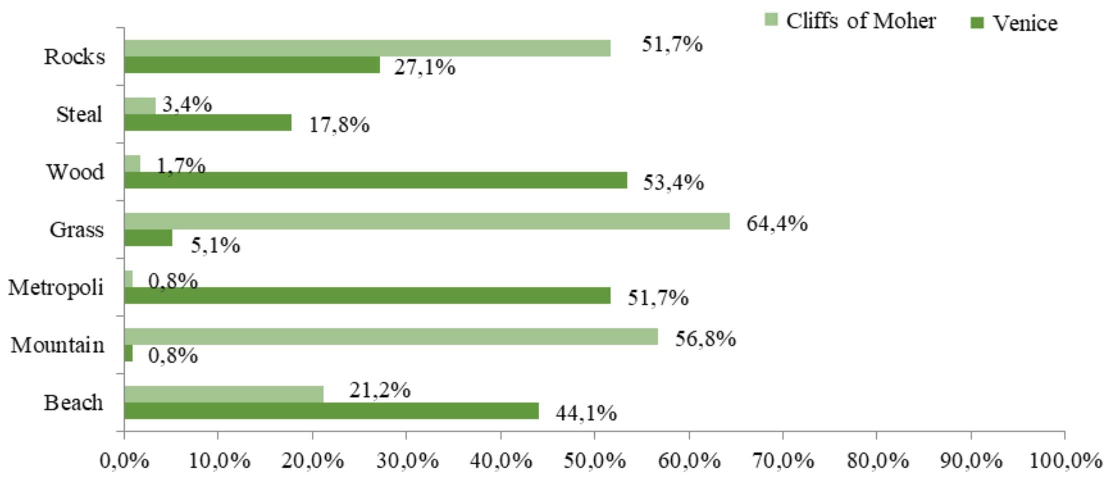
Foods



Drinks



Elements from the environment



The purpose of these questions was twofold: first, as ice-breaking questions so that the participant could start associating the destinations to different stimuli; second, as an initial check of the selection of the olfactory stimuli. As can be observed in the graphs, for Venice, wine was the most frequent answer, and coffee was the second most indicated (61% of the participants), on the contrary, beer was the most reported drink for Cliffs of Moher; interestingly, only 22.9% indicated coffee as a drink associated to Cliffs of Moher. Regarding the environmental elements, 64.4% of the participants associated grass to Cliffs of Moher (versus 5.1% to Venice).

Second, we carried out an apperception test based on a story. Specifically, the participants were randomly assigned to one of two imagined situations, in which they read a story about a trip to Venice (or Cliffs of Moher). The story was similar in both conditions, and only the destination was changed. The imagined situation was the following:

"It's 8 am. You just woke up. You are in Venice (Doolin, one of the closest villages to Cliffs of Moher). You arrived last night to enjoy a few days off after some weeks of hard work. When you move the curtains, you notice a wonderful day, with a shiny sun. You open the window, and a breath of fresh air with a pleasant scent gets into your room… you think: it smells so good! You cannot wait to start enjoying your trip."

After reading the description, we used an open-ended question to ask the participants: "what smell has come to your mind?". After refining the participants' answers, the following word clouds show the scents reported by the participants:

Venice

In the Venice vignette, 60 participants reported a total of 68 scents. As can be observed, coffee was the most reported aroma (21 times; 30.9%). Most of the responses were oriented toward breakfast-related scents (46 out of 68 responses were about coffee and food); scents related to water and the sea were also projected (16 out of 68). Very few participants (6 out of 68) imagined a scent related to nature (flowers, grass, fresh air).

Cliffs of Moher

The participants who read the Cliffs of Moher vignette (n = 58) reported a total of 75 scents. Several differences can be observed with regard to the Venice story. In this situation, grass was the most repeated word (28 times; 37.3%), and a total of 49 scents (out of 75) were related to nature (e.g. sea, fresh air, salt, humidity). Scents related to breakfast were also frequently reported (26 out of 75); however, in this case, coffee was cited only by one participant.

Therefore, both tests (closed options from a list and an open-ended, free association test) point out that coffee seems to be more related to Venice than to Cliffs of Moher, whereas grass appears to be more associated with Cliffs of Moher than with Venice.

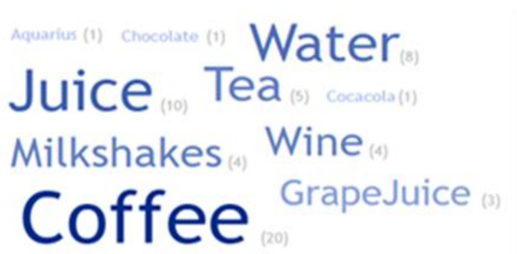
Third, we used projective techniques for participants to freely associate the destinations to different stimuli. The presentation was counterbalanced in a way that the participants who read the story about Venice answered to the projective techniques about Cliffs of Moher, and vice versa. The specific questions and the answers were as follows. The answers about Venice (n = 58) appear at the left side (blue), whereas those of Cliffs of Moher (n = 60) are displayed at the right side (green):

The first image that comes to my mind when I think about Venice/ Cliffs of Moher is…

The first scent that comes to my mind when I think about Venice/ Cliffs of Moher is…

The first taste that comes to my mind when I think about Venice/ Cliffs of Moher is…

The first non-alcoholic drink that comes to my mind when I think about Venice/ Cliffs of Moher is…



A pleasant smell that comes to my mind when I think about Venice/ Cliffs of Moher is…

An unpleasant smell that comes to my mind when I think about Venice/ Cliffs of Moher is…

Several interesting insights can be observed from these results. First, even though the first question (about the image) was an ice-breaker question, the participants' answers reassured us about the 360-degree videos chosen for the experiment. Second, regarding the specific questions about scents, the participants' answers reveal two important patterns: first, both destinations are associated with water-related scents. Thus, choosing one scent in this line (e.g. sea) would not have been useful to discriminate between congruent and non-congruent scents with each destination; second, water-related scents had both positive and negative meanings for the participants, especially in the case of Venice. As we looked for including an undoubtedly pleasant scent, water-related aromas seemed not to be the best choice. Third, scents related to the Italian gastronomy appeared to be the most related to Venice. However, this kind of scents was not available at the company's offer from which the scents were chosen. Moreover, displaying food-related scents could have induced an undesirable state in the participants of the experiment (e.g. hunger which may have led to anxiety and rush to finish the task). Fourth, even though the question about the non-alcoholic drink was somewhat forced, it was still found that coffee was much more related to Venice than to the Cliffs of Moher.

All these qualitative results were further confirmed quantitatively, using close-ended questions. On 7-point scales, all the participants rated the coffee and the grass scents in terms of pleasantness (unpleasant-pleasant, unlikable-likeable, irritating-delightful; Cronbach αs > 0.96). The average values were calculated to create a measure of pleasantness. The results of a one sample T test, taking the mid-point of the scale (4) as the reference value, showed that both coffee (M = 5.88, SD = 1.46; $t_{(116)}$ = 13.936; p < 0.001) and grass (M = 5.67, SD = 1.57; $t_{(116)}$ = 11.512; p < 0.001) were rated as pleasant scents. The difference between the aromas was not significant, according to a related samples T test (p = 0.280).

Finally, the participants assessed the degree of congruence between the scents and the destinations (Venice and Cliffs of Moher). We asked the participants to indicate, on 7-point semantic differential scales, to what extent each scent was more (1) related, (2) congruent, (3) fitted, and (4) appropriate, to each destination (1 = Venice, and 7 = Cliffs of Moher) (Cronbach αs > 0.94). The average values were calculated. The results of one sample t-tests, taking the mid-points of the scales (4) as reference values, showed that the coffee scent was significantly more congruent to Venice than to Cliffs of Moher (M = 2.57, SD = 1.61, $t_{(116)}$ = -9.606, p < 0.001), whereas the opposite was the case with the grass scent (M = 6.34, SD = 0.90, $t_{(116)}$ = 28.054, p < 0.001). Altogether, these results confirmed the suitability of the scents for the main experiment.