Exploring the Impact of VR and AR on Tourist Experiences: The Case of Ulldecona

Irene Pinto

Department of Law, Economics and Sociology, Magna Graecia University of Catanzaro, Viale Europa – 88100 Germaneto, Catanzaro, Italy, irene.pinto@studenti.unicz.it.

Department of Tourism and Geography, Rovira i Virgili University, Tarragona, C. Joanot Martorell, 15 – 43480 Vila-Seca, Tarragona, Spain, irene.pinto@estudiants.urv.cat

Phone number: +39 3463627118

ORCID: 0009-0007-2968-8936

Assumpció Huertas

Department of Communication Studies, Universitat Rovira i Virgili, Av. Catalunya, 35 43002 Tarragona, Spain, sunsi.huertas@urv.cat

ORCID: 0000-0001-6684-4220

Irene Pinto, PhD candidate at the "Magna Graecia" University of Catanzaro (Italy) in the Department of Economics, has spent one semester at Rovira i Virgili University, Tarragona (Spain), in the Department of Tourism and Geography. Her main research interests include the socio-economic implications of digital innovation in the field of cultural tourism in peripheral areas, with the objective of both innovating the tourism infrastructure and fostering community resilience in such areas.

Assumpció Huertas is a senior lecturer in Communication Studies at Rovira i Virgili University (Tarragona, Spain) and is member of the Asterisc research group at the same university. She teaches on the bachelor's degree in Communication; the master's degree in Strategic Communication, and on the master's degree in Tourism Destination Management (URV). Her lines of research focus on the communication of tourist destinations, social media analytics and smart destinations. She has participated in several research projects. She has published in impact journals and international books.

Abstract

Advanced technologies such as VR (virtual reality) and AR (augmented reality) applications are increasingly being implemented in the heritage and cultural tourism sector, providing visitors with immersive and engaging experiences. Taking into account the gaps in the literature concerning the topic, the objective of this study is to compare the impacts of AR and VR applications on the tourism experience in two different cultural sites, both located in Ulldecona, a peripheral city in the region of Catalonia (Spain), characterised by little accessibility and tourism: the cave paintings of the Abrics de la Ermita and the Mediaeval Castle. Utilising a qualitative real-world approach, the study combines a self-report method (post-visit interviews with visitors) and a non-self-report method (participant observation during visits). The study focuses on the cognitive, emotional and sensorial/physical impacts, capturing both positive and negative dimensions of the tourist experience. The findings emerged from the two different methods will then be compared. Notably, visitors' responses during interviews may not consistently match their sensorial and physical behaviours during the experience. The study contributes to a wider understanding of the role of advanced technologies in shaping tourist experiences, particularly in peripheral and less touristic destinations like Ulldecona.

Keywords: *virtual reality - augmented reality - heritage tourism - tourist experience - comparative study - participant observation*

1. INTRODUCTION

VR and AR applications have been widely implemented in the tourism sector (Fan, Jiang, & Deng, 2022; M. J. Kim, C. K. Lee, & Jung, 2020) transforming products, services and tourism destinations (Loureiro, Guerreiro & Ali, 2020). These immersive technologies provide added value to the tourism sector and modify tourism experiences (Bec et al., 2019; Jung, M. C. tom Dieck, H. Lee & Chung, 2016; Rainoldi et al., 2018; M. C. tom Dieck & Jung, 2018; Tussyadiah, 2014) allowing tourists a more dynamic and autonomous role (Flavián, Ibáñez-Sánchez & Orús, 2019).

VR and AR create powerful 3D interactive visual experiences (Yung & Khoo-Lattimore, 2017), stimulating visitors' senses and immersing them in the visit (Nayyar, Mahapatra, Le, & Suseendran, 2018). VR can be defined as a computer-generated three-dimensional environment that constructs a virtual world where users can navigate and interact (Guttentag, 2010). AR, however, is the enrichment of real environments using computer-generated voices, images, and other virtual data (Gaberli, 2019) by means of devices that generate a lower degree of immersion compared to VR (Yung & Khoo-Lattimore, 2017).

Destinations, attractions and tourism companies have adopted these technologies (Guttentag, 2010; M. C. tom Dieck, Jung and D.-I. Han, 2016; Tussyadiah, Jung & M. C. tom Dieck, 2017) to generate more interactive and diversified experiences for tourists and benefits for the sector as a whole (Jung et al., 2018).

These immersive technologies have been mostly developed in the field of heritage and cultural tourism, where tourists' experiences are particularly important (Bec et al., 2019; D.-I. Han, M. C. tom Dieck & Jung, 2018). Heritage tourism offers experiences that involve visiting places or reliving activities from the past, and these immersive technologies not only allow heritage to be preserved and managed, but also integrate history into heritage (Zhu, Io, Ngan & Peralta, 2023), engage with history at the heritage site, recreate the places or events as they were originally, and offer additional enriching information that renders places more attractive, entertaining and educational (Y.-L. Chang, Hou, Pan, Sung & K.-E. Chang, 2015; Yung & Khoo-Lattimore, 2017). All this increases the level of visitor immersion in the application experience (Jung et al., 2016), generates greater engagement and enriches the tourist experience (Bec et al., 2019; Mura, Tavakoli & Sharif, 2017).

Although most studies on VR and AR applications in heritage tourism highlight the advantages offered by these technologies such as the added value they bring to heritage sites and museums with more innovative, interactive and exciting information (M. C. tom Dieck et al., 2016; Yung & Khoo-Lattimore, 2017), some studies also show the limitations of these technologies, such as the effect of reducing the authenticity of the heritage site (Dueholm & Smed, 2014), or certain users' reluctance to use them (Bogicevic, Liu, Seo, Kandampully & Rudd, 2021).

Numerous academic studies examine the role of VR and AR as marketing tools to promote attractions and destinations (Huang, S. J. Backman, K. F. Backman & Moore, 2013; Li & Y. Chen, 2019) or users' acceptance and use of these technologies (Chung, H. Lee, S. J. Lee, & Koo, 2015; Huang et al., 2013; Huang, K. F. Backman, S. J. Backman & L. L. Chang, 2016; Li & Y. Chen, 2019).

However, there are still few empirical and theory-based studies on the tourist experience (Jung & M. C. tom Dieck, 2017; Jung et al., 2016; Tavakoli & Mura, 2015; Wei, Qi & Zhang, 2019) and consumer behaviour (Huang et al. 2016), especially with regard to VR applications (Bogicevic et al., 2021; Bogicevic, Seo, Kandampully, Liu & Rudd, 2019; Flavián, Ibáñez-Sánchez & Orús, 2021). Such studies often focus on AR or VR or treat the two technologies together, but there are hardly any studies that compare the experiences generated by the two technologies (Verhulst, Woods, Whittaker, Bennett & Dalton, 2021). In addition, there are practically no *real-world studies*, carried out with real visitors to the heritage site, without having been previously invited by the researchers to participate (Verhulst et al., 2021). Nor are there many studies that take into account the possible drawbacks or negative effects that these applications can generate (Dueholm, J. & Smed, 2014; Verhulst et al., 2021). Moreover, the vast majority of studies are quantitative and based on self-reports by the participants collected through questionnaires and analysed using quantitative methods (Disztinger, Schlögl & Groth, 2017; Jung et al., 2016; Tussyadiah, Jung & M. C. tom Dieck, 2018; Wei et al, 2019), while the real physical and sensorial impact of the applications has practically not been studied at all (Gaberli, 2019).

Taking all these shortcomings into account, the objective of this study is to compare the impacts of AR and VR applications on the tourist experience in a rather inaccessible peripheral area with scarce tourism, through a qualitative *real-world* study that compares the self-reports by the study participants with participant observation (PO) to verify whether what visitors express and value matches their sensorial and physical behaviour during the experience. In addition, it analyses the tourist experience in all its dimensions: cognitive, emotional, and physical/sensorial, taking into account both the positive and the negative effects that these applications can generate.

2. THEORETICAL FRAMEWORK

2.1 Impact of AR and VR technologies on the visitor experience

Although the tourist experience generated by VR and AR is still little researched (Jung & M. C. tom Dieck, 2017; Jung et al., 2016; Tavakoli & Mura, 2015; Wei et al., 2019) and the research that does exist sometimes even offers contradictory results (Fan et al., 2022), nowadays it is expanding, especially in the field of cultural tourism (D.-I. Han, M. C. tom Dieck & Jung, 2018). Some studies have focused on the impact of these technologies on the visitor experience (Falk, Ballantyne, Packer & Benckendorff, 2012; Ismagilova, Safiullin & Gafurov, 2015); others on the advantages and functionalities that these technologies provide to users (S. Li, Scott & Walters, 2015; Trunfio, Jung & Campana, 2022). Loureiro et al. (2020) compiled the existing literature on these immersive technologies in tourism in the last 20 years, although research dealing with the experiential impact is still limited.

Thus, studies on the tourist experience generated by AR and VR have focused on various effects of these technologies such as: attention, involvement, engagement (E. A. Boyle, Connolly, Hainey & J. M. Boyle, 2012; Leue, Jung & D. tom Dieck, 2015; Tscheu & Buhalis, 2016), learning and knowledge of history (Bec et al., 2019), enjoyment (Dey, Billinghurst, Lindeman & Swan, 2018; Haugstvedt & Krogstie, 2012; Huang et al., 2016; Leue et al., 2015; Leue, D. tom Dieck & Jung, 2014; Y. M. Li, Lai & C. W. Chen, 2011; Li & Y. Chen, 2019), perceived visual appeal (Marasco, Buonincontri, van Niekerk, Orlowski & Okumus, 2018), escaping reality and the routine (Jung et al., 2016), and mental imaginary about the experience (Bogicevic et al., 2019).

Regarding their effects on experiences, some studies analysed the perceived advantage (Jung et al., 2016; W. J. Lee & Y. H. Kim, 2021; Yu, S. Kim, Hailu, Park, & H.

Han, 2023), others, the perceived enjoyment, the satisfaction (Chung et al., 2018; González-Rodríguez, Díaz-Fernández & Pino-Mejías, 2020). Zhu et al. (2023) analysed the perceived authenticity generated by the two technologies, demonstrating their impact on the tourist experience and their positive influence on tourists' satisfaction and visit intention. Similarly, Bogicevic et al. (2019) and Flavián et al. (2021) showed that VR can generate a tourist experience even before arriving at the hotel, generating positive mental imaginary and an enhanced brand experience (Bogicevic et al., 2019), creating more positive emotional reactions and higher levels of psychological and behavioural engagement (Flavián et al., 2021). Yu et al. (2023) have also analysed the possible limitations of these technologies in the experience of senior tourists. Yersüren & Ózel (2023) showed that VR experience quality influences perceptions and visit intentions.

Some authors have created theoretical and conceptual models that take the tourist experience into account (Bec et al., 2019; Fan et al., 2022; Trunfio et al., 2022). Bec et al. (2019) created a conceptual model of heritage preservation and management through these new technologies, also aimed at promoting memorable tourist experiences. Trunfio et al. (2022) created a conceptual model to analyse the experience generated by MR (Mixed Realities) with six functional dimensions (format, information, customisation, usability, interaction and information saving) and five items to analyse the experience (heritage, valorisation, educational, entertainment, socialisation and escape). On the other hand, Fan et al. (2022) created a meta-analytical framework that includes all the previously analysed aspects of AR/VR applications and found that the type of simulation and social interaction positively moderate the effect of presence on the tourist experience. However, despite the expansion of the literature, there are still many gaps in the study of the tourist experience generated by these immersive technologies (Verhulst et al., 2021).

2.2 Detected gaps in the AR and VR visitor experience literature

Only in the last decade have studies begun to investigate the emotions generated by the tourist experience of these immersive technologies (Del Chiappa, Andreu & Gallarza, 2014; Errichiello, Micera, Atzeni & Del Chiappa, 2019; S. Li et al., 2015; Moyle et al., 2017; Prayag, Hosany & Odeh, 2013). Some have focused on the information, learning and emotions generated by these technologies (Falk et al., 2012; D.-I. Han, Weber, Bastiaansen, Mitas & Lub, 2018; Ismagilova et al., 2015). Taking into account various socio-demographic clusters, Errichiello et al. (2019) analysed the emotional responses of VR users and found significant differences between them. Some studies have highlighted the importance of observation and active experimentation, which affects emotions, but few take into account the impact on the overall experience (Flavián et al., 2019; Minocha, Tudor & Tilling, 2017). It is also observed that the majority of studies analyse the experience as a cognitive or emotional response to the use of these technologies during the trip, but do not take their sensorial and physical impact into account. For this reason, this study aims to analyse the overall tourist experience in all its dimensions: cognitive, emotional, and also physical/sensorial.

Furthermore, most studies on the impact of VR and AR on visitor experiences are quantitative, while there are very few qualitative, mixed methods and even fewer experiments (Jung, M. C. tom Dieck, Moorhouse & D. tom Dieck, 2017), and they are usually based on tourists self-reporting, through surveys (Disztinger et al., 2017; Jung et al., 2016; Tussyadiah et al., 2018; Wei et al., 2019). Very few have applied in-depth interviews (M. C. tom Dieck, Jung & Michopoulou, 2019) or focus groups (D.-I. Han, M. C. tom Dieck & Jung, 2018). It has been shown that a self-report methodology does not fully capture the sensorial and emotional dynamics of the users (Larsen & Fredrickson, 1999). For this reason, studies are beginning to emerge that can take the physiological aspects into account by applying

neuroscience and psychology techniques (Beck & Egger, 2018; J. Kim & Fesenmaier, 2015; J. Li et al., 2012; Marchiori, Niforatos & Preto, 2017). Along these lines, some studies analysed skin conductance responses (J. Kim & Fesenmaier, 2015) and others heart rate variability (Beck & Egger, 2018; Marchiori et al., 2017; J. Li et al., 2012). Studies on tourist experiences have recently begun to take into account the sensorial impacts along with the cognitive and emotional ones (Gaberli, 2019; M. J. Kim et al., 2020; T. Li & Y. Chen, 2019); however, they are still in a very incipient stage. Therefore, this qualitative study aims to analyse the sensorial aspects of the experience by comparing the self-report resulting from in-depth interviews with PO.

AR and VR are different technologies. While VR provides visitors with a real experience of illusion in the virtual world, AR creates the illusion of virtual elements in the real environment (Fan et al., 2022). But although the experiences created differ from each other (Yu et al., 2023), there are practically no comparative studies between them (Verhulst et al., 2021). In fact, many studies analyse the experience generated by these technologies together (Trunfio et al., 2022) denominated with inclusive concepts such as Mixed Reality (MR) (Fenu & Pittarello, 2018; Flavián et al., 2019; Trunfio et al., 2022), Augmented Virtuality (Gaberli, 2019), or Virtual Exhibition (VE) (Pervolarakis et al., 2023) technologies, defined as a variety of technological solutions with different interactions and immersive styles.

Considering the few existing comparative studies, Aslan, Dang, Petrak, Dietz & André (2019) compare the experience generated between different AR devices, and Loizides, El Kater, Terlikas, Lanitis & Michael (2014) between different types of VR. Voit, Mayer, Schwind & Henze (2019) found that AR generates less immersion than VR. On the other hand, Verhulst et al. (2021) later managed to compare the two technologies at the same tourist attraction (i.e., a gallery in Verona). They analysed enjoyment, presence, cognitive, emotional and behavioural engagement through a survey (self-report). They also analysed the negative emotions generated by these applications, such as nausea or feelings of discomfort. They found enjoyment to be present in both technologies, although more so in VR, because it is more immersive (Voit et al., 2019). On the other hand, Verhulst et al. (2021) found a low number of reported negative effects in the two applications, demonstrating that both VR and AR create overall positive visitor experiences.

Thus, there is a lack of comparative studies between the experiences generated by AR and VR (Yu et al., 2023), a lack of real-world studies (Verhulst et al., 2021), and a lack of qualitative studies that also analyse the possible drawbacks generated by these technologies (Suh & Prophet, 2018; Verhulst et al., 2021). For all of the above, this study analyses the differences between VR and AR through a real-world study, carried out with the visitors who visited the attractions analysed that same day, taking into account both the positive and negative effects generated and comparing the qualitative self-report with PO.

3. METHODOLOGY

3.1 Territorial context of Ulldecona and two innovative tourist experiences

The two tourist experiences take place in Ulldecona, a small town in the province of Tarragona, in the south of Catalonia. Its population is 6,241 and is currently decreasing (Idescat, 2023). One of the main weaknesses that emerged from the fieldwork is the scarcity of public transport linking the town to the rest of the region. Ulldecona's area of influence has always marked a political-administrative, socio-economic and cultural frontier between Catalonia and the Valencian Community. This feature of the town, together with its distance from regional centres and from the capital, as well as being rural and small-sized, are some of

the typical characteristics of European inner peripheries (Servillo, Russo, Barbera & Carrosio, 2014). However, to counteract Ulldecona's marginal status, the municipality has been able to exploit the rich heritage present in the town by making use of VR and AR technologies to transform the area into a more attractive place for its inhabitants and for tourists.

The study analyses two heritage sites that have applied VR and AR to enhance tourist experiences and raise cultural awareness among local inhabitants. The first is the cave paintings of the Abrics de la Ermita, depicting the first signs of human settlement in the area, a UNESCO World Heritage Site since 1998, consisting of a series of thirteen shelters that make up the most important group of Levantine-style paintings in Catalonia. Since 2013, thanks to a preventive conservation scheme using 3D scanning techniques, the municipality developed an AR initiative for visitors, through a downloadable app, the official website and, today, via a tablet held by the guides during the visit that includes more detailed information.

The second is the mediaeval castle, another major piece of Ulldecona's heritage. Its origins date back to the 12th century and it currently consists of two towers, a 16th-century church, the remains of some demolished buildings and a perimeter wall. In recent years, some restoration works brought to light architectural remains from different eras. From these findings and from recent developments of 3D scanning, the municipality developed the idea of a non-standard museum inside the castle, namely a virtual reality (VR) tour. The objective was to build an immersive experience through 3D glasses consisting of a virtual exploration of all the different historical epochs through five different perspectives.

These experiences provide an alternative language to communicate cultural heritage and contribute to making the latter more attractive and accessible to a larger audience, increasing both the local community's awareness and appreciation of its local area and the tourist attractiveness of the area.

Although the AR and VR applications analysed were applied to different heritage elements, the collection of data from the two experiences allowed us to compare the results and observe similarities and differences between the two technologies.

3.2 Research approach, data collection and analytical methods

This study aims to examine AR and VR experiences and compare their positive and negative cognitive, emotional and sensorial/physical impacts on visitors. Given the scarcity of qualitative studies in the literature about AR and VR tourist experiences (Verhulst et al., 2021), qualitative methods were selected. Moreover, due to the complex and fragmentary nature of these social and tourism-related technologies, a qualitative approach seemed more appropriate than a quantitative one (Walle, 1997) for exploring and attributing meaning, in-depth understanding and description (Geertz, 1973), to avoid generalising while implying a high level of reflexivity.

More specifically, we used a non-self-report method, namely PO during the visit, and a self-report, consisting of in-depth interviews. The fieldwork helped us become more familiar with the main project stakeholders, the geographic context and the local community. It consisted of two full days spent in the town during which the researcher had the opportunity to conduct PO during the visit, and to hold in-depth interviews with the person in charge of Ulldecona's heritage and the visitors present on the day, after their visit. The data collected from the interviews were then compared with those of PO, to see if what was reported by the users coincided with what was observed.

Participant observation during the visit

PO allows developing a holistic understanding of the phenomena analysed and also to capture users' physical and sensorial reactions to the experience that may not be reported by them (Musante & DeWalt, 2010). While participating in the collective visit of that day, the researcher openly informed the visitors of the two experiences of her role, explaining that the purpose was to fully understand the cognitive, emotional and sensorial/physical impacts that these experiences would arouse in them. It should also be mentioned that the subjects were complete strangers to the researcher and did not have any previous knowledge of the study. Indeed, the purpose was to carry out a real-world observation that had not been prepared in advance. Furthermore, it should be noted that generally visits are very few and sporadic. This also explains the low number of visitors participating in the visit and, hence, the number of interviews conducted.

Throughout the PO work, we focused on studying, observing and discovering the interaction and perceptions of the visitors towards the object of study. More specifically, the researcher focused, in both visits, on their facial expressions, their comments and their (conscious and unconscious) physical movements and, in the VR experience, the time during which they wore the VR glasses and their balance while wearing them and walking. The visitors' experiences were videorecorded in order to complement the researcher's on-site observation with subsequent observations.

In-depth interviews post-visit

In-depth interviews allow extending the findings of the observation, maximising understanding and meaning while capturing the subjective sensations and emotions reported by the interviewees. This method is suitable for our research purpose as it is a flexible process based on open questions that generate rich information (Olabuènaga & Ispizua, 1989).

The interview with the person responsible for Ulldecona's heritage was used as a major source of information and for creating a storyline of the development of the two projects over time. The interviews with the visitors aimed to explore the cognitive, emotional and sensorial impact that the two technological attractions had on them. Before the observation, all visitors present (three for AR and seven for VR) were asked if they would mind participating in a short interview after the visit. Some socio-demographic details were asked of them (age, place of origin, profession), to which they all consented. The following Table shows the profiles of the visitors interviewed for each experience.

Table 1: Description of the interviewees of the experiences

	Interviewees	Gender	Age	Origin	Profession
AR	1	Woman	27	Italy (living in Tarragona)	Student
	2	Man	27	UK (living in Tarragona)	Student
	3	Man	74	Almeria (living near Tortosa)	Retired
VR	1	Woman	55	Vinaros	Administrative personnel
	2	Woman	55	Ulldecona	Graphic designer
	3	Woman	61	Ulldecona	Housekeeper
	4	Man	57	Ulldecona	Factory worker
	5	Man	57	Ulldecona	Ambulance driver (retired)
	6	Man	57	Vinaros	Welder
	7	Woman	27	Italy (living in Tarragona)	Student

The researcher also asked each participant which means of transport they had used to get to the site and, in case they came from outside Ulldecona, whether they were staying in

the town for more than one day. Then some questions were asked about their degree of competence with new technologies and their use of social media (SM). More specific questions on the experiences were asked in order to investigate their cognitive effects. They were asked if they liked the experiences, if the applications were easy to use, if they transported them to ancient places, if they increased their knowledge about Ulldecona's history, if they showed what the heritage was really like, if they promoted the Ulldecona brand, if the experiences were attractions in themselves and if they were worth seeing, if they would recommend them to others, and if the experiences contributed to fostering an image of Ulldecona as a smart destination.

The interviewees were finally asked to rate their experience from 0 to 5 in certain aspects related to their physical/sensorial and emotional reactions to the two experiences. More specifically, among the positive effects, we asked the interviewees, for each experience, to assess (on a scale from 0 to 5), the degree of "excitement", "satisfaction", "diversion", "amusement", "adrenaline rush", "curiosity", "fear", "dizziness", "vertigo/instability", "restlessness", and "distrust", thus including both positive and negative reactions.

The combination of PO with in-depth interviews sets this study apart from other previous ones, the majority of which are based solely on self-report methods (questionnaires or interviews). It should be noted that the interviewees are either not always aware of their emotional reactions or are not willing to recognise the negative part of their reactions to these innovative experiences. Moreover, while other studies have investigated the knowledge generated by such experiences and their added value (Y.-L. Chang et al., 2015; Yung & Khoo-Lattimore, 2017; Bec et al., 2019; M. C. tom Dieck & Jung, 2018) and, in some cases, their emotional impact (Errichiello et al., 2019; Flavián et al., 2021), this article, in addition to all these aspects, delves further, within the emotional sphere, also into the physical and sensorial aspects generated by this experience, obtained from the visitors' ratings and the researcher/observer's assessment. Moreover, in order to increase the validity of the research results, on the one hand, we used a double-edged method, including PO and in-depth interviews, and on the other, we carried out a comparative study between two different technological experiences at the same destination.

4. RESULTS

The first part of the in-depth interviews with the participants focused on gathering practical information on means of transport used, the number of days spent in the town and visitors' awareness of the virtual experiences before their visit. The results are summarised in the following Table.

Table 2: Practical information about the participants' experience and their degree of familiarity with new technologies

	Interviewees	Transport	One day/overnight	Specifically there for AR/VR	How they learned about the experience	Familiarity with new technologies	SM accounts	Time per day in SM
AR	1	car	2 days (overnight)	Yes	University	Quite familiar	Yes (Instagram, Fb and LinkedIn)	1.5 hours
	2	car	2 days (overnight)	Yes	Wordofmouth	Quite familiar	Fb, Twitter, LinkedIn, Snapchat	10 min
	3	car	1 day	No		Quite familiar for his age	Fb	10 min
VR	1	car	1 day	Yes	Draw of Ulldecona radio	A little	Fb and Instagram	1.5 hours
	2	car	1 day	Yes	Wordofmouth	A little	No	-
	3	car	1 day	Yes	Wordofmouth	Relatively familiar	Instagram	30 min

4	car	1 day	Yes	Draw of Ulldecona radio	Not very familiar	Fb and Instagram	More than 2 hours	
5	car	1 day	Yes	Wordofmouth	Not familiar at all	Instagram	More than 2 hours	
6	car	1 day	Yes	Wordofmouth	Very little	No	More than 2 hours	
7	car	1 day	Yes	University	Quite familiar	Yes (Instagram, Fb and LinkedIn)	1.5 hours	

Table 2 reveals that the majority of respondents had gone to Ulldecona by car just for one day and, as can be seen, they live in nearby areas or came from Ulldecona itself (all respondents came from Catalonia). Only the two 27-year-old students spent a night in a rural house in the Ebro Delta, taking advantage to visit the surrounding area. Almost all participants came specifically for the visit (either AR or VR). The only one who was not aware of the technological experience was the 74 year-old man visiting the rupestrian paintings. He merely stated that having already visited other rupestrian art paintings in Valladolid, he was curious to see other similar ones.

The first investigation concerned the visitors' degree of familiarity with new technologies, the results of which are varied. The two 27-year-old visitors said they are quite familiar with new technologies, the 74-year-old man also considered himself familiar for his age. All other respondents, ranging from 55 to 61 years of age, considered themselves from "a little familiar" to "not familiar at all". All respondents, apart from the welder, said they had at least one SM account, but the amount of time spent on SM varied from 10 minutes per day to more than two hours.

We also investigated how they became aware of the two experiences and the answers were very diverse. One student learned about both experiences in the academic environment, while her friend learned about the AR experience through word of mouth. The retired gentleman, as mentioned, went to Abrics de l'Ermita just to visit the rupestrian art and was not aware of the AR experience, which ended up providing added value to his experience. As for the VR participants, all six (apart from the student) were couples. One couple (from Vinaròs) learned about the VR experience thanks to a draw on Radio Ulldecona that they won and allowed them to get free tickets for the castle's virtual experience. The other two couples, from Ulldecona, heard about the experience through word of mouth and were curious to see how the castle had been restored (they remembered visiting it many years before the restoration works).

The interview continued with more specific questions to find out about their cognitive reaction to the two experiences. The results gathered were then complemented with PO carried out by the researcher during both visits. This dual approach allowed us to compare the answers given by the participants with their live reaction to the experiences observed by the researcher. As a result, we were able to provide a more reliable framework of visitors' reactions and feedback to such experiences. The results are reported in the following table. The differences observed between the interview and PO are highlighted in yellow in the Table.

Table 3: Summarised results of cognitive reactions to the experiences and PO (cognitive reaction)

	Interviewees	Did you understand how the devices work?		What did you like the most?		Did the experience transport you to the place?		Did this experience increase your knowledge of Ulldecona's history?	
		Interview	**PO**	**Interview**	**PO**	**Interview**	**PO**	**Interview**	**PO**
AR	1	Yes	Partially	Landscape	Confirmed	Yes	A little	Yes	Yes
	2	Yes	Yes	Landscape	Confirmed	Yes	A little	Yes	Yes
	3	Yes	Yes	Paintings	Confirmed	Yes	A little	Yes	Yes
VR	1	Yes	No	Everything	Confirmed	Yes	Yes	Yes	A little

	2	Yes	No	Everything	Confirmed	Yes	Yes	Yes	A little
	3	Yes	No	Everything	Confirmed	Yes	Yes	Yes	A little
	4	Yes	No	History of the castle	Confirmed	Yes	Yes	Yes	A little
	5	Yes	No	Everything	Confirmed	Yes	No	Yes	A little
	6	Yes	No	Everything	Confirmed	Yes	Yes	Yes	A little
	7	Yes	No	View	Confirmed	Yes	Yes	Yes	A little

	Interviewees	Did the experience show you how the paintings / castle were for real?	Was the experience helpful to communicate the Ulldecona brand?	Was the experience an attraction in itself? Was it worth the visit? Would you recommend it?	Does the experience foster the image of Ulldecona as a smart destination?
		Interview	Interview	Interview	Interview
AR	1	Yes	Partially	Yes	Yes
	2	Yes	Partially	Partially	Yes
	3	Yes	Yes	Yes	Yes
VR	1	Yes	Yes	Yes	Yes
	2	Yes	Yes	Yes	Yes
	3	Yes	Yes	Yes	Yes
	4	Yes	Yes	Yes	Yes
	5	Yes	Yes	Yes	Yes
	6	Yes	Yes	Yes	Yes
	7	Yes	Partially	Yes	Yes

The first question concerned the ease of understanding the functioning of the technological equipment, that is the tablet (held by the guide) for AR, and 3D glasses for VR. Regarding AR, all three participants reported finding the device easy to understand, due to the good support and explanation provided by the guide on site. PO, in this case, confirmed the very precise explanations of the guide, but one visitor was more interested in seeing the result of the 3D scanning technology rather than fully understanding its mechanism, which was explained carefully but in rather a technical manner. In this case, the technological tool was not considered an attraction in itself but rather as a tool to access the digital representation of the paintings. As for VR, all visitors said that they found the functioning of their glasses easy to understand. However, upon observation, it was noted that the guide helped them repeatedly to wear the glasses properly and to select the suitable information using the remote control. Here we found the first noticeable difference between the interviewees' answers and how they actually behaved.

The participants were then asked what they liked most about the experiences. AR respondents focused on the nature and landscapes around them and on the opportunity of imagining the storyline (the two students) and on the discovery of ancient rupestrian art (the 74-year-old man). VR respondents said that they liked everything instinctively. Additionally, the 27-year-old woman reported having particularly enjoyed the view from the highest tower and the possibility to compare it to the VR view. A man from Ulldecona also added that he enjoyed learning more about the history of the castle that he had always seen throughout his life. All these answers were confirmed by PO, which verified the general enjoyment of the whole experience.

The participants were then asked whether they had felt transported to the ancient places. They all answered that they were easily transported through both AR and VR experiences. However, from accurate observation it was apparent that AR, being less immersive than VR, did not literally transport participants to the place, rather it focused on recognising (in a playful game) the figures painted on the walls that had been shown to them on the tablet. However, the story concerning the surrounding landscape, told by the guide, helped make the experience more evocative and exciting. VR, however, is more immersive by nature, and we observed a high degree of involvement of almost all participants who seemed to have been literally transported to the original place. Only one participant did not allow himself to be 'transported' to the ancient castle, as he was continuously putting on and taking off his glasses.

The participants were also asked whether the experiences helped them increase their knowledge of the history of Ulldecona, and they all answered affirmatively. Observation

11

confirmed that AR, probably due to its lower degree of immersivity and its higher contact with reality, helped the visitors increase their knowledge about the place. VR was rather a separate experience that estranged the visitors from reality, so it was observed that they were more focused on the 3D images they were seeing than on the details concerning the history of the town.

For the following questions, we considered PO not very useful for providing a more reliable framework, so we only relied on the respondents' answers. More specifically, we asked whether they found that the experience showed what the paintings/castle were really like. Here the answers were all affirmative. We then asked whether they considered the experience helpful to communicate the Ulldecona brand outside Ulldecona. All respondents answered affirmatively, apart from the students who considered that the dissemination of the destination brand of Ulldecona, thanks to these experiences, is probably limited to the surrounding areas, due to the scarce transport infrastructure. In terms of recommending the experience and considering it worthwhile and an attraction in itself, everyone replied affirmatively, apart from the 27-year-old man who said that he would recommend the AR experience only to travellers who are passing by or that come from the surroundings, while he would not recommend planning a visit to the Abrics exclusively for the AR experience. The last question was about the added value contributed by the two experiences to the image of Ulldecona as a smart destination. Most respondents recognised this added value, apart from the 27-year-old woman who considered that these experiences are not enough to make such a peripheral and scarcely connected town a smart destination.

The last part of the investigation concerned the emotional and sensorial impact of the two experiences on the visitors. The results are summarised in the Table below.

Table 4: Summarised results of emotional and sensory impact of the experiences and PO (emotional and sensory reaction)

	Interviewees	Excitement		Satisfaction		Amusement		Adrenaline rush		Curiosity	
		Interview	PO	Interview	PO	Interview	PO	Interview	PO	Interview	PO
AR	1	4	4	5	5	4	4	4	4	5	5
	2	3	3	4	4	3	3	3	3	5	5
	3	More than 5	More than 5	More than 5	More than 5	5	5	5	5	5	5
VR	1	5	5	5	5	5	4	5	4	5	5
	2	5	5	5	5	5	5	5	5	5	5
	3	5	5	5	5	5	5	5	5	5	5
	4	5	5	5	5	5	5	5	5	5	5
	5	5	3	5	3	5	3	5	3	5	4
	6	5	5	5	5	5	3	5	3	5	5
	7	5	5	5	5	5	5	5	5	5	5
	Interviewees	Fear		Dizziness		Vertigo/instability		Restlessness		Distrust	
		Interview	PO	Interview	PO	Interview	PO	Interview	PO	Interview	PO
AR	1	2	0	0	0	0	0	1	0	1	0
	2	2	0	0	0	0	0	1	0	1	0
	3	0	0	0	0	0	0	2	0	0	0
VR	1	More than 5	More than 5	1	3	1	5	0	2	0	2
	2	1	1	1	1	1	3	0	0	0	0
	3	0	0	0	0	0	1	0	0	0	0
	4	0	0	0	1	0	1	0	0	0	0
	5	0	1	0	3	0	3	0	2	0	0
	6	0	More than 5	0	5	0	5	0	5	0	2
	7	0	0	1	1	1	1	0	0	0	0

The investigation continued with the visitors' self-reported evaluation, on a scale from 0 to 5, of the emotional and sensorial impact of their experiences. Here we noticed how in some cases, the evaluation given by participants matched the observations of the researcher, while in others it was quite misleading. The degree of "excitement" expressed by the three participants in the AR experience varied from one to another: "4" for the 27-year-old female,

"3" for the 27-year-old male, and "more than 5" for the 74-year-old man, who expressed his enthusiasm with the experience. The latter also scored "satisfaction" with "more than 5", while the two students awarded scores of "5" and "4". As for the "amusement" and "adrenaline rush" categories, scores of "4" and "3" were awarded by the students, and the retired gentleman gave it a "5". The only category in which the three participants expressed a unanimous "5" was "curiosity". For all these emotions, PO confirmed the evaluations provided by the visitors, who were surprised by the high technological development enabling such an experience. They continuously expressed their emotions orally ("wow!") and made clear facial expressions every time the guide showed them an ancient painting using the AR on the tablet.

As for the negative emotions, visitors awarded two "2" and one "0" to "fear", three "0" to "dizziness", three "2" to "vertigo/instability", two "1" and a "2" to "restlessness", and two "1" and a "0" to "distrust". Here PO confirmed the evaluation on "dizziness", but "fear", "restlessness", "vertigo/instability" and "distrust" were actually experienced due to some physical elements of the visit, namely the steep path along which the visitors were led and a specific point of the path where they found themselves before a missing piece of land filled with an artificial iron bridge, that the guide put down just for the visitors to proceed and then lifted it up in order to prevent animals from crossing. This "scary" element, however, was not considered in the evaluation derived from PO, as it was not directly related to the digital experience. As the AR experience is not as immersive as the VR one, it did not arouse any visible negative emotions.

However, combining the three visitors' responses, we can affirm that they were all very curious to find out more about the rupestrian paintings but also about the functioning of AR and how such technology was able to provide a clear digital representation of the real paintings that, in some cases, were not so clearly visible. The excitement, satisfaction, amusement and adrenaline rush generated by the experience were moderate (high only for the 74-year-old man). As for the negative emotions, none of the visitors felt any form of distrust and the other emotions were only due to the physical part of the experience.

In the VR experience, the evaluation given by the seven participants was high ("5") for all positive emotions. From PO, it was noted that the visible level of excitement and satisfaction corresponded to that declared by all participants except for interviewee 5, who was constantly sitting on a chair putting on and taking off the 3D glasses, showing only slight interest in the experience. The amusement and adrenaline rush were awarded a "5" by all participants, but during PO participants 1 and 5 were seen to be sitting for the whole time, so they did not seem to fully enjoy the visit and experience a high adrenaline rush. Participant 6 seemed only partially amused too. In fact, he was pressed against the wall for the whole time, probably due to the fact that he was not feeling completely safe walking while wearing the 3D glasses, and he did not seem to enjoy the adrenaline side of the experience. All participants reported being very curious, but participant 5 did not seem particularly motivated to fully take part in the experience, showing greater interest in taking pictures of his friends.

Moving on to the negative emotions, only a few participants reported experiencing any of them. Participant 1 reported greatly fearing the experience and participant 2 just a tiny bit. All other participants reported not having feared it at all, but the reality is that, apart from the two participants who gave realistic feedback in this scenario, two other visitors displayed fear, although to a different extent: we assumed that participant 5 experienced little fear (this would explain the fact that he was sitting all the time) and participant 6 experienced great fear, keeping pressed up against the wall throughout the virtual visit. Only three participants admitted feeling slightly dizzy and unstable, but the reality is that most of them visibly appeared to feel dizzy and unstable. None of the participants admitted that they had felt

restless or distrustful, but the researcher observed that some of them did not feel completely safe, having to sit down, lean against the wall, or remove the glasses.

When comparing the two experiences, it appears that the VR experience aroused more positive emotions. This is probably due to the fact that the visitors, in this case, were able to live a more active and immersive experience, detached from reality. In the AR experience, although all positive emotions were present, the extent to which the visitors enjoyed the experience (especially in terms of irrational emotions such as "excitement", "amusement" and "adrenaline rush"), varied from one to the other. Negative emotions were also experienced more with VR. In the AR experience, however, they were very limited and not actually related to the digital experience, but rather to some peculiarities of the visit. In the VR experience, in some cases the visitors felt overwhelmed by this parallel view that they were seeing through virtual glasses, which caused different degrees of emotions such as "fear", "dizziness", "vertigo/instability" and, to a lesser extent, "restlessness" and "distrust". Overall, all visitors reported being very satisfied with the two experiences and willing to recommend them to other people.

5. CONCLUSION

Regarding the comparative objectives of the study, it is shown that there are differences in the experiences generated by the two technologies (AR and VR). The familiarity of the visitors interviewed with new technologies and SM varied greatly, and this has also been shown to influence visitor experiences. In this context, it was noted that especially (but not only) those less familiar with new technologies and SM found it difficult to use the technological devices that were provided for VR and struggled with some negative emotions. The study, through the visitors' responses, has also shown the different degrees of "immersivity" of the two different experiences. AR is less immersive, which makes it more suitable for contexts where a non-digital experience is already provided, giving it added value. VR, however, is more immersive, hence it should be used in contexts where the physical experience is limited (e.g., an empty castle) to value ancient places endowed with a rich history but few physical remains. In such contexts, VR is more capable than AR of "transporting" people to the place and helping them live a parallel virtual experience. The study also shows that positive emotions and sensorial impact are higher in VR than AR, although curiously VR is also the technology that generates a slightly negative sensorial impact, which AR does not. All in all, we can say that these minimal negative sensations generated by VR are not reported by users in their opinions, perhaps because they are not aware of them or because they do not want to acknowledge it to others. However, regardless of the reason, it seems that these slight negative sensorial impacts end up generating greater adrenaline and excitement in the overall experience.

Thus, the study shows that what users report in interviews does not always coincide with what is observed in their actions and physical reactions, hence the need for PO as a complement to in-depth interviews, as it provides a more realistic overview of the real effects of AR and VR on visitors. The choice of combining in-depth interviews with PO allowed to better elicit even the negative reactions of the visitors. Moreover, observation revealed that visitors are not "ready" to experience AR and VR autonomously, hence the important supporting role of the guide.

Another contribution of the study is that it demonstrates the importance of real-world studies to analyse the experiences generated by AR and VR technologies. In fact, a prepared sample of users is not taken for the study. Rather, the participants are the actual visitors to the attractions. Our work has shown that a real-world study reflects both positive and negative impacts in a more objective and disinterested way. On the one hand, the study portrays the reality of the heritage attractions analysed: very few visitors, all coming from nearby areas,

were present on the day at the heritage sites in question (especially for the AR experience), even though the fieldwork was conducted on a Saturday in June (a time of the year and a day of the week when people are more likely to go on an excursion). Due to the fact that the visitors had not been prepared in advance, their responses (according to both interviews and PO) were more reliable. The limitation of this real-world study is that, despite the realistic portrayal of the visitors to the sites, we need to consider that the sample is extremely small. However, given the choice of using an entirely qualitative methodology, the scarcity of data does not constitute a real obstacle to the analysis.

The study has also shown that the two technological applications are a tourist attraction in themselves, because all but one participant stated that they had decided to visit the two places to learn about these technological experiences. In fact, most of the visitors already knew about the heritage of the place beforehand and had decided to go just to see what the virtual experience would be like.

More broadly, both experiences were considered useful assets to increase the tourist reputation of the area and to build an image of Ulldecona as a smart destination. However, these heritage sites mainly attract domestic tourists and local inhabitants of the area, who gain awareness of the value of their local heritage, which is the basis of the value-chain leading to potential improvements of infrastructure/transport and, as a consequence, to enhancing a tourism reputation at national and international level. Considering the fact that most visitors became aware of such experiences through word of mouth, the importance of more widespread promotion outside the area should be considered, proving the need to enhance the use of SM and other online tools. A future research agenda should tackle the holistic impact of such technological experiences on the territorial context of other similar peripheral areas where such tools could contribute to both enhancing community resilience and building a tourist reputation.

CONFLICT OF INTEREST STATEMENT

On behalf of all authors, the corresponding author states that there is no conflict of interest.

REFERENCES

Aslan, I., Dang, C. T., Petrak, B., Dietz, M., Filipenko, M., & André, E. (2019). Viewing experience of augmented reality objects as ambient media-a comparison of multimedia devices. *In European Conference on Ambient Intelligence*, 324–329. Cham: Springer International Publishing.

Bec, A., Moyle, B., Timms, K., Schaffer, V., Skavronskaya, L., & Little, C. (2019). Management of immersive heritage tourism experiences: A conceptual model. *Tourism Management*, *72*, 117–120.

Beck, J., & Egger, R. (2018). Emotionalise me: Self-reporting and arousal measurements in virtual tourism environments. In *In Information and communication technologies in tourism 2018* (pp. 3–15). Retrieved from https://doi.org/10.1007/978-3-319-72923-7_1

Bogicevic, V., Liu, S. Q., Seo, S., Kandampully, J., & Rudd, N. A. (2021). Virtual reality is so cool! How technology innovativeness shapes consumer responses to service preview modes. *International Journal of Hospitality Management*, *93*, 102806.

Bogicevic, V., Seo, S., Kandampully, J. A., Liu, S. Q., & Rudd, N. A. (2019). Virtual reality presence as a preamble of tourism experience: The role of mental imagery. *Tourism Management*, *74*(February), 55–64. https://doi.org/10.1016/j.tourman.2019.02.009

Boyle, E. A., Connolly, T. M., Hainey, T., & Boyle, J. M. (2012). Engagement in digital entertainment games: A systematic review. *Computers in Human Behavior*, *28*(3), 771–780.

Chang, Y.-L., Hou, H.-T., Pan, C.-Y., Sung, Y.-T., & Chang, K.-E. (2015). Apply an augmented reality in a mobile guidance to increase sense of place for heritage places. *Educational Technology & Society*, *18*(2), 166–178.

Chung, N., Lee, H., Lee, S. J., & Koo, C. (2015). The influence of tourism website on tourists' behavior to determine destination selection: A case study of creative economy in Korea. *Technological Forecasting and Social Change*, *96*, 130–143. https://doi.org/https://doi.org/10.1016/j.techfore.2015.03.004

Chung, N., Lee, H., Kim, J. Y., & Koo, C. (2018). The Role of Augmented Reality for Experience-Influenced Environments: The Case of Cultural Heritage Tourism in Korea. *Journal of Travel Research*, *57*(5), 627–643. https://doi.org/10.1177/0047287517708255

Del Chiappa, G., Andreu, L., & Gallarza, M. (2014). Emotions and visitors' satisfaction at a museum. *International Journal of Culture, Tourism and Hospitality Research*, *8*(4), 420–431.

Dey, A., Billinghurst, M., Lindeman, R. W., & Swan, J. (2018). A systematic review of 10 years of augmented reality usability studies: 2005 to 2014. *Frontiers in Robotics and AI*, *5*, 37.

Disztinger, P., Schlögl, S., & Groth, A. (2017). Technology acceptance of virtual reality for travel planning. In *Informationa and Communication technologies in tourism 2017* (pp. 255–268). Cham: Springer.

Dueholm, J., & Smed, K. M. (2014). Heritage authenticities – a case study of authenticity perceptions at a Danish heritage site. *Journal of Heritage Tourism*, *9*(4), 285–298.

Errichiello, L., Micera, R., Atzeni, M., & Del Chiappa, G. (2019). Exploring the implications of wearable virtual reality technology for museum visitors' experience: A cluster analysis. *International Journal of Tourism Research*, *21*(5), 590–605. https://doi.org/10.1002/jtr.2283

Falk, J. H., Ballantyne, R., Packer, J., & Benckendorff, P. (2012). Travel and learning: A neglected tourism research area. *Annals of Tourism Research*, *39*(2), 908–927.

Fan, X., Jiang, X., & Deng, N. (2022). Immersive technology: A meta-analysis of augmented/virtual reality applications and their impact on tourism experience. *Tourism Management*, *91*, 104534.

Fenu, C., & Pittarello, F. (2018). Svevo tour: The design and the experimentation of an augmented reality application for engaging visitors of a literary museum. *International Journal of Human-Computer Studies*, *114*, 20–35.

Flavián, C., Ibáñez-Sánchez, S., & Orús, C. (2019). The impact of virtual, augmented and mixed reality technologies on the customer experience. *Journal of Business Research*, *100*, 547–560.

Flavián, C., Ibáñez-Sánchez, S., & Orús, C. (2021). Impacts of technological embodiment through virtual reality on potential guests' emotions and engagement. *Journal of Hospitality Marketing and Management*, *30*(1), 1–20. https://doi.org/10.1080/19368623.2020.1770146

Gaberli, Ü. (2019). Tourism in digital age: An explanation for the impacts of virtual, augmented and mixed reality technologies on tourist experiences. *Journal of Tourism Intelligence and Smartness*, *2*(2), 61–69.

Geertz, C. (1973). *The interpretation of cultures* (Vol. 5019). Basic books.

González-Rodríguez, M. R., Díaz-Fernández, M. C., & Pino-Mejías, M. (2020). The impact of virtual reality technology on tourists' experience: A textual data analysis. *Soft Computing*, *24*(18), 13879–13892.

Guttentag, D. (2010). Virtual reality: Applications and implications for tourism. *Tourism Management*, *31*.

Han, D.-I., Weber, J., Bastiaansen, M., Mitas, O., & Lub, X. (2018). Virtual and Augmented Reality Technologies to enhance the visitor experience in cultural tourism. In *M. Claudia tom Dieck & Timothy Jung (Eds.) The Power of Augmented and Virtual Reality for Business,*. Springer.

Han, D.-I., tom Dieck, M. C., & Jung, T. (2018). User experience model for augmented reality applications in urban heritage tourism. *Journal of Heritage Tourism*, *13*(1), 46–61.

Haugstvedt, A. C., & Krogstie, J. (2012). Mobile augmented reality for cultural heritage: A technology acceptance study. *2012 IEEE International Symposium on Mixed and Augmented Reality (ISMAR)*, 247–255. IEEE.

Huang, Y. C., Backman, S. J., Backman, K. F., & Moore, D. (2013). Exploring user acceptance of 3D virtual worlds in travel and tourism marketing. *Tourism Management*, *36*, 490–501.

Huang, Y. C., Backman, K. F., Backman, S. J., & Chang, L. L. (2016). Exploring the implications of virtual reality technology in tourism marketing: An integrated research framework. *International Journal of Tourism Research*, *18*(2), 116–128.

Idescat. (2023). *El municipi en xifres Ulldecona (Montsià).* Retrieved October 25, 2023 from https://www.idescat.cat/emex/?id=431567.

Ismagilova, G., Safiullin, L., & Gafurov, I. (2015). Using historical heritage as a factor in tourism development. *Procedia-Social and Behavioral Sciences*, *188*, 157–162.

Jung, T., tom Dieck, M. C., Moorhouse, N., & tom Dieck, D. (2017). Tourists' experience of virtual reality applications. *Proceedings from 2017 IEEE International Conference on Consumer Electronics (ICCE)*, 208–210.

Jung, T., tom Dieck, M. C., Rauschnabel, P., Ascenção, M., Tuominen, P., & Moilanen, T. (2018). Functional, hedonic or social? Exploring antecedents and consequences of virtual reality rollercoaster usage. In *Augmented Reality and Virtual Reality: Empowering Human, Place and Business* (pp. 247–258).

Jung, T., & tom Dieck, M. C. (2017). Augmented reality, virtual reality and 3D printing for the co-creation of value for the visitor experience at cultural heritage places. *Journal of Place Management and Development*, *10*(2), 140–151.

Jung, T., tom Dieck, M. C., Lee, H., Chung, N. (2016).   Effects of Virtual Reality and Augmented Reality on Visitor Experiences in Museum. In *Information and Communication Technologies in Tourism*. https://doi.org/10.1007/978-3-319-28231-2-45

Kim, J., & Fesenmaier, D. R. (2015). Measuring emotions in real time: Implications for tourism experience design. *Journal of Travel Research*, *54*(4), 419–429.

Kim, M. J., Lee, C. K., & Jung, T. (2020). Exploring consumer behavior in virtual reality tourism using an extended stimulus organism-response model. *Journal of Travel Research, 59*(1), 69–89.

Larsen, R. J., & Fredrickson, B. L. (1999). Measurement issues in emotion research. *Well-Being: The Foundations of Hedonic Psychology*, *40*, 60.

Lee, W. J., & Kim, Y. H. (2021). Does VR tourism enhance users' experience? *Sustainability*, *13*(2), 806.

Leue, M. C., Jung, T., & tom Dieck, D. (2015). Google glass augmented reality: Generic learning outcomes for art galleries. In *Information and communication technologies in tourism 2015* (pp. 463–476). Springer, Cham.

Leue, M.C., tom Dieck, D., & Jung, T. (2014). A Theoretical Model of Augmented Reality Acceptance. *EReview of Tourism Research*, *5*, 1–5.

Li, J., Yang, D., He, L., Tao, S., Zeng, L., & Buckley, R. (2012). Psychological, physiological and behavioural responses of tourists to interactions rhesus macaques at Zhangjiajie, China. *Journal of Ecotourism*, *11*(3), 202–206.

Li, Y. M., Lai, C. Y., & Chen, C. W. (2011). Discovering influencers for marketing in the blogosphere. *Information Sciences*, *181*(23), 5143–5157.

Li, S., Scott, N., & Walters, G. (2015). Current and potential methods for measuring emotion in tourism experiences: A review. *Current Issues in Tourism*, *18*(9), 805–827.

Li, T., & Chen, Y. (2019). Will virtual reality be a double-edged sword? Exploring the moderation effects of the expected enjoyment of a destination on travel intention. *Journal of Destination Marketing and Management*, *12*(101), 15–26. https://doi.org/10.1016/j.jdmm.2019.02.003

Loizides, F., El Kater, A., Terlikas, C., Lanitis, A., & Michael, D. (2014). Presenting cypriot cultural heritage in virtual reality: A user evaluation. *In Euromediterranean Conference*, 572–579. Cham: Springer International Publishing.

Loureiro, S. M. C., Guerreiro, J., & Ali, F. (2020). 20 years of research on virtual reality and augmented reality in tourism context: A text-mining approach. *Tourism Management*, *77*, 104028.

Marasco, A., Buonincontri, P., van Niekerk, M., Orlowski, M., & Okumus, F. (2018). Exploring the role of next-generation virtual technologies in destination marketing. *Journal of Destination Marketing and Management*, *9*(January), 138–148. https://doi.org/10.1016/j.jdmm.2017.12.002

Marchiori, E., Niforatos, E., & Preto, L. (2017). Measuring the media effects of a tourism-related virtual reality experience using biophysical data. In *In R. Schegg, & B. Stangl (Eds.), Information and communication technologies in tourism 2017* (pp. 203–215). Cham: Springer International Publishing.

Minocha, S., Tudor, A. D., & Tilling, S. (2017). Affordances of mobile virtual reality and their role in learning and teaching. *Electronic Visualisation and the Arts*, *2017*, 1–10.

Moyle, B., Scherrer, P., Weiler, B., Wilson, E., Caldicott, R., & Nielsen, N. (2017). Assessing preferences of potential visitors for nature-based experiences in protected areas. *Tourism Management*, *62*, 29–41.

Mura, P., Tavakoli, R., & Sharif, S. P. (2017). 'Authentic but not too much': Exploring perceptions of authenticity of virtual tourism. *Information Technology & Tourism*, *17*(2), 145–159.

Musante, K., & DeWalt, B. R. (2010). *Participant observation: A guide for fieldworkers*. Rowman Altamira.

Nayyar, A., Mahapatra, B., Le, D., & Suseendran, G. (2018). Virtual Reality (VR) & Augmented Reality (AR) technologies for tourism and hospitality industry. *International Journal of Engineering & Technology*, *7*(2.21), 156–160.

Olabuénaga, J. I. R., & Ispizua, M. A. (1989). *La descodificación de la vida cotidiana: métodos de investigación cualitativa*. Bilbao: Universidad de deusto.

Pervolarakis, Z., Zidianakis, E., Katzourakis, A., Evdaimon, T., Partarakis, N., Zabulis, X., & Stephanidis, C. (2023). Visiting Heritage Sites in AR and VR. *Heritage*, *6*(3), 2489–2502. https://doi.org/10.3390/heritage6030131

Prayag, G., Hosany, S., & Odeh, K. (2013). The role of tourists' emotional experiences and satisfaction in understanding behavioral intentions. *Journal of Destination Marketing & Management*, *2*(2), 118–127.

Rainoldi, M., Driescher, V., Lisnevska, A., Zvereva, D., Stavinska, A., Relota, J., & Egger, R. (2018). Virtual reality: An innovative tool in destinations' marketing. *The Gaze: Journal of Tourism and Hospitality*, *9*, 53–68.

Servillo, L., Russo, A. P., Barbera, F., & Carrosio, G. (2016). Inner Peripheries: towards an EU place-based agenda on territorial peripherality. Italian Journal of Planning Practice, 6(1), 42-75.

Suh, A., & Prophet, J. (2018). The state of immersive technology research: A literature analysis. *Computers in Human Behavior*,*86*, 77–90.

Tavakoli, R., & Mura, P. (2015). 'Journeys in Second Life'–Iranian Muslim women's behaviour in virtual tourist destinations. *Tourism Management*, *46*, 398–407.

tom Dieck, M. C., Jung, T., & Han, D.-I. (2016). Mapping requirements for the wearable smart glasses augmented reality museum application. *Journal of Hospitality and Tourism Technology*, *7*(3), 230–253.

tom Dieck, M. C., Jung, T., & Michopoulou, E. (2019). Experiencing virtual reality in heritage attractions: Perceptions of elderly users. In *Augmented reality and virtual reality* (pp. 89–98). Cham: Springer International Publishing.

tom Dieck, M. C., & Jung, T. (2018). A theoretical model of mobile augmented reality acceptance in urban heritage tourism. *Current Issues in Tourism*, *21*(2), 154–174. https://doi.org/10.1080/13683500.2015.1070801

Trunfio, M., Jung, T., & Campana, S. (2022). Mixed reality experiences in museums: Exploring the impact of functional elements of the devices on visitors' immersive experiences and post-experience behaviours. *Information and Management*, *59*(8), 103698. https://doi.org/10.1016/j.im.2022.103698

Tscheu, F., & Buhalis, D. (2016). Augmented reality at cultural heritage sites. In *Information and communication technologies in tourism 2016* (pp. 607–619). Springer, Cham.

Tussyadiah, I. P., Jung, T., tom Dieck, M. C. (2017). Embodiment of Wearable Augmented Reality Technology in Tourism Experiences. *Journal of Travel Research*, 1–38.

Tussyadiah, I. P. (2014). Toward a theoretical foundation for experience design in tourism. *Journal of Travel Research*, *53*(5), 543–564.

Tussyadiah, I. P., Wang, D., Jung, T., & tom Dieck, M. C. (2018). Virtual reality, presence, and attitude change: Empirical evidence from tourism. *Tourism Management*, *66*, 140–154. https://doi.org/10.1016/j.tourman.2017.12.003

Verhulst, I., Woods, A., Whittaker, L., Bennett, J., & Dalton, P. (2021). Do VR and AR versions of an immersive cultural experience engender different user experiences? *Computers in Human Behavior*, *125*, 106951. https://doi.org/10.1016/j.chb.2021.106951

Voit, A., Mayer, S., Schwind, V., & Henze, N. (2019). Online, VR, AR, lab, and insitu: Comparison of research methods to evaluate smart artifacts. *In Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems*, 1–12.

Walle, A. H. (1997). Quantitative versus qualitative tourism research. *Annals of tourism research, 24*(3), 524-536.

Wei, W., Qi, R., & Zhang, L. (2019). Effects of virtual reality on theme park visitors' experience and behaviors: A presence perspective. *Tourism Management*, *71*, 282–293.

Yersüren, S., & Özel, Ç. H. (2023). The effect of virtual reality experience quality on destination visit intention and virtual reality travel intention. *Journal of Hospitality and Tourism Technology*.

Yu, J., Kim, S., Hailu, T. B., Park, J., & Han, H. (2023). The effects of virtual reality (VR) and augmented reality (AR) on senior tourists' experiential quality, perceived advantages, perceived enjoyment, and reuse intention. *Current Issues in Tourism*, 1–15. https://doi.org/10.1080/13683500.2023.2165483

Yung, R., & Khoo-Lattimore, C. (2017). New realities: a systematic literature review on virtual reality and augmented reality in tourism research. *Current Issues in Tourism*, *0*(0), 1–26. https://doi.org/10.1080/13683500.2017.1417359

Zhu, C., Io, M. U., Ngan, H. F. B., & Peralta, R. L. (2023). Understanding augmented reality marketing in world cultural heritage site, the lens of authenticity perspective. *Journal of Vacation Marketing*, *29*(2), 242–255. https://doi.org/10.1177/13567667221090990