



# Does familiarity with the attraction matter? Antecedents of satisfaction with virtual reality for heritage tourism

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## Abstract

Virtual reality (VR) is a topic of growing interest. While many researchers have identified factors that influence satisfaction with VR, additional important factors remain uninvestigated. In our research model, system quality, presence, and authenticity influence two mediating variables of enjoyment and usefulness of information. Enjoyment (a hedonic aspect of the VR experience) and usefulness of information (a utilitarian aspect), in turn, influence satisfaction, with familiarity moderating both of these relationships. PLS analysis of survey data collected in a heritage tourism context finds relationships that have not been previously identified. While system quality and authenticity are associated with enjoyment and usefulness of information, presence is positively associated only with enjoyment. Familiarity negatively moderates the relationship between enjoyment and satisfaction with VR. This study thus extends prior research on a key metaverse technology, VR, by identifying and explicating the roles of authenticity and familiarity—and also extends prior research by focusing on the hedonic and utilitarian dimensions of the VR experience.

**Keywords** Virtual reality (VR) · Metaverse · Virtual tourism · Heritage tourism · Hedonic · Utilitarian · Partial least squares (PLS)

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## 1 Introduction

The world is becoming increasingly digital. Many jobs are completed entirely on computers. Artificial intelligences are supporting jobs—and sometimes replacing them. The development of Virtual Reality (VR) affects how we experience the world. VR, in particular, is stimulating interest in a host of areas. It is one of the foundational technologies of the emerging metaverse, allowing users potentially endless opportunities to interact with others in social, work, educational, and other settings, providing a seamless connection between the physical and virtual world (Buhalis et al. 2023).

VR has already found applications in medicine, entertainment, aviation, education (Diemer et al. 2015; Hyun and O’Keefe 2012), and especially in tourism (Beck et al. 2019; Guttentag 2010; Hobson and Williams 1995; Jung et al. 2016). In tourism, VR can be used before travel to stimulate interest in a destination or attraction, during travel to augment the tourism experience, and also after travel to enable visitors to remember or re-live an experience (Beck et al. 2019; Guttentag 2010; Huang et al. 2010; Jung et al. 2016; Tussyadiah et al. 2018). VR offers a relatively low-cost complement or alternative to traveling, one with a low environmental impact (Wiltshier and Clarke 2017). It also offers the possibility of visiting sites that are dangerous, environmentally sensitive, protected, or even those that no longer exist in the physical world (Egger 2016; Hobson and Williams 1995; Sussmann and Vanhegan 2000). VR has been used for “planning and management, marketing, entertainment, education, accessibility, and heritage preservation” (Guttentag 2010, p. 637).

In cultural heritage tourism, VR is particularly interesting because of its potential to create greater interactions with the destination, promote learning, and enhance tourists’ experiences (Lee et al. 2020). Interest in VR grew substantially during the COVID-19 pandemic, as travel became difficult, leading many individuals to use VR more often (Kim et al. 2021; Sarkady et al. 2021). Given this interest from travelers and from managers of tourism attractions, it is unsurprising that VR has stimulated considerable research interest (Beck et al. 2019).

Scholars have focused their attention on users’ behavior with VR, and especially on their satisfaction with VR systems (Wu et al. 2019). Several prior studies have investigated the direct relationship between various factors and tourists’ satisfaction. Often, the effect of presence (Kang and Gretzel 2012), enjoyment (Huang et al. 2013a), immersiveness (Beck et al. 2019), system quality (Kim and Hyun 2016), and other variables have been studied. Identifying meaningful factors related to VR and investigating direct relationships among them are important research subjects given the novelty of this technology.

As VR research begins to take shape, it is not sufficient to merely explain the behavior of VR users since there are additional mediating and moderating effects to identify and new factors that need to be investigated. Hedonic and utilitarian motivations have been shown to influence consumers’ behavior in tourism settings (Kim and Hall 2019; Opreana et al. 2015; Prebensen and Rosengren 2016), and in users’ satisfaction with information systems (Kim and Hall 2019; Pöyry

et al. 2013). Education-orientated VR provides information and appeals to users for whom utilitarian considerations are important, while gaming VR provides enjoyment and appeals to hedonically attuned users. In a tourism setting, however, both hedonic and utilitarian aspects may exist simultaneously; people may visit VR destinations to obtain information before a trip (Beck et al. 2019; Tusyadiah et al. 2018), and revisit the same VR destination after the trip to enjoy their travel memories (Beck et al. 2019). On other occasions, enjoyment could occur when individuals watch VR of destinations to which they are unable to travel (Nam et al. 2022; Rubio-Escuderos et al. 2021). Hypothetically, an individual could participate in a VR experience of a heritage site for educational purposes and be satisfied with the experience. The same individual later could participate in the same VR experience for leisure purposes but be dissatisfied. In this case, the users' experience when participating in the VR environment—including hedonic and/or utilitarian benefits—can influence their overall opinion of the experience and desire to use the systems again (Akdim et al. 2022; Davis 1989).

Prior studies have not thoroughly investigated factors that may affect the differential experiences of users on their satisfaction. For instance, past research has not considered how users' familiarity with a site may affect their satisfaction with a VR experience (Nam et al. 2022). That is, if an individual is already familiar with a certain site before experiencing VR, would their overall satisfaction be affected? Although these situations occur frequently in reality, prior studies have failed to study this common phenomenon.

Therefore, an important objective of this study is to investigate the mediating role of utilitarian and hedonic aspects on satisfaction with VR. Additionally, we include familiarity as a moderating variable in the research model and study how these mediating and moderating variables are related to other VR variables such as system quality, presence, and authenticity.

The paper proceeds as follows. In Sect. 2, we formally define VR and note variables used in prior VR research. We explain how this prior research can be extended by including authenticity, familiarity, and user perceptions of utilitarian and hedonic benefits. Section 3 describes our research model in detail. The model indicates that system quality, presence, and authenticity influence enjoyment and usefulness of information. Enjoyment, a hedonic aspect of the VR experience, and usefulness of information, a utilitarian aspect, in turn, each influence satisfaction, with familiarity moderating both relationships. Section 4 describes our survey and the data in our sample, drawn from VR users of a non-immersive VR (niVR) heritage tourism site, Dubai360.com. Section 5 describes how our PLS results support the majority of the hypotheses in our research model. Section 6 highlights the role of authenticity in studies of satisfaction with VR, a heretofore uninvestigated factor—and highlights the important moderating role of familiarity. Practical applications appear as well. We also discuss the boundaries of generalizability for our results, the limitations of our study, and directions for future research.

## 2 Literature review

Researchers have defined VR as “the use of a computer-generated virtual environment, that one can navigate and possibly interact with, resulting in real-time stimulation of one or more of the user’s five senses” (Guttentag 2010, p. 638). User-controlled navigation is one of the components for an information system to be considered a type of VR.<sup>1</sup>

There are three distinct types of VR. First, VR experiences include those making use of head-mounted displays (HMDs) sold by Oculus (Meta), Sony, Samsung, HTC, and others. These are defined by researchers as *fully-immersive VR (fiVR)* systems (Beck et al. 2019) and are most often used for gaming. Second, VR experiences also include *semi-immersive VR (siVR)* systems consisting of large monitors or multiple projection screens that display images on walls, ceilings, and/or floors, accompanied by 3D sound (Beck et al. 2019; Loizides et al. 2014; Pantano and Servidio 2012; Zarzuela et al. 2013). These siVR systems are often on-site applications for heritage tourism, and may emphasize cultural or ecological aspects of the tourism site (Beck et al. 2019). Third and finally, the most common of all types of VR is *non-immersive VR (niVR)*, which displays “synthetic or 360-degree real-life captured content on a conventional (computer) screen, enabling...experiences that stimulate the visual sense and potentially other senses of the user” (Beck et al. 2019, p. 592). Navigation controls may include a keyboard, mouse, or touch-sensitive device. Examples of niVR include one of the earliest steps in the development of the metaverse, Second Life (Huang et al. 2013a; Tavakoli and Mura 2015), as well as online 3D virtual tours (Hyun and O’Keefe 2012; Lee and Ahn 2012; Wan et al. 2007), and 360-degree virtual tours using interactive photography (Chiou et al. 2008).

It is niVR, with its broad application and relative maturity as a technology, that will be the focus of this study. While all three types of VR—niVR, siVR, and fiVR—have been studied, by far the most common implementation of VR is niVR. The 360-degree views of hotels, museums, and other tourism sites require no special equipment to view (such as the HMDs for fiVR). The niVR applications similarly require no special projection setup, nor a visit to a specific location with the VR installation (such as siVR). The widespread usage of smartphones, tablets, and PCs on which to view niVR experiences indicates that niVR clearly seems to be the most widely used and viewed type of VR. Thus, given the niche appeal of HMDs, given

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<sup>1</sup> VR may be contrasted with a related term, augmented reality (AR). AR is an application that supplements the natural world (as opposed to the artificial world) with additional information, achieved by overlaying visual, auditory, or even haptic materials on physical objects presented through see-through displays. When a user views the real world through a special pair of glasses that project labels onto items within the field of view, such as with the Microsoft HoloLens, these are examples of AR. The PokemonGo game that projects animated characters onto a real-world scene is another example of AR. Snapchat lenses that superimpose animations and emoji-like figures onto photos are yet another example. AR is thus the superimposing of synthetic images onto real images (Jung et al. 2016). This stands in contrast to VR, which creates synthetic images without superimposing them onto an individual’s real-world surroundings. While AR has many interesting applications, this study focuses exclusively on VR.

the widespread availability of hardware to view niVR applications, and given the low barriers to adoption and use, we see research on this most common type of VR application to be of greatest benefit to the scholarly and practitioner communities.

## 2.1 VR in tourism

In a tourism context, VR “creates a virtual environment by the provision of synthetic or 360-degree real life captured content with a capable non-, semi-, or fully-immersive VR system, enabling virtual touristic experiences that stimulate the visual sense and potentially additional other senses of the user for the purpose of planning, management, marketing, information exchange, entertainment, education, accessibility, or heritage preservation, either prior to, during, or after travel” (Beck et al. 2019, p. 591).

Scholarly discussion of VR in tourism was recognized as early as the 1990s (Hobson and Williams 1995), with some observing its potential to supplant real-world tourism (Cheong 1995). Empirical research on non-immersive VR (niVR) began in earnest in the 2000s. Early studies compared the advertising effectiveness of niVR applications to brochures, revealing that niVR can be superior, but that multiple factors need to be considered rather than simply assuming that new media types such as VR are inherently superior to old (Wan et al. 2007). Viewers’ cognitive preference is one such key factor, with verbalizers preferring brochures and visualizers preferring niVR experiences (Chiou et al. 2008). Comparisons of online niVR content to offline information also revealed that niVR creates a greater sense of presence, or the feeling of “being there” at a tourist attraction (Hyun and O’Keefe 2012).

Subsequent research investigated the perceptions and behaviors that niVR experiences can influence. Such experiences can build trusting intentions in the viewers (Lee and Ahn 2012), where viewers might be willing to engage in behavior they viewed as risky until viewing trust-forming niVR content. Additionally, a series of studies revealed that niVR experiences can influence viewers’ intention to travel, create positive emotions, and lead to a sense of enjoyment (Huang et al. 2012, 2013a, b, 2016). Each of the aforementioned studies used the proto-metaverse virtual world Second Life or online virtual tours as the research context. Table 1 summarizes notable studies which have used niVR systems and highlights the variables investigated.

Patterns emerge when observing the independent variables. Some seem clearly related to the system and its functionality, such as perceived ease of use, perceived usefulness, and system quality. Others seem more directly related to the user, including competence, autonomy, emotions, skills, ability, benevolence, integrity, cognitive preference, perceptions of risk or security or hazard, and prior visit experience. Others examine the system-user interaction such as perceptions of flow, authenticity, mental imagery, challenge, interactivity, and presence that are formed when using the system.

Examination of the dependent variables reveals two groupings of dependent variables. First, there are attitudes, such as enjoyment, satisfaction, positive emotions, desire, attitude toward the brand, and attitude toward the advertising. Second, there

**Table 1** Variables and methodologies in prior niVR research

Citation	Independent variables	Dependent variables	Methodology
Nam et al. (2022)	System quality Object-related authenticity Activity-related authenticity Presence	Satisfaction	Survey
El-Said and Aziz (2022)	Perceived ease of use Perceived usefulness Enjoyment Risk perception Hazard perception Hazard-related attributes	Intention to visit	Survey
Kang (2020)	Physical Distance Media (fiVR or niVR) Telepresence Hypothetical Distance Perceived knowledge Affective intensity Perceived risk	Impulsive Desire	Experiment and survey
Bogicevic et al. (2019)	Preview mode (static images, niVR, fiVR) Elaboration of mental imagery Quality of mental imagery	Sense of presence Tourism brand experience	
Yeh et al. (2017)	Presentation mode (VR or picture) Pleasure Arousal	Consumers' response	Experiment and survey
Huang et al. (2016)	Perceived ease of use Perceived usefulness Autonomy Competence Relatedness	Behavioral intention Enjoyment	Experiment and survey
Tavakoli and Mura (2015)	n.a. [ethnographic study]	n.a.	Observation, interviews

Table 1 (continued)

Citation	Independent variables	Dependent variables	Methodology
Huang et al. (2013a)	Perceived ease of use Perceived usefulness Enjoyment Positive emotions Emotional involvement Flow	Behavioral intention	Experiment and survey
Huang et al. (2013b)	Competence Autonomy Relatedness Flow Involvement Skills Challenges Interactivity Telepresence	Intrinsic motivation Positive emotions	Experiment and survey
Huang et al. (2012)	Flow Involvement Skills Challenges Interactivity Telepresence	Flow experience Travel intentions	Experiment and survey
Hyun and O'Keefe (2012)	Offline travel information Web-mediated virtual information	Telepresence Virtual cognitive image Virtual affective image Virtual conation Trust Risk acceptance	Survey
Lee and Ahn (2012)	Ability Benevolence Integrity Perceived security concern Cognitive preference	Trust Risk acceptance	Survey
Chiou et al. (2008)		Advertising attitude Brand attitude Purchase intention	Experiment

**Table 1** (continued)

Citation	Independent variables	Dependent variables	Methodology
Wan et al. (2007)	Presentation method Destination type Information involvement Prior visit experience	Advertising effect	Experiment and survey



are behavioral intentions, such as intention to use the VR system, or intention to visit.

## 2.2 Authenticity

Inspection of Table 1 reveals that one variable that has not been thoroughly investigated in prior VR studies is authenticity. At museums, historical sites, festivals, and other heritage tourism sites and experiences, tourists seek authentic experiences. Authenticity takes multiple forms, including objective and constructive authenticity (Sharpley 2018; Wang 1999). Objective authenticity refers to visitors' desire for real-world, genuine items with clear provenance and certification from historians or other experts. Constructive authenticity refers to items that tourists perceive as matching their expectations (Selwyn 1996; Wang 1999). These two types are important to distinguish since some objects may seem authentic to tourists and possess constructive authenticity, but are simply well-constructed replicas, thereby lacking objective authenticity. The converse may be true as well, with some items possessing objective authenticity, but failing to meet tourists' expectations and thus lacking constructive authenticity.

Research on authenticity has been conducted primarily in real-world contexts. In heritage sites, authenticity is a significant element of visitor satisfaction (Cho 2012; Lee et al. 2021; Moscardo and Pearce 1986) and improves visitors' sense of presence (Sylaiou et al. 2010). Aspects of authentic experiences at cultural events, museums, and other heritage sites have been frequently studied (Castéran and Roederer 2013; Guttentag 2010; Loureiro 2019; Nguyen and Cheung 2016; Schwan and Dutz 2020; Wu et al. 2019; Zhang et al. 2018). If, in the physical world, authenticity plays a noteworthy role, it is important to consider how it may affect the virtual world. While some have begun to explore authenticity in VR research (Kim et al. 2020; Nam et al. 2022), these studies are few in number and therefore, we see value in continuing to extend the discussion of authenticity to the VR context. Specifically, we will investigate constructive authenticity,<sup>2</sup> the authenticity projected onto toured objects by tourists themselves. It is important for both researchers and practitioners to understand ways that VR experiences are perceived as constructively authentic by tourists and match their expectations.

## 2.3 Familiarity

Another variable that remains almost completely uninvestigated in VR research is familiarity. In marketing, familiarity is defined as "the number of product-related experiences accumulated by the consumer" (Alba and Hutchinson 1987, p. 411). In offline, real-world tourism, familiarity has to do with the amount of information a tourist has acquired and the amount of time he or she has spent processing that

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<sup>2</sup> Objective authenticity (Wang 1999), on the other hand, is obviously outside the scope of this study; VR is by its very definition virtual and does not present an objectively authentic object.

information (Lee and Tussyadiah 2012). Tourists may gain familiarity with a site as a result of information, previous visits, proximity, descriptions, education, assurance, and expectations (Casali et al. 2021; Prentice 2004). Familiar things are likely to generate an affective response in the individual who is experiencing them (Tasci and Knutson 2004). Behavior of tourists who are familiar with an attraction has been observed to differ from that of tourists that are unfamiliar with a site (Clarke and Bowen 2018). Familiarity affects consumers' evaluations and feelings about a destination, thus influencing their intention to visit (Kim and Hall 2019).

To date, familiarity has been investigated empirically only in real-world tourism contexts. It has been shown to influence the attractiveness of tangible tourism attractions (Szubert et al. 2021) and the positive image of the destination and intention to visit (Kim et al. 2019). Familiarity also has positive effects on image, intention to recommend, and intention to visit (Casali et al. 2021). It is also positively related to intention to recommend and intention to revisit, but interestingly may not always be related to satisfaction (Toyama and Yamada 2016).

If familiarity affects tangible, real-world tourist attractions, could it possibly also affect virtual attractions? The enjoyment that a user feels when involved in VR experience may be tempered if the user is familiar with the real-world site itself. Or the information presented in a VR experience may seem less useful if the user is already familiar with the site. Familiarity could thus influence the satisfaction a user ultimately has with a VR experience. VR contexts therefore represent a logical extension of this research and provide an opportunity for a contribution.

### 3 Research model and hypothesis development

While some conceptual and theoretical grounding exists, we note that users' hedonic or utilitarian perceptions of the VR experience have been under-investigated. Individuals with a strong focus on utilitarian benefit focus on the instrumental, functional, practical, rational, goal-oriented value that is provided by an experience (Babin et al. 1994). In contrast, individuals with a strong hedonic focus note the entertainment and emotional value provided by an experience; that is, its non-instrumental, experiential, aesthetic, or affective value (Babin et al. 1994). Indeed, products have been described as either hedonic or utilitarian (Das et al. 2019). Similarly, managers of tourism events have been advised to consider the hedonic or utilitarian motives of their target audience (Lee et al. 2020). Since users' hedonic and utilitarian considerations affect technology usage (Pöyry et al. 2013), it is important to understand how users evaluate a system; utilitarian users likely focus on the quality of information provided while hedonic users prioritize entertainment value. Thus, we propose to incorporate hedonic and utilitarian factors into our model of satisfaction with VR.

Hedonic and utilitarian motivations have been examined in tourism research, where they have been found to have differing impacts on satisfaction (Prebensen and Rosengren 2016) and consumer behavior (Kesari and Atulkar 2016). The frequent links from hedonic and utilitarian motivation to intention to use in other research can imply an effect on satisfaction, since satisfied users are more likely to use and

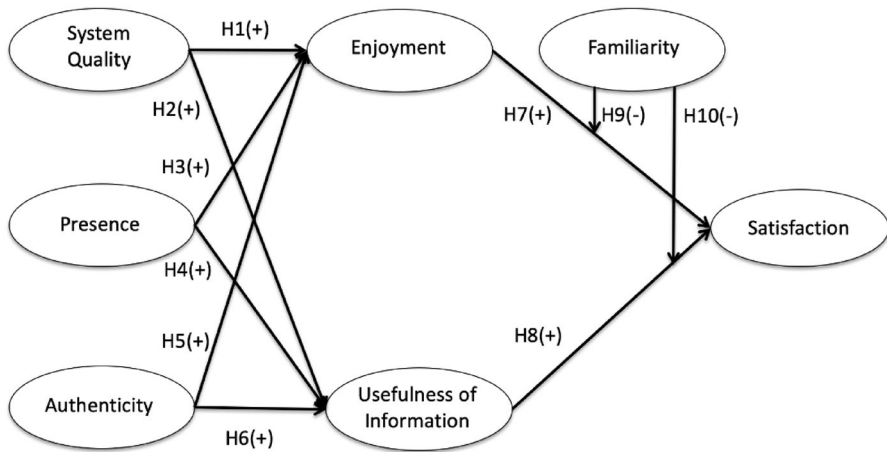


Fig. 1 Research model

reuse a system (Choi and Sun 2016). Given the role hedonic and utilitarian values have been found to play in influencing satisfaction and loyalty (Akdim et al. 2022; Davis 1989; Deb 2021; Jung et al. 2018a) and the significant emphasis placed on consumer and user satisfaction in business and research from other domains (Alegre and Cladera 2006; Cobanoglu et al. 2011; Lee et al. 2016; Torres Martín et al. 2021), this aspect has been under-researched in VR settings (Jung et al. 2018b) as Table 1 attests.

While hedonic and utilitarian considerations are sometimes depicted primarily as inputs that determine technology usage (Kim and Hall 2019; Pöyry et al. 2013), at other times they are clearly revealed to have a moderating influence on individuals' attitudes and behavior, such as in consumer research (Das et al. 2019) and also in studies of technology usage (Martín-Consuegra et al. 2019). We suggest that a particular VR experience might satisfy users who perceive hedonic benefits but not those who perceive utilitarian benefits (and vice-versa). Thus, we intend to examine hedonic and utilitarian factors as mediators between other VR antecedents of satisfaction.

The research model, as portrayed in Fig. 1, shows that system quality, presence, and authenticity directly influence enjoyment as well as usefulness of information. Enjoyment (hedonic), and usefulness of information (utilitarian), each then influence satisfaction. Importantly, familiarity moderates the relationships from enjoyment to satisfaction and from usefulness of information to satisfaction. We now explain the model in detail as we formally develop our hypotheses.

### 3.1 System quality

System quality refers to the ease of use, reliability, functionality, flexibility, and convenience of a system (Delone and McLean 2003; Jung et al. 2016). It has been reported to have a significant effect on the overall success of a VR system

(Guttentag 2010). A connection between system quality and satisfaction with the experience has been reported in numerous studies (Cadet and Chainay 2020; Chung et al. 2018; Delone and McLean 2003; Dinh et al. 1999; Guttentag 2010; Jung et al. 2016; Oghuma et al. 2016; Orru et al. 2019; Tussyadiah et al. 2018; Wei et al. 2019). This is because high quality systems are easier to use (Oghuma et al. 2016) and less distracting, allowing users to better focus on and enjoy the experience (Beck et al. 2019; Cadet and Chainay 2020; Pizzi et al. 2019; Tussyadiah et al. 2018). It is suggested that high system quality relates to high satisfaction because the system is able to fulfill users' hedonistic values, and better allow them to enjoy their VR experience (Pizzi et al. 2019; Tussyadiah et al. 2018). In a retail setting, the connections between increased arousal, involvement, and freedom have been associated with hedonistic values (Babin et al. 1994), traits that are best conveyed with a high-quality system. Although not specifically hypothesized, through a manipulation check, Li and Chen (2019) found that participants using a high-quality VR system reported greater enjoyment than those using a low-quality system.

Since VR environments have been found to promote enjoyment (Pizzi et al. 2019) and system quality is specifically important in helping users avoid distractions and focus more on the experience (Beck et al. 2019; Cadet and Chainay 2020; Oghuma et al. 2016), thus promoting enjoyment (Beck et al. 2019; Tussyadiah et al. 2018), we propose that:

***Hypothesis 1:*** *System quality is positively associated with enjoyment.*

While enjoyment (H1) is hedonic, VR systems have also been shown to influence utilitarian behavior (Pizzi et al. 2019). The efficient acquisition and application of information are utilitarian considerations (Babin et al. 1994), both of which are made more efficient through VR systems (Pizzi et al. 2019). In research on the perceived usefulness of e-learning systems, system quality has been found to be an important component of users' perceptions of information quality and usefulness (Alsabawy et al. 2016). This result is likely since superior system quality will provide users with a smooth and efficient experience, and not distract them from the task-related features of the VR system (Pizzi et al. 2019). The converse of this effect was reported by Peukert et al. (2019), who found that poor system quality negatively affected users' utilitarian perceptions. We, therefore, propose that:

***Hypothesis 2:*** *System quality is positively associated with usefulness of information.*

### 3.2 Presence

Presence is a subjective construct whereby users of a technology describe a feeling of 'being there' (Beck et al. 2019; Sanchez-Vives and Slater 2005). If a VR system is successful at developing a sense of presence, users would describe feeling as if they were physically present at the site they were viewing. Given the emotive state related to it, presence has been found to relate closely to enjoyment (Animesh et al. 2011; Beck et al. 2019; Israel et al. 2019; Lombard and Ditton 2006; Nah et al. 2011; Pavlou et al. 2007; Smith 2019; Sylaiou et al. 2010; Zhang et al. 2022) and

satisfaction (Wei et al. 2019; Zhang et al. 2022). Such results have been repeatedly found in a variety of settings, including museums (Sylaiou et al. 2010), virtual retail outlets (Peukert et al. 2019; Pizzi et al. 2019), virtual games (Animesh et al. 2011), and hospitals (Nah et al. 2011). In all instances, presence was found to have a strong and positive effect on enjoyment and, in some cases, was reported as being a predecessor of enjoyment (Lombard and Ditton 2006; Nah et al. 2011). Considering the strong support for presence's effect on enjoyment, we propose:

**Hypothesis 3:** *Presence is positively associated with enjoyment.*

Past research has found that presence has a positive impact on participants' education experiences from VR systems (Jung et al. 2016; Wei et al. 2019). Presence has also been reported to improve participants' episodic memory due to its attentional engagement mechanisms (Smith 2019). When a system stimulates greater presence, users give more attention to the virtual experience and are less distracted by their physical surroundings which improves their memories of the experience (Kober and Neuper 2012; Lin et al. 2002; Smith 2019). In research on mindfulness, reduced distraction and greater attention on information facilitated greater awareness, understanding, and application of information (Moscardo 2009). Similarly, the presentation of a hotel using virtual reality with good presence can improve perceived usefulness because it can more effectively demonstrate a possible real-life experience and reduce the need for the user to imagine (Israel et al. 2019). Additionally, VR has been found to relate to utilitarian experiences in retail settings (Pizzi et al. 2019). The argument researchers put forward to explain this relationship appeals to the improved efficiency of virtual over physical experiences in terms of better navigation (Spiers et al. 2008), improved product information acquisition (Walsh and Pawlowski 2002), and more accurate anticipation of product usefulness (Jeandrain 2001). In other research, however, the connection between presence and utilitarian considerations was less apparent, possibly due to the complexity of tasks applied in the VR system (Pengnate et al. 2020). Considering these arguments and the requirement for further empirical exploration of this relationship (Pengnate et al. 2020), we propose that:

**Hypothesis 4:** *Presence is positively associated with usefulness of information.*

### 3.3 Authenticity

Authenticity has frequently been connected to promoting greater enjoyment and satisfaction within visitors to sites (Cho 2012; Moscardo and Pearce 1986). In both physical and virtual settings, authenticity can positively affect users' perceptions as well as satisfaction (Cho 2012; Park et al. 2019; Zhang et al. 2018). Literature has suggested that visitors who believe a display is authentic feel more involved at a site (Orru et al. 2019), which in turn makes them feel more aware, stimulates greater learning, and increases satisfaction with the site (Lee et al. 2021; Moscardo 2009). Other researchers have found more elaborate relationships; such as constructive authenticity being an expectation rather than a satisfaction-inducing feature (Park et al. 2019), authenticity positively affecting perceptions of value rather than

satisfaction while visiting heritage sites (Lee et al. 2016), or quality of experience acting as a mediator between authenticity and satisfaction (Domínguez-Quintero et al. 2020). Since there is evidence to suggest that constructive authenticity relates to enjoyment, we propose:

**Hypothesis 5:** *Authenticity is positively associated with enjoyment.*

Given that authenticity refers to how ‘real’ individuals perceive an object or experience to be (Wang 1999), displays that are perceived to be authentic are also frequently judged to be genuine and traditional (Chhabra et al. 2003). Carson and Harwood (2007) implied that visitors desired an authentic experience when visiting historical or cultural sites. Research on education found that learners in authentic environments resulted in better learning (Shadiev et al. 2020). Furthermore, those studying what they perceived as authentic information presented in an authentic fashion, reported greater interest and an improved learning experience (Ray et al. 2019). Authenticity encourages visitors to engage more with the site, displays, and experiences they are having (Wang 1999). Improved visitor engagement at heritage sites has been found to result in more learning and understanding (Moscardo 2009). We therefore propose:

**Hypothesis 6:** *Authenticity is positively associated with usefulness of information.*

### 3.4 Enjoyment

Satisfaction and enjoyment—hedonism—have the potential to support one another given their interrelated nature around seeking and receiving enjoyment (Chung et al. 2018; Kim et al. 2013; Lim 2014; Pura 2005). Results frequently suggest that enjoyment is positively associated with satisfaction (Grappi and Montanari 2011; Kim et al. 2015; Lim 2014). In virtual settings, similar results have been frequently reported (Pizzi et al. 2019). However, Chung et al. (2018) found that enjoyment and satisfaction did not relate, possibly due to the context of their research at a cultural heritage site. The argument they proposed was that while enjoyment and satisfaction may relate, this may not be the case at heritage sites, where visitors’ focus is on information, not entertainment (Chung et al. 2018). Given these ambiguous results, we seek additional clarity and propose that:

**Hypothesis 7:** *Enjoyment is positively associated with satisfaction.*

### 3.5 Usefulness of information

The utilitarian considerations of visitors have been found to be positively associated with repeated usage of AR systems (Shin and Jeong 2021) and satisfaction with the experience (Pizzi et al. 2019), possibly due to their improved efficiency in relaying information to viewers (Pizzi et al. 2019). This result is supported in research on Airbnb users (Lee and Kim 2018) and also in a study of student satisfaction (Arizzi et al. 2020). In all cases, the results suggest that individuals’ utilitarian values are

positively associated with satisfaction. While these outcomes have been found at tourism destinations, schools, and retail establishments, it is possible that this will be more pronounced at heritage sites where the value and usefulness of information take a more central role (Chung et al. 2018). Given these findings, we propose that:

***Hypothesis 8:** Usefulness of information is positively associated with satisfaction.*

### 3.6 Familiarity

Familiarity refers to the user's prior knowledge of the destination before visiting the corresponding VR site. If a user visits a certain place in the real world and then watches the corresponding VR later, their familiarity is considered to be high. Similarly, if a user visits a certain VR site depicting a destination he/she has never visited before in the real world or has less information regarding the destination, the user is assumed to have low familiarity. This study focuses on the impact of prior knowledge or experience of the destination on the usage of VR. Because past experience can offer a point of comparison, familiarity may be an important moderator of satisfaction (Jaalama et al. 2021; Pouke et al. 2019).

Prior studies of VR have focused on the vicarious role of VR which is often used before or without visiting the destination. Kim and Hall (2019) compared visitors to non-visitors of a tourism destination based on whether they visited destinations after experiencing them using VR. They found that while no significant difference existed between the two groups, visitors demonstrated a stronger relationship between enjoyment and flow state, suggesting that familiarity through VR positively moderates the relationship between enjoyment and flow state.<sup>3</sup> That is, information obtained through VR can positively affect travelers' behavior. Itani and Hollebeek (2021) indicated that VR systems will not replace physical visitation but could offer a "taste" of the experience, being a classic case of a digital twin.<sup>4</sup> However, prior studies regarding how familiarity with a destination in the real world affects the perception of VR are scant. Those which have reported this relationship present mixed findings (Pouke et al. 2019).

When travelers visit physical sites, they encounter a wide variety of stimuli which help to construct a holistic experience for them. However, when they visit a VR site, many of these stimuli, such as tactile and olfactory inputs, are lost (Jaalama et al. 2021; Pouke et al. 2019). Therefore, we assume that if a traveler has already visited the destination in the real world, he is less likely to enjoy the VR contents. Hence, we propose that:

<sup>3</sup> In this context, flow state has been described as a mediator between enjoyment and satisfaction (Huang et al. 2010), similar to being the psychological equivalent (Riva et al. 2004) or component (Kim and Ko 2019) of presence, as described above.

<sup>4</sup> A digital twin replicates a destination or a tourist, hospitality or cultural heritage facility (Buhalis et al. 2023) by representing the real-world physical attraction in a virtual space, and connecting data and information from the virtual and real products together (Grieves 2014).

***Hypothesis 9:*** Familiarity negatively moderates the relationship between enjoyment and satisfaction.

In a similar manner to the above argument for H9, where familiarity negatively moderates the relationship between enjoyment and satisfaction, familiarity can similarly affect perceptions of the usefulness of information. In a non-virtual setting, it was observed that the more popular a destination, the less familiar the tourists are with information about the destination (Lee and Tussyadiah 2012). When considering satisfaction, however, informational familiarity has been found to positively affect satisfaction with destination image (Sanz-Blas et al. 2019). However, following the argument for familiarity and satisfaction, it is possible that the more familiar a user is with the destination being displayed, the less novel and therefore, less memorable it will be (Moscardo 2009). This could particularly be the case in heritage sites where the focus is more on information rather than entertainment (Chung et al. 2018). Much of this research, however, has been conducted in a physical setting (Lee and Tussyadiah 2012; Sanz-Blas et al. 2019). Therefore, understanding the relationship in a virtual case is necessary, since users may compare their virtual experience with their past physical one (Lee et al. 2020; Pouke et al. 2019). We therefore propose that:

***Hypothesis 10:*** Familiarity negatively moderates the relationship between usefulness of information and satisfaction.

## 4 Methodology

### 4.1 Data collection

This study collected data from students who attended two private universities in the United Arab Emirates. Subjects were drawn from diverse majors such as business, engineering, psychology, and mass communications. The respondent pool included students from the freshman (first-year) level to the senior (fourth or fifth-year level), as well as graduate students. Of the 296 potential participants, a total of 276 responses (93.24% response rate) were received. Out those 276 responses, 22 were dropped when some items were left blank or when the response showed straight-line patterns. Thus, 254 responses were used for the analysis of this study.

This study chose a non-immersive VR (niVR) site, Dubai360.com, for the collection of data. This study chose the niVR type because of its popularity and common usage by travelers, and because it does not require any special equipment, nor special input or output devices. Furthermore, Dubai360.com was current with a good amount of heritage content about the city of Dubai, including historical information as well as cultural events.

Testing our model in the context of heritage tourism offers significant insight into an area where VR can, and is, having notable impacts. Heritage sites try to provide visitors with a mix of interesting and information experiences—what has been termed “edutainment” (Lee et al. 2020). As heritage sites consider adopting VR, it is vital that they understand the impact of perceptions of authenticity (Lee et al. 2020;



**Table 2** Demographic Characteristics of Respondents (n = 254)

Characteristics	Category	Freq	Percentage (%)
Gender	Male	115	45.28
	Female	139	54.72
Length of residency	< 5 years	51	20.08
	5–10 years	27	10.63
	> 10 years	176	69.29
Grade classification	1st year	12	4.72
	2nd year	91	35.83
	3rd year	64	25.20
	4th year and older	68	26.77
	Graduate	18	7.09

Nam et al. 2022), past experience (Jaalama et al. 2021), and the value users place on hedonistic and utilitarian experiences, since these considerations also directly relate to heritage sites (Lee et al. 2020). For these reasons, Dubai.360 was considered appropriate to collect data and validate the research model.

Researchers conducted a 20–30 min orientation session to explain the purpose of this study, describing how to use the Dubai360.com site, and how to respond to the survey. Before responding to the survey, participants were requested to visit three heritage attractions on the website: the Etihad Museum, a historic Emirati house, and the Sikka Art Fair. These heritage sites were chosen based on the historical importance and the popularity of content with the participants. Subjects were then asked four questions, the responses to which required them to fully navigate and experience the heritage content. Thus, subjects' familiarity with and use of the site was ensured before collecting responses to items measuring research variables. Research subjects averaged 37 min to navigate around the site, perform the required tasks, and complete the survey (minimum time was 11 min, maximum was 1 h, 39 min).

Students voluntarily participated in the survey with a small extra credit incentive offered to encourage participation as well as sincere responses. They were also informed that their responses would be confidential and anonymous and that they would be free to quit or withdraw from the survey at any time.

Even though this study collected data from students, there are at least four reasons why students are an appropriate group from which to sample for this study. First, the inclusion of authenticity as a variable in the research model requires the respondents to be familiar with real objects to assess whether VR objects are authentic or not. Since most students have lived in the UAE for multiple years, they could evaluate the authenticity of VR representations properly. Second, to measure familiarity in the research model, it is important to include subjects with a wide range of length of stay in the region. The population of the UAE is composed of expatriates from many countries, and the universities where samples were collected have students enrolled from over 90 countries. Furthermore, the length of residence among students in the UAE was widely distributed from less than 5 years to more than 10 years (for details, please see Table 2). Third, respondents should not have any problem with

using IT devices. Even though the Dubai360.com was a new site with a user interface likely not seen by students before, the respondents in this study quickly learned how to navigate the site without difficulty. Furthermore, since most students used the Dubai360.com site for the first time when they participated in this study, the chance of biased responses was extremely low. Fourth and perhaps most importantly, these research subjects are representative of the population we seek to study. They are expatriates and therefore travelers; they are also young and technologically-savvy.

Descriptive statistics for our sample appear in Table 2.

## 4.2 Operationalization of constructs

This study used constructs of multi-item scales based on a seven-point Likert rating scale. When possible, existing measures validated by prior studies were adopted and revised carefully to reflect the VR environment if required. Table 3 shows the specific items used in this study. System quality, presence, enjoyment, and satisfaction were directly adopted from prior studies, while authenticity, usefulness of information, and familiarity were adapted from prior studies that were carried out in slightly different contexts.

Common method bias was tested before conducting the measurement assessment. Self-reported data collected from the same person at one time could yield unintended correlations that contaminate data obtained from that source. The risk of common method variance was tested by two statistical analyses: (i) Harman's one-factor test (Podsakoff et al. 2003) and (ii) Lindell and Whitney (2001) marker variable test. For Harman's one-factor test, there was no single factor that accounts for a large proportion of the variance in factor analysis. For the Lindell and Whitney marker variable test, a marker variable did not have significant correlations with research variables of this study. Thus, we concluded that there is no evidence of common method bias in this study.

## 5 Results and analysis

### 5.1 Measurement assessment

This study adopted the Partial Least Squares (PLS) method to perform an evaluation of the measurement model as well as the structural model. The PLS structural equation modeling (PLS-SEM) method is suitable for theory building and theory testing (Hair et al. 2017). Given that PLS-SEM is more prediction-oriented, PLS is considered to be appropriate since this study is one of the first attempts to investigate the effect of authenticity and familiarity on VR satisfaction.

The internal consistency of constructs was assessed by Cronbach's  $\alpha$  and composite reliability (CR). The internal consistency requirements (Lindell and Whitney 2001; Podsakoff et al. 2003) are satisfied when scores of both tests exceed 0.7. Table 3 shows that all Cronbach's  $\alpha$  values are higher than 0.7 and CRs range from 0.70 to 0.95. For convergent validity, the average variance extracted (AVE)

**Table 3** Measurement Items

Constructs	Measurement items	Source
System quality (SYSQ)	<p>I think the Dubai360 website is</p> <ul style="list-style-type: none"> <li>• Easy to use</li> <li>• Fast</li> <li>• Convenient to use</li> <li>• Easy to navigate</li> </ul>	Kim and Hyun (2016)
Presence (PRES)	<p>While visiting the recommended attractions on the Dubai360 website,</p> <ul style="list-style-type: none"> <li>• I felt like that I have actually been there</li> <li>• It seemed as if I actually took part in sightseeing</li> <li>• It was as if my true location has shifted to the virtual environment</li> <li>• I felt as if I was physically present in the virtual environment</li> </ul>	Kang and Gretzel (2012)
Authenticity (AUTH)	<p>While visiting the recommended attractions on the Dubai360 website,</p> <ul style="list-style-type: none"> <li>• It looked like real</li> <li>• It was as accurate as the real attractions</li> <li>• It showed me the genuine features of the attractions</li> <li>• I was able to figure out the real features of the attractions</li> <li>• It accurately reproduced the real object virtually</li> </ul>	Castéran and Roederer (2013), Lin and Liu (2018), Wu et al. (2019), Zhou et al. (2015)
Enjoyment (ENJY)	<p>Visiting the recommended attractions on the Dubai360 website,</p> <ul style="list-style-type: none"> <li>• Fun</li> <li>• Pleasant</li> <li>• Enjoyable</li> <li>• Exciting</li> <li>• Interesting</li> </ul>	Cheung and Lee (2012), Venkatesh et al. (2012)
Usefulness of information (USEF)	<p>While visiting the recommended attractions on the Dubai360 website,</p> <ul style="list-style-type: none"> <li>• I gained information and knowledge about the attractions</li> <li>• I learned many different things about the attractions</li> <li>• I expanded my understanding of the attractions</li> <li>• It made me more knowledgeable about the attractions</li> </ul>	Bhattacharjee (2001), Chung et al. (2015)

Table 3 (continued)

Constructs	Measurement items	Source
Familiarity (FAMI)	As for the recommended attractions that I visited the Dubai360 website, <ul style="list-style-type: none"> <li>• I am familiar with attractions</li> <li>• I have knowledge about attractions</li> <li>• Places reminds me good memories</li> <li>• I have experienced the attractions before</li> </ul>	Flavián and Guinaliu (2007)
Satisfaction (SAT)	How do you feel about your overall experience of visiting the recommended attraction? <ul style="list-style-type: none"> <li>• Satisfied</li> <li>• Pleased</li> <li>• Content</li> </ul>	Wu et al. (2019)

**Table 4** Cross Loadings and Internal Consistency Measures

ITEM	SYSQ	PRES	AUTH	ENJY	USEF	FAMI	SAT	Alpha	C.R	AVE
SYSQ1	<b>0.851</b>	0.400	0.478	0.521	0.510	0.339	0.514	0.854	0.902	0.698
SYSQ2	<b>0.759</b>	0.439	0.472	0.540	0.507	0.307	0.527			
SYSQ3	<b>0.896</b>	0.511	0.542	0.568	0.546	0.361	0.555			
SYSQ4	<b>0.829</b>	0.477	0.465	0.454	0.426	0.325	0.519			
PRES1	0.451	<b>0.880</b>	0.609	0.590	0.456	0.324	0.475	0.914	0.939	0.794
PRES2	0.531	<b>0.897</b>	0.613	0.607	0.488	0.369	0.91			
PRES3	0.472	<b>0.881</b>	0.525	0.494	0.417	0.326	0.389			
PRES4	0.493	<b>0.905</b>	0.538	0.551	0.465	0.361	0.438			
AUTH1	0.433	0.563	<b>0.846</b>	0.583	0.580	0.211	0.470	0.880	0.913	0.676
AUTH2	0.437	0.521	<b>0.813</b>	0.530	0.542	0.241	0.483			
AUTH3	0.521	0.482	<b>0.831</b>	0.596	0.633	0.326	0.605			
AUTH4	0.539	0.571	<b>0.804</b>	0.619	0.661	0.363	0.578			
AUTH5	0.475	0.506	<b>0.815</b>	0.548	0.590	0.287	0.479			
ENJY1	0.565	0.556	0.600	<b>0.903</b>	0.658	0.292	0.673	0.921	0.941	0.761
ENJY2	0.526	0.555	0.622	<b>0.841</b>	0.598	0.402	0.661			
ENJY3	0.583	0.556	0.617	<b>0.904</b>	0.622	0.312	0.676			
ENJY4	0.531	0.564	0.598	<b>0.860</b>	0.604	0.373	0.579			
ENJY5	0.533	0.527	0.626	<b>0.849</b>	0.662	0.278	0.637			
USEF1	0.560	0.435	0.615	0.608	<b>0.858</b>	0.314	0.614	0.885	0.921	0.743
USEF2	0.554	0.484	0.633	0.639	<b>0.872</b>	0.342	0.600			
USEF3	0.479	0.412	0.641	0.620	<b>0.864</b>	0.266	0.551			
USEF4	0.472	0.435	0.643	0.620	<b>0.854</b>	0.296	0.517			
FAMI1	0.301	0.287	0.289	0.295	0.279	<b>0.857</b>	0.270	0.839	0.888	0.666
FAMI2	0.381	0.313	0.314	0.290	0.315	<b>0.865</b>	0.314			
FAMI3	0.334	0.393	0.323	0.411	0.343	<b>0.837</b>	0.377			
FAMI4	0.283	0.207	0.156	0.150	0.140	<b>0.690</b>	0.133			
SAT1	0.611	0.442	0.569	0.658	0.630	0.305	<b>0.895</b>	0.872	0.921	0.796
SAT2	0.574	0.467	0.589	0.676	0.601	0.327	<b>0.901</b>			
SAT3	0.510	0.445	0.552	0.648	0.564	0.341	<b>0.879</b>			

Bold indicates significant results within the relevant item

*SYSQ* system quality, *PRES* presence, *AUTH* authenticity, *ENJY* enjoyment, *USEF* usefulness of information, *FAMI* familiarity, *SAT* satisfaction

should be higher than 0.5 and factor loading scores of each construct should be higher than 0.7. Table 4 also shows that all constructs satisfy the requirement of convergent validity, with AVE scores higher than 0.6 and factor loadings from 0.7 to 0.9.

Discriminant validity is confirmed in Table 5 since the correlation between pairs of constructs is lower than 0.9 and the square root of AVE is greater than its correlation estimates, and the cross-loadings of factor scores are higher in the corresponding construct than loadings in other constructs. Therefore, the three criteria of discriminant validity are satisfied.

**Table 5** Discriminant validity

	SYSQ	PRES	AUTH	ENJY	USEF	FAMI	SAT
SYSQ	<b>0.835</b>						
PRES	0.548	<b>0.891</b>					
AUTH	0.589	0.644	<b>0.822</b>				
ENJY	0.628	0.633	0.461	<b>0.872</b>			
IMFO	0.600	0.513	0.379	0.431	<b>0.862</b>		
FAMI	0.401	0.387	0.351	0.380	0.354	<b>0.816</b>	
SAT	0.635	0.506	0.640	0.741	0.672	0.364	<b>0.892</b>

Bold face items on the diagonal are the square root of AVE

*SYSQ* system quality, *PRES* presence, *AUTH* authenticity, *ENJY* enjoyment, *USEF* usefulness of information, *FAMI* familiarity, *SAT* satisfaction

**Table 6** Results of hypotheses tests

Hypo. no.	Variables	Coefficient	<i>p</i> value	Result
H1	SYSQ → ENJY	0.269	0.000***	Supported
H2	SYSQ → USEF	0.259	0.000***	Supported
H3	PRES → ENJY	0.230	0.000***	Supported
H4	PRES → USEF	-0.006	0.911	Not supported
H5	AUTH → ENJY	0.396	0.000***	Supported
H6	AUTH → USEF	0.587	0.000***	Supported
H7	ENJY → SAT	0.472	0.000***	Supported
H8	USEF → SAT	0.256	0.000***	Supported
N/A	FAMI → SAT	0.072	0.096	N/A
H9	ENJY*FAMI → SAT	-0.139	0.034*	Supported
H10	USEF*FAMI → SAT	0.051	0.396	Not supported

*SYSQ* system quality, *PRES* presence, *AUTH* authenticity, *ENJY* enjoyment, *USEF* usefulness of information, *FAMI* familiarity, *SAT* satisfaction

\* $p < 0.05$ , \*\* $p < 0.01$ , \*\*\* $p < 0.001$

## 5.2 Structural model assessment

Smart PLS was used to estimate the structural model. A bootstrapping procedure with resampling of 500 subsamples was used to determine the statistical significance of estimates. Table 6 and Fig. 2 show the result of hypotheses tests.

Out of ten hypotheses, eight are supported (all except H4 and H10). These results indicate that system quality is positively associated with enjoyment (H1:  $\beta = 0.269$ ,  $p = 0.000$ ) and usefulness of information (H2:  $\beta = 0.259$ ,  $p = 0.000$ ). Presence is positively associated with enjoyment (H3:  $\beta = 0.230$ ,  $p = 0.000$ ), but not with usefulness of information (H4:  $\beta = -0.006$ ,  $p = 0.911$ ). Authenticity is positively associated with enjoyment (H5:  $\beta = 0.396$ ,  $p = 0.000$ ) and usefulness of information (H6:  $\beta = 0.587$ ,  $p = 0.000$ ). Regarding the two mediating variables, both enjoyment (H7:

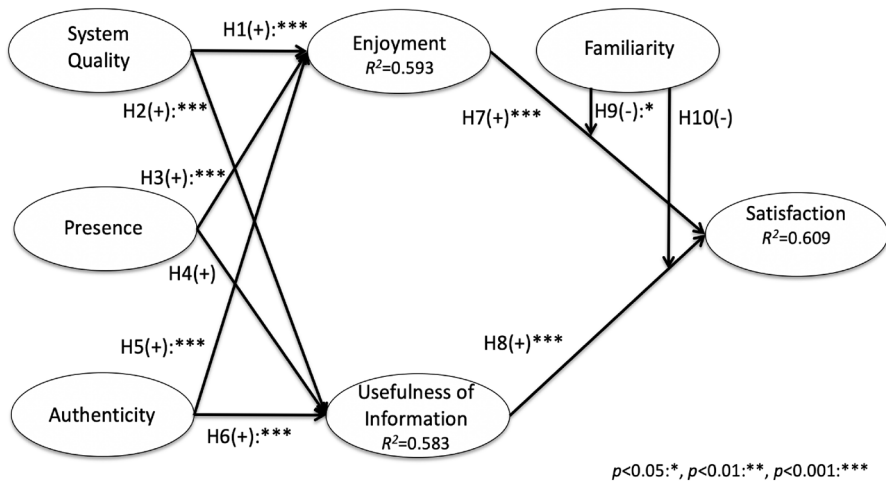


Fig. 2 Results of the structural equation model

$\beta = 0.472$ ,  $p = 0.000$ ) and usefulness of information (H8:  $\beta = 0.256$ ,  $p = 0.000$ ) are positively associated with satisfaction.

Regarding the moderating variable of familiarity, familiarity negatively moderates the relationship between enjoyment and satisfaction (H9:  $\beta = -0.139$ ,  $p = 0.034$ ), but the moderating effect is not found between usefulness of information and satisfaction (H10:  $\beta = 0.051$ ,  $p = 0.396$ ).<sup>5</sup>

The  $R^2$  values of the model were 0.593, 0.583, and 0.609 for enjoyment, usefulness of information, and satisfaction respectively. The variance in enjoyment and usefulness of information is well-explained by system quality, presence, and authenticity. Similarly, over 60% of the variance in satisfaction with using VR implies that the hedonic and utilitarian variables, enjoyment, and usefulness of information, explain VR satisfaction very well.

## 6 Discussion

### 6.1 Theoretical implications

This study included enjoyment (a hedonic aspect of the VR experience) and usefulness of information (a utilitarian aspect) as mediators between factors such as system quality, presence, authenticity, and VR satisfaction. As illustrated in the opening

<sup>5</sup> The presence of familiarity as a moderator also indicates the possibility of a direct link from familiarity to satisfaction. While such a link was not indicated in literature, nor hypothesized, the relationship was explored and no significant relationship was found. This result has been provided in Table 5, marked N/A.

paragraphs of the Introduction, some tourists may enjoy VR for the beauty and scenery of the heritage site while others may use VR to obtain useful information about the site. The results of this study show that these two dimensions—enjoyment and usefulness of information—are influenced differently by three factors of system quality, presence, and authenticity. Likewise, familiarity moderates their links to satisfaction in different ways. These findings imply that the design of VR should vary depending on the emphasis users place on hedonic or utilitarian benefits.

Out of the three factors affecting the two mediators, system quality and presence have been studied as important determinants in prior VR studies. For instance, Yung et al. (2021) and Wei et al. (2019) included presence as a single mediator of the various dependent variables of VR, which means that presence is one of the most important factors that determines the performance of VR. Indeed, we observe that the positive relationship of system quality with both with enjoyment and usefulness of information is consistent with prior studies. However, presence has a positive relationship only with enjoyment and no relationship was found with usefulness of information. This finding implies that the perception of presence is less important to VR users in terms of satisfaction for those who use VR to obtain information on a destination. When the users enjoy the VR content, presence is an important factor affecting the quality of using VR. Additionally, results confirm that enjoyment and usefulness of information are two different dimensions of using VR because they are affected by different factors.

Authenticity is a relatively new factor in VR studies. Recent studies (Kim et al. 2020; Mura et al. 2017) tend to focus more on activity-related (experiential) authenticity to investigate whether vicarious experiences in the VR world are as good as real experiences in the physical world. Even though the quality of VR content is directly related to constructive authenticity, experiential aspects of VR tend to be weighted more strongly in recent studies. Indeed, constructive authenticity has positive relationships with enjoyment and usefulness of information (Nam et al. 2022). To compare the explanatory power of the individual contributions of system quality, presence, and authenticity, the  $R^2$  values of enjoyment and usefulness of information were examined. The  $R^2$  values of authenticity on enjoyment and usefulness of information were 0.495 and 0.541, while system quality had values of 0.395 and 0.363 and presence of 0.401 and 0.264 respectively. Thus, authenticity has the highest explanatory power of the three factors. These  $R^2$  values also suggest that system quality and presence have a greater explanatory power for enjoyment, while authenticity was found to have a greater explanatory power for usefulness of information.

Prior studies in real-world (non-VR) settings indicate that familiarity does not have a positive relationship with satisfaction. Therefore, this study included familiarity as a moderator of the links from enjoyment and usefulness of information to satisfaction, the first attempt in VR studies to do so. Results indicate that familiarity negatively moderates the relationship between enjoyment and satisfaction while it does not moderate the relationship from usefulness of information to satisfaction. When people watch VR content on a destination they are familiar with, their satisfaction decreases, but the VR content is still useful to obtain information about the destination regardless of familiarity. That is, when users watch heritage VR sites which they are familiar with, they feel that the VR is less



enjoyable, but they still get useful information from the VR content. This finding is also considered one of the important contributions of this study.

## 6.2 Practical implications

There are several practical implications of this study. First and foremost, system quality and presence remain important considerations. Ease of use, ease of navigation, speed of the system, and convenience, as well as the creation of a sense in the user's mind that he or she was present in another location are essential features for VR systems. These must be priorities for managers of VR heritage tourism experiences and system designers. Second, the authenticity of the heritage VR experience is vital as well. In fact, in our results authenticity was of even greater importance than system quality and presence. Thus, if trade-offs must be made, system designers should prioritize the creation of objects and locations that appear real and genuine over other considerations. Third, the VR design process should include an assessment of users' intended experience. If the majority of VR users desire hedonic experiences or place a high value on their perceived hedonic benefit, particular decisions should be made regarding content and VR system functionality. The same is true if users can be identified as primarily utilitarian. While many system design methodologies focus on users' requirements, few explicitly include hedonic and utilitarian considerations. Fourth and finally, our investigation of the moderating role of familiarity reveals that satisfaction with a VR system may decline over time if familiarity increases. Familiarity could perhaps increase by visiting the real-world site or through repeated visits to the VR site. System designers and managers of VR experiences should consider a plan that will regularly and consistently add new features, functionality, or content to maintain a high level of user satisfaction with the system over time. Given the important role of authenticity found here, it could suggest the value that can be gained by testing physical additions or modifications through the better utilization of digital twins. Similarly, in cases where user familiarity is known, customized displays and experiences can be provided to cater to that level of familiarity and maximize satisfaction.

## 6.3 Limitations

There are two limitations to this study that should be noted. First, there is the student sample. While our respondents clearly represent the young, tech-savvy travelers that constitute the target market of many VR sites, our subjects' motivation for participating could be different from other target audiences. For example, the role of enjoyment could be exaggerated and should, therefore, be considered in future studies. Second, only one site, Dubai360.com, was examined. Results should be confirmed with other niVR systems. The use of a wider variety of systems would provide added insight.

## 6.4 Future research

In addition to the aforementioned considerations for a more varied sample and varied VR sites, we also note the importance of extending these results by investigating siVR and fiVR sites. While niVR remains the most common form of VR in use today, siVR and especially fiVR are growing in importance. As discussion of the metaverse continues, researchers' understanding of this technology and its applications outside of gaming will need to grow. Furthermore, future researchers should also consider further investigation of object-related authenticity in VR research to more thoroughly understand its role and impact, particularly considering the impact of digital twins. This is particularly valuable given the prominent role of authenticity in many tourist experiences. Future research should also consider replicating this study at non-heritage sites to consider how the nature of the depicted site can affect the determinants of satisfaction with VR systems.

## 7 Conclusion

This study set out to explore the role of various mediating and moderating variables in research on satisfaction with VR systems. In particular, this study explored the mediating roles of usefulness of information, and enjoyment, and the moderating role of familiarity on users' satisfaction with a VR system. The role of these variables has not been explored in previous VR studies and so this study addresses a notable gap in current understanding. This is particularly evident when considering the empirical setting of heritage sites.

The results from this study reveal that users' hedonic and utilitarian evaluations are effective in predicting users' satisfaction with a VR system. While focusing on enjoyment (a hedonic aspect) is important, its effectiveness in influencing satisfaction is negatively moderated by user familiarity.

Furthermore, authenticity played a noteworthy role in predicting users' perceptions of enjoyment and usefulness of information. Authenticity, in fact, explained a higher amount of variability in satisfaction than the traditional VR variables of system quality and presence. It is important, therefore, to consider the authenticity of the VR displays and users' familiarity with the depicted heritage site when considering user satisfaction. It is also necessary to ensure that sites are authentic and that the usefulness of information is prioritized, as these factors explain users' satisfaction well, regardless of their degree of familiarity.

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**Data availability** The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

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