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# Evaluating visitor experience of digital interpretation and presentation technologies at cultural heritage sites: a case study of the old town, Zuoying

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## Abstract

Digital technologies are increasingly used in the interpretation and presentation process at cultural heritage sites, shifting the manner of heritage display from previous ways, which tended to be monolithic and static, to a more diversified, experiential, and interactive approach and enabling new connections between heritage and the public. Digital experience is gradually becoming an important component of visitors' heritage experience. However, little attention has been paid to the influence and effects that these technologies have on the visitor experience, and a corresponding measurement framework for the heritage digital experience is still lacking. To contribute to the design, implementation, and management of digital display systems at cultural heritage sites, this research aims to evaluate visitors' expectations, acceptance, and experience of digital interpretation and presentation technologies. A mixed methodology, combining questionnaires based on a digital experience evaluation framework and semi-structured interviews, was adopted and used in Old Zuoying City (OZC), a typical heritage site for the application of digital display technologies in Taiwan. Our study indicates that digital display technologies received high acceptance from heritage visitors and had a positive impact on some specific aspects, such as encouraging their exploration of and further learning about the site, helping them better visualize the richness of heritage, and creating new experiences of perceiving, engaging, and communicating with history. In addition, based on the survey findings, a number of recommendations for the current stage of digital display design are presented. The survey results and evaluation framework can be used as a reference for other research on heritage visitors and to improve digital interpretation and presentation design.

**Keywords:** Digital technology, Visitor experience, Cultural heritage site, Interpretation and presentation

## Introduction

Heritage conservation is essentially 'a communication act' (ICOMOS 2008), that is, the inheritance and transmission of heritage value. Therefore, as an activity aimed at raising public awareness and improving the public's understanding of cultural heritage sites (interpretation) and the planned dissemination of

heritage contents at cultural heritage sites (presentation), the interpretation and presentation of heritage have always been regarded as one of the critical missions in the national and international protection of cultural and natural heritage and as the essential component in the process of heritage conservation (UNESCO 1972; ICOMOS 2002; 2008). By communicating to people the significance and connotation of cultural heritage through the organization of 'potential activities', 'interpretive information', 'physical access', and 'interpretive infrastructure' at cultural heritage

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sites (Guo 2009; ICOMOS 2008), interpretative and presentative activities convey cultural values and cultural identities, enhancing visitors' understanding of, enjoyment of and positive attitudes towards heritage sites (Stewart et al. 1998) and stimulating visitors' further learning, experience, and exploration to ultimately 'encourage the high level of public awareness and support necessary for the long-term survival of the cultural heritage' (ICOMOS, 2002). Consequently, planning interpretation and presentation that effectively communicate heritage information and value and that provide visitors with a positive and valuable experience is becoming a significant mission for cultural heritage institutions.

The application of various technologies in the process of cultural presentation and interpretation has been ongoing for decades (Othman et al. 2011). For instance, the first use of voice-guided navigation technology in cultural spaces dates back to 1952, when the Stedelijk Museum in Amsterdam provided historical background and exhibition content to visitors through handheld guides (Tallon 2008). Similarly, numerous international cultural heritage protection documents emphasize the importance of technology integration in heritage interpretation and presentation at different levels. For example, the 1972 UNESCO Convention indicates that presentation work should keep abreast of advances in 'communication, audiovisual techniques, automatic data-processing, and other appropriate technology, and cultural and recreational trends' and suggests that 'all media of information should be employed as required' during the heritage display process (UNESCO 1972).

Since the 1990s, digital technologies have been widely used in the context of cultural heritage (He et al. 2017), becoming strong supports in heritage interpretation and presentation. In particular, the incorporation of *Reality Creation Technologies*,<sup>1</sup> such as virtual reality (VR), augmented reality (AR), and mixed reality (MR), which provide diversified content formats (video, 3D-animation, multimedia, etc.) and abundant methods of interaction (voice interaction, touch-screen interaction, gamified operation, etc.), have shifted the form of heritage display from previous forms, which were supported only through printed images, textual descriptions or other limited static settings, enhancing the authenticity, experience and interactivity of presentations (Kong and Rong 2017) and enabling new interactions and connections between heritage and the public (Liu 2018).

<sup>1</sup>In the 2018 Digital Heritage International Congress, UNESCO summarized three groups of digital technology related to digital heritage: Reality Capture (digitization, scanning, remote sensing, etc.), Reality Computing (databases & repositories, KM, GIS, etc.), and Reality Creation (VR, AR, MR, games, multimedia, 3D printing, etc.).

Importantly, in the context of the increasing application of digital technologies in heritage interpretation and presentation, the use of digital technologies should not just be considered 'an information-distribution platform' (Wasserman 2011) or an alternative to traditional means of heritage information presentation. Instead, according to Othman et al. (2011), such technologies should be considered 'further ways to connect and engage visitors with objects, collections, and exhibits'. Accordingly, what influence and effects these technologies have on visitors is an issue requiring further discussion. Although digital technologies continue to create new opportunities and possibilities for heritage display, it could also negatively impact heritage communication and interfere with the visitor experience if they are not carefully developed and applied. Consequently, it is important to gain a holistic understanding of visitors' acceptance, experience, and expectations of digital interpretation and presentation to improve digital display design at heritage sites and to develop sustained visitor/heritage site relationships.

However, although research on digital heritage is on the rise, most recent studies have focused almost exclusively on digital documentation and information management (He et al. 2017). A few digital presentation-related papers, such as Wang et al. (2006) paper about the structure and working principles of the immersive outdoor AR system in Yuanming Garden, and Gleue and Dähne's (2001) paper about the design and implementation process for an outdoor mobile device for ancient Olympia in Greece, mainly explore the planning and implementation of digital display technologies in cultural heritage sites from design or technical perspectives through case studies. Far too little attention has been paid to the impact of digital interpretative technologies on the visitor experience. Moreover, while prior visitor studies in the cultural heritage site domain have conducted a certain amount of research on the visitor experience, with such research providing the essential theoretical underpinning of this study, there has been little specific research focusing on the role of digital display technologies in enhancing the heritage visitor experience. Furthermore, regarding the evaluation model or framework, there is still a lack of specific guidelines and scales for cultural heritage sites to evaluate the on-site visitor experience in contexts of digital display technologies (Pallud and Monod 2010).

Therefore, to contribute to the design, implementation, and management of digital interpretation and presentation at cultural heritage sites, this research aims to develop measures based on previous studies to quantify

the influence that digital display technologies have on heritage visitors to gain in-depth insights into visitors' experience and response to using interpretative and presentative technologies.

### **The evaluation of the visitor heritage experience**

As the visitor experience is increasingly recognized as a core product of heritage site offerings (Packer and Balantyne 2016), researchers from different disciplines have conducted extensive research on the heritage visitor experience, identifying visitors' key expectations (knowledge gains, education, participation, entertainment, active involvement, engagement, etc.) of a heritage attraction (Masberg and Silverman 1996; De Rojas and Camarero 2008; Pine and Gilmore 1999; Hughes and Benn 1995) and summarizing some critical influences (audio and visual communication; atmospherics; on-site engagement; information, etc.) on visitor heritage experience (Kempiak et al. 2017). Such research provides the essential theoretical underpinning of this study. Notably, however, these studies do not explicitly discuss the role of technologies in the heritage context.

On the other hand, there has been a small amount of research that includes surveys on visitors' experience of digital technologies. For instance, 'interactive and digital media' were set as one of the survey scales in Kempiak et al.'s investigation (Kempiak et al. 2017) of the visitor experience at a heritage attraction in Northern Ireland, and according to their results, interactive and digital media were 'vital forms of communication of heritage content and play a major role in visitor experience'. While some of these studies have addressed visitors' legacy digital experiences, most of them have emerged only as a very small facet of visitor heritage experience research, and an in-depth and comprehensive discussion is lacking.

Additionally, regarding the evaluation framework, there is still a lack of specific guidelines for measuring the visitor heritage experience, particularly in the context of digital display technology use (Pallud and Monod 2010). As such a framework involves the evaluation of visitors' digital experience, it seems that some frameworks from the field of digital product design regarding user experience (UX) research can be adopted to fill this gap. As a discipline that emphasizes user-centredness, UX evaluation is an important research component in the digital product design domain, and some systematic UX evaluation concepts and standards for product usability tests have been developed. For instance, Norman (2005) proposed three levels (visceral, behavioural, and reflective) of product design from the user psychological perspective and emphasized that these three levels were interrelated and together constituted the overall UX of

the product. On the other hand, Hartson and Pyla (2012) took more of a digital design perspective, emphasizing that ease-of-use and learnability were very important in and fundamental to most digital products and that users could not derive joy from using a digital product that was very awkward to use. Accordingly, they argued that the scope of UX evaluation should include the dimensions of usability, usefulness, and emotional impact. These studies provide informative frameworks for assessing visitors' heritage digital experiences, but they do not address the context of cultural heritage.

Therefore, conducting a follow-up survey, this study develops an evaluation framework of the visitor digital experience (Fig. 2) with reference to the abovementioned criteria related to UX testing, and it establishes specific measurement dimensions regarding the objectives of heritage site interpretation and presentation as well as visitors' heritage expectations. The framework is then used in this research to evaluate the digital experience of heritage visitors in an actual venue.

### **Methodology**

This study was designed to investigate the impact of digital interpretation and presentation at cultural heritage sites on the visitor experience. Therefore, to gain a detailed understanding of the issues raised, this study employed a field study methodology in which a self-administered questionnaire was used as the main research method to gather quantitative data on visitors' experiences, with the support of interviews to obtain further in-depth information on the specific feedback of participants.

### **Research venue**

The selected venue in this study, Old Zuoying City (OZC), is a well-known cultural heritage site located in Kaohsiung, Taiwan; it was registered as one of the First-Level Monuments of Taiwan in 1986. As one of Taiwan's first stone fortifications built during the Qing Dynasty, OZC (Fig. 1) is currently the largest and most well-preserved ancient city in Taiwan and has a special position among other ancient cities built during the same period. In addition, according to the results of archaeological research conducted over the past two decades, traces of human activity in OZC and the surrounding areas date back to the Neolithic period approximately 5000–4000 years ago (Liu 2008). The unique and profound history and culture of the prehistoric era, the Ming and Qing Dynasties, the Dutch period, and the period of Japanese occupation are interwoven in this area, making OZC an



**Fig. 1** The former appearance of the North Gate of Old Zuoying City (This photo was taken in 1917 and shows the representative building, the North Gate (also known as Chengong Gate), of OZC. The structure of the gate is still intact, but the buildings on top of it collapsed during the period of Japanese occupation). (Source: Taiwan Repository of Cultural Heritage. Research Center for Digital Humanities, NTU, 2010. [https://doi.org/10.6681/NTURCDH.DB\\_NRCH/Collection](https://doi.org/10.6681/NTURCDH.DB_NRCH/Collection))

indispensable and precious cultural heritage bearing witness to Taiwan's history.

Moreover, OZC was selected as a significant implementation site in the Regeneration of Historic Site Project, which is a public infrastructure investment project launched in 2016 by the Taiwan Bureau of Cultural Heritage to support the revitalization of local cultural assets and resources. The core concept of 'regeneration' emphasizes the utilization of diverse media to reproduce the historical meaning of each site and the use of emerging digital technology to guide people through diverse historical memories, connecting the current generation with cultural values (Taiwan Bureau of Cultural Heritage 2016). As a subproject of the Regeneration of Historic Site Project, OZC Renovation Project is regarded as an unprecedented large-scale cultural heritage preservation plan in Kaohsiung City that demonstrates the evolution of the cultural heritage preservation concept in Taiwan (Wang et al. 2018). Guided by the project's vision of presenting the past to the public by applying innovative experiential methods to combine culture and technology (Taiwan Bureau of Cultural Heritage 2016), OZC utilizes digital technologies to present its history to visitors, to evoke the public's memory of the historical site, and to promote the public's recognition of the value of cultural heritage (Wang et al. 2018). The whole interpretation and presentation system in OZC includes eight areas, six of which are integrated with digital technologies (see Table 5 in Appendix 1), such as AR, VR, moving models and

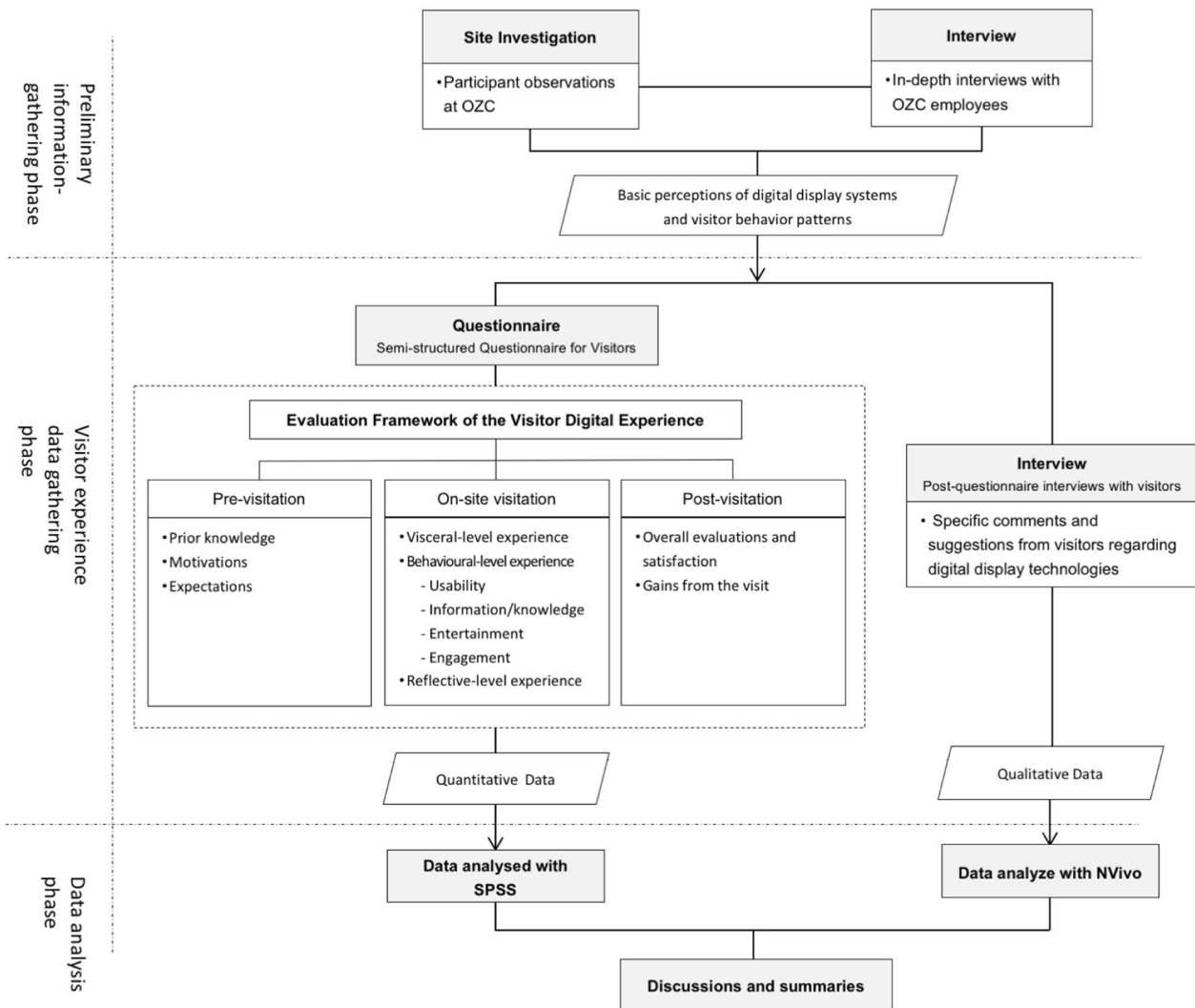
projection mapping, offering diverse media content, such as audio and video. Consequently, historical and cultural display system in OZC operates not through cultural relics or other static presentations but primarily through digital technologies and dynamic content. Accordingly, OZC is an excellent setting for evaluating and determining the effects that digital display technologies have on the visitor experience in cultural heritage sites.

#### Survey design

The overall structure of the survey took the form of three phases (Fig. 2). First, site investigations and interviews with OZC employees were conducted to gather information about the setting of the digital display system at OZC and visitors' reactions during their visits and their interactions with the digital interpretation and presentation settings to ensure the relevance of the questionnaire design before conducting the next phase of the investigation.

In the second phase, an evaluation framework of the visitor digital experience was created based on the abovementioned research related to the assessment of the visitor heritage experience and the UX testing of digital products. Guided by the framework, a three-section questionnaire with both close-ended and open-ended questions was developed and used to gather quantitative data from visitors during the pre-visitation, on-site visitation, and post-visitation periods.

## Field Study Methodology



**Fig. 2** Research framework (Source: the author)

The first section (pre-visitation) of the questionnaire covered information about the respondents’ experience of digital technologies, their prior knowledge of OZC, and their motivations for and expectations of their visit.

The second section (on-site visitation) of the questionnaire (see Table 6 in Appendix 2), which was the key part of this survey, was designed to measure the respondents’ experience of digital interpretation and presentation technologies during their visit. Since OZC offers several types of digital technologies, this section surveys the equipment globally. Information on visitors’ experience of different specific technologies was gathered in this section of the questionnaire. Guided by Norman’s (2005) theory of the three levels of user cognitive experience, the second section of the questionnaire was divided into

three parts: the first part focused on the *visceral level* of the respondents’ experience, gathering their first impressions of the digital display system; the second part investigated the *behavioural level* of the respondents’ experience during their visit, addressing four key areas (usability, information/knowledge, entertainment, and engagement) through items that integrate the influence of both the digital product UX and the heritage visitor experience; the third part examined the *reflective level* of the respondents’ experience to gain a further understanding of the influence that the digital interpretation and presentation system has on visitors. A five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree) was employed for each question to measure the items above.

The final section (post-visitation) aimed to gather visitors' overall evaluations of and satisfaction with the digital interpretation and presentation system, their gains from the visit, and their recommendations for digital display design at OZC and other cultural heritage sites.

As a supplement to quantitative data on the visitor experience, post-questionnaire interviews were conducted with respondents who wanted to share further information. Through a semi-structured interview, the researchers aimed to gain further insights into the reasons for the different choices and evaluations made by the questionnaire respondents and to gather their specific comments and suggestions on the form, content, interaction mode and other aspects of digital interpretation and presentation.

The collected quantitative and qualitative data were computerized and further analysed using SPSS and NVivo, respectively.

### Data generation

The survey was conducted at OZC from June to July 2019 on both weekdays and weekends. To ensure the maximum number of respondents, the researcher was positioned at the entrance of OZC, where visitors need to return rented AR devices before leaving the site. As two out of the eight display areas in the site do not use digital technologies, the survey questionnaires were distributed to only visitors who experienced the digital interpretation and presentation settings to guarantee the validity of the collected data. All the questionnaires and follow-up interviews were completed on site by the respondents immediately after they finished their visit. Over 90 took part in the survey, with an average questionnaire completion time of 15 min. In addition, a total of 41 short follow-up interviews (ranging from 10 min to 40 min) were conducted with questionnaire participants who were willing to share further information regarding their interaction with digital technologies.

### Findings

After deleting unusable questions with too many unanswered questions, a total of 81 valid responses constituted the final sample of this study. The descriptive statistics of the respondents were coded and computed in SPSS (v26) for analysis.

### Respondent details

As shown in Table 1, female visitors (63.4%) represented a larger proportion of the survey respondents than male visitors (34.6%). The age of the respondents ranged from 13 to 70 years, and the majority (75.5%) of visitors were within 13–20 (37%) and 21–30 (38.5%) age groups. Regarding fields of interest, history (51.6%), culture (64.2%), architecture (50.6%), and cultural heritage (50.6%) received relatively high ratings from the participants, followed by art (37%) and three digital technology-related options (23.5%).

The descriptive statistics also indicate that over 87% of the visitors who participated in this study had experience visiting cultural heritage sites. Most of them had visited 1–5 different sites (59.3%), followed by more than 10 (17.3%) and 6–10 (11.1%). With regard to the respondents' experience using on-site cultural display settings, the study showed that the figures for information boards (67.6%), literature and historical text (60.6%), simulation items and models (60.6%), and multimedia (62%) tend to be fairly similar; thus, they are the four types of cultural display settings most frequently used by respondents who had visited cultural heritage sites before. The proportion of participants who used navigation (31%) was slightly higher than the proportion of participants who used digital interactive applications (22.5%) or other settings (22.5%).

### Pre-visit expectations and prior knowledge of the site and digital technologies

Surprisingly, according to the participants, the main expectation of OZC visitors was to experience different digital display technologies at the site (32.6%); this result, was even slightly higher than the expectation to learn more about the history and culture of the heritage (30.8%). The prior interviews with employees at the site and the post-questionnaire interviews with visitors show that the major reasons for this result are closely related to the digital display technology-focused marketing strategy launched by OZC and the online and offline promotion content (YouTube videos, Facebook posts or paper flyers) received by the public. To some extent, this result also reflected the attractiveness of cultural heritage digital interpretation and presentation to visitors. Furthermore, the survey revealed that over three-fourths of the sample knew nothing (12.3%) or had extremely limited knowledge (77.8%) about the site, thus indicating an area for improvement. Additionally, over 70% of those surveyed indicated that they were unfamiliar with AR/VR or other digital technologies, and nearly 10% had never used any of the above equipment or technologies.

### Experience of digital interpretation and presentation during the visit

In this section of the questionnaire, the participants were asked to indicate their experience of digital display technologies using a Likert scale. Their responses were analysed in SPSS (v26) to measure the scales of experience at three levels. Before proceeding with further analysis, the data were checked for internal reliability using Cronbach's alpha coefficient. Except for *usability*, which had a Cronbach's alpha (0.698) slightly lower than 0.70 (Table 3), the other survey results (ranging from 0.788 to 0.960) were above the recommended values, indicating a relatively high level of reliability. According to Nunnally and Bernstein (1994), 0.6 is acceptable for exploratory investigations; thus, all of the scores for each scale were adopted in this study.

**Table 1** Respondent characteristics

Gender	Distribution	Age	Distribution	Field of interest	Distribution	Experience visiting cultural heritage sites	Distribution	Experience using on-site cultural display settings (N = 71)	Distribution
Male	28 (34.6%)	13–20	30 (37%)	History	50 (61.7%)	None	10 (12.3%)	Information boards	48 (67.6%)
Female	53 (65.4%)	21–30	29 (38.5%)	Culture	52 (64.2%)	Visited 1–5 different sites	48 (59.3%)	Literature and historical text	43 (60.6%)
		31–40	7 (8.6%)	Architecture	41 (50.6%)	Visited 6–10 different sites	9 (11.1%)	Simulation items and models	43 (60.6%)
		41–50	6 (7.4%)	Art	30 (37%)	Visited more than 10 different sites	14 (17.3%)	Navigation (manual or navigators)	31 (43.7%)
		51–60	6 (7.4%)	Cultural heritage	41 (50.6%)			Multimedia (movies or animations)	44 (62.0%)
		61–70	3 (3.7%)	Digital technologies/products	19 (23.5%)			Digital interactive applications (interactive devices/AR/VR/etc.)	16 (22.5%)
				Digital art	19 (23.5%)			Others	16 (22.5%)
				Digital games	19 (23.5%)				

Note: Only respondents who had visited cultural heritage sites (N = 71) needed to answer the question about their experience of using on-site cultural display settings. The field of interest and experience using on-site cultural display settings results are presented using percentages of cases; thus, the data summation exceeds 100%

**Table 2** Analysis results of the respondents' visceral-level experience

Level	Question	Mean	SD	Level Mean	Cronbach's Alpha
Visceral level	Q1	4.10	0.752	4.11	0.960
	Q2	4.14	0.685		
	Q3	4.10	0.718		

**Visceral-level experience**

Regarding their first impressions of the digital interpretation and presentation at the site (Table 2), the majority (85.2%) of the sample indicated that they were satisfied (55.6%) and perfectly satisfied (29.6%) with the way history and culture were presented, while only 2.2% reported that the digital display technologies were unacceptable. The results also revealed that most of the respondents were willing (55.6%) and very willing (28.45%) to operate the different settings themselves to discover the history of OZC. Visitors are motivated to interact with the digital settings at heritage sites.

Moreover, one-way ANOVA was conducted to determine whether there were any age differences in the variables with regard to visceral-level experience. The test revealed significant age differences in the respondents' first impressions of digital interpretation and presentation at the site ( $F = 8.356, p < 0.001$ ) as well as the presentation of cultural heritage and the willingness to learn about history through self-operated digital devices ( $F =$

7.123,  $p < 0.001$ ). The respondents in the 21–30 age group appeared to have the best first impressions of the digital display technologies at the site (mean = 4.59) and were the most willing to operate the various digital devices (4.59), closely followed by the visitors in their 30s (mean = 4.57 & 4.43); on the other hand, the participants in their 60s had a relatively low acceptance of digital displays (mean = 3.00 & 3.33).

**Behavioural-level experience**

As shown in Table 3, the overall satisfaction with behavioural-level experience appeared to be high, as the average score for every factor was higher than the mean score of 3.00.

Unexpectedly, *usability* resulted in the lowest value (mean = 3.543) among all the factors. This finding indicates limited user satisfaction with the basic performance of digital display devices, such as learnability and operability. Specifically, only 7.4% of the respondents strongly agreed that they could complete the various operations of the devices without guidance

**Table 3** Analysis results of the respondents' behavioural-level experience

Level	Factor	Question	Mean	SD	Factor Mean	Cronbach's Alpha
Behavioural level	Usability	USA1	3.94	0.927	3.543	0.698
		USA2	3.41	0.959		
		USA3	3.91	0.869		
		USA4	2.91	0.990		
	Information/knowledge	INF1	3.85	0.760	4.086	0.921
		INF2	4.17	0.738		
		INF3	4.21	0.702		
		INF4	4.04	0.749		
		INF5	4.22	0.671		
		INF6	4.02	0.758		
	Entertainment	ENT1	4.30	0.697	4.173	0.788
		ENT2	4.23	0.841		
		ENT3	3.99	0.789		
	Engagement	ENG1	4.07	0.803	4.007	0.913
		ENG2	3.89	0.806		
ENG3		3.96	0.732			
ENG4		4.04	0.749			
ENG5		4.07	0.755			



from staff, and 16% of the visitors agreed with this assertion. Employees play a crucial role in directing visitors how to use digital devices. Similarly, the results show that nearly half (53.1%) of the users could not determine how to operate different devices within a short period of time. This result may be related to the fact that most of the digital devices at OZC are more recent technologies such as AR and VR; moreover, this result is associated with the respondents' prior experience with digital products (more than 70% of the sample had never used similar devices before visiting OZC).

Regarding *information & knowledge*, the contribution of digital technologies in reliving historical scenes and presenting historical information was largely recognized by the visitors, with mean scores of 4.27 and 4.21, respectively. Additionally, 35.8% of the respondents strongly agreed that digital technologies allowed them to understand the history of

OZC in a more dynamic way, and 50.6% agreed with the above statement, suggesting that digital display technologies play an effective role in the dissemination of heritage content. They also considered the digital presentation and interpretation to be intuitive and impressive. On the other hand, the results show that the visitors were not entirely satisfied with the clarity of the historical content presented by technologies (mean = 3.9), which is the most basic requirement that should be met.

The *entertainment* factor was rated as the best experience provided by the digital display technologies. The display design of OZC combines the advantages of digital technologies in terms of gamification and interactivity, to a certain extent enriching the presentation and form of user participation. For instance, the *Treasure Hunt in the Old City* display area combines the presentation of different artefacts with a scavenger hunt, guiding visitors to find golden coins



**Fig. 3** Screenshot of the *Our Old City* VR experience

**Table 4** Analysis results of the respondents' reflective-level experience

Level	Question	Mean	SD	Level Mean	Cronbach's Alpha
Reflective level	Q1	3.79	0.754	3.92	0.891
	Q2	3.91	0.762		
	Q3	3.98	0.774		
	Q4	4.00	0.725		

(AR content trigger points) using AR devices to obtain dynamic artefact information; moreover, in another display area, *Our Old City*, visitors can rebuild the heritage site themselves in virtual 3D space with VR equipment (Fig. 3). The survey revealed that 46.9% and 42% of the sample agreed and strongly agreed, respectively, that the way in which history was presented was entertaining, with only 1.2% of respondents reporting that they took no pleasure, suggesting the significant contribution of digital display technologies in enhancing the fun of visitors' experience. The overall interactive process and game design in the display content also received high ratings from users.

Finally, the mean score for the *engagement* factor was 4.007, with most (76.5%) of the sample reporting that they had an immersive experience of OZC history offered by digital display technologies. In addition, 51.9% and 27.2% of the visitors agreed and strongly agreed, respectively, with the statement that digital display technologies at OZC contributed to the sense of historical participation. The results also revealed that digital technologies, at least to a certain extent, increased the respondents' interest in visiting cultural heritage sites, given that 74.1% of them were willing to spend time exploring different digital display areas and 66.7% would like to repeatedly operate different digital display devices and watch or experience digital display content.

Additionally, further one-way ANOVA revealed no significant age differences for most of the items included here, suggesting that visitors of different ages shared similar perceptions of the behavioural-level digital experience. However, differences in age had a greater impact on ENT 1 ( $F = 4.510$ ,  $p = 0.01$ ) and ENT 2 ( $F = 6.069$ ,  $p < 0.01$ ) for the *entertainment* factor and ENG1 ( $F = 8.118$ ,  $p < 0.01$ ) and ENG 2 ( $F = 5.378$ ,  $p < 0.01$ ) for the *engagement* factor. Specifically, participants in their 20s had a higher recognition of entertainment both in the digital display technologies (mean = 4.39) and the interaction process (mean = 4.61) with digital display settings compared to participants in other age groups, especially those over 60. Similarly, compared to other participants, those between the ages of 21 and 30

showed higher enthusiasm for exploring different digital display contents and repeatedly operating digital display settings.

#### **Reflective-level experience**

Regarding the holistic perception of heritage and a deeper intellectual resonance, the results (Table 4) reveal that the majority (64.2%) of the sample reported that digital display technologies gave them a comprehensive understanding of the architecture, history, and culture of the heritage, while 71.6% indicated that technologies increased their interest in OZC. Additionally, 79.1% of the visitors agreed (55.6%) and strongly agreed (23.5%) that technologies had furthered their understanding of and reflection on history and cultural heritage.

#### **Post-visit experience**

The content of the open-ended questions and the results of the post-questionnaire interviews relating to the details on overall satisfaction with digital presentation and interpretation at the site were analysed.

In relation to how visitors described their experience of digital display technologies, the results reveal that 'lively', 'interesting', and 'attractive' were the three feelings most frequently mentioned by the respondents. Quite a few interviewees argued that static presentations (i.e., images or text) need to be understood by themselves, which results in a boring experience, while the dynamic presentations offered by digital technologies were 'more intuitive', 'more stimulating', 'delicate and vivid', making it 'easier for us to understand historical events'. One individual stated that 'Through moving pictures and sounds, you can get a basic understanding of the history of this building in just ten minutes' (30s, F).<sup>2</sup> Another commented, 'It (digital display) gets your attention through a combination of various presentations; you will pay attention while it is speaking' (40s, M).

Participation, engagement and immersion were also reported by the respondents as meaningful experiences

<sup>2</sup>The interviewee's gender and age are indicated at the end of the quotations. F = female, M = male.

that digital technologies satisfactorily provided. The interactive presentations supported by digital technologies were well appreciated by the majority of the participants: 'Interaction is very important. Most of the displays at cultural heritage sites provide a one-sided experience; it is more interesting to have a sense of participation' (70s, M). Another participant 'Thought it was interesting. Something will be displayed after the operation, and the content will be different each time it appears so that you'll want to go through it again and again' (20s, F). In addition, the interviewees indicated that they felt immersed and gained a sense of historical engagement created by digital technologies, especially AR and VR, during their visit: 'It's more contemporary and intimate, like following them through history'; 'We basically rely on our imagination for historical things, but this technology (VR), although it relies on simulation, allows us to enter into the historical scene, to be there, to hear, to see, to feel, to have a sense of profundity' (40s, F).

Furthermore, a certain amount of negative feedback on digital interpretation and presentation focusing on three main areas was provided during the post-questionnaire interviews. First, issues related to equipment and supporting hardware were mentioned repeatedly. Digital displays need to be presented with the help of supporting equipment, and some interactive displays require users to operate the corresponding equipment themselves. According to the survey results, a common view among the vast majority of female interviewees was that some of the hand-held devices used at OZC (i.e., the AR devices provided at the site) were too heavy and became a burden on users' hands after a period of use; other devices also suffered from problems such as mismatches with users' height and caused eye discomfort. Moreover, several of the parents interviewed were concerned that some digital devices were difficult for children to operate independently. Second, there were a small number of negative comments focused on the disruption caused by the stacking of too many dynamic elements. During the interviews, some visitors indicated that too many motion effects (i.e., sound, motion pictures, and other feedback generated in conjunction with user actions, etc.) were presented at the same time while they were watching the content on the display, which to some extent affected their access to history. Finally, a few interviewees, mainly those with a cultural history-related background or history enthusiasts, considered that part of the digital display content could be improved in terms of its relevance to heritage history. For example, one interviewee said,

'It has more interaction, but fewer parts that are integrated with history; It's more interesting, but some historical content is sacrificed' (40s, F). Another commented, 'The AR game at OZC is fun on its own, but the content part of it could be a little more in depth; it is like triggering the event, but the event itself, in terms of getting to know the history of OZC, is of limited practical use' (30s, F).

In summary, the overwhelming majority perceived that digital display technologies were impressive, allowed them to learn more about the site during their visit and increased their willingness to seek knowledge about heritage. Some individuals stated that due to the special nature of this presentation, they were more willing to share their experiences and gains with others. Moreover, nearly all of the respondents (88.9%) indicated that they would use digital display devices and technologies when visiting other cultural heritage sites.

## Discussion

The findings relating to the expectation of heritage site visitation indicated that experiencing digital technologies has become a vital motivation and attraction for visitors. In addition, the results of visceral-level experience show a high level of acceptance of digital interpretation and presentation technologies and a high willingness to interact with digital settings at different heritage sites from a large proportion of the participants, especially young respondents. Therefore, it can be theorized that on-site digital display technologies are becoming an important component of the heritage visitor experience, with a similar result presented by Othman et al. (2011). To a certain extent, introducing digital technologies may be beneficial for heritage sites to attract wider visitor segments, especially young technology enthusiasts (Leask et al. 2013).

However, although digital technologies are increasingly becoming attractions for heritage visitors, the respondent characteristic and pre-visit experience results show that the majority of the participants had limited exposure to digital display technologies in their past visits to heritage sites and that a significant number of them were first introduced to digital settings such as AR and VR at OZC. Accordingly, digital display technology '*beginners*' (Cooper et al. 2007) constitute the majority of heritage site visitors at the present stage. Additionally, most digital display settings are no longer a unilateral presentation of information but require user participation, which to some extent increases the

difficulty of initial use. Therefore, to ensure rapid, efficient and targeted interaction, it is essential to optimize the basic usability, learnability and accessibility design of digital display settings, for which the lowest results among all four factors in this visitor experience survey were obtained. Meanwhile, the instruction and guidance services offered by heritage site workers are also considered to be helpful in enhancing visitors' first use experience, especially the sense of security, with unfamiliar digital technologies, according to the questionnaire findings and results of the interviews with OZC employees and visitors.

In addition to usability, the survey relating to visitors' behavioural-level experience evaluated three other components: information/knowledge, engagement, and entertainment. The survey results supported the work of Masberg and Silverman (1996), Poria et al. (2006) and Packer and Ballantyne (2016), who argued that gaining more knowledge and knowing more about heritage were still the main purposes of visiting heritage sites. Meanwhile, the visitor experience findings revealed that the dynamic presentation incorporating multiple media (i.e., sound, moving image, 3D animation) with digital technology support had obvious advantages in recreating historical scenes and damaged artefacts and in visually presenting historical contents and that it had a significant effect in helping visitors quickly, intuitively and easily understand heritage, enhancing their interest in learning and deepening their impression of heritage. However, the findings also indicated that the simultaneous use of excessive dynamic effects and overly voluminous multimedia content tend to reduce the clarity of heritage presentation, thus interfering with visitors' experience accessing information. This result highlights the need for and importance of user testing before officially launching digital display settings to assess the impact of different combinations of presentation technologies and the design of presentation effects on visitors to ensure appropriate use. In addition, the results identified an association between visitors' prior knowledge of heritage and their needs in terms of the depth and breadth of digital presentation content. Stewart et al. (1998) proposed a similar finding and suggested that the provision of interpretation should be differentiated by visitor type (seekers, stumblers, shadowers, and shunners). Given the advantages of digital technology in the identification of user information and the segmentation of user needs (Kong and Rong 2017) as well as the technical superiority of digital displays in presenting diverse, interactive heritage content, it is highly feasible for heritage sites to further satisfy the diverse needs of visitors from different categories by creating and providing more

targeted, hierarchical, and customizable digital display content.

A study by Kong and Rong (2017) pointed out that a heritage display system was a *pleasure-oriented information system* and emphasized the need to enhance visitors' perceived enjoyment. In this study, the findings reveal the importance of digital technologies in the creation of enhanced on-site entertaining experiences. In particular, some digital presentations that incorporated story-based content and game-like participation helped create a more interesting learning process. In addition to the mechanical digitization of various heritage information, some creative development and transformation (i.e., storytelling narrative or gamification) in the forms or content of digital displays will contribute to enhancing and enriching the visitor experience at cultural heritage sites. Nevertheless, this study also showed weaknesses associated with an over-emphasis on entertainment design, which affected the systematization and clarity of heritage messaging, as a result of which the visitor experience process lacked effective access to heritage information. Therefore, a good balance should be struck in the design of digital displays to avoid diluting the connotation and value of cultural heritage due to excessive entertainment content.

The results emphasized that visitors are willing to actively participate in some co-creation processes and to interact with different digital display settings. Consequently, they tend to spend more time exploring and experiencing different displays compared to general static displays. Moscardo (1996) proposed a similar result and highlighted that interactive displays had a positive effect on increasing visitors' interest and effectiveness in learning. The findings also highlighted that these interactive processes, overcome the limitations of traditional forms of display, which are mainly limited to a unilateral information transfer, and help empower visitors' historical engagement and involvement. Furthermore, the majority of the participants considered that digital presentation, especially the immersive environment created by AR or VR, conveyed a sense of historical immediacy apart from other display forms. Li (2010) highlighted that one of the ultimate goals for cultural heritage was to find ways to bring people back to the site, to be there, and to have a direct dialogue. For cultural heritage sites, especially those that are no longer fully accessible to visitors, introducing creative technologies in heritage presentation will lead to a breakthrough in recreating a user-perceptible, conversational historical environment.

Additionally, the study revealed that compared to the older participants, the young participants showed greater recognition of the entertainment and immersive experience offered by digital technologies, which raises the question of how to better balance the experience of different age groups when planning digital displays.

Regarding reflective-level experience, most visitors recognized that digital display technologies provided a relatively comprehensive introduction to heritage and, to a certain extent, further triggered them to think in depth about the development and current status of cultural heritage. Overall, the establishment of the visitor's reflective experience is the result of the synergy and cooperation of various presentations within the whole display system (Li and Yan 2018); among them, research has shown that the advantages of digital displays in these aspects, such as the integration of multimedia content presentation, the interactive display process, and the creation of immersive historical scenes, play significant roles in enhancing the comprehensiveness and depth of visitors' understanding of heritage sites.

### **Limitations of this research and future directions**

The evaluation of this study focuses on a range of digital technologies (including AR, VR, projection mapping, etc.) used for heritage presentation at OZC rather than on any specific technology. Therefore, this study can be followed by further testing related to the specific role and impact of a representative type of technology in heritage interpretation and presentation. Furthermore, future research can use on-site observations to investigate details on visitors' interaction with different digital settings, which can complement the results of this quantitative study to provide further insights into visitors' digital experience at the operational level. Finally, as an effective supplement to traditional displays, digital interpretation and presentation have created many new possibilities for heritage communication, but the addition of new forms does not mean a complete abandonment of traditional ways. Conversely, how to establish an interconnected and complementary relationship between digital and traditional displays (i.e., physical displays or live tours) to jointly build a visitor-centred heritage display system is an issue that warrants investigation in the next stage of research.

### **Conclusion**

This study aimed to evaluate visitors' experience of digital interpretation and presentation technologies at

cultural heritage sites. On the basis of a review of the relevant literature, an evaluation framework, with key aspects and factors influencing visitors' digital experience at a heritage site pre-visitation (prior knowledge, motivations, expectations), during visitation (visceral-level, behavioural-level and reflective-level experience), and post-visitation (overall evaluations and satisfaction, gains from the visit), was developed. Based on this framework, a multi-approach survey, combining on-site investigations and interviews, was conducted at OZC, Taiwan.

The investigation of visitors' motivations and visceral-level experience indicated that digital display technologies received high acceptance from heritage visitors and motivated them to explore the site. In addition, regarding the perception of use during the visit, the results indicated that the presence of digital interpretation and presentation technologies at OZC contributed to a positive heritage visitation. Specifically, the dynamic, participatory, and immersive nature of digital display technologies enhanced the effectiveness, interactivity, and interest in the communication of heritage culture and values. Such technologies helped the public visualize the richness of the site and enhanced their interest in gaining more knowledge about the heritage; furthermore, they enriched the on-site heritage experience. In particular, some interactive and gaming programs had a significant impact on visitors' entertainment experience and, more importantly, created new experiences for visitors to perceive, engage with and communicate with history. Moreover, based on the analysis of the visitor experience data, this study suggests several areas for further improvement and attention in digital display design and management, such as improving the usability of digital settings, innovating digital display content, and promoting the personalized display of the site, to better meet visitors' expectations and guarantee more satisfying visitor heritage experiences.

However, it is also important to recognize that the use of digital technology is not a replacement for cultural heritage itself; rather, it is a medium for heritage communication as well as a support for and complement to visitors' experience of heritage (Guo and Zhuang 2017; Li 2010). The fundamental purpose of the digital presentation and interpretation of cultural heritage can be better achieved by unifying multi-layered heritage content and digital technologies to serve the cultural needs of visitors while at the same time actively creating valuable cultural, technological and emotional experiences for visitors and further inspiring them to resonate with heritage values.

## Appendix 1

Interpretation areas supported by digital technologies at OZC (Table 5).

**Table 5** Details on the interpretation technologies and content at OZC

Division of the interpretation areas	Main digital technologies used in each area	Interpretation content
Treasure Hunt in the Old City	Augmented reality	Basic information about unearthed artefacts discovered at archaeological sites and virtual restoration results of partially damaged artefacts
Representation of OZC	Moving model & projection mapping	Historical and cultural evolution of OZC over time and the changes in the construction of buildings within OZC in different periods
A Tale of Two Cities	Virtual reality & projection mapping	Introduction to the relationship between Zuoying and Fongshang, which are regions belonging to OZC, and their historical changes
Image of the Old City	Projection mapping & digital animation	Old memories of OZC residents
Chronology of Major Events	Augmented reality	Representative and important events from different historical periods of OZC
Our Old City	Virtual reality	Construction details on the different buildings in the city; visitors can also create their OZC in the VR game

## Appendix 2

The second section (on-site visitation) of the questionnaire (Table 6).

**Table 6** Factors and items developed for each experience level

Level	Items
Visceral level	<p>I was pleased with the way digital technologies were used to recreate the historical scenes and the original appearance of artefacts at OZC.</p> <p>I was pleased with the way digital technologies were used to show the historical development and evolution of OZC.</p> <p>I was pleased with the way the history of OZC was understood by operating digital interactive devices such as AR and VR by myself.</p>
Behavioural level	<p>Usability</p> <p>I considered the operation of digital display devices such as AR/VR to be easy to learn.</p> <p>I can understand the operation of different digital display devices in a short period of time.</p> <p>I considered the process of operating digital display devices such as AR/VR to be simple.</p> <p>I can complete the various operations of digital display devices on my own without guidance from staff.</p> <p>Information/knowledge</p> <p>I can clearly understand the digital display content in different areas.</p> <p>Digital display technologies recreated the historical scenes and the historical landscape of OZC.</p> <p>Digital display technologies presented the historical evolution and development of OZC.</p> <p>Digital display technologies allowed me to know and understand OZC more intuitively.</p> <p>Digital display technologies allowed me to know and understand OZC more dynamically.</p> <p>I was more impressed by the process of understanding and getting to know OZC through digital display technologies.</p> <p>Entertainment</p> <p>I considered the way the history of OZC was presented through digital display technologies to be interesting.</p> <p>I considered the interactive process with digital display devices such as AR/VR to be entertaining.</p> <p>I considered the addition of gamification factors has made the process of understanding OZC more enjoyable.</p> <p>Engagement</p> <p>I was willing to spend time exploring different digital display areas.</p> <p>I was willing to repeatedly operate different digital display devices and watch or experience digital display content.</p> <p>Digital display technologies offered me an immersive experience.</p> <p>Digital display technologies offered me the experience of participating in the history of OZC.</p> <p>Digital display technologies offered me a personalized, unique experience.</p>
Reflective level	<p>Digital interpretation and presentation gave me a comprehensive understanding of the history and culture of OZC.</p> <p>Digital interpretation and presentation made me more interested in the history of OZC.</p> <p>Digital interpretation and presentation made me more interested in cultural heritage.</p> <p>Digital interpretation and presentation made me think in depth about the significance and meaning of history and cultural heritage.</p>

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### Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

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The authors declare that they have no competing interests.

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