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Optimal telepresence experience in heritage tourism: A multidimensional scale and its impact on tourist behavior

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ABSTRACT

Virtual reality (VR) is increasingly being integrated into on-site heritage tourism, yet little is known about how visitors evaluate hybrid experiences combining physical heritage environments with VR-mediated reconstructions. To address this gap, drawing on telepresence and flow theory, this study conceptualizes and validates Optimal Telepresence Experience (OTE) as a higher-order experiential construct reflecting visitors' overall technology-enhanced heritage experiences. Using a multi-stage scale development process with data collected at a heritage museum in Hue, Vietnam, the study develops and validates the OTE measurement instrument. The findings show that OTE, reflected through emotional, cognitive, and functional dimensions, strengthens visitors' memory formation and revisit intention. Theoretically, the study advances immersive tourism research by conceptualizing and validating OTE as a higher-order experiential construct for hybrid technology-enhanced heritage experiences. Practically, the validated OTE scale provides a tool for designing and evaluating VR-enhanced heritage experiences that foster deeper visitor engagement and behavioral outcomes.

1. Introduction

Virtual reality (VR) has emerged as a valuable tool in cultural tourism, enabling users to remotely explore heritage sites and gain insights into their cultural significance (Aziz & Siang, 2014; Huang et al., 2023; Wu et al., 2020). A key construct in VR experiences is "telepresence" which is the feeling of *being there* within a mediated environment (Steuer, 1992). This concept has been widely studied in off-site VR contexts, where users remotely interact with virtual representations of cultural heritage locations (Zhu, Hall, et al., 2023). While existing research has focused on how telepresence enhances remote VR experiences (Krasonikolakis et al., 2018; S. Lee et al., 2011; Alkarney & Almakki, 2022), comparatively little attention has been paid to on-site VR contexts, where visitors remain physically present at a heritage site while simultaneously engaging with VR-mediated heritage content. Consequently, the psychological processes underlying these hybrid heritage experiences remain underexplored (Doan et al., 2025).

Existing telepresence research has substantially advanced understanding of how individuals experience presence within mediated environments (Zhu et al., 2024). Telepresence captures the extent to which users feel *perceptually* present in a mediated environment, a continuum along which greater virtual presence is typically achieved through reduced awareness of the physical surroundings (Draper et al., 2008; Steuer, 1992). However, on-site VR heritage experiences represent a structurally different experiential condition. Rather than trading physical awareness for virtual presence, visitors simultaneously engage with physical heritage environments and VR-mediated reconstructions as integrated components of a single tourism experience. The experiential challenge is therefore not one of degree of presence in a mediated field, but of coherence across two co-present experiential fields, a condition that telepresence's extent continuum has not been developed to explain (Lorenz et al., 2025). Flow theory provides a complementary perspective by explaining optimal experience through deep absorption, focused attention, and sustained involvement in an activity (Mirvis & Csikszentmihalyi, 1991; Noor et al., 2025). However, its emphasis on concentrated absorption provides limited explanation of how visitors maintain a coherent experience while engaging across co-present physical and virtual experiential fields. To address this gap, the present study introduces the concept of Optimal Telepresence Experience (OTE), a higher-order experiential construct proposed as an explanation for visitors' overall evaluative experience of hybrid heritage encounters under conditions of dual engagement.

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Specifically, OTE captures how visitors evaluate and make sense of a technology-enhanced heritage encounter as a single integrated experience, rather than as separate physical and virtual experiences. The conceptual core of OTE lies in visitors' overall experiential evaluation of a technology-enhanced heritage encounter rather than the technological environment itself. In this study, the simultaneous engagement with physical heritage environments and VR-mediated reconstructions defines the experiential context in which OTE emerges, but does not constitute the construct itself. Emotional, cognitive, and functional attributes are therefore conceptualized as complementary dimensions reflecting this higher-order experiential construct. Accordingly, OTE provides a holistic conceptualization of visitors' technology-enhanced heritage experiences while remaining conceptually distinct from related constructs that primarily focus on specific aspects of the visitor experience in mediated or hybrid contexts.

Beyond the immersive experience itself, OTE is expected to exert significant psychological and behavioral effects on users. One such effect is the memory for the heritage site response. Prior studies suggest that emotionally rich VR experiences enhance memory encoding (Angelino et al., 2022), which in turn influences user engagement and revisit intention (Angelino et al., 2022; Han et al., 2021). In this sense, OTE functions as a higher-order experiential construct through which technology-enhanced heritage experiences are associated with memory formation and subsequent behavioral outcomes. By facilitating deeper processing of heritage content and stronger emotional involvement, OTE provides a theoretical explanation for how immersive experiences become memorable and subsequently influence tourists' future behavioral intentions.

In this study, virtual reality serves as an enabling tool, whereas the analytical focus is placed on tourists' experiential responses while physically on-site, which are conceptualized here as OTE. Specifically, the objectives of the study are threefold: (1) To conceptualize OTE; (2) to develop measurement items that capture the dimensions of OTE from on-site tourists using VR; and (3) to examine and confirm the construct validity of the developed scale. By shifting the focus to on-site VR experiences, the research expands understanding of immersive technology in cultural tourism, providing both theoretical insights and practical tools for enhancing visitor engagement in the digital age. This study makes several important contributions. First, it advances heritage tourism research by introducing OTE as an integrative framework that explains how users coordinate physical and digital realities on an actual site, thereby complementing existing telepresence and flow perspectives by conceptualizing visitors' overall technology-enhanced heritage experience within hybrid heritage settings. Second, by positioning OTE as an experiential mechanism linking hybrid engagement to enhanced memory formation and behavioral outcomes, this study provides a clearer understanding of how immersive technologies shape tourist experiences. Finally, from a practical perspective, the findings offer actionable insights for heritage site managers and tourism practitioners seeking to design VR-enhanced experiences that foster deeper engagement and more memorable visitor experiences.

2. Literature review

2.1. The telepresence experience in heritage tourism research

Telepresence is the perception of presence and feeling presented in a remote but natural environment (Draper et al., 2008). According to Draper et al., the combination of the words "tele" and "presence" convey the concept of projection into a distant area, whether the distance is *actual* (as in teleoperation and telecommunication), or *imagined* (as in VR). Telepresence more commonly refers to an operation in a computer-mediated environment, which is why a user who experiences telepresence in this setting, feels physically present (Akin et al., 1983); the effectiveness of the human-machine interface is frequently cited as a factor in determining the quality of the experience. In the VR environment, the relationship between the person who is the "sender" and the person who is the "receiver", and the mediated environment in which they are interacting, are the main points of emphasis from a telepresence perspective (Steuer, 1992).

As immersive technologies have advanced, telepresence has increasingly been examined as a core experiential outcome of VR systems. Prior research has shown that higher levels of telepresence are associated with greater perceived vividness and interactivity, thereby enhancing overall VR experience quality (Cowan & Ketron, 2019; Kim et al., 2021; Rodríguez-Díaz et al., 2022). Telepresence has also been linked to users' behavioral responses, including willingness to purchase (Orth et al., 2019) and visit intention (Ying et al., 2022), highlighting its role as a psychological mechanism through which VR experiences influence consumer decision-making. In addition, user characteristics and behaviors have been found to moderate telepresence experiences, suggesting that telepresence reflects not only technological attributes but also users' experiential engagement with VR environments (Surovaya et al., 2020).

Within tourism research, telepresence has been widely applied to understand how VR facilitates engagement with destinations prior to, or independent of, physical travel. In heritage tourism in particular, telepresence enables users to experience cultural and historical sites virtually, supporting early exposure, interpretation, and destination evaluation (Hong & Kim, 2022). Empirical studies have demonstrated that telepresence allows users to feel as though they are visiting World Heritage sites, contributing to both cognitive and affective destination images and enhancing aesthetic and educational experiences (Hong & Kim, 2022; Zhu et al., 2023a; Zhu et al., 2023b; 2024). As such, telepresence has become a valuable construct for examining the internal experiential responses of VR users in heritage contexts.

However, existing heritage tourism research has predominantly examined telepresence in off-site or fully virtual settings, where users engage with heritage content remotely. Comparatively little attention has been given to hybrid on-site contexts, in which visitors are physically present at a heritage site while simultaneously interacting with VR content (Kim, Kim, Park, & Yoo, 2023; Yoo, 2023; Zhao et al., 2023). These hybrid settings introduce a more complex experiential condition that may extend beyond traditional telepresence conceptualizations. Addressing this gap, the present study focuses on telepresence experiences that emerge when VR is used on-site at heritage destinations, thereby providing a foundation for reconceptualizing telepresence as an optimal experiential state in hybrid tourism environments.

2.2. Flow theory

Flow was proposed by American psychologist, Csikszentmihalyi in the 1970s. According to Csikszentmihalyi (1970, cited in Wang et al. (2023)), flow is a person's overall feeling when fully absorbed in an activity. In the flow stage, the thoughts, intentions, feelings and senses are integrated as they are aligned on a single goal (Mirvis & Csikszentmihalyi, 1991). Individuals experiencing flow, typically demonstrate heightened concentration, a sense of control and comfort, altered time perception, and intrinsic enjoyment derived from the activity itself, rather than from external outcomes (deMatos et al., 2021; Koufaris, 2002). As such, flow represents a state of optimal engagement that has been widely used to explain experiential quality and attitudinal change (Wang et al., 2023).

Flow theory has often been applied in research related to human experiences in remote technological environments (Kim, Kim, Park, & Yoo, 2023). Virtual realms provide users with both entertaining and demanding elements and the concept of flow is regarded as a legitimate metric for assessing users' experiences in these environments (Muhammad Sohail Jafar et al., 2024). Flow also plays an important role in determining user acceptance and willingness to engage with virtual worlds (Huang et al., 2023). Empirical research has applied flow theory to a range of contexts, including online shopping (Han et al., 2020),

online education (Zhu, Jiang, & Li, 2022), and destination marketing (Chang & Chiang, 2022), demonstrating its explanatory power in predicting user engagement, acceptance, and behavioral intention.

Recent studies further suggest that flow plays a central role in immersive media experiences. Wang et al. (2023) found that higher levels of perceptual immersion, such as those afforded by VR and 360-degree video, are associated with stronger flow experiences compared with traditional 2D formats. These findings are consistent with prior experimental and empirical research showing that immersive display technologies facilitate deeper involvement and enjoyment by enabling more seamless interaction and sensory engagement (Chang & Chiang, 2022; Koufaris, 2002). In this regard, flow has been identified as a core experiential benefit of immersive media, particularly in VR environments.

From a psychological perspective, flow is often described as an "optimal experience," referring to moments in which individuals experience a high degree of enjoyment, engagement, and experiential coherence (Mirvis & Csikszentmihalyi, 1991). In this study, "optimal state" is used as a broader umbrella term referring to high-quality experiential states, whereas "flow" refers to a specific theoretically defined optimal state characterized by deep absorption, intrinsic enjoyment, and experiential coherence. However, while flow theory explains one form of optimal psychological experience, it does not fully capture the experiential complexity of hybrid environments in which users simultaneously interact with physical and virtual elements (Doan et al., 2025). The present study treats flow theory as a foundational psychological mechanism that facilitates immersive engagement, rather than as a direct equivalent of OTE This distinction provides a theoretical basis for examining how flow supports the emergence of OTE in on-site VR-enhanced heritage tourism contexts.

2.3. *Re-conceptualizing the telepresence experience – optimal telepresence experience*

Telepresence research has primarily focused on users' perceived relocation into mediated environments, often assuming a psychological shift away from the physical environment (Doan et al., 2025; Shi et al., 2025). In tourism research, this perspective has been useful for understanding how virtual representations of destinations influence users' emotions, attitudes, and intentions. In the context of the COVID-19 pandemic outbreak, a number of studies were conducted on VR in general, and telepresence in particular; these demonstrated the role of telepresence in positively affecting users' feelings (Muhammad Sohail Jafar et al., 2024; Ongsakul et al., 2021; Sinha et al., 2025). Complementing this perspective, flow theory provides a lens for understanding immersive experience as a state of deep absorption characterized by focused attention, intrinsic enjoyment, and a merging of action and awareness (Cobb & Gouda, 1997; Mirvis & Csikszentmihalyi, 1991). In immersive environments, telepresence has been shown to facilitate flow by enabling seamless interaction and sustained engagement (Albayrak et al., 2025). However, both telepresence and flow are conceptually grounded in contexts where attention is directed toward a virtual remote experiential domain. Although telepresence and flow explain important aspects of immersive experiences, each focuses on a specific experiential process, namely perceived presence and attentional absorption (Mirvis & Csikszentmihalyi, 1991; Sinha et al., 2025). Neither construct was originally developed to conceptualize visitors' overall technology-enhanced heritage experience in which physical and virtual environments are experienced simultaneously (Deng et al., 2025). This insufficiency matters theoretically because it leaves the mechanisms linking hybrid immersion to memory formation and behavioral intention underspecified. It also matters practically because heritage managers cannot rely on telepresence or flow optimization alone when designing on-site VR experiences that integrate physical and virtual engagement.

In heritage settings where virtual reality is experienced on-site, we argue that users do not disengage from their physical surroundings. Instead, they remain simultaneously engaged with both the physical heritage environment and the VR-mediated reconstructions, a condition referred to in this study as dual engagement (Deng et al., 2025; Lorenz et al., 2025). As a result, immersive engagement in such contexts cannot be adequately explained by models that assume either attentional displacement (telepresence) (Draper et al., 2008) or uninterrupted absorption (flow) (Cobb & Gouda, 1997). Importantly, the need for OTE does not arise from the novelty of the hybrid context itself, but from the inability of existing constructs to explain how users sustain a coherent experience under conditions of simultaneous engagement. Telepresence's extent continuum remains oriented toward a single mediated field even where partial physical awareness is acknowledged, the theoretical logic positions it as residual, rather than as an active co-present experiential layer requiring integration. OTE addresses a fundamentally different condition: one in which both physical and virtual environments are simultaneously foregrounded as experientially meaningful, requiring active coordination rather than passive residual awareness. In this study, simultaneous engagement refers to the structural condition in which visitors encounter physical heritage environments and VR-mediated reconstructions within the same on-site experience. Dual engagement, in turn, refers to visitors' experiential involvement across these two co-present layers, through which the physical and virtual components remain jointly relevant to the overall heritage experience.

To address this limitation, this study introduces Optimal Telepresence Experience (OTE) as a higher-order integrative experiential construct. Optimal Telepresence Experience does not refer to the intensity of immersion alone, nor does it represent a general or all-encompassing experiential state. Rather, it specifically captures how users maintain experiential coherence while engaging with co-present physical and virtual environments. Accordingly, OTE conceptualizes the overall technology-enhanced heritage experience, rather than any single experiential process occurring within hybrid heritage encounters. A targeted construct addressing only dual engagement or the physical dimension would explain specific experiential inputs into that evaluation, but not the holistic evaluation itself – which is where variation in memory formation and revisit intention is most meaningfully explained. In this sense, OTE shifts the focus from immersion as a unidirectional process, to immersion as a condition requiring the ongoing coordination of perception, attention, and meaning-making across dual experiential layers.

Table 1 summarizes the key conceptual distinctions among telepresence, flow, and OTE, highlighting their differences in terms of underlying assumptions, attentional structure, and experiential mechanisms.

As shown in Table 1, OTE differs fundamentally from telepresence and flow, not in terms of intensity or constituent components but in the experiential condition it seeks to explain. While telepresence and flow primarily operate within single-domain assumptions (Kim, Kim, Park, & Yoo, 2023), OTE addresses experiential conditions of simultaneous engagement, in which visitors encounter both physical heritage environments and VR-mediated reconstructions within the same on-site experience (Lorenz et al., 2025). This hybrid experiential context creates conditions that extend beyond those captured by telepresence or flow alone. Accordingly, OTE should not be interpreted as a generalized form of immersion or engagement. Rather, it is conceptualized as a context-bound experiential construct that reflects how visitors perceive, evaluate, and make sense of technology-enhanced heritage encounters through the integration of physical and virtual realities. This conceptualization does not introduce another experiential component alongside telepresence or flow. Rather, it integrates emotional, cognitive, and functional responses into a higher-order experiential construct that reflects visitors' overall technology-enhanced heritage engagement across co-present physical and virtual layers. Consistent with recent research on physical–digital experiences (Lorenz et al., 2025), visitors are not

Table 1
Conceptual distinction between telepresence, flow and OTE.

Aspect	Telepresence (Draper et al., 2008)	Flow (Cobb & Gouda, 1997; Mirvis & Csikszentmihalyi, 1991)	Optimal telepresence experience (OTE)
Core focus	Perceived spatial presence in a mediated (virtual) environment.	Deep absorption and engagement in an activity	Experiential coherence across co-present physical and virtual realities
Underlying assumption	Users' psychological experiences shift toward the virtual environment	Users are fully immersed in a single, uninterrupted activity stream	Users remain simultaneously engaged with both physical and virtual environments
Attention orientation	Directed toward the virtual environment	Fully concentrated on a single activity	Continuously coordinated across dual experiential layers
Experiential structure	Single-domain (virtual) experience	Single-stream engagement	Dual-layered experience (physical and virtual)
Key mechanism	Spatial immersion and perceived "being there"	Attentional absorption and intrinsic enjoyment	Coordination of perception, attention, and meaning-making across domains
Role of physical environment	Serves as a backdrop	Largely irrelevant during absorption	Remains present and actively integrated into the experience
Primary limitation	Primarily conceptualizes mediated presence rather than simultaneous physical–virtual engagement.	Assumes uninterrupted immersion in a single activity	Addresses the challenge of maintaining coherence under simultaneous dual engagement

exclusively immersed in either the physical or virtual realm. Instead, they remain physically embodied while simultaneously engaging with digitally mediated heritage representations, continuously integrating the cues, meanings, and sensory information derived from both environments.

3. Methodology

A psychometrically sound scale for OTE was developed, with a strong focus on reliability and validity. Consistent with Churchill's (1979) procedure, the process unfolded in four stages: (1) item generation; (2) purification and dimensionality assessment; (3) validation of the measurement model; and (4) assessment of nomological validity.

3.1. Stage 1: construct conceptualization and item generation

This phase delved into the novel concept of OTE rooted in optimal experience, flow theory and telepresence. The elucidation of the optimal experience associated with flow theory highlights the coherence between this new concept and its predecessors. Furthermore, it underscores the optimal experience based on previous studies related to its predecessors. The new definition is derived from flow theory, telepresence and optimal experience.

3.1.1. The interview process

This phase aimed to explore and define the construct of OTE in VR at a heritage site. Empirical data was collected from tourists who used the VR application at the site through a semi-structured interview. The interview questions focused on participants' experiences, and provided insight into how optimal telepresence can improve participants' actual visits. Given that VR users are immersed in reality, their combined viewpoint is crucial for comprehending the intricate social dynamics that influence the efficacy of an ideal telepresence encounter.

A set of criteria was utilized to select participants for the interview: They were required to: (1) be tourists currently visiting The Imperial City of Hue, Vietnam, aged 18 and over, (2) have proficient understanding of Vietnamese or English (international tourists only) in order to effectively communicate during the interview, and (3) be able to allocate approximately 20 to 30 min for the interview session.

The semi-structured interview protocol (Appendix A) was explicitly informed by prior literature on telepresence and optimal or flow experience. The central questions were designed to elicit participants' perceived sense of "being there" and their ability to integrate virtual and physical environments, consistent with foundational telepresence conceptualizations (Cho et al., 2022; Jang et al., 2019) and tourism-focused VR studies (Lee et al., 2020). Additional questions probed deep absorption, emotional engagement, enjoyment, and meaning-making aligned with flow and optimal experience theory (Nah et al., 2011; Wu & Lai, 2022). Finally, before and after questions were included to capture cognitive and affective changes associated with immersive experiences, which prior research links to behavioral outcomes (Kim et al., 2021; Sancho-Esper et al., 2022). The use of qualitative interviews for item generation follows established scale development procedures (Churchill, 1979).

The qualitative interviews were conducted from 1st August to 1st October 2023 at the Imperial City of Hue after participants had completed their VR experience. Twenty-eight participants, including 14 domestic visitors from different regions of Vietnam and 14 international tourists from Europe, Asia, and North America, were recruited and a semi-structured interview guide was used. (Appendix A). To break the ice, a set of general questions relating to participants' reasons for visiting Hue City and the heritage site itself, as well as questions regarding nationality and age, were first posed. Subsequent questions related to visitors' perceptions and feelings while experiencing the VR technology. Participants ranged in age from 18 to 52 years, with both male and

Table 2
Participants' demographic information.

Domestic tourists			
Participant ID	Gender	Age	City
DT1	Male	22	Ninh Binh
DT2	Male	25	Thanh Hoa
DT3	Male	23	Gia Lai
DT4	Male	22	Nha Trang
DT5	Male	20	Ha Noi
DT6	Male	30	Da Nang
DT7	Male	19	Quang Binh
DT8	Female	21	Quy Nhon
DT9	Female	21	Quang Tri
DT10	Female	22	Ha Tinh
DT11	Male	31	Kien Giang
DT12	Female	22	Ho Chi Minh
DT13	Female	23	Ha Nam
DT14	Male	23	Nghe An
International tourists			
IT1	Female	21	China
IT2	Male	30	Spain
IT3	Female	34	Spain
IT4	Female	24	England
IT5	Female	39	Puerto Rico
IT6	Male	30	Holland
IT7	Female	27	Netherland
IT8	Female	20	England
IT9	Male	52	France
IT10	Male	18	USA
IT11	Female	30	Italy
IT12	Male	32	Italy
IT13	Male	29	Spain
IT14	Female	20	England

female respondents represented (Table 2). The inclusion of domestic and international visitors with diverse demographic backgrounds provided a broad range of perspectives on on-site VR experiences at the heritage site, and supported the exploration of shared experiential patterns during the qualitative item-generation phase.

Ethical approval for this study was obtained from the first author's university ethics committee prior to data collection. All participants were informed about the purpose of the study, the voluntary nature of their participation, and their right to withdraw at any time without consequence. Written informed consent was obtained before participation, and permission was sought for audio recording. To ensure confidentiality and anonymity, no personally identifiable information was collected, and participant data were anonymized using coded identifiers (e.g., DT1, IT1). All participants were aged 18 years or older; therefore, parental or guardian consent was not required. All data were stored securely and used solely for research purposes.

For statistical analysis, the interviews were transcribed from audio recordings. Prior to analysis, the versions recorded in Vietnamese were translated into English by the researcher. To maintain anonymity, each participant was assigned a coded identifier, such as IT1 (International Tourist 1) and DT1 (Domestic Tourist 1).

3.1.2. Thematic analysis and coding

Thematic analysis was used on the qualitative data set to identify potential themes used by participants to express their feelings after experiencing VR at the site. NVivo26 software was used to manage and code the data. A thematic analysis was conducted using Braun & Clarke's (2006) process as a guide. First, the researchers familiarized themselves with the data by repeatedly reading transcripts and noting initial impressions. Second, initial codes were generated by systematically identifying meaningful segments relevant to participants' on-site VR experiences, such as emotional reactions, perceptions of "being there," or of the connections between virtual and physical environments, and reflections from before and after the VR experience. Third, codes were collated into candidate themes by grouping related codes that reflected recurring experiential patterns. Fourth, themes were reviewed and refined by checking their coherence against the coded extracts and the full dataset, ensuring that themes accurately represented participants' accounts. At this stage (December 2023), the researchers discussed the themes with three academic researchers to obtain a range of points-of-view on the subject. Fifth, themes were defined and named to clearly capture their conceptual meanings and boundaries. Finally, the finalized themes were used to inform item generation for the initial pool of scale statements in Stage 1 (Appendix B).

3.1.3. The dimensions of OTE

Thematic analysis of the interview data revealed three key dimensions of OTE: emotional, cognitive, and functional attributes. Representative codes illustrating each dimension are presented in Appendix C. These qualitative insights formed the conceptual basis for the subsequent development of the measurement scale.

The purpose of identifying emotional, cognitive, and functional attributes was not to represent three independent experiential constructs. Rather, the thematic analysis consistently indicated that participants described their on-site VR heritage experiences through interrelated emotional reactions, cognitive interpretations, and functional evaluations. These dimensions therefore represent complementary experiential facets through which visitors evaluate their overall technology-enhanced heritage experiences. Accordingly, OTE is conceptualized as the higher-order experiential construct reflected by these complementary dimensions, rather than as a simple aggregation of existing experiential concepts.

The emotional attribute: When individuals experience a sense of immersion while using VR technology, they perceive it as being more comfortable and user-friendly. This heightened engagement also leads to positive attitudes toward the content (Zhao et al., 2023). The emotional attribute in OTE refers to the extent to which users' optimal experience in VR at the heritage site enables them to fully engage with the emotional nuances of the virtual environment. See below for some examples of emotional attributes from the interviews.

> "*Virtual reality technology is really, really great. I think it should be applied to more heritage sites in Hue because it adds a lot to real-life visits like this.*" (DT10)

> *"Since the VR experience has helped me understand the heritage before its full restoration, I'm even more excited to visit when it's finished."* (DT14)

The cognitive attribute: The cognitive image of a tourist destination is constructed from an individual's personal beliefs regarding the location (San Martín & Rodríguez del Bosque, 2008). In OTE, the cognitive attribute refers to the extent to which the VR heritage site experience enables users to acquire information and knowledge through visual and immersive interaction in the virtual world. See below for a sample of responses relating to the emotional attribute:

> *"It (VR) allowed me to gain a deeper understanding of the various activities that took place within the royal court."* (DT12)

> *"It's interesting when I get some knowledge because actually in the present you can read a lot of books, but actually you don't really understand how many buildings, so VR give you the construction of the of the site that you understand completely."* (IT11)

The functional attribute: By using technological functions, VR technology has transformed how people interact with digital surroundings, providing immersive and engaging experiences that transcend traditional media (Quesnel & Riecke, 2018). In OTE, the functional attribute refers to the practical functions that enhance users' experience at the heritage site, enabling them to achieve a sense of fulfillment both psychologically and physically. Some illustrative responses from the interviews include:

> *"Sitting down with the VR headset on, having both visual and auditory elements explaining what you were seeing was enjoyable."* (IT4)

> *"It's always like a ride with being moved with that and it's a bit more fun and I find it easier to take the information or actually like read and understand where I am."* (IT8)

3.1.4. Content validity assessment

The dimensions and item list were forwarded to three tourism academics of Hospitality and Tourism field for evaluation of the item pool's validity. Feedback on the content validity of the items resulted in a reduction of the initial pool of potential OTE items, primarily through revisions to wording and the removal of duplicated meanings. During expert review, particular attention was paid to ensuring that each retained item reflected the conceptual domain of OTE within onsite hybrid heritage experiences, rather than measuring isolated experiential constructs.

Following adjustment, there remained eleven items related to emotional attributes, seven related to cognitive attributes, and nine related to functional attributes. Of these, three items were withdrawn due to meaning duplication. See Appendix D for a list of the OTE item pool validation results.

3.2. Stage 2: scale purification and dimensionality

Hue Imperial City, a UNESCO World Heritage Site in Vietnam, serves as a prominent cultural tourism destination characterized by its historical significance and large-scale architectural heritage (The Imperial City of Hue and the Nguyen Legacy of Vietnam, 2020). The site has recently integrated on-site VR technologies that allow visitors to experience reconstructed historical environments while physically present at the location (Anh, 2024). This combination of physical presence and

immersive digital content makes Hue Imperial City an appropriate setting for examining hybrid experiential processes (Anh, 2024). Specifically, it provides a natural context in which visitors simultaneously engage with physical and virtual realities, aligning closely with the conceptualization of OTE.

The paper survey questionnaire was designed to gather data from tourists regarding their VR experience at Hue Imperial City (Appendix E). All variables were evaluated using a 7-point Likert scale, with values ranging from 1 = strongly disagree, to 7 = strongly agree.

Table 3 presents the sample characteristics for each research stage following Stage 1, which focused on developing the OTE scale. It reports the participants in Stage 2 (scale purification and dimensionality), Stage 3 (scale validation), and Stage 4 (nomological validity).

In Stage 2, data were collected using convenience sampling. The paper questionnaire was distributed directly to the VR users at the site. Finally, 300 questionnaires were distributed and returned during March 2024. After the elimination of nine invalid questionnaires, 291 valid data points were retained for analysis.

In the next stage, exploratory factor analysis was employed to examine the set of items, allowing the researcher to verify the *reliability* of the qualitative findings. Reliability, in this context, refers to the proportion of variance in an observed score that can be attributed to the true score of the variable under assessment (Devellis, 2017). The results of the OTE EFA analysis indicated that the KMO value was 0.925, surpassing the recommended threshold of 0.5 (Hair et al., 2010). Barlett's test of sphericity results ($\chi^2 = 4307.518$, $df = 351$, $p < 0.001$) demonstrated that there were common factors of variables, and that factor analysis could be performed.

The rotated component matrix indicated that the first three factors had eigenvalues greater than 1, suggesting that they explain a significant portion of the variance in the data. The EFA results also showed that most of the measuring items developed from the qualitative research phase naturally grouped together. Items with low loadings or cross-loadings were removed in line with Straub (1989).

The results revealed that some items had cross-loading, including: *"The VR experience on this site made me fully immersed in the virtual world" (EA8), "The VR experience on this site made me gain an appreciation of the country's culture" (EA10), "The VR experience on this site made me feel an increased sense of pride regarding this heritage site" (EA11), and, "The VR experience on this site helped me to improve my sense of direction and understand the site's layout" (CA3)*. These items were therefore excluded based on the recommendations from the EFA variable elimination. The rotated component matrix demonstrated a strong relationship between measurable items and OTE dimensions, with all items having loadings above 0.6. After the removal of eight items, the final loading matrix can be seen in Table 4.

Finally, the reliability of the measurement items within each factor group was assessed (Table 4). This step of scale purification involves computing internal reliability using Cronbach's alpha (Churchill, 1979). All three dimensions, emotional attribute (EA), cognitive attribute (CA), and functional attribute (FA), demonstrated Cronbach's alpha values above 0.7, specifically 0.88, 0.85 and 0.90 respectively. These results indicated that the variables met the requirements for conducting scale validation.

3.3. Stage 3. scale validation

The aim of Stage 3 was to identify the three dimensions of OTE proposed by the study through confirmatory factor analysis (CFA). From 395 distributed surveys, 381 valid responses were retained for analysis.

Procedures for testing second-order factor models were applied (Rindskopf & Rose, 1988), and a hierarchical approach was used to develop four models (Table 5). Model 1 was a single first-order factor model, in which all indicators loaded on OTE. Model 2 was an uncorrelated first-order factor model, where the indicators loaded on three uncorrelated dimensions without a second-order factor. Model 3 was a correlated first-order factor model, in which the three dimensions of OTE were correlated but not explained by a second-order factor. Model 4 was a second-order factor model of OTE. Finally, CFA was conducted to test and compare these models (Table 3).

As a result, Model 2 (CFI = 0.761; TLI = 0.737; RMSEA = 0.120; $\chi^2/df = 6.489$) performed marginally better than Model 1 (CFI = 0. 0.752; TLI = 0.727; RMSEA = 0.122; $\chi^{2/df} = 6.689$), but both indices suggested poor fit. Model 3 demonstrated adequate model fit, and the three dimensions were highly connected (CFI = 0.921; TLI = 0.910; RMSEA = 0.070; $\chi^{2/df} = 2.866$). Model 4 also presented acceptable fit (CFI = 0.908; TLI = 0.896; RMSEA = 0.075; $\chi^{2/df} = 3.160$), but its performance was not superior to that of Model 3. This was to be expected, as a model that hypothesizes a second-order factor (Model 4) will never fit better than one that posits a correlated first-order factor (Model 3) (Rindskopf & Rose, 1988). Hence, if the second-order factor model has an acceptable fit, it should be considered as the most appropriate model and evaluated in terms of total measurement and structural models.

Table 6 presents the convergent and discriminant validity results for three dimensions in OTE: EA, CA, and FA. All constructs demonstrated strong internal consistency, with Cronbach's alpha values exceeding 0.80. Correlations between constructs were below 0.70, supporting discriminant validity.

Table 7 shows that all standardized factor loadings exceeded 0.50, confirming convergent validity. Average variance extracted values ranged from 0.50 to 0.54, meeting the recommended threshold of 0.50. Composite reliability values ranged from 0.88 to 0.92, exceeding the minimum criterion of 0.70. These results collectively indicate satisfactory reliability and validity for the OTE scale.

Table 3
Profile of participants.

Variable	Category	Stage 2 (n = 291)		Stage 3 (n = 381)		Stage 4 (n = 484)	
		Frequency	Rate (%)	Frequency	Rate (%)	Frequency	Rate (%)
Gender	Male	133	45.7	178	46.7	226	46.7
	Female	158	54.3	203	53.3	258	53.3
Age	17-27	91	31.3	106	27.8	149	30.8
	28-38	103	35.4	143	37.5	170	35.1
	39-49	51	17.5	69	18.1	80	16.5
	50-60	30	10.3	38	10	52	10.7
	> 61	16	5.5	25	6.6	33	6.8
Education	12th grade or less	19	6.5	31	8.1	38	7.9
	Graduated high school or equivalent	72	24.7	95	24.9	117	24.2
	Undergraduate	129	44.3	154	40.4	206	42.6
	Post-graduate	71	24.4	101	26.5	123	25.4
Length of stay	Less than 1 week	212	72.9	293	76.9	371	76.7
	1-2 weeks	62	21.3	63	16.5	80	16.5
	3-4 weeks	13	4.5	19	5.0	27	5.6

Table 4
Exploratory factor analysis results (Stage 2).

Items	Component		
	Factor 1	Factor 2	Factor 3
The vivid visuals in the VR made my experience on this site more complete.	0.676		
The vivid visuals in the VR made my experience on this site enjoyable	0.684		
The vivid visuals in the VR experience on this site enabled me to better understand this heritage structure.	0.631		
The music in the VR experience on this site increased my level of immersive experience.	0.590		
The music in the VR experience on this site made my experience at this destination more authentic.	0.566		
The music in the VR experience on this site enhanced a feeling of nostalgia.	0.703		
The narrative in the VR experience on this site increased my level of immersive experience.	0.759		
The narrative in the VR experience on this site made my experience at this destination more authentic.	0.686		
When I experienced VR on this site, the movement of the chair increased the level of immersiveness.	0.613		
The VR experience on this site made me feel thrilled.		0.691	
The VR experience on this site made me feel like I was actually walking and passing through the site.		0.658	
The VR experience on this site helps me enjoy the experience of the tour		0.701	
The VR experience on this site stimulated my curiosity to fully explore the significance of this heritage site.		0.678	
The VR experience on this site made me want to visit more palaces that have been destroyed/damaged at the site.		0.645	
The VR experience on this site made me feel like I had travelled back to the ancient times.		0.682	
The VR experience on this site created a stronger connection between the past and present, allowing me to opportunity of a more complete experience.		0.764	
The VR experience on this site made me evoke a sense of nostalgia for this site.		0.549	
The VR experience on this site helped me to understand this heritage site better.			0.676
The VR experience on this site helped me to realize that a VR experience provides more interesting knowledge than just a physical visit.			0.622
The VR experience on this site enabled me to compare the past and present conditions of the heritage site more effectively.			0.675
The VR experience on this site enhanced my understanding of the historical context surrounding the heritage site.			0.772
The VR experience on this site raised my awareness about the importance of heritage preservation.			0.698
The VR experience on this site noticed me that a lot of buildings are no longer in existence and have been destroyed.			0.674
Eigenvalues	9.430	1.942	1.462
Cronbach's alpha	0.90	0.88	0.85
Variance explained	41.002%	49.447%	55.803%

3.4. Stage 4: nomological validity

In Stage 4, the study examined the nomological validity of the OTE scale by testing its capacity to predict theoretical relationships with other concepts. Kock et al. (2024) reviewed scale development procedures in hospitality research and found that nomological validity testing was largely absent in previous studies. This step, however is crucial for establishing valid operational measurements, as it strengthens the knowledge domain by integrating theoretical reasoning with empirical evidence (Kock et al., 2024). The current study evaluates nomological validity through a structural model linking experiential attributes, OTE, memory of the heritage site, and revisit intention. In this framework, emotional, cognitive, and functional attributes represent complementary facets of OTE. This conceptualization is consistent with the experience literature, which characterizes experiences as holistic and multidimensional phenomena involving multiple interconnected responses rather than isolated evaluations (Gahler et al., 2023). Accordingly, OTE is conceptualized as a higher-order experiential construct that captures visitors' overall technology-enhanced heritage experience. Optimal telepresence experience thus provides an integrative explanation of how visitors evaluate technology-enhanced heritage encounters under conditions of dual engagement, and how this evaluation shapes subsequent memory formation and behavioral intention

Table 5
Model comparison of OTE (Stage 3).

Fit indices	Single first-order factor (Model 1)	First-order uncorrelated factors (Model 2)	First-order correlated factors (Model 3)	Second-order model (Model 4)
χ^2	1538.402	1492.512	639.166	707.947
$\chi^{2/df}$	6.689	6.489	2.866	3.160
CFI	0.752	0.761	0.921	0.908
TLI	0.727	0.737	0.910	0.896
RMSEA	0.122	0.120	0.070	0.075

Table 6
The convergent and discriminant validity (Stage 3).

OTE dimensions	M	SD	EA	CA	FA
1. Emotional attribute (EA)	5.266	0.951	**1**		
2. Cognitive attribute (CA)	5.652	0.869	0.613[a]	**1**	
3. Functional attribute (FA)	5.127	1.095	0.629[a]	0.655[a]	**1**

[a] Correlation is significant at the 0.01 level (2-tailed).

Table 7
OTE scale validity and reliability (Stage 3).

Construct and items	St Factor Loadings	Cronbach alpha	CR	AVE
Emotional attribute		**0.88**	**0.89**	**0.50**
EA1	0.623			
EA2	0.631			
EA3	0.704			
EA4	0.752			
EA5	0.659			
EA6	0.684			
EA7	0.714			
EA9	0.566			
Cognitive attribute		**0.87**	**0.86**	**0.51**
CA1	0.678			
CA2	0.628			
CA4	0.616			
CA5	0.744			
CA6	0.766			
CA7	0.705			
Functional attribute		**0.92**	**0.91**	**0.54**
FA1	0.619			
FA2	0.663			
FA3	0.611			
FA4	0.720			
FA5	0.715			
FA6	0.682			
FA7	0.764			
FA8	0.691			
FA9	0.643			

Note. EA = Emotional attribute; CA = Cognitive attribute; FA = Functional attribute.

(see Fig. 1).

The study also acknowledges the growing importance of VR in tourist destination marketing (Chang & Chiang, 2022; Lin et al., 2020), given its role as a powerful tool for shaping tourists' visitation decisions (Atzeni et al., 2022). Optimal Telepresence Experience extends this by capturing tourists' dual engagement with both physical and virtual heritage environments. In prior research, revisit intention has often been examined when tourists complete their visits and consider returning in the future (Brown et al., 2016). Factors related to destination image, place attachment (Yamagishi et al., 2023), and satisfaction have emerged as antecedents of tourist revisit intention (Brown et al., 2016). These studies, however, have only focused on the actual visits - a different perspective from the current research objective. The proposed model provides a theoretically grounded framework for examining how immersive VR experiences shape tourist behavior through experiential coordination and memory formation. The theoretical relationships tested in this study are illustrated in Fig. 2.

The coordinated experiential state captures how emotional, cognitive, and functional attributes are experienced as a unified whole, rather than as independent components.

3.4.1. Hypotheses development

Emotion is the most frequently examined construct in VR research and is often assessed in relation to the technological quality of VR systems (Diemer et al., 2015; Han et al., 2021) further demonstrated the influence of emotional arousal on visitors' memories of heritage sites in a VR environment. Cognition is another construct that can affect user behavior in VR (Garzón-Paredes & Royo-Vela, 2023). Garzón-Paredes and Royo-Vela (2023) suggest that images of a virtual destination are positively impacted by the cognitive impact of places that are

Stage 1 (construct conceptualization and item generation)			
Method	**Developing the OTE scale**	**Purpose**	**Action taken**
Semi-structured interviews (28 respondents)	• Explore the nature of optimal telepresence experience	To facilitate the formation of the interview instrument and generate a set of items to capture each dimension of construct	Thematic analysis to explore the dimension of the main construct. 3 dimensions identified.
	• Generate the measure items for the concept	To evaluate and validate the items	Items refined by academic experts of hospitality and tourism. Items reduced from 30 to 27.
Stage 2 (scale purification and dimensionality)			
Method	**Scale purification and dimensionality**	**Purpose**	**Action taken**
Questionnaire survey (291 samples)	• Exploratory factor analysis	To identify the latent construct	EFA method. Items reduced from 27 to 23.
	• Internal consistency assessment	To examine the reliability of the construct	Reliability tests conducted including Cronbach's alpha and Composite reliability
Stage 3 (scale validation)			
Method	**Scale validation**	**Purpose**	**Action taken**
Questionnaire survey (381 samples)	• Confirmatory factor analysis	To validate the scales	Convergent validity Discriminative validity
	• Competitive model analysis	To validate the final scale	Structural validity
Stage 4 (Nomological validity)			
Method	**Nomological validity**	**Purposes**	**Action taken**
Questionnaire survey (484 samples)	• Confirmatory factor analysis for the whole model	To validate the model fit	Reliability and validity
	• Multiple regression testing	To test the relationship among variables via mediator effects.	Nomological validity

Fig. 1. Process of scale development for OTE.

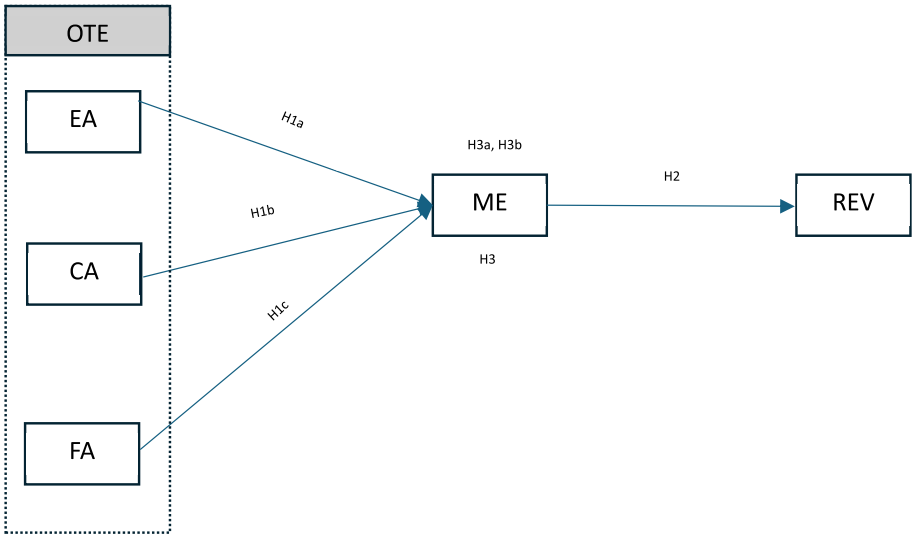


Fig. 2. Test of nomological validity with OTE. Note: EA = emotional attribute; CA = cognitive attribute; FA = functional attribute; ME = memory of the heritage site; REV = revisit intention.

distinguished by their heritage and replicated through VR. Cognitive processing in VR enables users to form mental representations of the environment, which in turn can strengthen memory of a site (Diemer et al., 2015). Virtual reality functions (e.g., vividness, sound, and narrative) enhance users' perceptions of the target objective (Jafar et al., 2023), and have crucial roles in triggering memories of a site (Jafar et al., 2023). From the perspective of OTE, these attributes represent key experiential facets that collectively contribute to how users process and retain immersive experiences. Accordingly, the following hypotheses are proposed:

H1a. Emotional attribute has a positive effect on memory of the heritage site.

H1b. Cognitive attribute has a positive effect on memory of the heritage site.

H1c. Functional attribute has a positive effect on memory of the heritage site.

Prior studies show that revisit intention is strongly related to destination marketing (Brown et al., 2016; Chen et al., 2020). Specifically, it is influenced by the way people perceive and experience a destination (Chang et al., 2014; Cheung et al., 2023; Yamagishi et al., 2023). In the tourism sector, tourists' revisits are crucial for enhancing a destination's image, as they indicate that tourists had a memorable experience at the site (Akgün et al., 2020). Accordingly, memory of the heritage site is hypothesized to positively influence revisit intention.

H2. Memory of the heritage site has a positive effect on revisit intention.

While emotional, cognitive, and functional responses have been widely recognized as important components of tourism and customer experiences, experience research suggests that such responses are often evaluated holistically, rather than as isolated reactions (Lemon & Verhoef, 2016; Verhoef et al., 2009). Specifically, OTE captures the coordinated nature of immersive engagement, through which individual experiential facets are organized into a coherent experiential state. From this perspective, OTE provides an overarching explanation for how immersive experiences translate into meaningful cognitive and behavioral outcomes.

Memory formation represents a primary outcome through which this coordination manifests, and plays a central role in shaping emotional connections and guiding future decisions (Dolcos & Carbeza, 2002; Escalas, 2004). Virtual reality further stimulates active cognitive processing by immersing users in highly interactive environments, making tourist experiences more memorable (Chen & Yao, 2022). From a functional perspective, VR enables users to explore destinations or products in a controlled yet realistic setting (Huang et al., 2016). Building on these insights, the following hypotheses are proposed:

H3a. Memory of the heritage site mediates the relationship between the emotional attribute and revisit intention.

H3b. Memory of the heritage site mediates the relationship between the cognitive attribute and revisit intention.

H3c. Memory of the heritage site mediates the relationship between the functional attribute and revisit intention.

H3d. Memory of the heritage site mediates the relationship between optimal telepresence experience and revisit intention.

3.4.2. Sampling and measurement

Stage 4 examined the impact of OTE on tourists' revisit intention using predictive path analysis in AMOS 24. Consistent with prior research employing covariance-based structural equation modelling in scale development and validation contexts (e.g. Hwang and Lee (2026); Ravichandran et al. (2026)), AMOS was selected, as it supports CB-SEM, which is appropriate for theory testing and confirmatory analysis when constructs have been refined and validated in earlier stages. Compared to alternative approaches—such as regression-based techniques or variance-based SEM (e.g., PLS-SEM)—CB-SEM is more suitable for studies with a strong theoretical foundation and an emphasis on model fit and construct validation, as it enables the simultaneous estimation of latent constructs, while accounting for measurement error. Accordingly, AMOS provides an appropriate approach to evaluate both the measurement and structural components of the proposed model (Hair Jr. et al., 2014). This phase still employed the questionnaire survey from Research Phase 2, aligning with the newly developed OTE items from Research Phase 1. However, in the nomological validity testing, the researcher used only the significant OTE items identified in the results of Research Phase 3 to test their relationships with other variables. Memories of the heritage site were measured based on Han et al.'s (2021) five items, and are as follows: "I have wonderful memories about this heritage site," "I can remember many positive things about this heritage site, " "I can relive my experiences about this heritage site," "I can feel the emotions about this heritage site now that I experienced it virtually," and, "I can remember the setting of this heritage site." Revisit intention was measured using Nian et al.'s (2019) three items, "This destination is

worth revisiting," "I would like to revisit this destination sometime in the future," and "I would like to revisit this destination with my friends or family."

3.4.3. Results

Table 8 shows the mean, standard deviations and correlation of the study variables. The independent variables, "emotional attribute" (EA), "cognitive attribute" (CA), and "functional attribute" (FA) in OTE had mean values of 5.31 (SD = 0.92), 5.66 (SD = 0.92) and 5.24 (SD = 0.99), respectively. The mediator variable, "memory of the heritage site" (ME) had a mean value of 31 (SD = 1.11), and the dependent variable, "revisit intention" (REV) had a mean value 5.84 (SD = 1.05). The results show the central tendencies and variabilities of the study variables that could be used for further analysis.

In terms of the correlations of all study variables, ME was positively correlated with independent variables such as EA ($r = 0.50$, $p < 0.01$), CA ($r = 0.57$, $p < 0.01$) and FA ($r = 0.62$, $p < 0.01$). This suggests that the more OTE (EA, CA, FA) is experienced in VR, the more the feeling of ME is stimulated. In addition, ME had a significant and positive relationship with the dependent variables REV ($r = 0.38$, $p < 0.01$). The correlation coefficients of all the relationships among the constructs were below 0.7, confirming the discriminant validity of the study variables.

Each variable was then tested for reliability and validity. In Appendix F, it can be seen that (1) all Cronbach's alpha values range from 0.88 to 0.92, (2) the CR values are above 0.86, and (3) the AVEs are above 0.5, indicating that every construct had sufficient internal consistency and convergent validity. Furthermore, the model fit was acceptable through CFA (χ^2/df = 2.813; CFI = 0.919; TLI = 0.911; RMSEA = 0.061).

Nomological validity was examined through structural modelling in AMOS 24.0, and the hypothesis model in Fig. 2 fitted the data well (χ^2/df = 2.845; CFI = 0.918; TLI = 0.909; RMSEA = 0.062).

Consistent with the hypotheses in Table 9, the results indicate that each dimension (EA, CA, FA) had a significant effect on ME. Specifically, the emotional attribute significantly influenced ME ($b = 0.603$, $p < 0.001$), supporting H1a; The cognitive attribute also had a significant effect ($b = 0.692$, $p < 0.001$), supporting H1b; and the functional attribute significantly affected ME ($b = 0.690$, $p < 0.001$), supporting H1c. These findings indicate that ME was positively shaped by all OTE dimensions. Memory of the heritage site also positively predicted revisit intention ($b = 0.359$, $p < 0.001$), supporting H2. Testing the indirect effects through bootstrapping with 2000 resamples indicated that EA, CA, and FA significantly influenced revisit intention ($b = 0.175$, $p < 0.05$), ($b = 0.204$, $p < 0.001$), ($b = 0.124$, $p < 0.001$), respectively. Moreover, the range 95% confidence interval (CI) in the indirect result excluded 0. Therefore, H3a, H3b, H3c were supported. Overall, OTE also significantly influenced revisit intention through the mediating effect of ME ($b = 0.207$, $p < 0.001$), supporting H3d. In summary, OTE (EA, CA, FA) was found to strengthen tourists' ME and to enhance their revisit intention. The findings offer significant evidence for the nomological validity of the OTE scales.

Table 8
Mean, Standard Deviations, Correlations of all study variables (Stage 4).

	M	SD	1	2	3	4	5
1. REV	5.84	1.05	**1**				
2. ME	5.31	1.11	0.38**	**1**			
3. EA	5.31	0.92	0.30**	0.50**	**1**		
4. CA	5.66	0.92	0.29**	0.57**	0.63**	**1**	
5. FA	5.24	0.99	0.34**	0.62**	0.68**	0.69**	**1**

Notes. REV = Revisit intention, ME = Memory of the heritage site; EA = Emotional attribute.
CA = Cognitive attribute; FA = Functional attribute.
**. Correlation is significant at the 0.01 level (2-tailed).

Table 9
Hypothesis testing results of nomological validity (Stage 4).

Hypothesis path	Estimate	SE	95% CI	
			Lower	Upper
H1a: EA → ME	0.603***	0.047	0.510	0.696
H1b: CA → ME	0.692***	0.045	0.603	0.780
H1c: FA → ME	0.690***	0.040	0.611	0.768
H2: ME → REV	0.359***	0.040	0.280	0.438
H3a: EA → ME → REV	0.175*	0.041	0.100	0.265
H3b: CA → ME → REV	0.204*	0.044	0.121	0.294
H3c: FA → ME → REV	0.176***	0.045	0.096	0.272
H3d: OTE → ME → REV	0.204***	0.053	0.107	0.317

Notes. REV = Revisit intention, ME = Memory of the heritage site; EA = Emotional attribute; CA = Cognitive attribute; FA = Functional attribute; OTE = Optimal telepresence experience.
*$p < 0.05$; ***$p < 0.01$. Unstandardized coefficient estimates are reported.

4. Discussion

This study advances immersive tourism theory by explaining how visitors' technology-enhanced heritage experiences unfold within hybrid physical-virtual heritage settings, and why such hybrid immersion reshapes memory formation and subsequent behavioral intention. Drawing on flow theory and telepresence, Optimal Telepresence Experience (OTE) is conceptualized as a higher-order experiential state that extends beyond the projection of consciousness into virtual environments to integrate physical site visits. By specifying the internal experiential mechanisms through which immersive engagement operates, this study shifts attention from technological novelty to the psychological architecture that links hybrid immersion to enduring tourist responses. The dual nature of the visit, integrating both physical and virtual elements, facilitates the enrichment of users' sensory experience. Accordingly, this study refines the definition of OTE as follows:

Optimal Telepresence Experience (OTE) is a higher-order experiential construct that captures visitors' overall technology-enhanced heritage experiences under conditions of simultaneous engagement with physical heritage environments and VR-mediated reconstructions. This higher-order experience is reflected through complementary emotional, cognitive, and functional attributes that collectively represent visitors' holistic evaluations of the technology-enhanced heritage encounter.

The conceptual core of OTE lies in visitors' holistic evaluations of a technology-enhanced heritage encounter, rather than in the technological environment itself. Existing experiential constructs, including telepresence, flow, and authenticity, each explain specific aspects of the visitor experience in mediated or hybrid contexts; however, none were developed to conceptualize visitors' overall experiential evaluations of hybrid physical-virtual heritage encounters (Lorenz et al., 2025). The theoretical gap addressed in this study concerns the absence of an integrative experiential construct rather than the absence of a single experiential dimension. OTE is proposed to fill this gap, referring to the overall experiential state through which visitors evaluate their technology-enhanced heritage encounter, with emotional, cognitive, and functional attributes conceptualized as complementary reflective dimensions of this higher-order construct, rather than as independent experiential phenomena. Prior studies of virtual experiences, have examined diverse computer-generated environments replicating aspects of the real world (Leotta & Ross, 2018), often focusing on psychological adaptation to mediated settings and on technological drivers such as hedonic performance (Sharma et al., 2022), or vividness (Sánchez-Bernardos et al., 2015), alongside responses such as cognitive reactions and satisfaction (Jafar & Ahmad, 2023). By contrast, this study positions OTE as a construct for understanding tourist psychology in on-site VR contexts by specifying how experiential dimensions operate together during hybrid engagement.

The mean scores indicate that the three experiential dimensions do not contribute equally to the formation of Optimal Telepresence

Experience. Cognitive attributes emerged as the most salient dimension, suggesting that on-site VR primarily enhances visitors' understanding and interpretation of heritage content. This contrasts with off-site VR contexts, where emotional novelty often dominates, and reflects the role of physical presence in anchoring virtual information to place-based meaning. Emotional attributes reinforce engagement by fostering affective attachment, while functional attributes enable both processes by minimizing disruption and reducing cognitive load during interaction.

Importantly, in hybrid heritage settings, the stimulus does not consist of virtual immersion alone. Instead, it comprises the coordinated presentation of material heritage environments and their digital reconstructions. While previous research has largely examined telepresence in fully virtual or off-site settings (Albayrak et al., 2025; Shi et al., 2025), the present results demonstrate that visitors' emotional, cognitive, and functional engagement depend upon the ways in which virtual content complements the material and spatial qualities of the heritage site. The physical site provides contextual grounding and perceived authenticity, whereas the virtual layer supplies interpretive depth and experiential reconstruction. This dual-layered stimulus structure helps explain why cognitive functional attributes become especially critical for memory formation and subsequent behavioral intention in on-site VR-enhanced tourism. Overall, OTE emerges from the interaction between physical heritage environments and virtual representations rather than from virtual immersion alone. This reinforces OTE as a construct that captures how experiential coherence is maintained under dual-layered conditions.

Finally, the findings indicate that each OTE dimension shapes tourists' memory of the heritage site, which in turn mediates revisit intention. Prior work has highlighted the role of VR experiences in shaping tourist intentions (Wang et al., 2022; Ying et al., 2022), while gaps remain in explaining how VR shapes evolving engagement and emotional responses (Omran et al., 2024). The present study strengthens this stream by showing how differentiated experiential mechanisms operate within hybrid on-site settings to influence memory and behavioral intention.

4.1. Theoretical implications

This study introduces OTE as a higher-order experiential construct to advance understanding of the psychology of on-site VR users at tourism destinations. Building on telepresence experience and flow theory, particularly Draper et al. (2008), this study reframes immersive tourism, shifting the focus from whether visitors feel "present" in a virtual environment to how immersive engagement restructures attention, meaning-making, and memory formation in hybrid contexts. Crucially, OTE is constructed through the continuous interaction between material heritage environments and their virtual augmentations, underscoring that immersive tourism experiences in hybrid contexts cannot be understood through virtual immersion alone.

In this context, balance refers not merely to technological sophistication, but to experiential alignment between material authenticity and virtual reconstruction. Optimal Telepresence Experience reflects the extent to which virtual augmentation complements rather than competes with the physical heritage environment, enabling visitors to integrate historical interpretation with embodied spatial presence. When this alignment is achieved, immersive engagement reinforces rather than displaces site-based meaning, suggesting that authenticity in hybrid heritage settings is mediated through integration rather than undermined by digital augmentation.

While telepresence captures the sense of "being there," flow emphasizes optimal absorption, engagement reflects motivational involvement, and immersion describes the depth of experiential absorption, these constructs have largely been predicated on a singular mediated field. In hybrid on-site VR settings, however, visitors must coordinate attention across two experiential layers simultaneously material heritage presence and virtual reconstruction. Optimal Telepresence Experience is introduced to explain this dual-layered experiential integration, specifying the internal architecture through which emotional resonance, cognitive meaning-making, and functional coherence are synchronized to maintain coherence between physical and virtual realities.

Traditional telepresence scales often rely on perceptual indicators of spatial or social presence (Gao & Li, 2019) In contrast, the proposed OTE scale uses multidimensional indicators to capture not only presence, but also the effectiveness, meaningfulness, and internal engagement of the immersive encounter. Most existing VR-on-site measurements concentrate on perceptual immersion, presence intensity, or post-experience evaluative outcomes such as satisfaction or destination image. By contrast, OTE captures the structured coordinated interaction among emotional, cognitive, and functional processes as they unfold in real time within hybrid physical-virtual environments. This shifts attention from perceived immersion alone to the internal experiential architecture through which immersive engagement is translated into memory formation and behavioral intention. Although emotional and cognitive components may appear close to destination image, VR destination image constructs typically capture evaluative perceptions as outcomes measured after interaction (Kim et al., 2020; Sinha et al., 2025). Optimal Telepresence Experience instead conceptualizes the experiential state that emerges during immersive interaction, explaining how emotional and cognitive mechanisms shape attention, meaning-making, and memory formation as users engage concurrently with physical and virtual environments. The inclusion of functional attributes further distinguishes OTE by incorporating technological mediation as an enabling condition for hybrid experiential integration. Accordingly, OTE complements rather than replicates existing experiential constructs by explaining the formation of experiential immersive tourism responses in hybrid contexts.

Importantly, OTE does not represent a simple additive aggregation of familiar experiential descriptors (e.g., enjoyment, immersion, authenticity, nostalgia). Instead, it conceptualizes how emotional resonance, cognitive interpretation, and functional coherence become structurally interdependent in hybrid experiential settings. The higher-order specification reflects the coordination required to sustain alignment between physical and virtual realities. It is this integrative architecture, rather than the individual experiential elements themselves, that constitutes the conceptual novelty of OTE.

More fundamentally, the contribution of OTE lies not merely in measurement refinement, but in explicating how physical and virtual experiences are structurally coordinated within hybrid tourism environments. In on-site VR contexts, visitors must continuously integrate embodied spatial presence with digitally reconstructed interpretation. Optimal Telepresence Experience specifies the psychological processes through which this dual-layered experiential field is stabilized, demonstrating how emotional resonance, cognitive meaning-making, and functional coherence jointly sustain integration across physical and virtual realities.

From a theoretical perspective, functional design conditions directly support OTE by enabling seamless interaction between physical and virtual environments. Consistent with telepresence and flow theory, high visual clarity, spatial alignment, and responsive device interaction reduce cognitive disruption and stabilize attentional focus (Cheng et al., 2014; Jinhee Yoo et al., 2022). In this regard, technological quality functions as a mechanism enabling hybrid experiential integration rather than merely intensifying sensory stimulation (Pettey et al., 2010). This interpretation also clarifies why VR users cans express emotional states towards the destinations they visit through immersive engagement (Quesnel & Riecke, 2018).

Although prior research has established positive relationships among immersive experience, memory formation, and behavioral intention (Debbabi et al., 2010; Faiola et al., 2013), the present study advances this stream by elucidating how these effects unfold in hybrid on-site VR contexts through OTE, a coordinated experiential integration of

emotional, cognitive, and functional engagement.

In relation to flow theory, the findings show that functional attribute extends beyond a simple technological antecedent to serve as a necessary precondition for achieving optimal experiential states in dual-layered environments. Because visitors must coordinate attention across both physical and virtual stimuli, high functional quality such as system responsiveness, visual clarity, and intuitive interaction reduces cognitive fragmentation and supports sustained attentional engagement. Unlike off-site VR experiences, where emotional novelty may be sufficient to sustain engagement (Sinha et al., 2025), on-site VR requires coherent coordination between material surroundings and virtual augmentation. Thus, functional attribute operates as an infrastructural condition that allows for the possibility of higher-order experiential integration.

Beyond the on-site context examined here, OTE may also provide theoretical value for fully virtual tourism environments or destinations lacking physical infrastructure. As heritage sites are increasingly recreated digitally or accessed remotely, OTE offers a lens for explaining how immersive engagement can be fostered when VR serves as the primary mode of experiencing a destination. Importantly, the experiential integration identified in this study, emotional, cognitive, and functional integration do not inherently depend on physical co-location, suggesting that OTE may provide a scalable framework for understanding immersive tourism across both hybrid and fully virtual environments.

Taken together, these theoretical refinements position OTE as a bridging construct across immersive tourism scholarship. By complementing telepresence and refining flow theory within dual-layered environments, and specifying the internal experiential structure through which immersive engagement is formed and translated into behavioral outcomes, this study clarifies how immersive experiences are structured in contemporary hybrid tourism contexts.

4.2. Practical implications

Importantly, the empirical finding that functional attributes exerted the strongest influence on memory formation suggests that heritage managers should prioritize operational reliability before investing in purely aesthetic or affective enhancements. This reorders common implementation assumptions, indicating that immersive effectiveness depends first on cognitive stability and attentional continuity rather than sensory intensity alone.

The findings provide actionable guidelines for heritage site managers seeking to implement VR effectively. In contrast to prior studies that focused primarily on shaping tourists' decision-making (Kokash et al., 2024), or destination image (Chang & Chiang, 2022), this study broadens the understanding of user perceptions in VR environments. Heritage managers can use the OTE dimensions to design and optimize VR content that triggers positive tourist responses to the site.

First, because functional attributes most strongly influence memory formation, managers should prioritize system performance that minimizes disruption to visitor attention. This includes ensuring rapid loading times, stable tracking, and intuitive navigation that allows users to switch easily between physical observation and virtual exploration. For example, VR interfaces should enable visitors to compare reconstructed historical scenes with the surrounding physical environment, reinforcing the integration of physical and virtual experiences.

Second, because cognitive attributes remain central, managers should design VR as an interpretive tool, rather than purely as entertainment. Managers should embed historically accurate narratives, explanatory annotations, and guided sequences that help visitors understand how the site functioned in the past. Structuring VR experiences around key historical moments, or spatial zones, can support meaning-making and strengthen memory formation.

Third, emotional attributes indicate that VR should evoke affective engagement through storytelling and sensory reconstruction. Recreating scenes from everyday life, as well as historical ceremonies, or royal activities, can help visitors to connect emotionally with the site. Managers could also incorporate brief reflection points after VR use, such as prompts or guided questions, to encourage visitors to link emotional impressions with the physical heritage environment.

By focusing on these dimensions, managers can align technological design with the psychological mechanisms of engagement identified in this study. Rather than adopting generic immersive features, managers should design VR experiences that simultaneously support functional usability, cognitive interpretation, and emotional resonance, to achieve OTE and enhance revisit intention.

The OTE framework further provides managers with a diagnostic tool to evaluate existing VR applications. By assessing visitor responses across functional, cognitive, and emotional dimensions, managers can identify whether experiential weaknesses stem from technological instability, insufficient interpretive scaffolding, or limited affective engagement, enabling more targeted resource allocation and iterative design refinement.

4.3. Conclusion

4.3.1. Conclusion

This study conceptualized and validated Optimal Telepresence Experience (OTE) as a higher-order construct encompassing emotional, cognitive, and functional attributes, and confirmed its role in shaping memory formation and revisit intention in on-site VR heritage contexts. Emotional resonance, cognitive meaning-making, and functional interaction each independently predicted memory of the heritage site, demonstrating that immersive VR shapes post-visit behavior through experiential integration rather than technological novelty alone.

These findings clarify how hybrid physical-virtual encounters are psychologically processed: OTE provides coordinated experiential structure through which VR engagement is encoded and retained, ultimately translating into behavioral outcomes. The complements existing telepresence and flow perspectives by providing a validated measurement instrument to hybrid heritage tourism contexts, offering a replicable measurement tool for examining immersive experiences across on-site and fully virtual tourism settings. Practically, designers of heritage VR applications should prioritize emotional engagement and interpretive depth alongside usability to maximize memory formation and encourage return visitation.

4.3.2. Limitations and future research direction

This research has conceptualized and validated OTE as a higher-order construct, but several limitations should be acknowledged. First, this study employed a single-site case design at the Imperial City of Hue and convenience sampling, as participation in the VR experience was voluntary. While appropriate for the initial development and validation of the new construct, these design choices limit the generalizability of the OTE framework and scale across broader heritage contexts and visitor populations. Future research should validate the OTE framework across diverse heritage destinations and cultural contexts to establish its external validity.

Second, this study focused primarily on validating OTE and examining its nomological relationships, rather than investigating the psychological mechanisms underlying its emergence. Future research could examine dual engagement as a potential antecedent of OTE and investigate how visitors' experiential involvement across physical heritage environments and VR-mediated reconstructions contributes to their overall technology-enhanced heritage experience. Such investigations would provide deeper theoretical insights into how OTE is formed under conditions of simultaneous engagement.

Third, future studies should further examine the conceptual boundaries between OTE and related experiential constructs, including telepresence, flow, authenticity, and dual engagement. Clarifying these relationships across different technology-enhanced heritage contexts would refine the theoretical domain of OTE and strengthen its

conceptual distinctiveness. Future research should also revisit the dimensional structure of the OTE scale with new data to examine each item specification and refine the boundaries between emotional, cognitive, and functional attributes.

Fourth, although this study focused on on-site VR-enhanced heritage tourism, the proposed framework may have broader applicability across emerging technology-enhanced heritage contexts. Future research could examine OTE in augmented reality, mixed reality, and AI-enhanced heritage interpretation. Longitudinal and experimental designs could further provide valuable opportunities to validate and extend the framework, investigating how OTE develops over repeated visits and influences long-term memory and revisit intention.

Finally, a further limitation relates to item specification within the OTE scale. While the overall measurement model demonstrated satisfactory psychometric properties, some closely related experiential meanings are captured within a single item, resulting in a potential double-barreled concern. This item-level limitation should be considered when interpreting the corresponding dimension and may represent a boundary condition on the construct validity of that dimension. Future research could further refine item wording and validate the OTE scale using independent samples to strengthen its measurement robustness.

CRediT authorship contribution statement

Thanh-Thuy Thi (Jessica) Doan: Writing – review & editing, Writing – original draft, Validation, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Sandra Goh:** Writing – review & editing, Writing – original draft, Supervision, Investigation, Conceptualization. **Chloe S. Kim:** Writing – review & editing, Writing – original draft, Supervision, Investigation, Conceptualization. **Dan Zhu:** Writing – review & editing, Writing – original draft, Validation, Data curation, Conceptualization. **Peter B. Kim:** Writing – review & editing, Writing – original draft, Supervision, Methodology, Conceptualization, Validation, Project administration.

Impact statement

This research introduces a new construct, Optimal Telepresence Experience (OTE), within on-site virtual reality (VR) settings at heritage sites and investigates its influence on tourists' behavior. By developing and validating a measurement scale for OTE, the study provides a framework for understanding how immersive VR experiences enhance memory and shape behavioral intentions. The findings contribute to the literature on digital engagement in cultural tourism and underscore the role of OTE as a key predictor of visitor behavior. Additionally, the study offers practical guidance for tourism marketers and heritage managers seeking to leverage VR technology to enrich visitor experiences and encourage repeat visitation.

Declarations of competing interest

None.

Appendix E. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.tourman.2026.105543.

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