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To cite this article: Yulia Eka Putrie , Sukmayati Rahmah , Aisyah Nur Handryant , Luluk Maslucha & Nunik Junara (24 Aug 2026): Spatial authenticity in physical and virtual experiences of sacred heritage: the Sendang Duwur case, Journal of Asian Architecture and Building Engineering, DOI: [10.1080/13467581.2026.2721903](https://doi.org/10.1080/13467581.2026.2721903)

To link to this article: <https://doi.org/10.1080/13467581.2026.2721903>



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Published online: 24 Aug 2026.



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Spatial authenticity in physical and virtual experiences of sacred heritage: the Sendang Duwur case

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ABSTRACT

Sacred heritage is increasingly encountered through physical and digital environments, raising questions about how spatial authenticity is constituted across different experiential modalities. This study examines physical and virtual encounters with the Sendang Duwur Pilgrimage complex, a sacred living heritage site in East Java, Indonesia. Using a comparative qualitative design informed by the phenomenology of space and the living heritage approach, reflective accounts from thirty participants who used a screen-based 360-degree virtual tour were analysed alongside on-site reflections from five researchers. Thematic analysis identified eight interrelated perceptual dimensions: visual, tactile, thermal, acoustic, olfactory, kinaesthetic, emotional, and transcendental sacred atmosphere. Physical engagement constituted spatial authenticity through multisensory perception, bodily movement, temporal change, ritual participation, and social presence. Virtual engagement relied more strongly on visual cues, symbolic interpretation, imagination, memory, and anticipatory sensory associations. Spatial authenticity, therefore, emerges not as a fixed property of sacred heritage but as a relational condition co-constructed through distinct perceptual and phenomenological pathways across physical and virtual engagement. The study advances an integrated understanding of spatial authenticity as experienced through phenomenological relations, sustained through living heritage practices, and reinterpreted across complementary modalities. This conceptualisation provides a basis for hybrid authenticity and more interpretive approaches to digital heritage design.

ARTICLE HISTORY

Received 3 April 2026
Accepted 17 August 2026

KEYWORDS

Hybrid authenticity;
phenomenology of space;
sacred living heritage; spatial
authenticity; virtual
pilgrimage

1. Introduction

Digital technologies such as virtual tours and virtual reality reconstructions have transformed how heritage sites are accessed and experienced, with particular implications for sacred heritage. Traditionally, pilgrimage spaces have been encountered through bodily presence and direct engagement with place. Virtual tools extend spatial encounters beyond physical presence, allowing wider audiences to access sites despite geographical or physical constraints. At the same time, they raise critical questions about authenticity and the embodied nature of spatial experience in architectural heritage discourse. One of the important questions in heritage studies is whether virtual representations can convey the emotional and spiritual qualities of historic or sacred sites.

A key issue in this transformation is the sensory difference between physical and virtual engagement with pilgrimage sites. Digital platforms often emphasise visual accuracy and curated movement but may not convey the acoustic, olfactory, tactile, and thermal dimensions vital to emotional and spiritual experiences (Fouad, Bingham, and Dean 2023). Physical

pilgrimage, on the other hand, engages the body and senses through movement and environmental atmosphere that foster authenticity and place attachment (Jubba et al. 2024; Scriven 2020). Virtual experiences, unless supported by advanced immersive technologies, tend to rely primarily on sight and sound, which may limit their affective and multisensory depth (Hwang et al. 2024; Tzanelli 2020).

Current debates reflect a tension between limitations and possibilities of virtual pilgrimage. Some studies suggest that virtual pilgrimage can foster meaningful engagement in specific contexts (Tufail et al. 2022), enhance perceived realism, encourage future physical visits (Gilchrist et al. 2025; Liu and Roehl 2025; Thomas, Kuhail, and AlBeyahi 2024), and broaden access to sacred sites (Hwang et al. 2024). Conversely, other studies highlight lingering feelings of inauthenticity and reduced emotional depth in mediated religious experiences (Hill-Smith 2009; Jubba et al. 2024). These contrasting findings suggest that virtual sacred experience should not be evaluated solely by how closely it reproduces physical

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pilgrimage, but by the forms of perception, engagement, and meaning it enables.

Understanding authenticity in sacred pilgrimage spaces requires a theoretical lens that moves beyond visual representation or material preservation alone. This study, therefore, adopts the phenomenology of space alongside the living heritage approach. Phenomenology, as developed by Norberg-Schulz (2011); Bachelard (1992), and Merleau-Ponty (2013), understands space not as something merely observed, but as lived through sensory interaction, bodily movement, and emotional resonance. Pallasmaa (2012); Tuan (1977), and Böhme (1993) likewise emphasise that atmosphere and perception are co-produced through the relationship between body, physical setting, and spatial situation.

In heritage contexts, this perspective challenges the authorised heritage discourse that privileges visual and material aspects of heritage sites (Smith 2006). It allows authenticity to be understood through embodied experience, emotional attachment, ritual practices, and community-based interpretations. The living heritage approach further supports this view by defining heritage not as a static artefact, but as a dynamic process embedded in the continuity of use, care, expression, and community connection (Wijesuriya 2018). The authenticity of sacred heritage is thus sustained through more than physical forms or visual representation. Together, phenomenology and living heritage suggest that authenticity of pilgrimage emerges from interactions among spatial form, bodily presence, ritual practice, and cultural memory.

This is particularly important in digital pilgrimage, where sacred places may be visually accessible but only partially embodied. Virtual pilgrimage can extend access and support interpretation, while also altering how atmosphere, movement, and sacred presence are perceived. Digital mediation should therefore be understood not as a substitute for physical pilgrimage, but as a distinct mode through which sacred heritage may be encountered and interpreted.

Recent studies increasingly view pilgrimage as an evolving cultural phenomenon shaped by practice, memory, negotiation, and adaptation (Galabova 2020; Luz 2023; Moscarelli, Lopez, and Lois González 2020). Longitudinal ethnographies further illustrate how ritual is dynamically adapted across settings and over time (Butler 2020; Maddrell and Scriven 2016; Scriven 2020). From phenomenological and living heritage perspectives, pilgrimage authenticity is consequently constituted through changing relationships among embodied movement, sensory atmosphere, memory, community participation, and modes of access.

Digital heritage scholarship has likewise shown that virtual tools can support interpretation, access, and new forms of engagement, even when they do not reproduce the full sensory and bodily conditions of

physical presence (Addison 2000; Bekele et al. 2018; Champion 2016). Digital and “glocal” innovations, such as mobile apps, virtual tours, and hybrid rituals, further expand understandings of sacred continuity beyond physical presence (Galabova 2020; Innocenti 2024; López Salas 2021). Within this discussion, the concept of hybrid authenticity has emerged to explain how virtual sacred spaces may generate forms of perceived authenticity that differ from, yet remain meaningful alongside, physical experience in contemporary sacred heritage contexts (Tran and Davies 2025). The central question is therefore not whether digital pilgrimage is identical to physical pilgrimage, but how mediated encounters construct meaning through perception, memory, imagination, and cultural association.

Nevertheless, empirical comparisons of multisensory experience and spatial authenticity across physical and virtual pilgrimage at heritage sites remain scarce. Much of the literature continues to emphasise technological fidelity or curated detail, with less attention to the experiential and phenomenological dimensions of sacred spaces (Fouad, Bingham, and Dean 2023). Research on virtual pilgrimage, digital religious communities, and long-term mediated pilgrimage experiences is growing, but studies comparing how embodied and mediated encounters construct spatial authenticity remain underdeveloped (Kratochvíl 2021; Malabanan et al. 2026; Paganopoulos 2024; Thomas, Kuhail, and AlBeyahi 2024; Tzanelli 2020). This gap is particularly significant for sacred living heritage sites, where authenticity is sustained not only through architectural fabric, but also through sensory atmosphere, ritual practice, community participation, and intergenerational continuity.

Sendang Duwur provides a particularly appropriate case for examining how spatial authenticity is negotiated across physical and virtual encounters. First, beyond its designation as a national cultural heritage property, it continues to function as a living sacred heritage complex where pilgrimage, prayer, communal activities, and collective reverence sustain its meaning. Second, the site presents a distinctive relationship between architectural transformation and material continuity. The mosque, originally built in the 16th century, has undergone adaptations that reflect its continuing socio-religious role, while the graveyard and tomb house of Sunan Sendang, a *wali* (Islamic saint) and religious leader associated with Sendang Duwur, have remained relatively intact. Third, its hill-top spatial sequence, comprising ascending routes, gateways, courtyards, the mosque, graveyard, and tomb house, creates a progressive pilgrimage experience shaped by movement, thresholds, atmosphere, and bodily effort. These characteristics make the site valuable for examining how sacred spatial meaning is constructed through sensory, emotional, and ritual engagement. Finally, Sendang Duwur is relevant to

virtual transposition because its hilltop accessibility and sequential routes raise questions about which aspects of sacred spatial experience can be represented, imagined, or lost through a 360-degree virtual tour.

At Sendang Duwur, historic architecture, ongoing religious practices, social events, collective reverence, and community memory shape the site's lived sacred character. However, it remains unclear how virtual experience might complement, challenge, or reconfigure this lived authenticity. Drawing on the phenomenology of space and the living heritage approach, this study examines how visitors perceive spatial authenticity in physical and virtual encounters with Sendang Duwur. It also investigates how embodied and digitally mediated interactions co-construct spatial authenticity within a sacred living heritage context. By comparing multimodal perceptions of pilgrimage space, this study contributes to discussions of spatial authenticity, multisensory architectural experience, and the digital mediation of sacred heritage. It also provides an empirical foundation for considering hybrid authenticity as a guiding concept for designing future digital heritage experiences that complement embodied pilgrimage rather than attempt to replicate it.

2. Materials and methods

This study forms part of a broader project investigating physical and virtual experiences of religious heritage sites in East Java. Building on earlier research into

sense of place within the virtual-tour dataset (Putrie et al., 2026), the present study incorporates on-site observations to examine how digitally mediated and physically embodied encounters construct spatial authenticity differently. The two modalities are compared through the phenomenology of space and the living heritage approach.

2.1. Research design and case selection

This study employed an exploratory comparative qualitative design to investigate how spatial authenticity is perceived through physical and virtual engagement with the Sendang Duwur Pilgrimage site. Phenomenological and autoethnographic approaches informed the examination of lived experience, sensory perception, emotional reflection, and embodied engagement with space (Innocenti 2024; Norris 2019). Rather than measuring authenticity as a fixed attribute, the study focused on how participants described, interpreted, and reflected on spatial experience across two modalities.

Sendang Duwur was selected as the case study because it offers a clear spatial and experiential basis for comparing physical and virtual pilgrimage. The site comprises a historic mosque, graveyard, tomb house, gateways, courtyards, ascending routes, and a hilltop pilgrimage sequence (Figure 1). These characteristics enabled examination of how spatial cues, sensory transitions, movement, and sacred atmosphere are perceived on site and through digital representation.

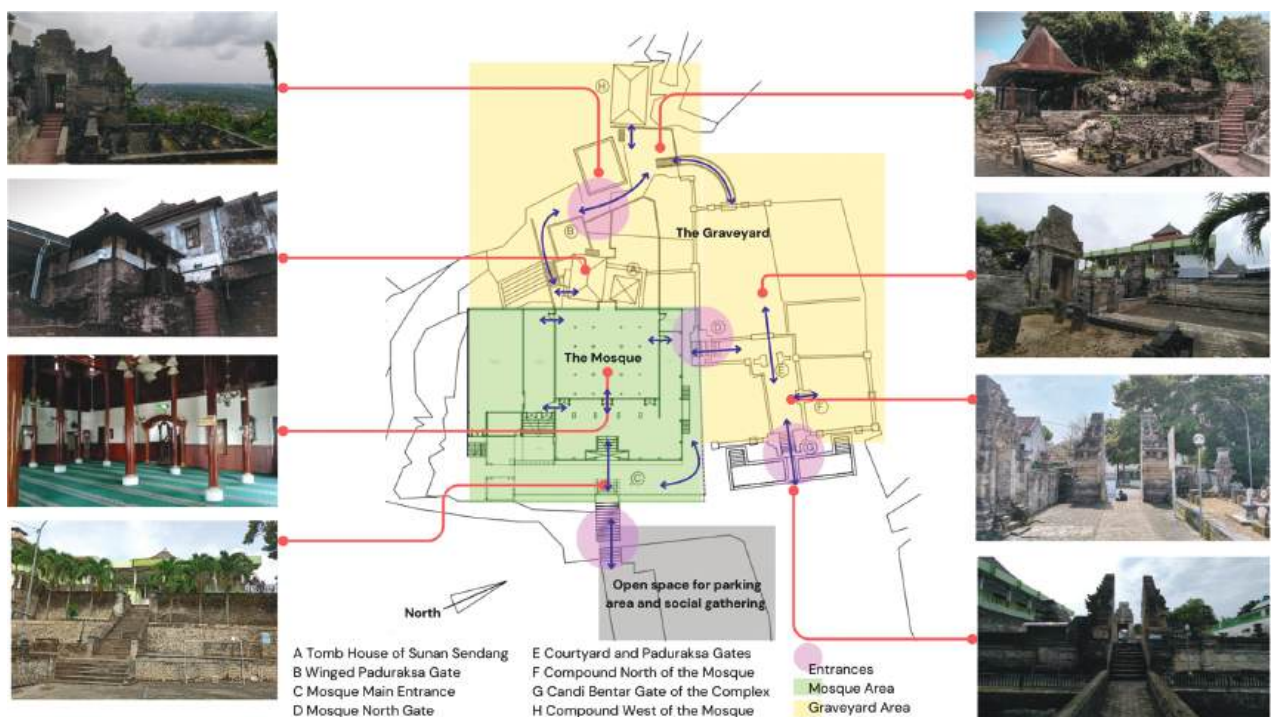


Figure 1. Spatial layout and selected visual elements of the Sendang Duwur Pilgrimage complex. The blue arrows indicate the on-site route from the lower entrance through the mosque, graveyard, and tomb house, while the photographs identify key spatial nodes and transitions encountered along the route.

A 360-degree virtual tour was selected as the virtual modality because it offered an accessible, low-cost digital format that could be experienced on common devices such as smartphones, laptops, and public computers. While immersive Virtual Reality (VR) is often celebrated for its representational depth (Fouad, Bingham, and Dean 2023; Mishra and Doria 2026), it has limited accessibility in many developing-country contexts due to cost, infrastructure, availability, and digital literacy. In low-tech contexts, particularly in heritage-rich developing countries such as Indonesia, virtual tours can play an important role in valorising and disseminating the historical and cultural value of built heritage (Savini et al. 2025). Accordingly, a 360-degree virtual tour was adopted as a contextually appropriate digital medium for investigating digitally mediated experiences of sacred heritage.

2.2. Data collection procedures

The data were collected from two sources: virtual tour reflections and on-site field observations. For the virtual experience, architecture students volunteered for a classroom-based research activity with no implications for course assessment or grades. The final analytic sample comprised thirty reflections from participants with no prior direct experience of Sendang Duwur and whose written accounts provided sufficient descriptive detail for phenomenological analysis. Responses that did not

meet these criteria were excluded. The participants' architectural background provided familiarity with spatial observation, while their lack of prior experience supported the study's focus on first-time mediated encounters. Because Sendang Duwur is less widely known and more distant from major urban centres than pilgrimage complexes such as Sunan Ampel and Sunan Giri, previous visitation among participants was unlikely.

The virtual tour was conducted in a classroom setting using individual computers and laptops (Figure 2). Participants were given approximately one hour to explore the curated 360-degree virtual tour and prepare their written reflections. All participants began from the same homepage, which provided access to the site's principal areas and navigation tools. They could then move at their own pace through interconnected panoramic nodes or select locations directly from the thumbnail gallery. Although the tour reflected the principal pilgrimage sequence, from the entrance area through the courtyards, mosque, graveyard, and tomb house, the interface did not require participants to follow a fixed route. They wrote their reflections on a paper-based response sheet containing an unannotated layout plan at its centre, either during the exploration or after completing the exploration. This procedure enabled participants to interpret spatial cues, atmosphere, sacredness, and authenticity independently within a screen-based environment.

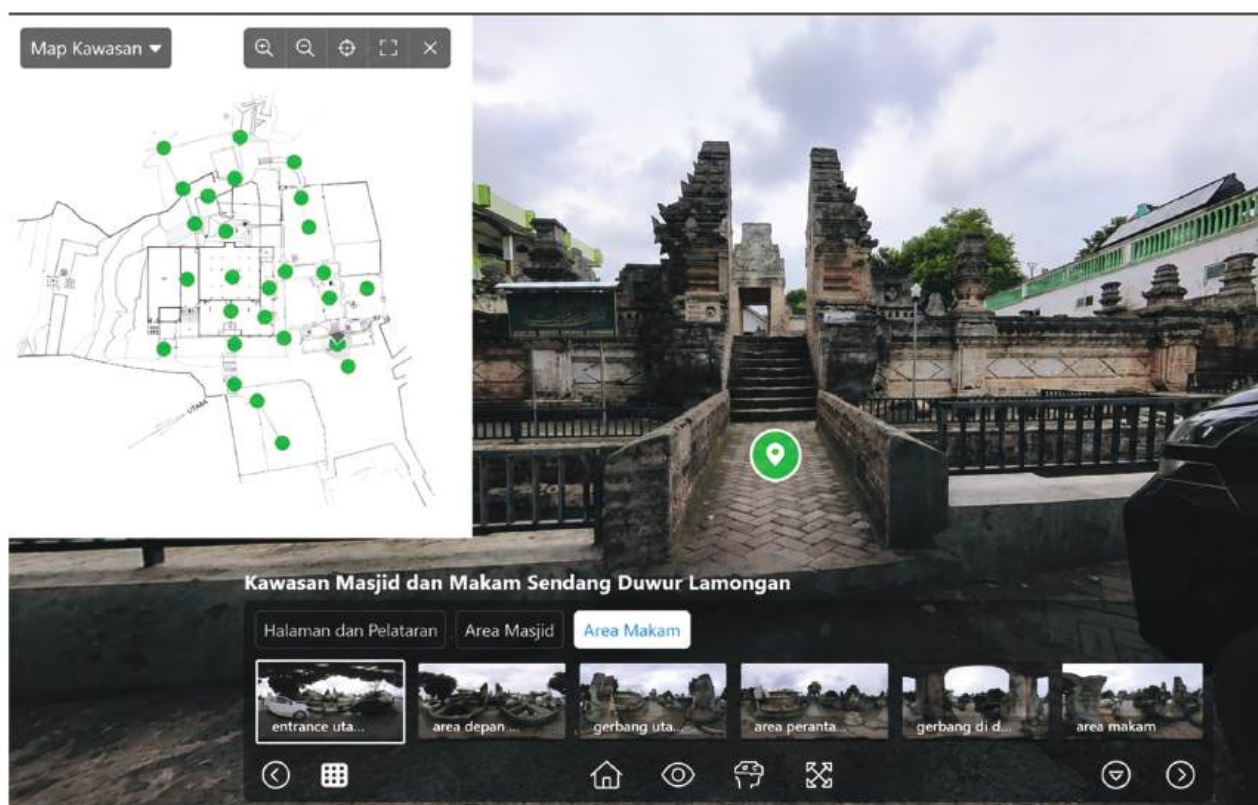


Figure 2. Interface of the curated 360-degree virtual tour used in the study. Participants began from a common homepage providing a site map, panoramic view, thematic categories, and thumbnail navigation. Although the interface was organised according to the principal pilgrimage sequence, participants were free to navigate independently between panoramic nodes.

Direct field observations were conducted by five research team members who also had no prior experience of the site. The visit lasted from the *dhuhr* (mid-day) prayer period to the *maghrib* (after-sunset) prayer period, allowing observation across changing temporal, thermal, acoustic, and ritual conditions. The on-site observation followed the main pilgrimage sequence rather than a random route, beginning at the lower entrance and ascending through the gateways, courtyards, the mosque area, the graveyard, and the tomb house. Each researcher independently recorded sensory and spatial reflections during and immediately after the visit. The notes were subsequently compared through collaborative triangulation, as described in the following subsection.

2.3. Data analysis and triangulation

The virtual participants' written reflections and the on-site field notes were compiled into a qualitative dataset and analysed using NVivo 11. A hybrid thematic approach combined deductive coding informed by the phenomenology of space and multisensory perception

with inductive coding that allowed additional experiential themes to emerge from the data.

The analysis proceeded through three stages (Figure 3). Open coding identified meaningful expressions related to sensory perception, spatial experience, and sacredness. Axial coding grouped related codes into broader conceptual categories. Selective coding integrated these categories into overarching themes for comparing physical and virtual experiences. NVivo 11 also generated word-frequency queries to support thematic interpretation rather than quantitative measurement. The resulting summaries were exported and re-rendered as word clouds for visual clarity while preserving original frequencies.

Eight perceptual dimensions were identified through this process. Six were informed by the multi-sensory perspective of the phenomenology of space: visual perception, tactile engagement, thermal sensation, acoustic atmosphere, olfactory cues, and kinaesthetic perception. Emotional engagement and transcendental sacred atmosphere emerged inductively as recurrent affective dimensions across the data. Together, the eight dimensions reflect an

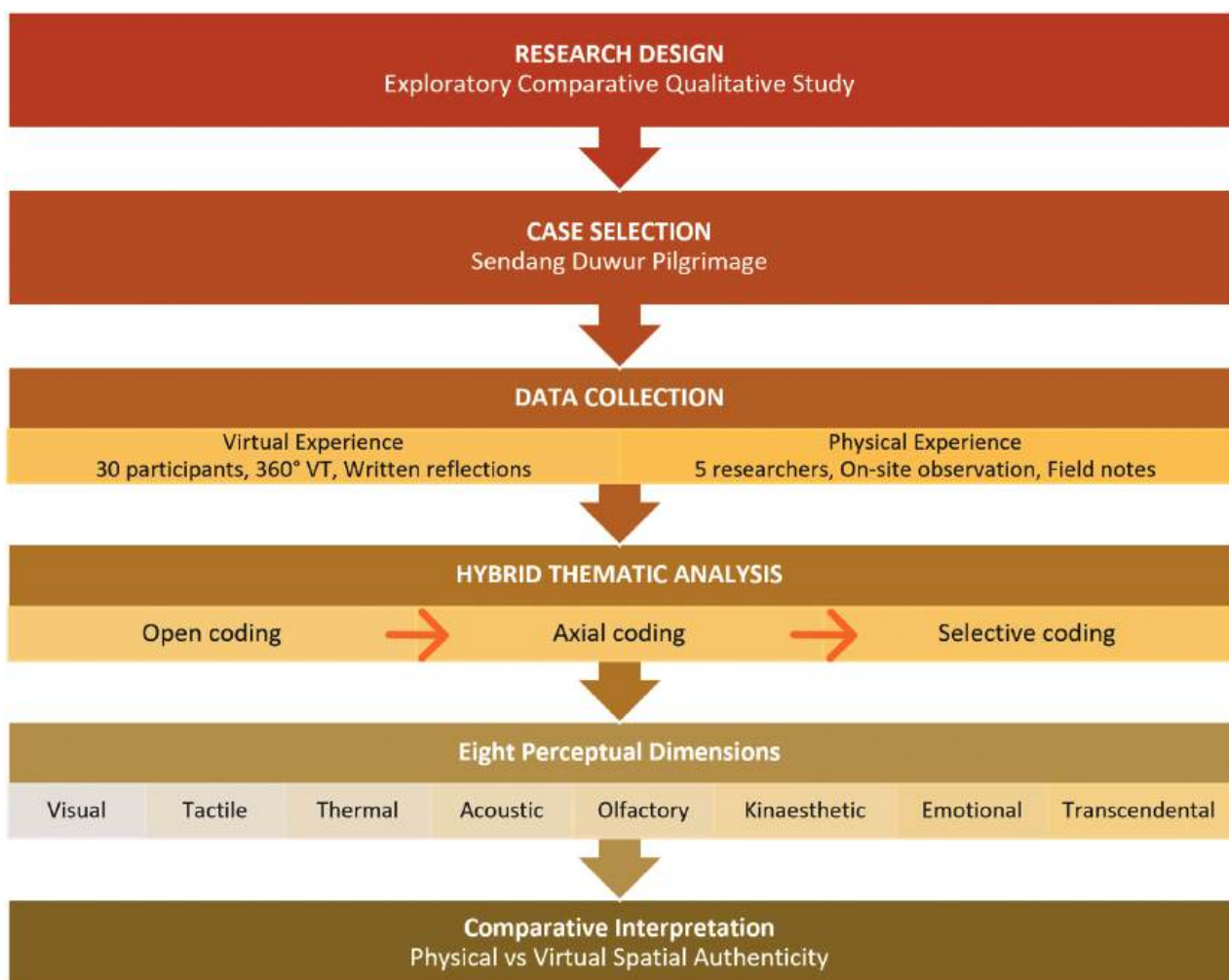


Figure 3. Workflow of the comparative qualitative research design showing case selection, data collection through virtual and physical experiences, hybrid thematic analysis, identification of eight perceptual dimensions, and comparative interpretation of spatial authenticity across physical and virtual pilgrimage experiences.

To enhance analytical credibility, the five on-site researchers independently documented their observations, then compared and discussed their interpretations through collaborative triangulation. They examined convergence and divergence across the field notes, refined code interpretations, and reached consensus where appropriate. The resulting thematic framework was applied consistently to both datasets to compare how spatial authenticity was perceived through physical and virtual engagement.

All participants provided verbal informed consent after receiving information about the study's purpose, the voluntary nature of participation, and the use of their written reflections or field notes for research. Participation in the classroom-based virtual-tour activity had no implications for course assessment or grades. Names and identifying details were removed and replaced with anonymous identifiers. The study followed established ethical guidelines for research involving human participants and received approval from the Research Ethics Committee of the authors' institution.

[illegible]

Second, the datasets differed in size and function. Thirty virtual participants provided reflections on mediated spatial experience, while five on-site researchers produced field observations through direct physical engagement. The groups were not designed for statistical equivalence; rather, they provided complementary qualitative perspectives. The findings should therefore be read as an interpretive comparison rather than a numerical comparison between matched groups.

3. Results

This section compares how spatial authenticity was perceived through virtual and physical experiences of the Sendang Duwur Pilgrimage site. A preliminary examination of vocabulary in the virtual-tour

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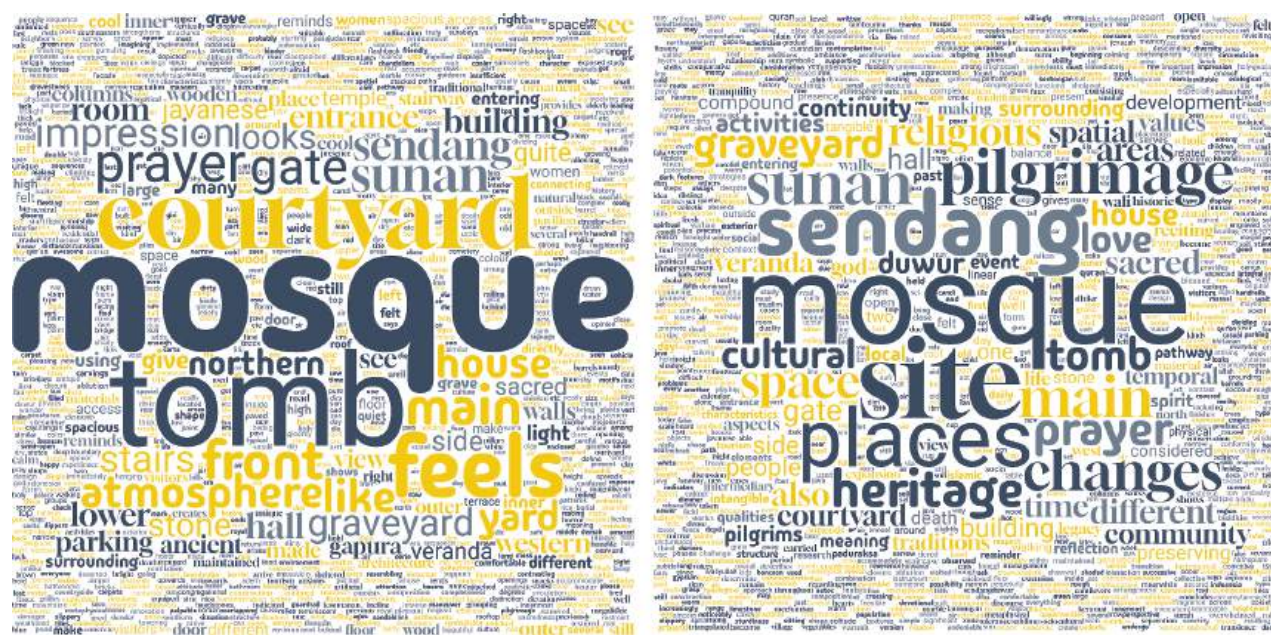


Figure 4. Word-frequency visualisations of virtual-tour reflections (left) and on-site field notes (right), generated in NVivo 11 and re-rendered at higher resolution. The comparison provides an initial overview of the vocabulary used to articulate each mode of experience.

reflections and on-site field notes identifies differences in spatial, sensory, and affective emphasis (Figure 4).

Both datasets reflected recognition of the site's principal architectural and sacred elements through terms such as "mosque," "tomb," "graveyard," "courtyard," and "prayer." This shared vocabulary establishes a common descriptive basis for comparing the two modes of engagement.

Differences became more apparent in the language used to describe the experience. Virtual-tour reflections emphasised visual and spatial impressions through terms such as "looks," "view," "atmosphere," "feels," and "impression," suggesting reliance on observation and interpretive projection. On-site field notes, by contrast, included terms such as "changes," "activities," "walking," "community," "continuity," and "cultural," indicating greater attention to movement, temporal change, social activity, and the site's continuing life. Although both datasets identified similar landmarks, the virtual participants focused more strongly visual-spatial interpretation, whereas the field notes incorporated embodied, temporal, and communal observations.

Building on this lexical comparison, the thematic analysis identified eight perceptual dimensions through which spatial authenticity was examined across virtual and physical engagement. These dimensions structure the comparative findings presented below.

3.1. Visual perception

Visual perception played a significant but distinct role in virtual and physical experiences. In both modalities, visible spatial elements supported orientation and shape participants' initial impressions of the pilgrimage complex. Virtual participants focused on architectural form, visual composition, and symbolic meaning presented through the curated 360-degree panoramas. One participant observed that "the columns hinder congregational prayer activities," (VT01), while another described how "the front yard with a wide courtyard and retaining walls arranged soaring upwards creates the impression of a sacred and protected building," (VT26). A further account noted that "the perspective in the entrance area of the mosque has unique visuals, such as columns that are wide and slender and have a span that spreads outward," (VT09). Another participant referred to a "calming impression with the light source coming from the mosque openings," (VT21). These accounts show how structural form, perspective, elevation, lighting, enclosure, and symbolic character were interpreted through screen-based visual cues.

Physical participants, by contrast, situated vision within a changing multisensory environment. The field notes recorded shifting light, human movement,

vegetation, material ageing, and the interplay between nature and architecture on the site. They also noted temporal change, construction details, and contextual qualities through remarks such as "different ceiling materials," "wood piles from the early mosque," and a "quiet and respectful" environment. These observations captured material modifications and environmental details that were less apparent in the virtual tour.

In this regard, virtual engagement supported broad visual recognition, formal analysis, and symbolic interpretation, whereas physical engagement enabled closer observation of material, temporal, and environmental conditions within a wider embodied encounter.

3.2. Tactile engagement

Tactile engagement revealed a key distinction between virtual and physical experiences of the site, particularly in how material qualities were inferred or directly encountered. In the virtual setting, participants projected texture and temperature from visual cues. One participant observed that "the columns and floor appear to be marble, as if they feel cold when being touched" (VT08), while another noted that "the mossy stairs make the floor look slippery" (VT15). These accounts show how visual perception prompted imagined sensations of temperature and surface condition. Virtual participants also made functional assessments from visible material and spatial cues. For example, "the stairs are made of concrete ... elderly people will likely have difficulty climbing" (VT02). Expressions such as "as if," "will likely," and "look" indicate both reliance on visual inference and awareness of tactile absence.

On the other hand, physical participants involved direct contact with materials through their hands, feet, posture, and movement. The field notes recorded the roughness of stone gateways, polished mosque timber, and cool tiled floors. One participant described how "the cold and slightly rough tile and stone pathways felt through our footsteps made us walk carefully," while another recorded, "We held onto the stainless-steel handrails along the tall, slippery stone steps leading up to the mosque." Further observations noted that "even during the day, the mosque's tiled floor felt slightly cold, while the prayer rug made it warmer and softer," and that "the *paduraksa* gate combines wood and stone carvings that are rich in textures and motifs."

Thus, virtual engagement supported tactile imagination and functional assessment, whereas physical engagement involved direct negotiation with texture, temperature, friction, and material resistance.

3.3. Thermal sensation

Thermal sensation further distinguished virtual from physical engagement with the site. Virtual participants inferred heat or coolness from visible environmental cues such as sunlight, material appearance, or vegetation's shade upon surfaces. Remarks such as "it feels hot when you see the stones that make up the gate," (VT15) and "the area behind the graveyard feels cool because there are trees," (VT10) illustrate how temperature was imagined through visual interpretation rather than directly sensed.

By contrast, on-site participants experienced thermal transitions through bodily sensation. They noted variations across walkways, shaded courtyards, and elevated terraces, including the "sudden change in warmth when moving from the sunny courtyard to the shaded tomb house," and "the cold and dim interior of the main prayer hall." These sensations were shaped by changing exposure to sunlight, shade, enclosure, and airflow as participants moved through the complex.

Virtual engagement, therefore, supported anticipatory readings of temperature, whereas physical engagement involved direct bodily adjustment to changing microclimatic conditions.

3.4. Acoustic atmosphere

Acoustic perception emerged as another important distinction between virtual and physical engagement. In the virtual mode, participants frequently associated silence with sacredness, although this relationship was inferred rather than directly experienced. They described the site as "quiet and eerie" (VT16, VT17), "deserted" (VT06), or "sacred" (VT02). Rather than responding to audible sound, participants constructed imagined soundscapes from visual cues and prior cultural expectations of pilgrimage environments. As one participant remarked, "in a place like this, we usually start to be silent to recite dhikr, or just be silent out of respect" (VT05). These accounts suggest that acoustic atmosphere was constructed through visual interpretation and cultural expectation rather than direct listening.

Conversely, physical engagement involved immersion in layered and changing soundscapes. Field notes captured the rhythmic sound of *bedug*, the adhan, children playing outside, rustling wind, and pilgrims reciting dhikr. These sounds varied across locations and moments of the visit, creating acoustic transitions between the mosque, courtyards, and tomb areas. The observations also noted the coexistence of everyday social life and religious practice, such as children playing outdoors while prayers took place inside the mosque. Unlike the virtual experience, sound was experienced as part

of the site's temporal rhythm, movement, and communal activity.

Hence, virtual engagement relied on culturally informed interpretations of silence and imagined soundscapes, whereas physical engagement involved direct participation in a changing acoustic environment.

3.5. Olfactory cues

Olfactory cues marked one of the clearest differences between virtual and physical engagement. None of the virtual-tour participants referred to or imagined scent in their written reflections. Unlike tactile and thermal qualities, smell was absent rather than visually inferred in the virtual dataset.

On-site field notes, by contrast, recorded distinct scents across different parts of the complex. Participants noted the smell of earth, incense, dried flowers, aged materials, and "the subtle smell of old wood" within the historic buildings. In the graveyard compounds, references to "earth and flowers" and "fresh soil after the rain" linked scent to vegetation, weather, material ageing, and ritual use.

Olfactory perception was therefore absent from the virtual reflections but emerged on site as a place-specific and temporally changing dimension of the material and ritual atmosphere.

3.6. Kinaesthetic perception

Kinaesthetic perception differed markedly between virtual and physical engagement. In the virtual mode, participants navigated through screen-based movement rather than bodily passage. Movement was therefore anticipated through visible features such as stairs, pathways, and changes in elevation. One participant wrote, "I felt tired already when I saw the stairs leading into the mosque" (VT15), while another observed that "the stairs are made of concrete ... elderly people will likely have difficulty climbing stairs" (VT02). These accounts indicate anticipatory awareness of effort, accessibility, and bodily risk based on visual cues. A further reflection noted that "the transition area with stairs adds a sacred impression and a high spiritual level" (VT05), showing that elevation and transition also acquired symbolic meaning without physical ascent.

In contrast, physical engagement involved direct bodily negotiation with the site's changing terrain. On-site participants described ascending terraced pathways, walking barefoot on cool stone, adjusting their pace on uneven surfaces, and gripping damp handrails along steep steps. Movement unfolded sequentially from the entrance through the courtyards, gateways, mosque, and tomb house, requiring changes in posture, speed, balance, and attention.

In summary, virtual engagement supported anticipatory and symbolic readings of movement, whereas physical engagement involved exertion, bodily adjustment, and sequential passage through the site.

3.7. Emotional engagement

Emotional engagement emerged in both virtual and physical experiences, although its character and intensity differed. In the virtual mode, emotions were associated primarily with visual impressions, historical imagination, and symbolic interpretation. One participant wrote, “when I saw the façade of this mosque, I felt like I was seeing the walls of Borobudur Temple. The feelings that arise are sadness and anxiety” (VT28). Others expressed awe at the temple-like gateway, describing how it “takes us to the past” and evokes admiration for ancient craftsmanship (VT05). Responses also included solemnity, mystery, otherworldliness, and anticipatory fatigue when viewing steep stairs (VT15). These accounts show that mediated emotional engagement developed through visual interpretation, memory, imagination, and personal association.

Physical engagement, by contrast, involved emotional responses that unfolded through sensory, spatial, and ritual encounters. Field notes described “tranquillity in the inner courtyard” and “goosebumps hearing others recite *tahlil*,” while old tombstones were perceived as “freezing time” and evoking reverence. Participants also recorded hesitation before entering the tomb house and emotional shifts while removing footwear, pausing in shaded courtyards, and progressing through the sequence of sacred spaces. These responses developed through movement, sensory immersion, ritual conduct, and changing spatial conditions.

Thus, virtual engagement generated emotions through mediated interpretation and association, whereas physical engagement produced emotional

responses through direct multisensory and ritual participation.

3.8. Transcendental sacred atmosphere

A transcendental sacred atmosphere was identified in both virtual and physical engagements, although it was articulated through different experiential conditions. In the virtual mode, participants recognised sacredness through visual symbolism, spatial hierarchy, architectural form, and culturally informed association. One participant described the site as having “a thick mystical atmosphere, dim but calming” (VT08), while another wrote that “the area under the main stairway ... begins to feel the sacredness of the ancient building” (VT12). Other accounts noted that “the sacred atmosphere is increasingly felt as you enter the graveyard area” (VT22) and that the approach from below created “a majestic and sacred impression” (VT30). These reflections show how elevation, gateways, lighting, enclosure, and tomb arrangement supported interpretations of sacredness through visual and cultural cues.

Physical engagement, by contrast, situated sacred atmosphere within multisensory, bodily, and ritual experience. Field notes recorded silence, scent, recitation, changes in pace, removal of footwear, barefoot movement, and hesitation at thresholds. One observation stated that “walking through the linear pathway with graves on the left and right made us think about how close death is.” Other accounts described the atmosphere as “heavier” near the tomb house and recorded hesitation before crossing its threshold. These responses developed through the combined effects of spatial sequence, sensory conditions, ritual conduct, and encounters with other pilgrims.

Virtual engagement, therefore, supported the recognition of sacredness through mediated

Table 1. Comparative analysis of virtual vs physical experiences of Sendang Duwur.

Aspect	Virtual Experience	Physical Experience
Visual Perception	Broad visual recognition, formal analysis, and symbolic interpretation based on screen-mediated spatial cues	Close observation of material, temporal, environmental, and contextual details within a wider embodied encounter
Tactile Engagement	Visually prompted tactile imagination and functional assessment of texture, temperature, friction, and accessibility	Direct bodily contact with material surfaces through touch, footsteps, balance, and movement
Thermal Sensation	Symbolic and anticipatory readings of heat and coolness derived from sunlight, materials, vegetation, and shade	Direct bodily adjustment to changing microclimatic conditions shaped by sunlight, airflow, shade, enclosure, and elevation
Acoustic Atmosphere	Culturally informed interpretations of silence and imagined soundscapes inferred from visual and sacred cues	Dynamic auditory experience involving ritual sounds, social activity, environmental sounds, and changing temporal rhythms
Olfactory Cues	Absent from participants' reflections	Place-specific and temporally changing scents associated with earth, flowers, incense, aged wood, weather, and ritual use
Kinaesthetic Perception	Anticipatory and symbolic interpretations of movement based on visible stairs, slopes, pathways, and thresholds	Actual exertion, bodily adjustment, and sequential movement through changing terrain and spatial transitions
Emotional Engagement	Emotional responses formed primarily through visual interpretation, imagination, memory, and personal association	Emotional responses developed through direct multisensory, spatial, ritual, and social encounters
Transcendental Sacred Atmosphere	Sacredness recognised through visually mediated symbolism, spatial hierarchy, cultural memory, and interpretation	Sacredness encountered through the combined effects of movement, sensory conditions, ritual behaviour, thresholds, and social presence

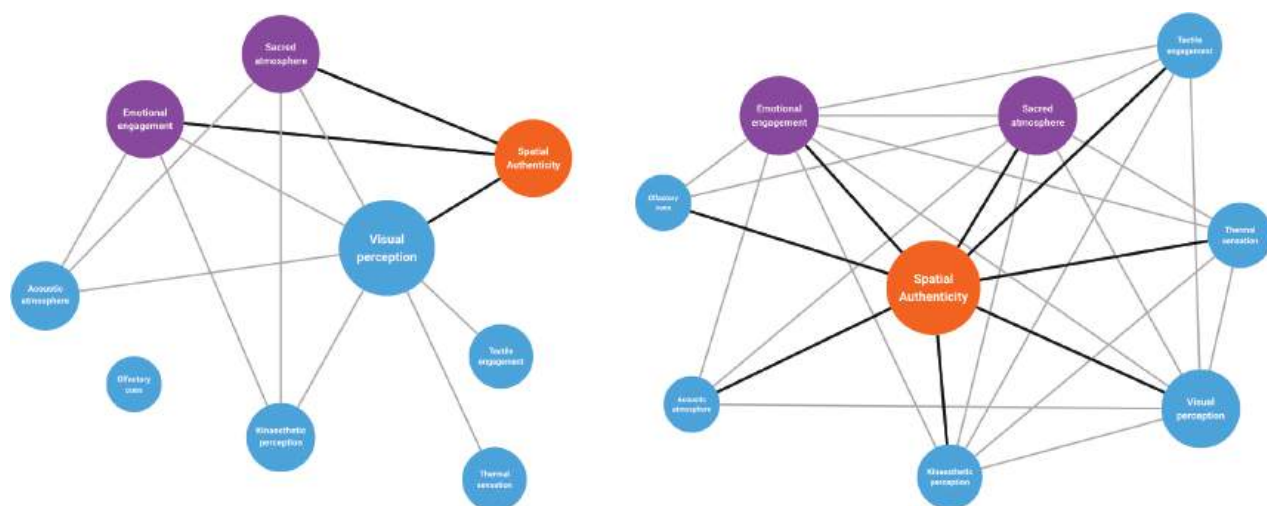


Figure 5. Interpretive conceptual networks of spatial authenticity in virtual engagement (left) and physical engagement (right). Blue nodes represent deductively derived perceptual dimensions, purple nodes represent inductively identified affective dimensions, and the orange node represents spatial authenticity. Node size indicates relative conceptual centrality, while black and grey lines indicate direct and supporting relationships, respectively.

symbolism and interpretation, whereas physical engagement involved participatory and multisensory encounters with sacred atmosphere.

Table 1 summarises how the eight perceptual dimensions were articulated differently across virtual and physical engagement with Sendang Duwur, providing a comparative overview of the experiential pathways through which spatial authenticity was constituted.

Furthermore, Figure 5 synthesises the relationships among the eight dimensions and spatial authenticity in each mode of engagement. In the virtual diagram (Figure 5, left), visual perception functions as the primary organising dimension, while the physical diagram (Figure 5, right) shows a denser integration of sensory, affective, and sacred-atmospheric relationships. The diagrams are interpretive syntheses of the coding results rather than outputs of quantitative network analysis.

Across the eight dimensions, physical engagement involved multisensory perception, embodied movement, temporal change, ritual participation, and social presence, producing a more integrated network of sensory and affective relationships. Virtual engagement was organised primarily through visual symbolism, prior knowledge, cognitive inference, and narrative cues, although participants also expressed reverence, curiosity, emotion, and imagined sensory qualities.

The findings indicate that physical and virtual encounters differ not merely in experiential intensity, but in the perceptual and phenomenological pathways through which spatial authenticity is constituted. The Discussion interprets these differences through the phenomenology of space, the living heritage

approach, and the emerging concept of hybrid authenticity.

4. Discussions: interpreting spatial authenticity and multimodal perception through phenomenology of space and living heritage

The findings demonstrate that spatial authenticity is constituted through different perceptual and phenomenological configurations rather than differences in experiential intensity alone. As illustrated in Figure 5, physical engagement integrates multisensory, affective, and sacred-atmospheric dimensions, whereas virtual engagement is organised primarily around visual perception. Spatial authenticity therefore emerges from the relationships among these dimensions, whose configuration varies across physical and virtual encounters.

4.1. Embodied experience and phenomenology of space

The phenomenology of space understands spatial experience as bodily, situated, and multisensory rather than as a purely visual act. Merleau-Ponty (2013) emphasises that perception emerges through the body's engagement with the world, while Pallasmaa (2000, 2012) describes architecture as a haptic experience in which materials, surfaces, movement, and sensory interaction contribute to spatial meaning. Böhme's (1993) concept of atmosphere further explains how spatial experience develops through bodily adjustment to ambient conditions such as light, temperature, sound, materiality, and human presence.

The physical experience of Sendang Duwur reflects this embodied structure of perception. On-site participants walked barefoot across uneven and sometimes slippery surfaces, experienced changes in temperature and airflow, moved through ascending pathways and narrow thresholds, and encountered layered soundscapes of the adhan, dhikr, conversation, children playing, and environmental sounds. These conditions unfolded sequentially across spatial zones and times of day, allowing spatial authenticity to emerge through continuous negotiation with movement, material resistance, atmosphere, and temporal change.

Virtual engagement followed a distinct phenomenological pathway. Instead of *dwelling* (Heidegger 2001), virtual users engaged in projective interpretation. Participants navigated through screen-based panoramic nodes and interpreted architectural elements through visual composition, symbolic associations, cultural memory, and imagined sensory responses. Participants inferred tactile, thermal, and kinaesthetic qualities from visible cues such as moss-covered steps, shaded courtyards, stone surfaces, and steep routes. Through this projective interpretation, they constructed meaningful impressions of sacredness and materiality without direct bodily contact.

The distinction is therefore not simply between an authentic physical experience and an inauthentic virtual one. Rather, the two modalities organise perception differently. Physical engagement co-produces presence through reciprocal interaction among body, material setting, movement, ritual, and atmosphere. Virtual engagement constructs a mediated presence through vision, imagination, memory, and culturally informed interpretation. Although metaverse environments may offer greater ecological realism and social presence (Thomas, Kuhail, and AlBeyahi 2024), their contribution to perceived authenticity in online religious practice remains partial rather than equivalent to embodied participation. Previous research similarly identifies the limited bodily depth of cyber pilgrimage (Hill-Smith 2009), while also showing that prior experience, digital affordances, narrative framing, and media literacy can support emotional engagement and perceived authenticity in virtual religious and heritage environments (Gilchrist et al. 2025; Lee et al. 2025; van Dun, Versteeg, and Roeland 2015). Embodied movement nevertheless remains significant because it contributes to spatial legibility, relational identity, and meaning-making during pilgrimage (Scriven 2020).

These findings contribute to phenomenological understandings of spatial authenticity by showing that authenticity is not reducible either to accurate

visual representation or to technological sophistication. It emerges through the meaningful co-production of presence across perceptual, affective, ritual, and cultural dimensions. In physical settings, this co-production is grounded in bodily immersion and temporal participation. In virtual settings, it develops through mediated perception and projective interpretation. Both pathways can produce meaningful encounters, although they engage the body, senses, memory, and imagination differently.

Embodied multisensory immersion is the condition through which Sendang Duwur is encountered as a changing lived environment. At the same time, virtual engagement demonstrates that meaningful spatial interpretation can emerge without full bodily presence. This tension between embodied experience and mediated projection provides the basis for considering how sacredness and authenticity are sustained, reconfigured, and transmitted through living heritage.

4.2. Sacredness between presence and mediation: a living heritage lens on meaning-making

From the perspective of living heritage, authenticity resides not in static architectural forms but in the continuous enactment of rituals, spatial rhythms, sensory practices, and communal participation. At Sendang Duwur, this continuity was expressed through everyday bodily acts such as removing footwear, walking barefoot, pausing at thresholds, and responding to changing scents, textures, sounds, and spatial transitions. They functioned as embodied carriers through which sacred meaning was continually experienced, reinforced, and transmitted across generations.

These practices demonstrate that living heritage does not preserve sacredness by eliminating everyday life. Sacredness is continually constituted through the coexistence of ritual and ordinary social activity. Prayer, adhan, dhikr, children playing, conversation, movement, and seasonal environmental change unfolded within the same spatial setting. Architecture provides the framework for these encounters, but sacred meaning is sustained through repeated communal participation rather than physical fabric alone.

Virtual visitors, by contrast, encountered the site through visual fragments, mediated narratives, and selective representation. Although some participants perceived sacredness or solemnity, these impressions arose primarily through symbolic interpretation, aesthetic resonance, prior knowledge, and cultural familiarity rather than lived participation. Digital encounters therefore remained largely observational and detached from the site's evolving

communal functions and temporal rhythms. This presents a central challenge for digital heritage: virtual media can document spatial form and suggest atmosphere, but they struggle to convey the participatory enactments through which living heritage is continually performed.

However, physical and digital modalities should not be viewed as oppositional but as differently situated and potentially complementary forms of engagement. Community-centred safeguarding increasingly operates through hybrid practices, in which digital and physical participation reinforce one another (Grau 2021; López Salas 2021; Moscarelli, Lopez, and Lois González 2020; Tran and Davies 2025). Pilgrims, custodians, designers, and institutions can co-create heritage narratives through social media, mobile guides, and interactive platforms, enabling broader participation, reinterpretation, and intergenerational transmission. These hybrid forms of engagement reflect the plural and adaptive model of living heritage, in which tradition is not merely maintained but continuously negotiated in response to contemporary conditions (Grau 2021; Innocenti 2024; López Salas 2021). Digital storytelling and virtual documentation thus support rather than replace embodied heritage transmission by extending its reach while remaining anchored in lived social relations.

Across both modalities, sacredness emerged not solely from built forms or spatial hierarchies, but through ritual gestures, sensory transitions, social presence, and collective memory. Under digital mediation, sacred perception was not necessarily lost but reconfigured: virtual encounters may evoke longing, curiosity, and imagined reverence, whereas physical encounters involve situated affect, bodily exertion, and participation in communal rhythms. Both modes, therefore, hold value, but they activate and transmit the site's living heritage differently.

Viewed through the lens of living heritage, spatial authenticity emerges from the coexistence of sacred and everyday rhythms. It is not a fixed property of architecture, but a continually enacted relationship among place, ritual, memory, community, and changing modes of engagement.

4.3. Multimodal engagement and the design of heritage experience

Taken together, these findings have important implications for the design of future digital heritage experiences. Rather than treating physical and virtual engagement as competing modes, the findings suggest that each contributes differently to spatial authenticity. Physical visits provide embodied, multisensory, ritual, and social participation, whereas

virtual environments offer accessible and interpretive points of entry for those unable to visit in person. Digital heritage should therefore complement, rather than attempt to reproduce the full conditions of embodied pilgrimage.

Recent developments in digital heritage support this complementary role. Virtual tours and immersive environments can extend access, support interpretation, document spatial transformation, and prepare or enrich subsequent physical visits. The use of virtual tours (Malabanan et al. 2026; Savini et al. 2025) and virtual reality (Jubba et al. 2024; Mishra and Doria 2026) needs to extend beyond visualisation to support cultural heritage interpretation and documentation (Comes and Buna 2026). More importantly, digital heritage need not function only as a visual or representational medium. Participatory digital frameworks can also involve communities, custodians, designers, and users in interpreting, safeguarding, and communicating heritage values, thereby connecting digital representation with continuing social and cultural practices (Farhan et al. 2025). Greater technological sophistication may strengthen perceived presence, but it does not automatically produce deeper authenticity. The experiential value of digital heritage depends on how visual, narrative, spatial, cultural, and participatory elements are organised.

These findings provide an empirical foundation for understanding hybrid authenticity. Hybrid authenticity does not require virtual experience to become identical to physical presence. Instead, it recognises that mediated and embodied encounters may contribute different but interconnected forms of meaning. Virtual participants in this study constructed sacredness through visual symbolism, imagination, memory, and cultural interpretation, whereas physical participants encountered it through bodily movement, multisensory immersion, ritual practice, and communal presence. The two modalities may therefore support one another across a broader heritage experience rather than functioning as substitutes.

The objective of virtual heritage design should not be to simulate embodied pilgrimage in its entirety. Digital environments should instead cultivate meaningful forms of spatial authenticity through the careful orchestration of visual narrative, spatial sequence, symbolic interpretation, atmospheric cues, and opportunities for reflection. Design strategies may include richer soundscapes, dynamic lighting transitions, deliberate pacing between panoramic nodes, contextual narratives, and sensory prompts that encourage users to imagine material, thermal, acoustic, and ritual qualities without equating those impressions with direct bodily experience.

Table 2. Conceptual synthesis of how spatial authenticity is experienced, sustained, and supported across physical and virtual engagement.

Conceptual lens	Virtual engagement	Physical engagement	Conceptual implication
Experiencing spatial authenticity (Phenomenology of space)	Mediated, visually oriented, imaginative, projective	Embodied, multisensory, affective, temporally situated	Spatial authenticity emerges through different phenomenological pathways
Sustaining spatial authenticity (Living heritage)	Mediated memory, cultural interpretation, digital transmission, expanded access	Ritual continuity, communal participation, collective memory, everyday sacred rhythms	Living heritage may be enacted and transmitted across physical and mediated forms
Supporting spatial authenticity (Hybrid authenticity and digital heritage design)	Atmospheric design, contextual interpretation, reflective engagement, hybrid access	Continued embodied access, ritual practice, community participation	Digital heritage should complement rather than attempt to reproduce embodied pilgrimage

Rather than replacing embodied pilgrimage, digital heritage should extend and enrich it by supporting interpretation, accessibility, and continuing community engagement. Hybrid authenticity therefore lies not in reproducing physical presence, but in designing meaningful relationships between digital and embodied experience.

Table 2 synthesises the principal conceptual distinctions developed across the Discussion, showing how spatial authenticity is experienced, sustained, and supported across physical and virtual engagement.

5. Conclusion

This study examined how spatial authenticity is perceived through physical and virtual engagement with the Sendang Duwur Pilgrimage complex. Drawing on the phenomenology of space and the living heritage approach, the comparative analysis identified eight interrelated perceptual dimensions through which participants articulated their experiences of the site.

The findings demonstrate that physical and virtual encounters differ not merely in experiential intensity, but in the perceptual and phenomenological pathways through which spatial authenticity is constituted. Physical engagement integrated bodily movement, multisensory perception, temporal change, ritual practice, and social presence within a dense experiential network. Virtual engagement was organised more strongly around visual perception, symbolic interpretation, imagination, memory, and anticipatory sensory associations. Virtual participants could therefore construct meaningful impressions of sacredness, although these emerged through mediated interpretation rather than the embodied and participatory conditions of on-site experience.

Spatial authenticity is consequently understood not as a fixed property of architectural fabric or representational fidelity, but as a relational and emergent condition co-constructed through interactions among body, space, atmosphere, ritual, memory, community, and mediation. The phenomenology of space clarifies how authenticity is experienced through situated perception and bodily engagement, while the living heritage approach explains how it is sustained through ritual continuity, communal participation, collective

memory, and the coexistence of sacred and everyday rhythms. Living heritage does not maintain sacredness by separating it from ordinary life. It is continually constituted through their coexistence. The study, therefore, contributes an integrated account of spatial authenticity as experienced through phenomenological relations, sustained through living heritage practices, and constituted differently across complementary physical and virtual modalities.

These findings also provide an empirical basis for considering hybrid authenticity in future digital heritage design. Virtual engagement should not be evaluated solely according to how closely it reproduces physical pilgrimage. Its value lies in offering a complementary mode of access, interpretation, reflection, and cultural transmission. Digital heritage should therefore move beyond visual documentation by structuring spatial sequences, contextual narratives, atmospheric cues, reflective pacing, and connections to continuing community and ritual life. Hybrid authenticity lies not in replicating physical presence, but in designing meaningful relationships between digital and embodied experience.

The study is limited by its focus on a single sacred heritage complex, the unequal size and methodological function of the two datasets, and the use of a screen-based 360-degree virtual tour rather than a fully immersive environment. The findings should therefore be understood as an interpretive comparison of complementary qualitative perspectives rather than a numerical comparison between equivalent participant groups.

Future research could extend the analysis across different sacred traditions, heritage settings, participant backgrounds, and digital platforms. Longitudinal and sequential studies, such as virtual encounters followed by physical visits, or physical visits subsequently revisited digitally, could clarify how memory, prior experience, embodiment, and mediation interact over time. Such research may further develop hybrid authenticity as a design-oriented concept for supporting sacred heritage across interconnected physical and digital environments.

Acknowledgements

The authors would like to express their sincere gratitude to the Directorate of Islamic Higher Education, Ministry of

Religious Affairs of the Republic of Indonesia, for the generous support provided through the Litapdimas Multiyear Research Program under grant number 221090000055335, which made this research possible.

Author contributions

CRedit: **Yulia Eka Putrie**: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Software, Visualization, Writing – original draft, Writing – review & editing; **Sukmayati Rahmah**: Formal analysis, Investigation, Methodology, Validation, Writing – review & editing; **Aisyah Nur Handryant**: Formal analysis, Investigation, Methodology, Validation, Writing – review & editing; **Luluk Maslucha**: Formal analysis, Investigation, Validation; **Nunik Junara**: Formal analysis, Investigation, Validation.

Disclosure statement

No potential conflict of interest was reported by the author(s).

The authors used DeepL, Grammarly, and OpenAI's ChatGPT during the manuscript-editing process for language refinement, grammatical correction, and improvements in clarity and coherence. All conceptual development, data collection and analysis, theoretical framing, and critical interpretation were undertaken by the authors. The authors reviewed and approved the final manuscript and take full responsibility for its content.

Funding

The work was supported by the Kementerian Agama Republik Indonesia [221090000055335].

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Data availability statement

The dataset generated and analysed during this study has been published on Figshare and is publicly available at <https://doi.org/10.6084/m9.figshare.31246045>. The dataset has been fully anonymized to ensure participant confidentiality, with all personally identifiable information removed in accordance with ethical research standards.

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