

Sacred thirdspace: Phenomenological intensification and the ontology of Shrine architecture in Penang, Malaysia

Hakimi Ahmad^{ID}, Mohd Jaki bin Mamat^{ID}, Tessa Eka Darmayanti^{*ID}

School of Housing, Building and Planning, Universiti Sains Malaysia,
USM, 11800, Malaysia



ARTICLE INFO	ABSTRACT
<i>Article history:</i> Received April 14, 2026 Received in revised form June 18, 2026 Accepted August 02, 2026 Available online September 01, 2026 <i>Keywords:</i> Architectural phenomenology Islamic architecture Penang Sacred space Thirdspace embodiment *Corresponding author: Tessa Eka Darmayanti School of Housing, Building and Planning, Universiti Sains Malaysia, USM, 11800, Malaysia Email: tessaed@usm.my ORCID: https://orcid.org/0000-0001-8705-1131	<i>Sacred space in Islamic architecture has predominantly been theorized through mosque typology, geometric order, and symbolic orientation. Such approaches privilege monumental congregational space while marginalizing shrine environments embedded within mosque compounds. This article develops the concept of Sacred Thirdspace as a phenomenological model to interpret how shrine architecture generates sacral intensification beyond formal codification. Drawing on architectural phenomenology and qualitative field observations at Makam Koya, Masjid Kapitan Keling, and Masjid Nagore in Penang, Malaysia, the study identifies three interrelated processes corporeal convergence, atmospheric field formation, and temporal sedimentation through which shrine environments spatialize sacred presence via condensation rather than expansion. Findings indicate that reduced scale, tactile proximity, layered enclosure, and accumulated material traces produce experiential density that differs fundamentally from the axial and monumental logic of congregational mosque halls. By reinterpreting Thirdspace from socio-spatial hybridity toward architectural ontology, Sacred Thirdspace conceptualizes sacred space as a process of spatial thickening generated through embodied inhabitation and atmospheric modulation. The article contributes to Islamic architectural theory by expanding discourse beyond typological centrality and proposing an ontological vocabulary for analyzing condensed sacred environments. Sacredness, in this sense, is not merely symbolically encoded but phenomenologically intensified.</i>

Introduction

Islamic architecture has long been interpreted through typology, geometry, symbolic ornamentation, and orientation toward the qibla (Adiputra and Salura 2021; Paramitha and Salura 2020). Within this discourse, the mosque functions as the primary architectural expression of sacred space (Shahridzal and Ahmad 2024; Urrahmi, Hanafiah, and Sudarisman 2026). Monumentality, axial alignment, and congregational organization have therefore

shaped scholarly understandings of sacral spatial production (Wirakusumah 2022). However, mosque compounds in many Muslim societies also contain shrine environments architecturally modest yet phenomenologically dense spaces associated with revered figures (Shahridzal and Ahmad 2024). These spaces do not rely on monumental scale or formal symmetry to generate sacred meaning. Instead, they cultivate intimacy, proximity, and atmospheric immersion (Putra and Octavia 2024).

This article proposes the concept of Sacred Thirdspace to interpret this layered spatial



condition. Rather than approaching shrines through doctrinal debate or institutional framing, the study positions them within architectural phenomenology. Sacred Thirdspace describes a condensed mode of sacred spatiality in which embodied nearness, atmospheric modulation, and temporal accumulation converge to intensify lived experience. Sacredness, in this sense, is not merely symbolically encoded but phenomenologically intensified a distinction that frames the central research question: How does shrine architecture generate sacral intensity through lived spatial experience within Islamic architectural environments? By foregrounding spatial ontology rather than symbolic representation, this article contributes to architectural theory and expands discourse on Islamic sacred architecture beyond mosque-centric paradigms.

Sacred space and islamic architectural discourse

Sacred space has frequently been conceptualized as a rupture from the profane (Eliade 1959). In architectural discourse, sacredness has often been associated with symbolic orientation, ritual alignment, and monumental articulation. Within Islamic architecture, mosque typology has dominated analysis, emphasizing domes, minarets, mihrab orientation, and geometric ornament. However, religion is not solely structured through formal symbolism but is spatially lived and enacted (Knott 2010). Studies of shrines in Malaysia demonstrate that these spaces continue to hold social and devotional significance despite their modest scale, functioning as nodes of embodied engagement and collective memory (Ahmad 2019). Yet architectural theory has insufficiently addressed how shrine environments generate sacral intensity through spatial means, necessitating a phenomenological reorientation.

Phenomenology and architectural experience

Architectural phenomenology shifts focus from representation to lived experience. Merleau-Ponty (1962) argues that perception is embodied; space is encountered through bodily orientation and movement (Lee 2022). Norberg-Schulz (1980) emphasizes existential belonging through the concept of *genius loci*. Pallasmaa (2005) critiques visual dominance in architecture and highlights multisensory, haptic engagement. Zumthor (2006) describes atmosphere as the emotional resonance emerging from material,

light, and enclosure. Böhme (2017) conceptualizes atmosphere as a spatially extended mood that mediates between subject and environment. These perspectives suggest that sacredness may emerge not solely through symbolic coding but through sensory and experiential depth.

From thirdspace to sacred thirdspace

Lefebvre (1991) spatial triad perceived, conceived, and lived space fundamentally repositioned space as socially produced rather than physically given. Space, in this formulation, is not a neutral container but a dynamic outcome of social relations, representations, and embodied practices. Soja (1996) extended this argument through the concept of Thirdspace, proposing a hybrid realm in which material spatiality, imaginative constructions, and lived experience converge. Thirdspace thus challenged binary distinctions between physical and mental space, foregrounding spatial multiplicity and socio-spatial hybridity.

However, while Lefebvre and Soja successfully displaced purely material conceptions of space, their formulations remain anchored in social production. The phenomenological dimension of spatial intensification how space becomes experientially dense remains underdeveloped. Architectural phenomenology provides a complementary lens. Reinterpreted through this phenomenological tradition, Thirdspace may be understood not only as socio-spatial hybridity but as experiential thickening. Sacred Thirdspace does not denote political negotiation or cultural interstitiality; rather, it describes ontological intensification within architecturally structured environments. In shrine architecture, sacred presence does not merely occupy space it condenses within it. The spatial field becomes thickened through corporeal proximity, atmospheric modulation, and temporal sedimentation.

Thus, Sacred Thirdspace translates socio-spatial production into phenomenological depth. It shifts emphasis from social construction alone toward experiential condensation. While socio-spatial theory reveals how space is shaped by social relations, its analytical emphasis often privileges representation and ideology over experiential depth. Sacred Thirdspace, therefore, does not displace socio-spatial theory but supplements it by foregrounding the

phenomenological processes through which sacred presence becomes experientially dense.

Theoretical framework: Sacred thirdspace

Sacred Thirdspace is defined as a layered sacred spatial condition in which embodied proximity, atmospheric modulation, and temporal continuity converge to intensify lived experience within Islamic architectural environments. Extending Lefebvre (1991) notion of spatial production and Soja (1996) Thirdspace, this framework reframes spatial multiplicity as ontological condensation. Sacredness is not merely socially constructed or symbolically encoded; it is spatially thickened through experiential convergence.

The framework operates through a concentric logic of condensation. Sacred space is understood not as outward expansion but as inward intensification. Each spatial layer narrows toward a core of experiential density, demonstrating how sacrality condenses progressively through three interrelated processes (table 1 and figure 1) - Temporal Sedimentation, Atmospheric Field Formation, Corporeal Convergence and Experiential Density.

Temporal Sedimentation constitutes the outer layer the slow accumulation of material traces and repetitive gestures that thicken duration within space. Drawing from Ricœur (1984) narrative temporality and Norberg-Schulz (1980) existential continuity, sacred environments are understood as layered fields of lived time. In shrine architecture, worn surfaces, layered textiles, devotional inscriptions, and recurring ritual practices embed memory into material

form. Time becomes spatially inscribed, establishing the foundational field within which sacred intensification becomes possible.

Atmospheric Field Formation constitutes the middle layer. Böhme (2017) describes atmosphere as a “tuned space” radiating affective presence, while Zumthor (2006) emphasizes how light gradation, material tactility, and acoustic modulation shape architectural mood. Within Islamic shrine environments, filtered illumination, textile drapery, muted acoustics, and tactile surfaces generate an enveloping spatial tonality. Sacred presence is diffusely sensed rather than formally declared. Atmosphere mediates between material continuity and bodily engagement, acting as a transitional field of condensation (Sloane 2014).

Corporeal Convergence constitutes the inner layer, where spatial distance collapses into embodied proximity. Drawing from Merleau-Ponty (1962) phenomenology of perception and Pallasmaa (2005) multisensory architecture, sacred intensity emerges through bodily nearness and tactile immediacy. Compressed circulation, lowered thresholds, and intimate enclosures heighten proprioceptive awareness. The body does not contemplate sacred space from a distance; it enters relational closeness. Spatial contraction becomes experiential intensification.

At the center of this concentric structure lies Experiential Density, the point at which temporal accumulation, atmospheric modulation, and corporeal proximity converge. This core represents not symbolic meaning alone but ontological thickening. Sacred presence is encountered as intensified spatial immediacy.

Table 1. Sacred thirdspace: Analytical framework

Layer	Process	Phenomenological operation	Architectural manifestation
Outer	Temporal Sedimentation	Memory inscription through repetition	Worn surfaces, layered textiles, accumulated offerings
Middle	Atmospheric Field Formation	Affective tonality through sensory modulation	Filtered light, muted acoustics, tactile surfaces
Inner	Corporeal Convergence	Embodied through compression	Reduced scale, lowered thresholds, intimate enclosure
Core	Experiential Density	Ontological thickening through convergence	Integrated sacral intensity

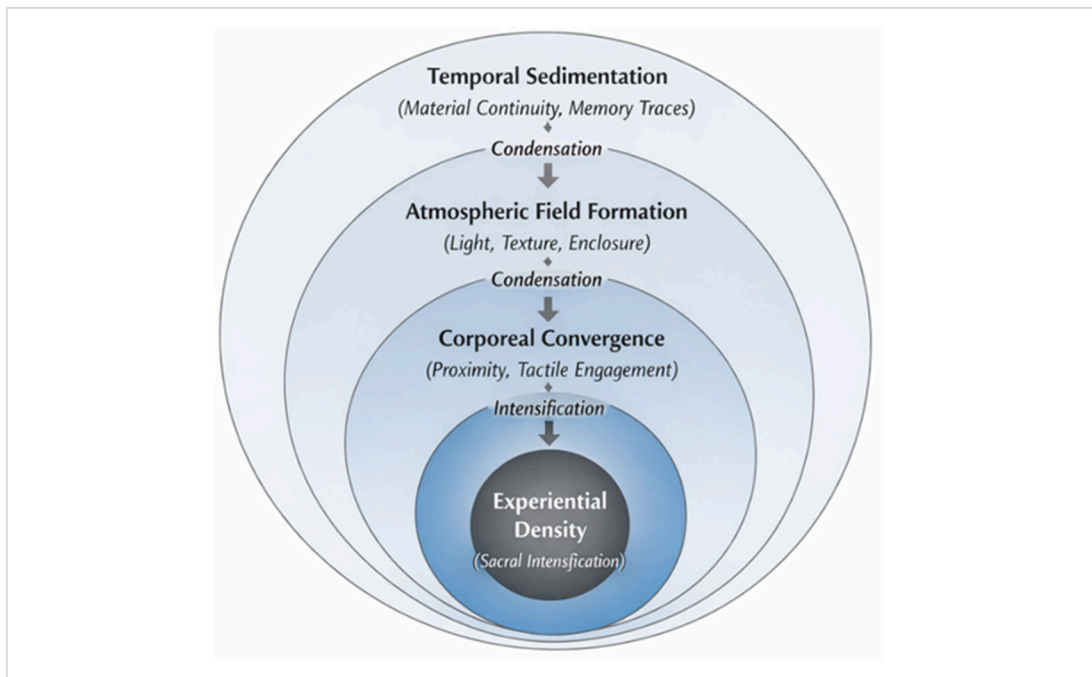


Figure 1. Ontological structure of sacred thirdspace: the condensation logic of sacred spatial intensification

Methods

This study adopts qualitative architectural phenomenology as its research design. Fieldwork was conducted between March and August 2023, comprising twelve site visits distributed across three case study locations in George Town, Penang: Makam Koya, Masjid Kapitan Keling, and Masjid Nagore. These sites were selected for the unique co-location of mosque and shrine architecture within their shared compounds, enabling comparative analysis of spatial intensification across a spectrum from civic to immanent sacred.

Each visit lasted between two and four hours, spanning different times of day and days of the week to capture temporal variation in occupancy, light conditions, and devotional activity. Observations were documented through descriptive field notes following [Seamon \(2000\)](#) guidelines for phenomenological observation, supplemented by photographic documentation and sketches of spatial configuration. Attention focused on bodily posture and gesture, tactile interaction with tomb structures, spatial compression and enclosure, light gradients and acoustic qualities, and material aging evident in surface patina.

No interviews were conducted, as the study's phenomenological orientation prioritizes firsthand spatial experience over discursive accounts. However, observations of devotee behavior were recorded anonymously from public areas of the compounds. The researchers' position as non-devotees external to the Malabari and Tamil Muslim communities necessarily shapes the observational frame; this study therefore describes spatial affordances rather than devotional meanings as understood by practitioners. The emphasis throughout was on descriptive thickness consistent with phenomenological methodology.

Results and discussion

Makam Koya: The Immanent Sacred

Makam Koya is not only about the makam, but it is also about the culture, the community, and the stories of how we used to live in a bygone era. The statement is in line with information from the Secretary of the Heritage Association, Dato Koyah, Adam Malik ([Mok 2025](#)). The interior chamber of Makam Koya measures approximately 4 by 5 meters, with a ceiling height of less than 3 meters. Carved timber screens (*jali*)

enclose the tomb on three sides, filtering light from unseen sources above. The floor is covered with woven mats, layered in places where kneeling occurs most frequently. Textiles (*ghilaf*) in green and gold drape the cenotaph, their surfaces softened by visible wear. Incense residue darkens the timber above the offering niches.

Visitors approaching the tomb must lower their heads to pass through the screen opening; once inside, standing is possible only at the chamber's center. Kneeling brings the body level with the textile-covered tomb surface, enabling tactile contact. These spatial conditions

compressed volume, filtered illumination, proximate surfaces constitute the phenomenological field within which devotional practice occurs.

The carved timber screens function not as rigid partitions but as permeable thresholds, mediating between the internal sacred realm and the external world. They create a translucent separation that allows the outside world to recede while maintaining a subtle connection. The visual field becomes concentrated, directing attention to the immediate spatial and material details of the tomb and its surroundings ([figure 2a](#)).

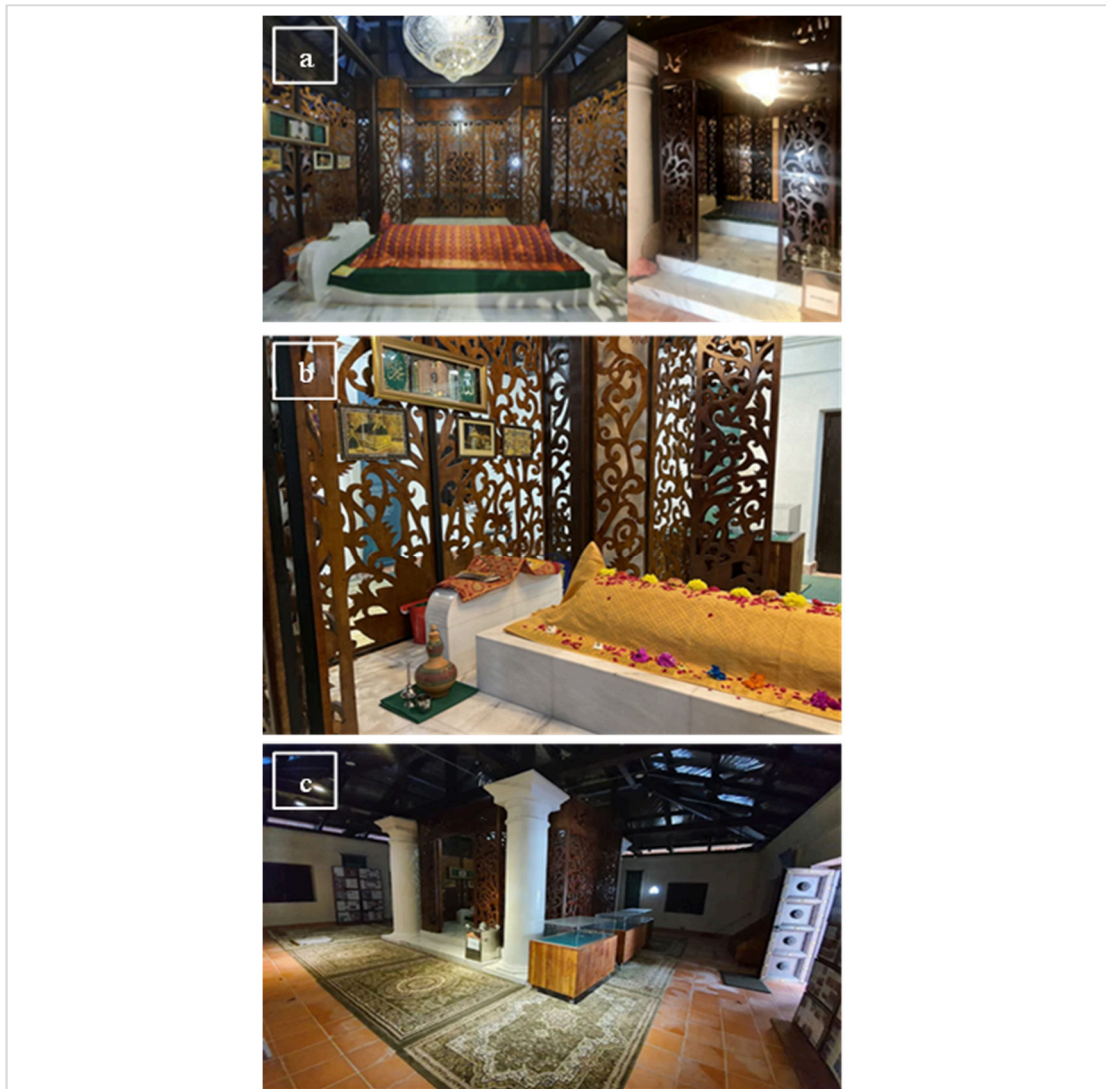


Figure 2. Interior shrine chamber at Makam Koya, Penang - Spatial condensation through carved timber screen (a), layered textiles (b) and compressed volume (c)

Source: ([Anderson 2023](#))

Layers of textiles, floral offerings, and incense have accumulated over decades, each marking a moment of devotion or prayer. These artifacts are not decorative; they inscribe human intention onto the architecture, creating a palimpsest of spiritual activity. Subdued lighting, tactile materials, the aroma of incense, and the layered visual texture of textiles combine to produce a haptic environment. Unlike the ocular-centric typology of larger mosques, Makam Koya invites the visitor to inhabit space physically rather than observe it from a distance (figure 2b and c).

Masjid Nagore: The portal sacred

Masjid Nagore was established in 1801 by Tamil Muslim merchants affiliated with the Qadiriyyah Sufi tradition and the revered saint Shahul Hamid of Nagore, India. The Penang structure functions as a localized counterpart to

the original Nagore Dargah. Its reduced scale operates not as an architectural limitation but as an intentional intensification: compressed volumetric proportion shortens bodily distance to the tomb, amplifying corporeal convergence (figure 3a).

The shrine chamber measures approximately six by six meters, with a ceiling height of four meters. Semi-permeable timber partitions modulate the enclosure without full separation, generating layered spatial boundaries. Filtered light enters through small openings high on the walls, supplemented by textile diffusers. Acoustic reverberation is noticeably muted; sound is absorbed rather than reflected. The floor is covered with thick mats, and the cenotaph itself is draped in multiple layers of textile, their edges frayed from repeated touching (figure 3b).

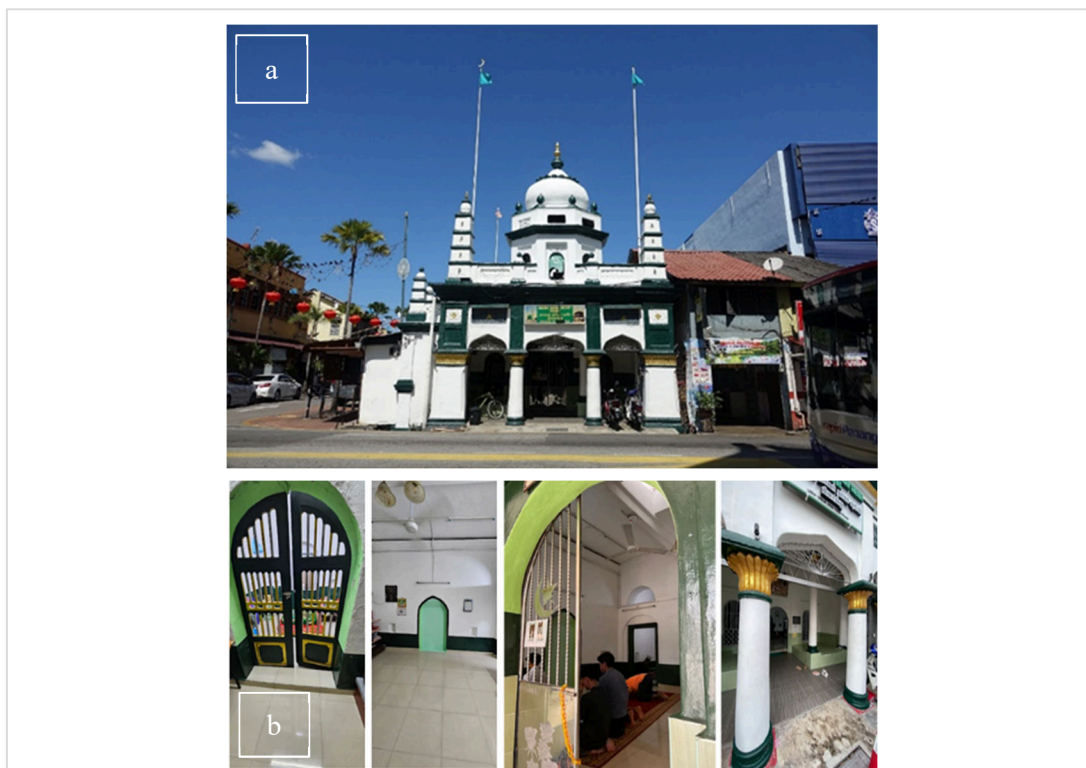


Figure 3. Interior shrine enclosure at Masjid Nagore, Penang. Illustrating atmospheric formation through filtered light, layered surfaces, and reduced volumetric

Unlike congregational mosque halls that expand outward through axial alignment, the shrine chamber at Masjid Nagore draws the body inward. Visitors must pass through a lowered opening to enter; once inside, the spatial field contracts around the tomb. The body is positioned

not as spectator but as participant in a condensed sacred field. Devotional repetition has accumulated as material trace: surfaces bear the patina of touch; textiles show the gradual discoloration of age and handling.

Masjid Kapitan Keling: The civic sacred

Founded in 1801 by Cauder Mohudeen, the Kapitan of the Chulias, Masjid Kapitan Keling is the largest historic mosque in George Town (Hassan and Ali 2019). Its outward identity is

defined by Moghul-revival grandeur, utilizing axial expansion long vistas, high domes, and wide prayer halls designed to orient the collective Ummah toward the infinite.

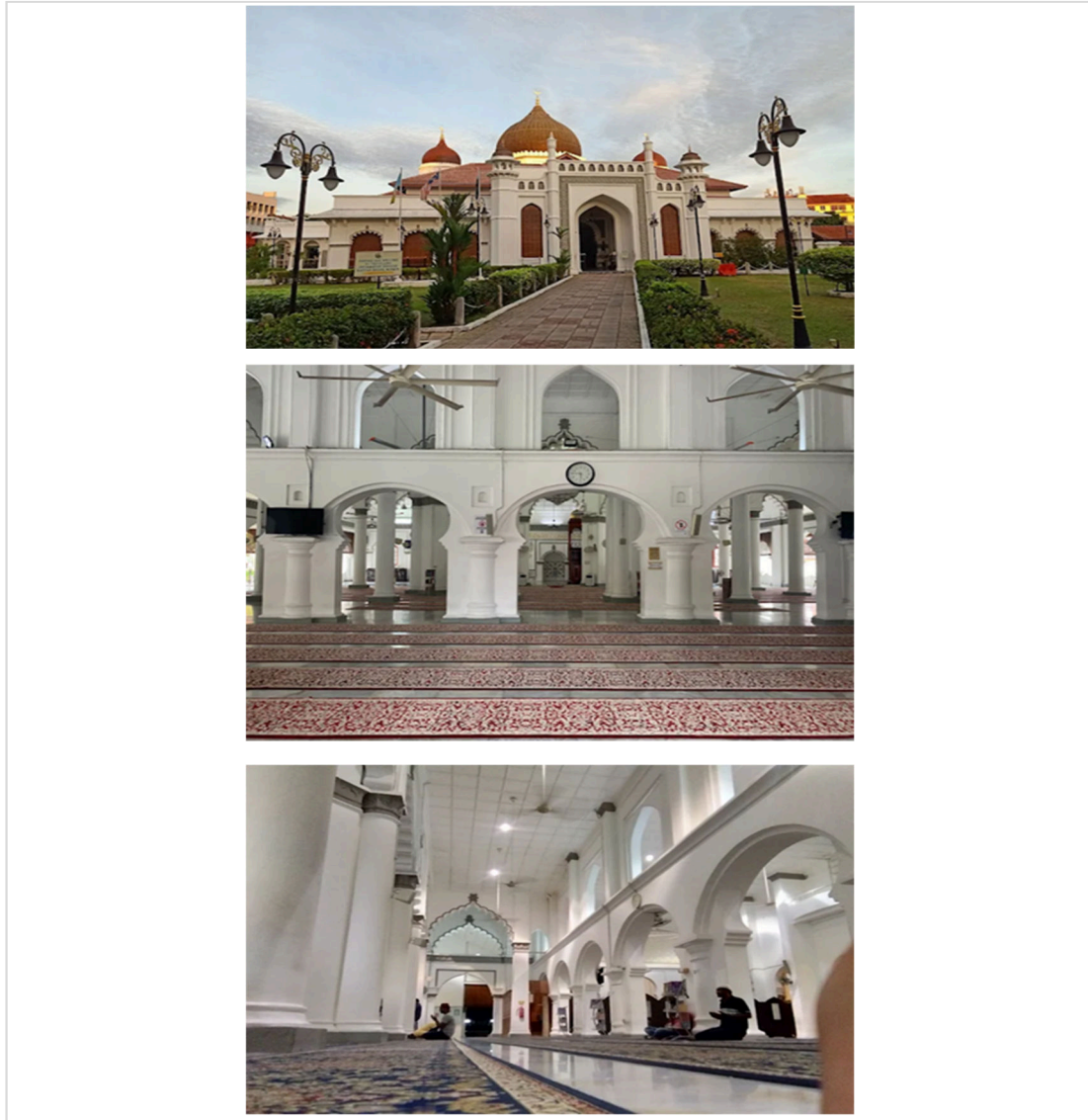


Figure 4. Transitional spatial compression within the compound of Masjid Kapitan Keling, Penang: Showing the shift from the expansive axial logic of the main prayer hall to intimate shrine-related space

The statement above is supported by Azmi and Ismail (2016) Kapitan Keling Mosque is well known as a center for community activities among the Indian Muslim community. However, the mosque created a ‘Friendly’ host and guest relationship. This large compound, the same Sacred Thirdspace mechanics found in the

intimate shrines, is preserved as concentrated pockets.

The main prayer hall measures approximately 20 by 30 meters, with a ceiling height exceeding 10 meters. Light enters through large arched openings, creating bright, even illumination. The floor is covered with uniformly arranged prayer rugs. Spatial organization emphasizes axial

alignment toward the mihrab and collective orientation (figures 4 and 5).

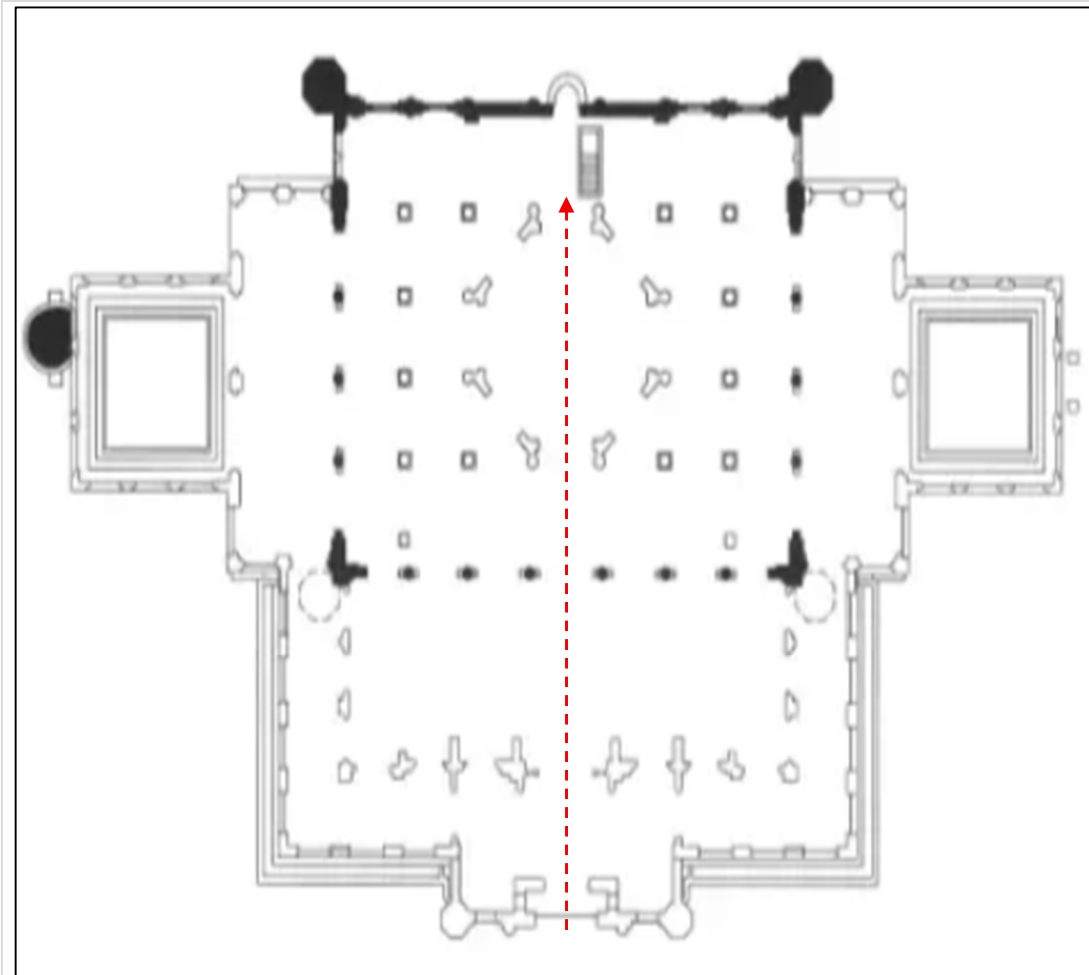


Figure 5. Spatial organization emphasizes axial alignment toward the mihrab
Source: Modified from <https://mosqpedia.org/masajid/kapitan-keling-mosque/>

In contrast, the peripheral areas particularly the walkways and the tomb of *Kapitan* Cauder Mohudeen exhibit markedly different spatial characteristics. Here, enclosure narrows, ceiling heights lower, and light becomes filtered through surrounding structures. The tomb enclosure measures approximately three by four meters, protected by a low wall and shaded by mature trees. Textiles drape the grave marker, and visitors must lean forward to read inscriptions or offer prayers. This spatial compression

reorients bodily experience from collective alignment toward localized proximity (figure 6). The gravestones of founders and early community leaders are scattered throughout the compound, each marking a point of temporal sedimentation. These are not mere historical markers but ontological anchors that hold lived space together against the pressures of the modern city. Worn surfaces, accumulated floral offerings, and the patina of touch on stone testify to continuing devotional engagement.



Figure 6. The intimate shrine of Masjid Kapitan Keling

Sacred geography: A spectrum of intensification

The three sites function as a networked Sacred Geography within George Town, Penang, each occupying a distinct position on the spectrum from civic to immanent sacred:

Masjid Kapitan Keling operates as the Macro-Space the civic and symbolic anchor that contains and legitimizes smaller pockets of Micro-Intensification. It corresponds to Lefebvre's Conceived Space: the official, symbolic center that provides social legitimacy and communal identity. Its sacrality is expressed through geometric order and structural grandeur.

Masjid Nagore functions as the Portal Sacred a symbolic bridge connecting the local diaspora to the global Sufi network. It begins the process of spatial condensation by compressing Indian Sufi identity into a tighter urban footprint on Chulia Street. It occupies the threshold between the civic and the immanent.

Makam Koya represents the Immanent Sacred the terminal point of the spectrum where spatial condensation reaches its fullest expression. Here, architecture abandons grandeur entirely in favor of corporeal convergence, bringing the sacred

down to the scale of the human body and achieving the highest state of inward intensification.

Based on the perspective of thirdspace, each space (read: case study) has its own symbol of "life" and has its own way of conveying its "soul." Thus, the definition of thirdspace is in line with the symbol space or identity space of a place (Darmayanti, Bahauddin, and Aryani 2024).

Discussion

The three processes of sacred thirdspace

The findings demonstrate that shrine architecture generates sacral intensity through three interrelated phenomenological processes, each operating across the case study sites with varying emphasis.

Corporeal Convergence manifests through reduced spatial scale compared to mosque prayer halls. At Makam Koya, ceiling heights below three meters and chamber dimensions under twenty square meters compel bodily proximity to the tomb. At Masjid Nagore, compressed circulation and lowered threshold heighten proprioceptive awareness. At Masjid Kapitan

Keling, the contrast between the expansive main hall and the intimate tomb enclosure dramatizes the shift from axial to proximate spatial logic. In each case, visitors lean forward, lower their posture, and engage in tactile contact. Spatial compression intensifies awareness; perception becomes participatory rather than observational (Merleau-Ponty 1962). Sacrality emerges through nearness.

Atmospheric Field Formation operates through distinct sensory modulation across all three sites. Light is filtered and subdued through timber screens at Makam Koya, through high openings at Masjid Nagore, through tree canopy at the Kapitan Keling tomb enclosure. Acoustic reverberation is softened; materials absorb rather than reflect sound. Textile layering, worn surfaces, and accumulated offerings create tactile richness. Following Böhme (2017), atmosphere radiates as spatially extended mood enveloping and contemplative rather than declarative. Pallasmaa (2005) emphasis on haptic experience finds confirmation: shrine spaces engage multiple senses simultaneously, producing field-like sacred presence rather than object-bound symbolism.

Temporal Sedimentation manifests in material wear, repeated visitation, and incremental modification across generations. At Makam Koya, layered textiles and accumulated offerings create a palimpsest of devotional activity. At Masjid Nagore, surfaces bear traces of touch; textiles show gradual discoloration. At Masjid Kapitan Keling, the gravestones of the founders anchor collective memory within the compound. Ricœur (1984) narrative temporality and Connerton (1989) argument that collective memory is enacted through bodily repetition find spatial expression: time thickens space through accumulated material traces.

Expansion and condensation as ontological registers

Sacred Thirdspace discloses a spatial logic within Islamic architecture that has remained undertheorized in mosque-centric scholarship. Whereas mosque halls traditionally spatialise sacrality through axial orientation, collective alignment, and volumetric expansion, shrine environments generate sacred intensity through compression and embodied convergence. These are not hierarchical oppositions but differentiated ontological registers of sacral spatiality.

Monumental mosque architecture organizes transcendence through scale, directionality, and collective alignment. Its spatial logic extends outward and upward, structuring a field of ordered orientation. Shrine architecture, by contrast, operates through inward condensation. Reduced scale, narrowed circulation, tactile proximity, and layered enclosure collapse the distance between body and locus of devotion. In this register, sacrality is not projected across space but thickened within it.

The distinction between expansion and condensation, therefore, concerns spatial ontology rather than typological difference. Mosque environments privilege transcendental orientation; shrine environments cultivate immanent intensity. In the latter, sacred presence emerges as experiential density through atmospheric modulation, corporeal nearness, and temporal sedimentation. Spatial meaning is not solely symbolically encoded but phenomenologically generated through embodied inhabitation.

Sacred thirdspace as architectural ontology

Sacred Thirdspace should thus be understood neither as a typological deviation nor a marginal anomaly within Islamic architecture. It constitutes a layered spatial register coexisting with monumental mosque typologies while operating according to a different logic of intensification. By repositioning Thirdspace from socioeconomic hybridity toward architectural ontology, this study advances a framework in which sacred space is conceptualized as a process of condensation. Sacredness is not only constructed through formal symbolism or doctrinal coding; it is spatially produced through calibrated compression, atmospheric thickening, and accumulated duration.

The concentric model articulated in the theoretical framework finds empirical confirmation across all three sites. Temporal sedimentation establishes the foundational field of lived time. Atmospheric formation mediates between material continuity and bodily engagement. Corporeal convergence collapses distance into proximity. At the core, experiential density emerges through the convergence of all three processes most fully realized at Makam Koya, partially realized at Masjid Nagore, and present in concentrated pockets within the larger compound of Masjid Kapitan Keling.

In this sense, Sacred Thirdspace offers a transferable theoretical model for interpreting

condensed sacred environments beyond the Penang case. It provides an ontological vocabulary for analyzing how architectural space intensifies presence through proximity, enclosure, and temporal layering. Rather than redefining mosque architecture, the concept expands the field of Islamic architectural theory by foregrounding phenomenological depth as a primary mode of sacral production.

Architectural Implications

Sacred Thirdspace suggests several implications for architectural design:

First, spatial compression may heighten embodied awareness and intimacy. Reduced scale, lowered thresholds, and narrowed circulation can intensify proprioceptive engagement without requiring monumental expression.

Second, atmospheric modulation through filtered light, textured materials, and acoustic control can shape affective tonality. Sacred intensity emerges not only through what space signifies but through how it feels to inhabit.

Third, material continuity that allows surfaces to age and accumulate traces can strengthen spatial memory. Designs that anticipate wear, patina, and incremental modification may generate deeper temporal sedimentation than those that resist it.

These principles indicate that sacred intensity does not depend exclusively on monumentality but may arise from calibrated spatial condensation. For contemporary mosque design, this suggests possibilities for incorporating intimate, shrine-like spaces within larger congregational complexes pockets of micro-intensification within macro-spatial order.

Conclusions

This study has demonstrated that shrine architecture in Penang operates through a distinct spatial logic of condensation, generating sacral intensity through corporeal proximity, atmospheric modulation, and temporal accumulation. The concept of Sacred Thirdspace provides a phenomenological framework for interpreting this mode of spatial production, extending Islamic architectural theory beyond mosque-centric paradigms.

Three conclusions emerge from the analysis. First, sacred space in Islamic tradition encompasses multiple ontological registers; the axial expansion of congregational mosques and the inward condensation of shrines are not hierarchical but complementary modes of spatializing the sacred. Second, phenomenological intensification occurs through calibrated architectural means compressed scale, filtered light, layered enclosure, material accumulation that do not depend on monumentality. Third, the three Penang sites function as a networked Sacred Geography, each occupying a distinct position on the spectrum from civic to immanent sacrality: Masjid Kapitan Keling as the civic sacred providing social legitimacy, Masjid Nagore as the portal sacred connecting local diaspora to global networks, and Makam Koya as the immanent sacred achieving pure inward intensification.

Limitations of this study include its focus on three sites within a single urban context and its reliance on observational rather than ethnographic methods. The researchers' positionality as non-devotees external to the communities studied necessarily shapes the observational frame; devotional meanings as understood by practitioners remain beyond the scope of this phenomenological analysis.

Future research might extend this framework to shrine environments in other Muslim societies, examining whether similar processes of condensation operate across diverse cultural contexts. Longitudinal observation could illuminate the temporal dynamics of devotional practice and material accumulation. Ethnographic methods might complement phenomenological description by accessing practitioners' understandings of sacred spatial experience. Finally, design research could investigate how contemporary mosque architecture might intentionally incorporate principles of spatial condensation, creating pockets of micro-intensification within larger congregational complexes.

Sacred Thirdspace, as articulated here, offers not only an analytical tool but also a design vocabulary for architecture that seeks to intensify presence through proximity, atmosphere, and duration. Sacred space, in this sense, is not merely constructed. It is spatially thickened, atmospherically sustained, and bodily inhabited.

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- Author(s) contribution**
- Hakimi Ahmad** contributed to the research concepts preparation, methodologies, investigations, data analysis, visualization, articles drafting and revisions.
- Mohd Jaki Bin Mamat** contribute to the research concepts preparation and literature reviews, data analysis, of article drafts preparation and validation.
- Tessa Eka Darmayanti** contribute to methodology, supervision, and validation.

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