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Spatial Configuration Transformation and Physical–Functional Resilience in Traditional and Contemporary Mosques: A Comparative Space Syntax Study of Iran and Qatar

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A b s t r a c t

This paper investigates how spatial configuration influences physical–functional resilience in mosque architecture through a comparative analysis of traditional and contemporary mosques in Iran and Qatar. While mosque typologies have been widely studied, limited research examines the relationship between spatial layout and resilience across different cultural contexts. Drawing on space syntax theory, one traditional and one contemporary mosque from each country were analysed using Depthmap software through axial and visual graph analyses. Key syntactic indices (integration, control, choice, depth, and connectivity) were used to evaluate spatial performance. Findings reveal that traditional Iranian mosques exhibit hierarchical depth and strong spatial control, supporting configurational resilience through morphological redundancy, while contemporary examples demonstrate increased network complexity and adaptability. In contrast, Qatari mosques, organized through radial and centralized layouts with limited depth, show high spatial transparency and strong integration but reduced substitution capacity. The study suggests integrating hierarchical depth with distributed networks to enhance adaptability in contemporary mosque design.

K e y w o r d s : Space Syntax; Mosque Architecture; Spatial Configuration; Morphology; Iran; Qatar.

1. Introduction

1.1 Research Gap

Mosque architecture has long been examined as a manifestation of cultural, religious, and spatial principles across Islamic societies. Traditional mosque typologies have been widely analyzed in relation to formal composition, spatial organization, and symbolic meaning, while contemporary mosque design has increasingly been explored through evolving urban conditions, construction technologies, and functional demands (Kahera, 2022; Alnaim, 2021). Beyond functioning as places of worship, mosques operate as complex spatial systems that organize movement, perception, social interaction, and ritual experience.

Traditional mosque typologies, particularly in regions such as Iran, are often associated with hierarchical spatial organization, articulated spatial sequences, and layered transitions between public and sacred domains (Ghouchani et al., 2019). In contrast, contemporary mosques, especially in rapidly developing contexts such as Qatar, tend to adopt more centralized and simplified spatial arrangements shaped by changing urban conditions, construction technologies, and functional requirements (Alnaim, 2021; Ibrahim & Al-Mohannadi, 2022). These transformations suggest that mosque evolution involves not only formal reinterpretation, but also shifts in configurational structure, movement systems, and perceptual organization.

In parallel, analytical frameworks such as Space Syntax have enabled the quantitative evaluation of spatial configuration through the analysis of accessibility, connectivity, visibility, and spatial hierarchy. Originating from the work of Bill Hillier, Space Syntax conceptualizes space as a relational system that shapes movement patterns and user interaction (Hillier & Hanson, 1984; Hillier, 1996). Recent studies have expanded the application of Space Syntax in evaluating spatial performance and user behavior within architectural environments (Peponis, 2024). However, despite growing scholarship on mosque architecture, the application of configurational analysis in mosque studies remains relatively limited and often descriptive, with insufficient comparative investigation of spatial transformation across different regional and historical contexts (Fadakari & Andaroodi, 2024; Redjem & Mazouz, 2022).

To address this gap, this study investigates spatial configuration transformation in traditional and contemporary mosque architecture through a comparative Space Syntax analysis of selected case studies in Iran and Qatar. Using Axial Analysis

and Visual Graph Analysis (VGA), the research examines how movement structure, visibility, spatial hierarchy, and perceptual organization differ across the selected mosque typologies. By comparing traditional and contemporary examples across two distinct cultural contexts, the study aims to reveal underlying configurational patterns and contribute to a deeper understanding of typological transformation in mosque architecture.

The research is guided by the following questions: (1) How do spatial configurations differ between traditional and contemporary mosque typologies in Iran and Qatar? (2) How do these configurations influence physical–functional performance in terms of accessibility, adaptability, and spatial redundancy? (3) What spatial strategies can inform contemporary mosque design?

By comparing traditional and contemporary examples across two distinct cultural contexts, the study aims to reveal underlying configurational patterns and contribute to a deeper understanding of typological transformation in mosque architecture. Furthermore, by establishing a relationship between spatial configuration and spatial performance, the study contributes to architectural theory and design practice, proposing a framework for understanding mosque architecture as an adaptive spatial system.

1.2 Iranian Mosque Architecture

1.2.1. Historical Tradition

Traditional mosque architecture in Iran represents a mature architectural tradition in which spatial organization, religious symbolism, environmental adaptation, and social functionality are integrated into a coherent spatial system. Developed through successive historical periods, particularly the Seljuk, Ilkhanid, Timurid, Safavid, and Qajar eras, Iranian mosques evolved into highly structured environments characterized by spatial hierarchy, centrality, continuity, and multifunctionality (Mirhosseini et al., 2018; Fadakari & Andaroodi, 2024).

A defining characteristic of traditional Iranian mosques is the principle of hierarchy. Hierarchy is considered a fundamental concept in Islamic thought and Iranian-Islamic architecture, reflecting the transition from the material world toward spiritual transcendence (Mirhosseini et al., 2018). In mosque architecture, this principle is manifested through a sequence of spaces that gradually guide worshippers from public domains into increasingly sacred zones. Entrances, vestibules, corridors, courtyards, iwans, and domed sanctuaries are arranged in a carefully ordered progression that creates both physical and spiritual preparedness for worship (Mirhosseini et al., 2018; Shirkhani et al., 2021).

The spatial hierarchy of traditional mosques contributes significantly to their legibility and experiential quality. Research on Iranian mosque architecture indicates that proportions, spatial form, lighting, visual framing, decoration, and changes in scale all contribute to the perception of hierarchy and reinforce users' awareness of movement through different levels of sacredness (Mirhosseini et al., 2018). Rather than emphasizing a single monumental space, traditional mosques create a sequence of interconnected spaces whose relationships generate meaning and orientation.

Another fundamental feature is the central role of the courtyard. In the dominant four-iwan mosque typology, the courtyard serves as the spatial and functional core around which the principal architectural components are organized (Fadakari & Andaroodi, 2024). The courtyard acts as a highly integrated node that connects prayer halls, iwans, educational spaces, and circulation routes while facilitating environmental comfort through natural ventilation and daylighting. Studies employing Space Syntax analysis consistently identify courtyards as the most integrated spaces within traditional mosque layouts, functioning as both organizational and social centers (Falakian et al., 2021; Fadakari & Andaroodi, 2024).

Space Syntax research further demonstrates that traditional Iranian mosques exhibit high levels of spatial integration and intelligibility. According to Hillier's theory, the meaning and social functioning of architectural environments are closely related to their spatial organization. Traditional mosques reveal a strong relationship between spatial configuration and patterns of movement, interaction, and collective behavior (Shirkhani et al., 2021). The arrangement of spaces promotes both accessibility and orientation while maintaining appropriate distinctions between public and more private or contemplative areas.

Visual continuity is another important attribute of traditional mosque architecture. Through the alignment of courtyards, iwans, domes, arcades, and openings, users experience a continuous visual relationship among different architectural elements. Such continuity enhances wayfinding and strengthens the perception of spatial unity (Falakian et al., 2021). The courtyard, in particular, plays a crucial role in creating transparency and visual connections among adjacent spaces, thereby increasing integration and reinforcing the mosque's collective character. (Ardalan & Bakhtiar, 2012)

Traditional mosques also demonstrate a strong relationship between spatial configuration and symbolic meaning. Meaning-oriented architectural studies indicate that spatial morphology itself can communicate religious and cultural values through integration, permeability, spatial unity, scale, and proportional relationships (Falakian et al., 2021). In Iranian mosques, symbolic concepts such as unity, order, and transcendence are embedded within spatial structures rather than merely expressed through decorative elements. Consequently, the physical organization of the mosque contributes directly to its spiritual significance.

Furthermore, traditional mosques functioned as multifunctional institutions serving religious, educational, social, and civic purposes. Courtyards, teaching chambers, arcades, and ancillary spaces accommodated a wide range of activities while remaining integrated within a unified spatial system. This multifunctionality contributed to the long-term adaptability and resilience of mosque complexes, enabling them to respond to changing social needs without losing their architectural identity (Fadakari & Andaroodi, 2024).

The resilience of traditional Iranian mosques is therefore rooted in a combination of hierarchy, integration, visual continuity, and functional diversity. Space Syntax studies suggest that these buildings achieve a balance between accessibility and privacy, collective gathering and individual contemplation, as well as symbolic meaning and practical functionality (Shirkhani et al., 2021; Falakian et al., 2021). Their enduring use across centuries demonstrates the effectiveness of spatial configurations that support both religious practices and broader community life.

2.2 Contemporary Mosque Architecture in Iran

Contemporary mosque architecture in Iran has developed within the context of rapid urbanization, modernization, changing social expectations, and evolving architectural discourse. Unlike traditional mosques, which emerged through relatively stable typological evolution, contemporary mosques often negotiate between historical continuity and architectural innovation (Pour Ahmadi, 2022). As a result, contemporary mosque design encompasses a wide range of approaches, from direct imitation of historical forms to radical departures from established architectural traditions.

Recent scholarship suggests that contemporary mosque architecture cannot be understood through a simple traditional-versus-modern dichotomy. Instead, architects employ different strategies when engaging with historical traditions. These strategies include imitation of historical forms, reinterpretation of traditional elements, critical modification of inherited typologies, and complete departure from conventional mosque architecture (Pour Ahmadi, 2022; Etemadi, 2019). Consequently, contemporary mosques display considerable variation in their spatial organization, formal expression, and symbolic representation.

One of the most significant transformations concerns spatial hierarchy. Traditional mosques typically guide users through a sequence of transitional spaces that gradually establish a sense of sacred progression. In many contemporary examples, however, these hierarchical sequences are compressed or simplified. Direct access to prayer halls often replaces the extended spatial progression characteristic of historical mosques (Shirkhani et al., 2021). Comparative studies indicate that the manifestation of Iranian-Islamic principles such as hierarchy and movement from exterior to interior is generally stronger in traditional mosques than in contemporary ones.

Another important change involves the role of the courtyard. In traditional mosque architecture, the courtyard functioned as the primary organizing element and the most integrated space within the spatial system. Contemporary urban conditions, including higher land values and limited site dimensions, have often reduced the size of courtyards or eliminated them altogether. As a result, many contemporary mosques rely more heavily on enclosed interior spaces to accommodate religious and social activities. This transformation can alter patterns of accessibility, interaction, and social integration that were traditionally facilitated by the courtyard (Falakian et al., 2021; Fadakari & Andaroodi, 2024).

Despite these changes, contemporary mosques increasingly emphasize flexibility and adaptability. Modern mosque complexes frequently incorporate educational facilities, libraries, cultural centers, conference halls, and community services alongside prayer spaces. This multifunctional approach reflects contemporary understandings of resilience, in which buildings are expected to accommodate diverse activities and changing patterns of use over time (Pour Ahmadi, 2022). Rather than relying solely on inherited spatial models, architects seek flexible solutions capable of responding to contemporary social needs.

Contemporary mosque architecture also demonstrates increasing concern for accessibility, efficiency, and user-centered design. Circulation systems are often simplified, and spatial layouts are designed to support larger congregations, diverse user groups, and contemporary operational requirements. From a functional perspective, such modifications may improve usability and adaptability. However, some scholars argue that excessive simplification risks weakening the symbolic and experiential qualities that historically distinguished mosque architecture (Shirkhani et al., 2021).

The relationship between contemporary mosque architecture and tradition therefore remains a central issue. According to Pour Ahmadi (2022), the critical question is not whether architects should preserve or abandon historical forms, but how they engage with architectural traditions in a conscious and meaningful manner. Traditional elements such as domes, minarets, courtyards, and iwans may be retained, reinterpreted, challenged, or omitted, depending on the architect's design intentions.

From a spatial perspective, successful contemporary mosques often preserve the underlying organizational principles of traditional architecture rather than merely replicating historical forms. Principles such as centrality, hierarchy, intelligibility, spatial unity, and social integration can be adapted to contemporary contexts while supporting new functional requirements (Falakian et al., 2021; Shirkhani et al., 2021). This approach allows contemporary mosques to maintain continuity with Iranian-Islamic architectural values while responding to modern urban conditions.

Overall, contemporary mosque architecture in Iran reflects an ongoing transformation from historically established spatial systems toward more flexible and diverse configurations. While some traditional characteristics—particularly hierarchy and courtyard centrality—have been weakened, contemporary mosques frequently compensate through multifunctionality, adaptability, and innovative interpretations of architectural tradition. Consequently, comparative Space Syntax analysis provides an effective framework for examining how resilience-related spatial qualities have been maintained, modified, or transformed across traditional and contemporary mosque typologies.

1.3 Qatari Mosque Architecture

1.3.1 Qatari Vernacular Mosque Architecture

Traditional mosque architecture in Qatar emerged from vernacular Gulf building traditions shaped by climate, local materiality, Islamic spatial values, neighborhood social structure, and communal worship practices. Historically, Qatari settlements developed as clustered community structures**,** organized through interconnected *fereej* or the neighbourhood shaped by kinship, proximity, and shared social life (Jaidah, 2009; Bianca, 2000). Within this compact urban morphology, the neighborhood mosque was not simply an isolated place of worship but a critical communal anchor embedded within daily life, supporting prayer, education, gathering, and social cohesion while reinforcing the spatial and social structure of the community (Wiedmann, Salama, & Thierstein, 2012). In this sense, the importance of the mosque in the Qatari neighborhood community emerged not only from its religious function but from its role within a localized socio-spatial network, contributing to forms of embedded communal resilience (Karawia, 2020).

Within this context, the organization of traditional Qatari mosques was shaped less through elaborate hierarchical articulation and more through spatial clarity, centrality, and environmental responsiveness. Centralized prayer halls,

transitional *iwan* spaces, and open courtyards *housh* were not merely architectural components but mediating spaces that structured movement, social encounter, and climatic comfort within a coherent spatial system (Karawia, 2020). Scholarship suggests that this apparent spatial simplicity should not be interpreted as reduced organizational complexity, but rather as an alternative configurational logic in which accessibility, visibility, and communal centrality are emphasized (Bianca, 2000). Similar to the role of sequential movement in other Islamic traditions, the progression from exterior threshold to courtyard to *iwan* to prayer hall structured a gradual movement experience while reinforcing the ritual and social role of transitional spaces.

Material systems were equally integral to this spatial logic. Coral stone, limestone mortar, gypsum, and mangrove timber were not merely responses to material availability but informed enclosure, thermal performance, construction spans, and patterns of occupation (Al-Mohannadi et al., 2020). Recent studies of Gulf vernacular architecture emphasize that climatic adaptation in these mosques was embedded within spatial organization itself, where courtyards, shaded interfaces, and compact volumes operated simultaneously as environmental and social infrastructures (Jaidah, 2009). In this sense, environmental responsiveness, communal use, and spatial configuration were deeply intertwined, contributing to forms of physical–functional resilience rooted in both building and neighborhood scales.

1.3.2 Contemporary Transformation of Mosque Architecture in Qatar

Recent scholarship situates contemporary mosque architecture in Qatar within broader processes of urbanization, globalization, and identity negotiation associated with rapid development since the 1970s (Salama & Wiedmann, 2013). During this period, mosque design increasingly incorporated larger spans, monumentality, imported stylistic vocabularies, and prototype-driven planning systems, reflecting both state-led development and transnational architectural influences (Ibrahim & Al-Mohannadi, 2022). While some scholars view these transformations as contributing to the challenge of localized spatial identities, others argue that contemporary mosques reinterpret rather than abandon vernacular principles of centrality, climatic responsiveness, and communal function (Alnaim, 2021). Beginning in the early 2000s, Qatar increasingly adopted standardized mosque prototype typologies as part of broader efforts to unify architectural identity while responding to rapid urban growth. Rather than signaling a departure from local traditions, these models may be understood as negotiating between modernization and continuity, advancing contemporary expressions that retain principles associated with Qatari spatial restraint, material simplicity, and communal orientation (Karawia, 2020).

At the same time, contemporary mosques in Qatar increasingly operate as multi-programmatic environments accommodating education, social services, gathering, and civic engagement alongside worship, suggesting expanded functional demands on mosque spatial organization. This shift has heightened the importance of adaptability, redundancy, and configurational flexibility within mosque design. Emerging studies indicate that while many contemporary mosques retain strong centralized prayer organization and visual coherence, they increasingly integrate distributed networks of auxiliary spaces that support broader forms of use (Alnaim, 2021; Ibrahim & Al-Mohannadi, 2022).

Rather than representing a rupture from traditional precedents, this transformation may be understood as an evolving spatial continuum in which centralized organization, material logic, environmental responsiveness, and communal functions are continuously renegotiated under contemporary conditions. Yet despite growing scholarship on typological evolution, identity, and formal transformation, limited research has examined how these shifts influence configurational performance and physical–functional resilience. Addressing this gap, this study investigates traditional and contemporary mosque typologies in Qatar as evolving spatial systems whose organization may reveal distinct models of accessibility, adaptability, and resilience through comparative space syntax analysis.

2. Materials and Methods

2.1 Research Design

This study adopts a comparative analytical framework to examine structural and formal transformations in traditional and contemporary mosque architecture in Iran and Qatar, with particular focus on spatial configuration. The research seeks to uncover underlying spatial logic of the ways spaces are organized and distributed in relation to movement, visibility, and perception through the application of Space Syntax theory and analysis.

Originally developed by Bill Hillier and Julienne Hanson (Hillier & Hanson, 1984), Space Syntax provides a theoretical and analytical framework for examining relationships between built space and social behavior. By translating architectural structures into spatial networks composed of nodes and links, the method enables the quantitative analysis of configurational properties through measurable indicators of accessibility, hierarchy, connectivity, and spatial depth (Hillier, 1996; Penn, 2003; Bafna, 2003).

Given that religious spaces such as mosques function not only as ritual environments but also as settings that structure movement, perception, and social interaction, Space Syntax provides an appropriate framework for analyzing their spatial organization. The method has been widely applied in studies of Islamic architecture and spatial behavior, yet few studies have employed it comparatively to examine transformations in mosque spatial configuration across distinct cultural contexts and historical periods. Addressing this gap, this study applies a mixed analytical approach combining quantitative configurational analysis with qualitative interpretation to investigate spatial performance and resilience across four mosque case studies.

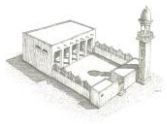
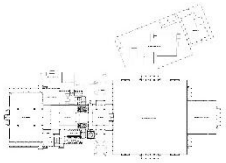
2.2 Scope of the Study and Case Study Selection

Four mosque case studies were selected to represent both traditional and contemporary typologies across two distinct regional contexts: Iran and Qatar. The selection was based on four criteria: (1) typological clarity (traditional versus contemporary), defined by historical built eras**,** (2) comparability of spatial scale and size to ensure meaningful analysis,

and (3) availability and reliability of architectural documentation suitable for detailed geometric and configurational analysis.

This comparative framework enables both intra-country and cross-cultural examination of spatial transformation, allowing transitions from traditional to contemporary spatial organization to be analyzed through quantitative indicators across two distinct architectural contexts.

Table 1. Case Study Selection.

Country	Historical Period	Mosque Name	Spatial Index Feature	Plan	Image
Qatar	Traditional (1940)	Al-Sabie'i Mosque	Focal structure, shallow depth, high visual clarity		
	Modern (2016)	Al-Darwish Mosque	A contemporary architectural language while preserving the central structure		
Iran	Traditional (1884)	Sepahsalar Mosque	Hierarchical courtyard–iwan typology with layered organization		
	Modern (2012)	Imam Reza Mosque	Multi-node, networked, and multi-level structure		

This selection enables a controlled comparison between historical and contemporary spatial configurations, as well as between differing cultural and architectural contexts.

2.3 Data Preparation and Analysis Procedure

Research data extraction was conducted in three main stages:

A) Geometric Modelling of Space

In the first stage, the floor plans of the selected mosques were redrawn based on verified architectural drawings and documentary sources. Physical elements relevant to spatial analysis, including walls, entrances, circulation paths, and open spaces were incorporated into the digital models. Spatial models were reconstructed in **DepthmapX** to generate spatial networks and support both axial and visual analyses. Particular attention was given to preserving scale, defining spatial boundaries accurately, and representing movement paths consistently, as these are critical to the validity of configurational analysis (Karimi, 2018; Sharmin & Kamruzzaman, 2017).

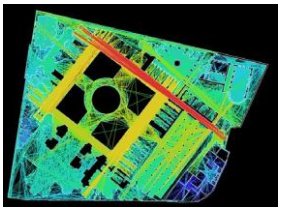
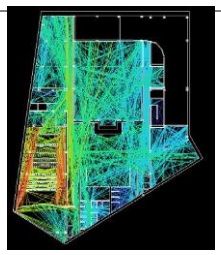
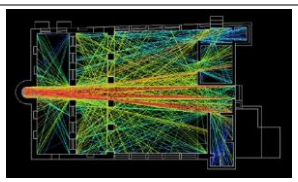
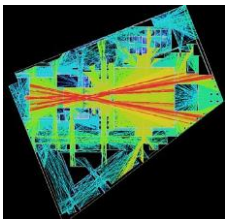
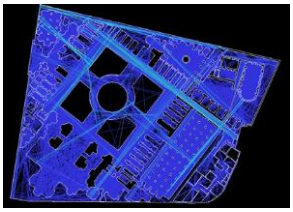
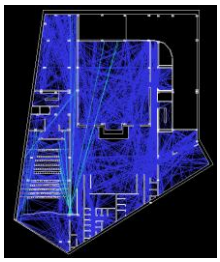
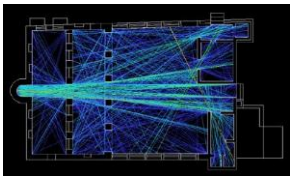
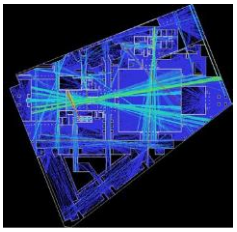
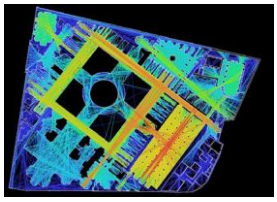
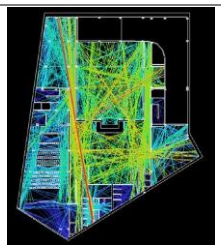
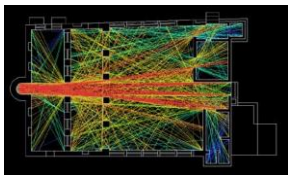
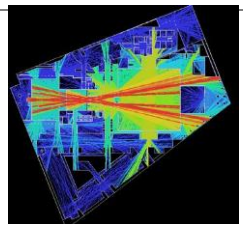
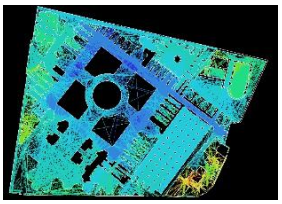
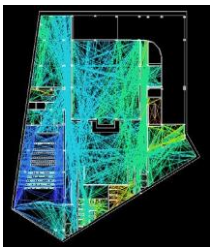
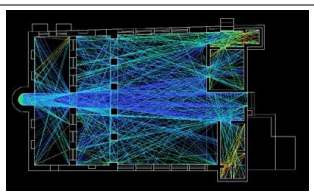
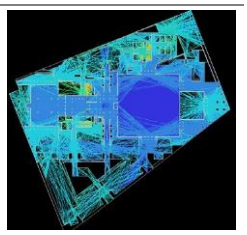
B) Axial Analysis

In the second stage, an axial map was generated for each case study. The axial map consists of the minimum set of straight lines that provides the greatest coverage of sight and movement within a spatial system and enables analysis of topological relationships between spaces (Hillier & Iida, 2005). Based on the axial graph, four syntactic indices were calculated:

- **Integration** measures the relative accessibility of a space within the overall system. Spaces with higher integration values tend to occupy central positions in the movement network and often function as primary gathering or circulation zones (Hillier, 1996).
- **Choice** (betweenness/selectivity) indicates the likelihood that movement paths pass through a space and reflects its mediating role within the network. Higher values suggest stronger importance in route distribution and movement flow (Hillier & Iida, 2005; Dalton, 2016).
- **Connectivity** measures the number of direct links a space has to adjacent spaces and indicates the degree of local accessibility and spatial interaction (Karimi, 2012).
- **Mean Depth** represents the topological distance of a space from other spaces in the system and is used to examine hierarchy and degrees of spatial nesting. Greater depth often corresponds to more secluded or controlled spatial conditions (Hillier, 1996; Karimi, 2018).

These indicators were used collectively to evaluate configurational structure, movement patterns, and spatial hierarchy across the selected mosque typologies.

Table 2. Axial Analysis Indicators used for the mosque analysis.

Indicators	Sepahsalar Mosque	Imam Reza Mosque	Al-Sabie'i Mosque	Al-Darwish Mosque
Integration				
Choice				
Connectivity				
Mean Depth				

C) Visual Graph Analysis (VGA):

In this stage, the Visibility Graph was computed based on the network-based segmentation of space into visible cells. Then, the relationships between cells were extracted based on direct line-of-sight (Turner et al., 2001; Varoudis & Penn, 2015). The computed indices are:

- **Visual Connectivity**

This index measures the number of points that are visible from a given location. A higher value of this index indicates a wider field of view and greater spatial transparency.

- **Visual Integration (Visual Integration)**

This index indicates a point's visual accessibility to the entire visual network and serves as a measure of the environment's legibility and spatial organization.

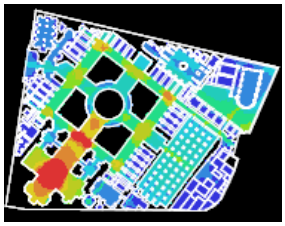
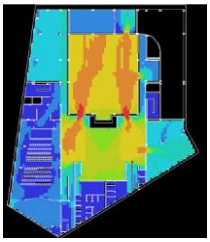
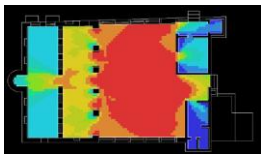
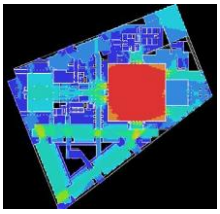
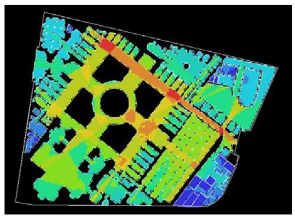
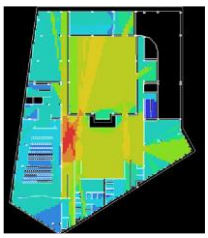
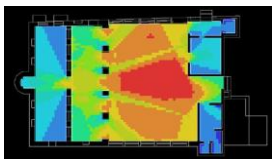
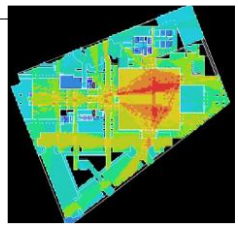
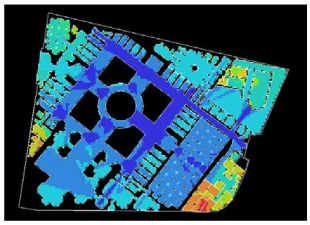
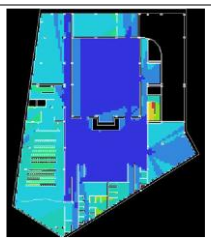
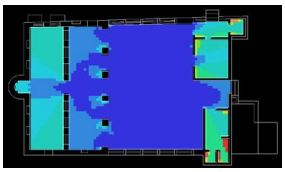
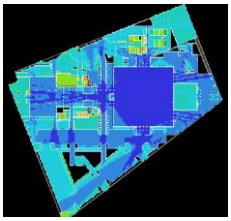
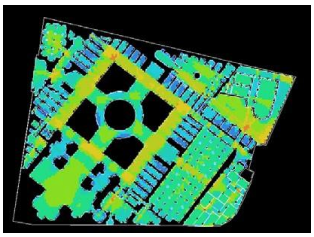
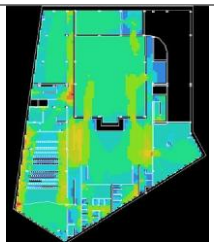
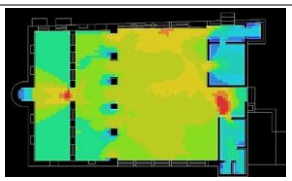
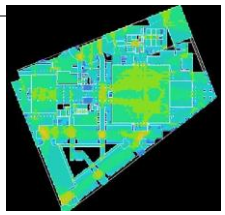
- **Mean Visual Depth (Mean visual depth)**

This index indicates the average visual distance of a point from other points in the visual network and represents the level of spatial perception complexity.

- **Visual Control (Visual Control)**

The Visual Control Index measures the degree of visual dominance of a point over other points in space. This index is the ratio of the number of spaces visible from a point to the number of points that observe that point. Points with a high visual control value are typically considered strategic positions in the spatial structure and can play an important role in guiding movement, spatial surveillance, and organizing activities (Turner et al, 2001; Varoudis, 2012).

Table 3. Visual Analysis Indicators for Mosques.

Indicators	Sepahsalar Mosque	Imam Reza Mosque	Al-Sabie'i Mosque	Al-Darwish Mosque
Visual Connectivity				
Visual Integration				
Mean Visual Depth				
Visual Control				

A central and visual analysis was conducted with the aim of integrating the two aspects of the space's movement and perception to reveal the movement patterns, legibility, and complexity of each mosque.

2.4 Comparative Analysis Framework

In the final stage, the quantitative results of the analyses among the four samples were comparatively compared to identify fundamental similarities and differences. This comparison was conducted along four axes:

1. Presentation of the results summary.
2. Comparative analysis of the Iranian and Qatari sample mosques based on configuration structure and movement patterns.
3. Comparative analysis of the Iranian and Qatari sample mosques based on visual structure and legibility.
4. Final Summary.

The validity of the results was assessed by comparing them with similar studies in the spatial analysis of mosques (Haq & Luo, 2012; Karimi, 2012; Bafna, 2003). The use of standard spatial syntax indicators and the DepthmapX software has ensured the reproducibility of the results and the reliability of the analytical accuracy.

2.5 Methodological Validity and Contribution

The validity of the results was assessed by comparing them with similar studies in the spatial analysis of mosques (Haq & Luo, 2012; Karimi, 2012; Bafna, 2003). The use of standard spatial syntax indicators and the DepthmapX software has ensured the reproducibility of the results and the reliability of the analytical accuracy.

By translating spatial metrics into measurable performance indicators, the study advances existing approaches that primarily focus on descriptive analysis. The use of both axial and visual methods further strengthens validity by capturing multiple dimensions of spatial performance, including movement, accessibility, and perception.

2.6 Limitations

This study is based on a focused set of case studies, enabling an in-depth comparative analysis of spatial configuration across distinct typologies and regional contexts. The analysis emphasizes configurational properties derived from space syntax methods, providing a systematic evaluation of spatial accessibility, hierarchy, and adaptability. While the study relies primarily on documented architectural data, the use of consistent analytical procedures ensures the reliability and comparability of the findings. Additionally, constraints related to regional instability and evolving geopolitical conditions during the study period limited opportunities for extended field access, on-site investigation and user behaviour. Future research may build upon this framework by incorporating expanded datasets, field-based observations, and complementary quantitative methods to further enrich the understanding of spatial configuration.

3. Results

Based on the results obtained from the spatial analysis of mosques, as shown in the table below, there are differences in spatial organization and spatial legibility between the mosques studied in Iran and Qatar. In the axial indicators, the Sepahsalar Mosque, as a traditional Iranian example, has higher values in connectivity, selectivity, and spatial depth, which indicates a more complex spatial network and a greater diversity of movement paths in this building. In contrast, the Imam Reza Mosque, as a modern Iranian example, has lower values in these indicators, featuring a simpler and more legible spatial structure for movement. A similar difference is observed in the Qatari mosques; the Al Saba'i Mosque (traditional) has less spatial depth and lower axial connectivity, while the Al Darwish Mosque (modern) shows greater depth in its axial structure.

In terms of visual indicators, the results show that the mosques of Qatar, particularly the Al Saba'i Mosque, have much higher values in visual connectivity and linkage, indicating a broader field of view and stronger visual continuity between spaces. In contrast, the Iranian mosques have more balanced values in these indicators, but they show a relatively similar level of visual control as the Qatari mosques. Overall, it can be concluded that in the samples studied, Qatari mosques have a greater tendency to create visual continuity and a wide field of view, while Iranian mosques, especially in the traditional sample, feature a more complex movement structure and a stronger spatial hierarchy.

Table 4. Comparative Axial and Visual Analysis Indicators for the Selected Mosque Case.

Analysis Type	Indicator	Sepahsalar Mosque Iran (Traditional)	Imam Reza Mosque Iran (Contemporary)	Al-Subaiei Mosque Qatar (Traditional)	Al Darwish Mosque Qatar (Contemporary)
Axial Analysis	Connectivity	4.59	1.73	1.75	2.24
	Choice	699.29	231.00	16.00	164.24
	Integration	1.34	1.16	0.79	1.06
	Mean Depth	4.53	3.08	2.82	4.67
Visual Analysis	Visual Connectivity	278.88	454.35	1160.25	459.63
	Mean Visual Depth	3.83	3.01	1.81	3.07
	Visual Integration	3.40	5.58	12.71	4.55
	Visual Control	0.86	0.90	0.87	0.87

3.1 Axial Analysis of Configurational Structure and Movement Patterns

The axial analysis reveals contrasting configurational structures and movement patterns between the Qatari and Iranian mosque samples (Table 5). In the Qatari mosques (Al-Subaiei and Al Darwish), the spatial configuration is predominantly concentrated, shallow, and unipolar. Integration is largely focused on the main prayer hall axes, while choice values remain low to moderate, indicating direct movement patterns, limited route alternatives, and strong spatial legibility. Access to the prayer hall is achieved through minimal spatial depth, resulting in simple and convergent circulation structures.

In contrast, the Iranian mosques exhibit a more multi-layered and hierarchical spatial organization. In Sepahsalar Mosque, the courtyard and *iwans* operate as key organizational nodes generating diverse movement paths, while higher choice and connectivity values indicate stronger spatial hierarchy and greater route diversity. Movement from public to more enclosed domains is structured through thresholds and layered spatial sequences, reinforcing a guided and gradual movement logic.

In Imam Reza Mosque, this logic evolves into a more complex multi-hub and multi-level networked structure. Increased choice and connectivity values suggest the formation of multiple competing pathways, while circulation corridors function as major organizational nodes within the system. The presence of multi-level circulation also contributes to increased spatial depth and a more distributed configurational structure.

Overall, while Qatari mosques largely maintain a centralized spatial logic characterized by concentration and directness, the Iranian examples demonstrate a transformation from traditional hierarchical models toward more networked spatial structures associated with greater complexity and configurational flexibility.

Table 5. Comparative Configurational Structure and Movement Patterns in the Case Studies.

Mosque	Typology	Predominant Axial Structure	Integration	Choice	Connectivity	Spatial Depth	Main Configurational Feature
Sepahsalar Mosque	Traditional	Hierarchical, courtyard-centered	Distributed across courtyards and iwans	Medium – High	High	Medium – High	Threshold sequence, route diversity, strong hierarchy
Imam Reza Mosque	Contemporary	Networked, multi-hub, multi-level	Distributed across corridors and key nodes	High	High	High	Distributed network structure and multi-level organization
Al-Subaiei Mosque	Traditional	Focused, monolithic	High in main prayer hall	Low – Medium	Medium	Low	Iwan-centered organization with direct access
Al Darwish Mosque	Contemporary	Focused, low-node	Concentrated in prayer hall	Low – Medium	Medium	Low – Medium	Continuity of concentrated logic with simple movement organization

3.2 Visual Graph Analysis (VGA): Visual Structure and Spatial Legibility

The Visual Graph Analysis (VGA) further confirms the distinction between the two emerging spatial patterns identified in the case studies (Table 6). In the Iranian mosques, the visual structure is characterized by layered and gradual perception. In Sepahsalar Mosque, the central courtyard operates as the primary visual core, while the *iwans* and surrounding arcades generate a spectrum of openness and enclosure. This produces a phased spatial experience in which perception unfolds progressively through movement, reinforcing a sequential and discovery-driven visual structure.

In Imam Reza Mosque, this layered visual logic evolves into a more complex networked hierarchy. Visual continuity is strengthened through major circulation corridors, which function as visual spines connecting multiple spatial nodes. Differences in perceived depth across these spaces generate a differentiated visual hierarchy that, while preserving overall unity, allows for varying degrees of boundary, enclosure, and spatial seclusion.

By contrast, the Qatari mosques exhibit shallower visual depth and stronger visual continuity. In both Al-Subaiei and Al Darwish mosques, the prayer hall dominates the field of view with relatively limited visual obstruction, facilitating immediate legibility and rapid perception of the overall spatial structure. This visual organization is consistent with a centralized perceptual pattern characterized by clarity and directness.

Overall, the VGA results suggest that Iranian mosques emphasize gradual and multi-stage visual perception through layered spatial relationships, whereas the Qatari examples prioritize immediate visual clarity and centralized perceptual coherence.

Table 6. Comparative Visual Structure and Spatial Legibility in the Case Studies

Mosque	Typology	Visual Connectivity	Visual Integration	Mean Visual Depth	Dominant Perceptual Feature
Sepahsalar Mosque	Traditional	Varied (high in courtyard, lower in enclosed spaces)	Focused across courtyards and iwans	Medium–High	Gradual perception with layered transparency and enclosure
Imam Reza Mosque	Contemporary	High in corridors and circulation nodes	Distributed across network nodes	High	Visual spine and complex layered hierarchy
Al-Subaiei Mosque	Traditional	Medium–High	Focused in prayer hall	Low	High legibility and singular visual field
Al Darwish Mosque	Contemporary	Medium–High	Focused in prayer hall	Low–Medium	Visual continuity and transparent spatial structure

4. Discussion

4.1 Spatial Transformation and Configurational Logic

The findings reveal that transformations in mosque architecture in Iran and Qatar extend beyond formal or stylistic evolution and are deeply rooted in shifts in spatial organization and configurational logic. The comparative analysis identified two dominant spatial patterns: a focal–shallow spatial logic in the Qatari examples and a hierarchical networked configurational logic in the Iranian cases. These patterns suggest differing approaches to organizing movement, perception, and spatial hierarchy within mosque architecture.

In the Qatari cases, both traditional and contemporary examples demonstrate continuity in a predominantly centralized spatial logic characterized by direct access, shallow depth, and strong visual legibility. Although contemporary examples introduce greater spatial depth and expanded organizational structures, they largely preserve a concentrated and coherent configurational model centered on the prayer hall. This continuity suggests that typological transformation in the Qatari context has occurred more through adaptation and expansion than through fundamental restructuring of spatial logic.

By contrast, the Iranian cases reveal a more pronounced transformation. While the traditional mosque is structured through hierarchical sequencing and layered thresholds, the contemporary example demonstrates a shift toward distributed and multi-nodal organization. This suggests that typological evolution in the Iranian context has involved not only formal reinterpretation but transformation in the underlying configurational logic of the mosque itself.

These findings support the argument that spatial transformation in mosque architecture should be understood not merely as stylistic change but as the reconfiguration of spatial relationships governing movement, visibility, and spatial experience.

4.2 Typological Evolution in Iranian and Qatari Mosques

The comparative results also suggest differing trajectories of typological evolution between the two contexts. In the Iranian examples, transformation appears to move from strongly hierarchical and courtyard-centered systems toward increasingly networked configurations capable of accommodating more diverse circulation patterns and spatial relationships. Rather than abandoning traditional principles, contemporary examples appear to reinterpret them through more distributed organizational strategies.

In contrast, the Qatari examples suggest stronger continuity across traditional and contemporary typologies. While contemporary mosques introduce changes in scale, support spaces, and formal expression, the underlying spatial logic remains comparatively stable, maintaining centralized organization and strong visual coherence. This finding aligns with scholarship suggesting that contemporary mosque development in Qatar often negotiates modernization through adaptation of established spatial principles rather than radical typological departure.

These contrasting trajectories indicate that typological transformation in mosque architecture is not uniform but shaped by different cultural, spatial, and architectural continuities. In this sense, the comparison reveals not two versions of the same transformation, but two distinct models of spatial evolution.

4.3 Implications for Contemporary Mosque Design

Beyond comparative analysis, the findings suggest broader implications for contemporary mosque design. The study indicates that spatial legibility and configurational complexity should not be understood as opposing conditions, but as potentially complementary design strategies. The centralized clarity observed in the Qatari examples supports coherent collective use and perceptual orientation, while the layered and networked structures observed in the Iranian examples offer spatial richness and distributed movement possibilities.

This suggests that future mosque design may benefit from integrating qualities associated with both spatial models: the clarity and coherence of centralized organization together with the depth, hierarchy, and distributed connectivity associated with more layered configurations. Such integration may support mosque environments that remain legible and accessible while accommodating evolving functional, social, and spatial demands.

More broadly, the study demonstrates the value of Space Syntax as an analytical framework for revealing hidden configurational structures in religious architecture and for supporting comparative interpretation of typological transformation beyond formal stylistic analysis.

5. Conclusion

This study investigated spatial configuration transformation in traditional and contemporary mosque architecture through a comparative Space Syntax analysis of selected case studies in Iran and Qatar. By examining axial and visual graph indicators, the research identified significant differences in movement structure, spatial hierarchy, and perceptual organization across the two contexts.

The findings reveal two dominant configurational patterns. The Qatari examples are characterized by a focal–shallow spatial logic centered on centralized organization, direct movement, and strong visual legibility, while the Iranian examples demonstrate a hierarchical–networked spatial logic marked by layered thresholds, distributed organization, and greater configurational complexity. The study further suggests that transformations in mosque architecture are not limited to formal or stylistic evolution, but involve deeper shifts in the underlying spatial logic through which movement, perception, and spatial relationships are structured.

Through this comparative analysis, the paper contributes to scholarship on mosque typology by framing spatial transformation as a configurational process and by proposing two conceptual models for interpreting differences in traditional and contemporary mosque organization. Methodologically, it also demonstrates the value of Space Syntax as a tool for revealing latent spatial structures in religious architecture and for supporting comparative analysis beyond formal description.

The findings suggest that future mosque design may benefit from engaging both spatial clarity and layered configurational complexity as complementary principles rather than opposing conditions. While the study is based on a limited number of case studies, it establishes a framework that may support broader comparative investigations of mosque typologies across other regional contexts. Future research may expand this work through larger case samples and by integrating configurational analysis with behavioral or user-based studies.

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Conflicts of Interest
The authors declare no conflict of interest.

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Sherin Karawia: Conceptualization; Supervision; Validation; Data Curation; Writing – review & editing; Project administration.
Ghazal Farjami: Data curation; Investigation; Resources; Methodology; Project administration; Writing – original draft; Visualization.
Safoora Mokhtarzadeh: Formal analysis; Software; Methodology; Validation; Investigation; Writing – results & discussion preparation.

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