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The Effects of Modern Architecture on the Evolution of Mosques in Sulaymaniyah

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Abstract: Since the establishment of the Kurdistan Region Autonomy in 1991, extensive construction, including that of mosques, has reshaped the architectural environment. This phenomenon requires an examination of the evolved architectural features in new mosques and also raises questions about their alignment with the religious and symbolic objectives of mosque designs. This study focuses on the transformative impact of modern architectural styles on mosque evolution in Sulaymaniyah and uses an in-depth case study approach to analyze 23 contemporary mosques built over the past three decades. They blend traditional architecture with modern design principles, producing evolved features. The evolution in mosque designs raises questions about the alignment of new architectural features with the religious and symbolic objectives of mosque designs. This study employs indicator-based impact assessments to examine how modern features affect mosque evolution in terms of religious needs and mosque symbolism. Based on the literature of modern architecture and Islamic legitimacy, indicators of modern architecture and mosque design objectives were determined for further analysis. Then, the collected data from the field survey were analyzed through developed formulas. The results were converted to numerical values for use with the Pearson correlation coefficient, which identifies the causal relationship between modern architecture and design objectives. The results revealed that the overall influence of modern architecture on mosque evolution tends to be negative. Modern architectural styles have impacted mosques by increasing structural obstructions in 14%, reducing symbolic elements in 23%, and simplifying designs with fewer embellishments in 43% of all the cases. This study can assist decision-makers and designers in revising mosque design regulations; the issue has recently been the subject of ongoing debate in architects' society.

Keywords: Islamic architecture; modern architecture; mosque evolution; religious symbolism; mosque design objectives; Sulaymaniyah; indicator-based impact assessment

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1. Introduction

Islamic religious architecture has transformed in recent decades due to cultural evolutions, technological advancements, and artistic innovation. Mosques, as symbols of spiritual sanctity and communal identity, have also been influenced by modern architecture [1,2]. This research focuses on understanding the impact of this style on mosque design in Sulaymaniyah, a city in the northeastern region of Iraq. Sulaymaniyah has underwent significant mosque construction over the past thirty years, driven by economic and political developments since 1991, and then in 2003. This boom in construction has raised questions about the alignment of new architectural features with the religious and symbolic objectives of mosque designs.

The study aims to examine the evolutionary impact of modern architectural styles on contemporary mosques in Sulaymaniyah. Additionally, it evaluates the alignment of the evolved features with religious and symbolic objectives. In this regard, the limitations and scope of the study are defined by the following specific criteria and constraints.

i. The sample size was limited by specific criteria, such as architectural style (contemporary mosques) and the time period (1993–2003). Additional constraints included geographic scope (Sulaymaniyah) and the requirement for professional design and construction.
ii. Detailed data, including drawings, construction years, and area, for all mosques in Sulaymaniyah do not exist, leading to a lack of comprehensive information about the mosques.
iii. The mosque design objectives were identified based on the Sunni sect, specifically the Shafi'i madhab, as most of the population in Sulaymaniyah follows this sect.
iv. The evolved mosque features examined in this study are limited to the interior and exterior symbolic elements and those connected to the religious objectives of mosque design. These objectives include reducing interior obstacles and decorations, enhancing indoor tranquility, and providing a longer Qibla wall compared to the side walls.
v. The developed formulas in this study serve as scales to assess and compare indicators within this research. The formulas may need adjustments for application in future studies based on the nature of the raw data and the objectives of the study.

There are five sections in this article. Section 1 is the "Introduction" of this study, which provides pertinent details on the research issue. Section 2 is "Literature Review", covers the previous reviews and research articles that take the study theme into consideration. The selection of the literature was based on the study's topic and research questions. Section 3 is "Material and Methods", outlines the research strategy that was employed to accomplish the study's goals. Analytical methodologies and data collection methods are covered in this chapter. Section 4 is "Results and Discussion", goes into further detail on the study's key findings. Section 5 is "Conclusions", which provides a summary of the entire manuscript along with closing thoughts.

2. Literature Review

Several recent studies have explored the influence of modern architectural trends and technologies on mosque design, highlighting contemporary developments in maintaining the spiritual essence and cultural identity of mosques. AL-Ammar and AL-Atabey [1] and Toorabally et al. [2] examined the impact of contemporary technologies on mosque architecture. In addition, Niknam et al. [3] studied the influence of contemporary architecture on Islamic motifs in mosques. Ra'ouf et al. [4] hypothesized that functional, esthetic, and symbolic religious factors may primarily influence contemporary mosque architecture designs, contrasting with traditional and environmental influences. Al Tal [5], Hoteit [6], and Mahdavinejad [7] also examined the impact of modern architectural theories and trends on mosque designs. The reviewed studies collectively underscore the importance of balancing between modern architectural trends and traditional elements in mosque designs to uphold their spiritual essence and cultural identity.

Additional studies delved into the evolution of contemporary mosque architecture, exploring the interplay between modernization, symbolism, and technological advancements. These studies highlight the complex dynamics shaping contemporary mosque designs. For instance, Hamzehnejad et al. [8] identified authenticity criteria for contemporary mosques in the Islamic world. Awad [9] and Mahmoud et al. [10] explored contemporary mosque design trends in northern UAE cities and across the world, respectively. In addition, Al-Bukhari et al. [11] emphasized that modern mosques reflect technological advancements, societal needs, and economic status while preserving cultural and spiritual identity. Furthermore, Alkhaled [12], Alhefnawy et al. [13], and Toman [14] examined the contemporary mosque architecture in Turkey, Italy, and Riyadh, respectively. Asfour [15] studied mosque architecture's evolution from historical to contemporary styles, highlighting the tension between modernism and symbolism.

Furthermore, several studies explored different aspects of mosque architecture in the Kurdistan Region of Iraq. Ali et al. [16] categorized mosques, including two old mosques in Sulaymaniyah on key mosque prototypes. Mustafa et al. [17] and Abdulhamid et al. [18] focused on the proportion of respective mosque designs in Erbil, and Mustafa and Is-

mael [19] conducted a typological study of historical mosques in Erbil. Furthermore, Qaradaghi et al. [20] investigated the influence of culture on mosque architecture, particularly those built between 1970 and 1990 in Erbil. Sadiq [21] explored the impact of architectural conservation on the Great Mosque in Duhok. Qaradaghi's study [22] examined the architectural and spatial configuration of mosques and is currently the only study to examine mosques in Sulaymaniyah. Qaradaghi conducted a field survey of mosques in Sulaymaniyah and concluded that several features in these mosques deviate from popular mosque designs. These include unfamiliar spatial configurations, poor circulation that disrupts prayer rows and reduces tranquility in the musalla, and the absence of key elements, such as arcades, to connect different parts of the mosque. Symbolic features like domes, minarets, and arches were often missing. Additionally, unfamiliar spatial configurations and poor circulation disrupted prayer rows and reduced tranquility in the musalla.

Despite extensive research on mosque architecture and contemporary trends, a gap remains in understanding the specific impact of modern architectural styles on mosque evolution, particularly in Sulaymaniyah. While studies have explored various aspects of mosque evolution, such as structural elements and decorative features, none have focused on how these changes align with religious requirements. Additionally, although some research addresses balancing tradition with innovation, few have defined the criteria for the extent of innovations in mosque design. In addition, the only study on mosques in Sulaymaniyah [22] revealed several negative aspects resulting from recent changes in mosques, while the effects of modern styles on these changes have not been examined yet. This gap highlights the need to explore the evolutionary impact of modern architectural styles on contemporary mosques and their alignment with the religious objectives of mosque design.

The null hypothesis states that incorporating modern architectural features in contemporary mosques in Sulaymaniyah has no impact on the fulfillment of religious objectives in mosque designs. In contrast, the alternate hypothesis, aligned with the negative changes observed in these mosques, suggests that incorporating modern architectural features has negatively impacted the fulfillment of religious objectives in mosque designs.

2.1. Historical Evolution of Mosques

The evolution of mosques through different periods and regions reflects diverse architectural styles and influences. Initially, the Prophet Muhammad (PBUH) and his companions constructed a simple mosque with a covered prayer shed, which later expanded to include arcades [23], serving as a spiritual model of mosque architecture and enabling flexibility and diversity in designs [24]. During the Umayyad period, mosques became more specialized, serving various purposes beyond prayer, while the Abbasid era saw further development and the establishment of mosque–palace complexes [25] (pp. 4 & 8). In Morocco and Andalusia, mosques followed the hypostyle type, influenced by Syrian architecture, with later innovations including complex vaulting and domes. In Yemen, mosques integrated elements from pre-Islamic temples. Anatolian and Kurdistan mosques, influenced by Iranian and Arabic traditions, featured pillared designs and emphasized arches and vault coverings [23]. In Egypt, mosques evolved from simple to more elaborate designs under the Fatimid, Ayyubid, and Mamluk periods, with distinct features such as keel arches and intricate minaret shapes, as elucidated in [26,27]. Iranian mosques, influenced by pre-Islamic traditions, incorporated domes and iwans, with developments seen in the Seljuk, Ilkhanid, Timurid, and Safavid periods [23]. Ottoman mosques, shaped by various cultural influences, evolved from simple hypostyle plans to more complex domed–square structures, reflecting the Ottoman concern for integrating large spaces with minimal vertical supports across successive stages of development [28] (pp. 19 & 29).

Mosque evolution over history in different regions resulted in shaping basic elements contributing to their architectural form and function. These elements can be classified into basic and additional components. Basic elements include the musalla (prayer hall), sahn (courtyard), mihrab (niche), and minbar (pulpit), and additional elements encompass

the minaret, dome, ablution facilities, riwaq (arcade), maqsurah (enclosure), reading desk, mosque furniture, and gate. The musalla serves as the main prayer area, typically adopting a rectangular shape parallel to the Qibla wall for optimal alignment. The sahn, an open central area, offers space for congregation and passive cooling purposes. It is surrounded by covered arcades called riwaq. The sahn enhances the mosque's esthetic appeal and functionality. Minarets, which are vertical features, historically symbolize Islam's presence and solemnity, evolving in shape and style over time. Domes, prevalent in mosque architecture, symbolize the sky and aid in lighting, acoustics, and ventilation, as described in [6,15]. The mihrab marks the direction of prayer, while the minbar, positioned nearby, is a stepped pulpit to facilitate the Imam's sermon delivery. Enclosures like the maqsurah, once reserved for rulers, underscored their status and protection [23]. Ablution facilities are integral to Islamic worship and ensure ritual purity before prayer; they evolved from fountains to designated rooms within mosque complexes. These elements, with their historical, functional, and symbolic significance, collectively shape the architectural identity and experience of mosques worldwide [6] (p. 13551).

Various types of mosques have emerged across different regions, each of which are influenced by local architectural features and climatic conditions [6] (p. 13551). While fundamental elements like arches, domes, minarets, and mihrabs are common throughout the Muslim world, regional variations have led to distinct styles [29] (p. 1). Six traditional typologies include the hypostyle or Arabic, Iranian or Persian, Turkish or Ottoman, Indian, and Chinese types. The hypostyle mosque, which originated from Arabia, features a large courtyard and a covered prayer hall, often with dome variations and diverse minaret forms [15] (p. 5). The Persian style, characterized by four iwans surrounding a courtyard, exhibits bulbous domes and colorful ornamentation [6] (p. 13552). Ottoman mosques boast centralized domes and slender minarets, which are influenced by Byzantine architecture [15] (p. 6), while Indian mosques feature triple domes and spacious courtyards. Chinese mosques resemble traditional Chinese buildings, with walled complexes, timber structures, and distinctive roof forms, exemplified by the Great Mosque of Xi'an [6] (p. 13553). These variations reflect the diverse cultural and architectural influences shaping mosque designs across regions.

Several functional and symbolic requirements are regarded as religious objectives in mosque design, as outlined below.

i. Orienting to the Qibla. The most important aspect of the mosque is the orientation of the musalla to the Qibla [15,30,31]. It is also confirmed by the Holy Quran: "We have seen your face turned towards the heaven. So, we will turn you towards a direction that will satisfy you. So, turn your face towards the Sacred Mosque. And wherever you may be, turn your faces towards it. Those who were given the Book know that it is the Truth from their Lord; and Allah is not unaware of what they do" [32] (p. 8, Verse 144).
ii. Avoiding cutting off rows with an excessive number of columns or walls and eliminating view restrictions [6,15]. It is confirmed in the Hadiths of the Prophet (PBUH) as follows: "...Whoever joins up a row, he will be joined to Allah; and whoever cuts off a row, he will be cut off from Allah" [33] (p. Hadith 101).
iii. Using plan forms allowing longer rows, especially the first row [15] (p. 7). This is due to the virtue of the first row, which is confirmed in the Hadiths of the Prophet (PBUH) as follows: "If people came to know the blessing of calling Adhan and the standing in the first row, they could do nothing but would draw lots to secure these privileges" [33] (p. Hadith 93).
iv. Providing a quiet environment for concentration, reverence, and piety during prayer [6] (p. 13554). The Quran describes the believers during prayer, stating "Successful are the believers. Those who are humble in their prayers. Those who avoid nonsense" [32] (p. 126, Verses 1, 2 & 3).
v. Avoiding over-decoration that may interrupt prayer concentration [15] (p. 7). It is confirmed in the Hadith of the Prophet (PBUH) as follows: "The Hour (Judgement

Day) will not come until people boast (to each other) with (the construction and decoration of) mosques" [34] (p. Hadith 135).

vi. Using the recognizable form as a mosque. Incorporating symbolic features into new mosque designs maintains cultural continuity and fosters a sense of Islamic identity within communities. Fethi [30] (pp. 54 & 60) introduced these symbolic features as minarets, domes, arches, vaults, and decorative elements. They hold deep symbolic meaning rooted in Islamic tradition and contribute to the esthetic harmony of mosque architecture. By respecting tradition and honoring past generations, new mosque designs can create a spiritually conducive atmosphere while also embracing environmentally sustainable practices.

In summary, mosque architecture has evolved over time, shaping basic elements and developing various types across different regions. These evolved features relatively align with mosque design objectives which include shaping a rectangular musalla with an extended Qibla wall and minimal visual obstructions to avoid cutting off prayer rows. The worship space should also be tranquil, with minimal decorations to prevent distractions during prayer. Additionally, incorporating symbolic features helps preserve cultural continuity, foster Islamic identity, and create a spiritually conducive environment. The dependent variables in this study are derived from these mosque design objectives.

2.2. Influences on Contemporary Mosques

Contemporary mosques have been influenced by modern architecture, altering traditional forms due to Westernization, urban growth, and societal changes. This has created tension between modern design and traditional religious symbolism, resulting in diverse architectural styles [30]. However, some argue against the compatibility of modern architecture with mosque design. Omer [35] believes that Islamic architecture, rooted in Islamic values, is fundamentally different from modern styles. Establishing harmony between them is impossible, as is aligning the Muslim mindset and behavior with the principles of modernist architectural legacies.

Contemporary mosque design trends are categorized into vernacularism, modernism, and postmodernism. Vernacularism preserves historical styles, modernism explores new forms, and postmodernism blends historical styles with modern contexts. There are ongoing debates about the necessity of elements like domes and minarets, with some arguing their overestimated spiritual significance and others emphasizing their evolved role in Islamic architecture. These elements are seen as complementary rather than essential, with some schools of thought considering them optional in modern mosque design [15].

Contemporary mosques have been designed under the effects of dominant architectural approaches and styles throughout the 20th century and the last two decades. The impact of the modern architectural style on these mosques can be examined by tracing the indicators of modern style in contemporary mosques. The main indicators of modern architectural styles are as follows:

i. Simplified geometric shapes: Modern architecture often features basic geometric forms like rectangles, squares, and circles. This style is epitomized by Mies van der Rohe's slogan "Less is more" [36] and rejects traditional esthetics in favor of innovative creativity, focusing on simplicity, abstraction, and rational solutions to location, purpose, and technological challenges [37].

ii. Use of new technology: Modern architecture incorporates materials like steel, glass, and concrete, offering structural flexibility and creative opportunities [36]. This approach emphasizes the visible use of technology and materials, avoiding unnecessary ornamentation [37].

iii. Emphasis on function over form: Modern architecture prioritizes functionality, designing buildings to serve specific purposes. This approach centers on human usability, encapsulated by L. Sullivan's slogan "Form follows function" [36].

iv. Minimalist design: Modern architecture features a minimalist esthetic with clean lines, simple surfaces, and no ornamentation [38]. It prioritizes simplicity, pure material

colors, and natural textures for decoration. This approach, which is epitomized by Adolf Loos' slogan "Decoration is a crime", reflects the Chicago school's use of cladding for decoration [36].

v. Open floor plans: Modern buildings often feature open floor plans with large, flexible areas for various activities. This style, characterized by the release of external walls from load-bearing functions allows for a "free plan" where interior walls can be arranged as needed [37] (p. 13).

vi. Emphasis on natural light: Modern buildings often make use of natural light, with large windows and skylights that provide daylight and reduce the need for artificial lighting [37] (p. 8).

vii. Flat roofs: Flat roofs became a feature of modern architecture, driven by a desire to align architectural form with evolving needs, materials, and industrial techniques [38].

viii. Extroverted layout: Modern buildings became extroverted, featuring open floor plans and large external windows to align with the extrovert paradigm of modern capital society [39].

In summary, despite arguments against the compatibility of modern architecture with mosque design, contemporary mosques have been influenced by modern styles. These effects are visible through various modern style indicators, including simplified geometric shapes, the use of new technology, minimalist design, open floor plans, an emphasis on natural light, flat roofs, and extroverted layouts. The independent variables in this study will be derived from these modern architectural indicators.

3. Materials and Methods

This research employs a cause-and-effect approach, examining how modern architectural styles influence expected changes (evolution) in mosque designs and utilizes the indicator-based impact assessment method, which identifies key variables indicating impacts. This method involves identifying these indicators and assessing their changes within a specific context or case study [40] (p. 9). In this study, the focus is on the impact of modern architectural styles on the evolution of contemporary mosque design in Sulaymaniyah. The method is designed to determine whether these impacts align with the religious objectives of mosque design. This study is divided into the following parts, as illustrated in Figure 1: literature review, data collection, and data analysis, followed by conclusions and recommendations. The variables involved in the data analysis are derived from the literature review.

Figure 2 provides an overview of the study's objectives. This diagram is derived from a study by Talpur et al. [41] (p. 10). It displays both the independent and dependent variables in the study. Additionally, it presents how modern architectural styles impact the religious and symbolic objectives of mosques.

Certain steps were performed to implement the research method.

1. According to the 2024 database of the Directorate of Endowments in Sulaymaniyah, there are 306 mosques. Concerning the adequate number of cases, Gustafsson [42], and Patnaik et al. [43] (p. 169) concluded that the number of cases is not important compared to the amount of new information the cases bring. Additionally, Patnaik et al. [43] conducted a comparative approach and then suggested 4 to 15 cases. This study therefore applied a comparative approach to validate the number of cases. As shown in Table 1, the number of mosques examined in ten related studies ranges from 1 to 24. So, the higher end of this range was considered as the possible number for mosque selection. Both Patnaik et al. [43] and Coombs [44] (p. 2) recommended criteria-based screening for case selection, which is guided by the research objectives of the study. Therefore, based on the following criteria, 23 mosques were selected:
    - Architecture style: contemporary design reflecting modern architectural styles;
    - Time period: built within the last three decades (1993–2023);
    - Designer: designed by an architect or architectural firm;
    - Builder: constructed under the supervision of an engineer;

- Building area: between 300 m^2 and 3000 m^2;
- Musalla area: between 150 m^2 and 1500 m^2.

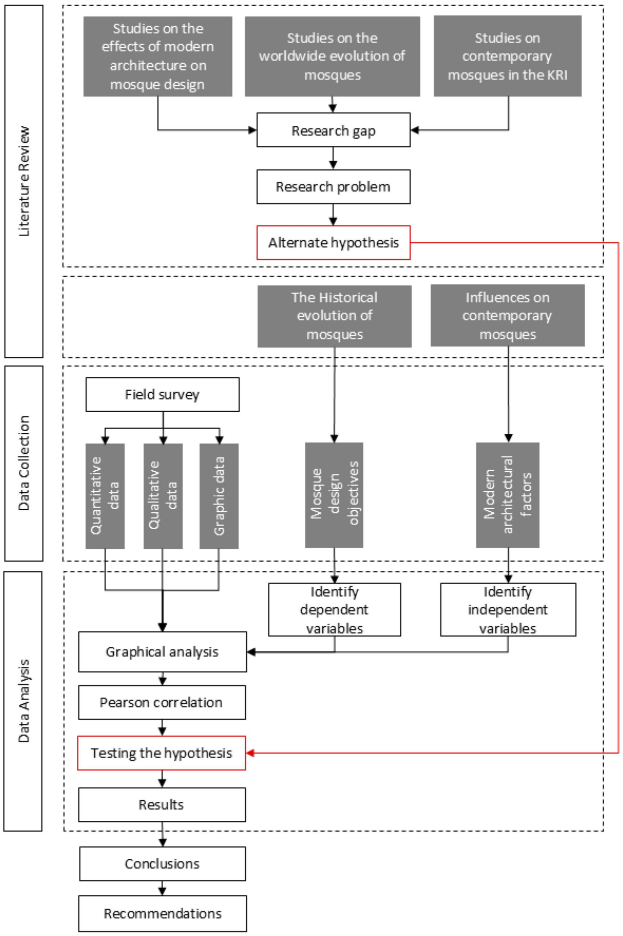


Figure 1. Research's design and workflow.

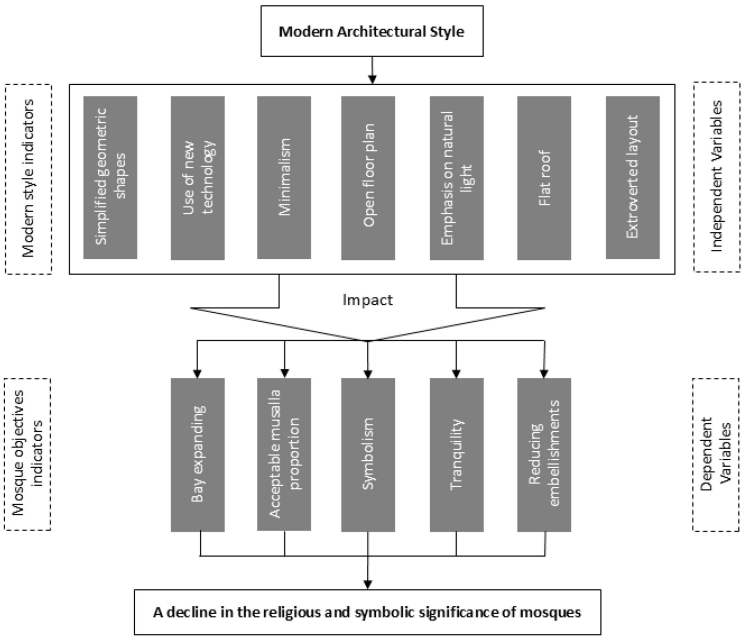


Figure 2. Theoretical framework of the impact of modern style on mosques.

Table 1. Studies on mosque architecture and sample size for each methodology.

Study	Geographic Region	Time Period	Focused Topic	Type of Research Method	No. of Selected Mosques
[45]	Iran		The evolution of concepts and spatial patterns	Qualitative and evolutionary historical research	4
[46]	Cairo, Egypt		The evolution of mosques	Qualitative research and descriptive research	5
[47]	Islamic world	Islamic period	Adaptation in the evolution of mosques	Qualitative and comparative analysis method	12
[22]	Sulaymaniyah, Iraq	1980–2010	Functional configuration	Qualitative research	15
[20]	Erbil, Iraq	1970–1990	The effects of culture on symbolism	Quantitative research and graphical analysis	20
[17]	Erbil, Iraq	1720, 1981, and 2010	Human scale and proportionality	Quantitative research	3
[19]	Erbil, Iraq	Before 1900	Typology	Qualitative research	5
[18]	Erbil, Iraq	1980–1989 and 2000–2015	Proportions of the prayer hall	Quantitative research	24
[21]	Dohuk, Iraq	1970s	Conservation and sustainability	Analytical approach	1
[16]	Islamic world	661–1923	Typo-morphological classification	Analytical approach	15

It is acknowledged that the total number of mosques in Sulaymaniyah meeting these criteria is about one-fourth of all mosques. In terms of the years the selected mosques were built, five mosques (21.74%) were built before 2003, eight (34.78%) between 2004 and 2013, and ten (43.48%) between 2014 and 2023. Most mosques built between 1993 and 2003 lack architectural value due to internal conflicts and economic blockades. Furthermore, the majority of mosques constructed between the 2003 occupation of Iraq and 2008 were neither designed nor built by professional architects or engineering firms.

2. Data collection: A data sheet was developed to gather qualitative, quantitative, and graphic data from the selected mosques through field surveys. The collected data encompassed information such as location, construction date, architect, geometric properties, floor plans, and photographs, which were subsequently refined and organized.
3. Based on the previous studies, relevant indicators of modern architectural style for contemporary mosques in Sulaymaniyah were identified. The indicators, which can be involved in the study as independent variables, were simplified geometric shapes, use of new technology, minimalism, open floor plans, emphasis on natural light, flat roofs, and extroverted layout. Then, they were weighted based on the opinions of experts in architecture to gauge the degree of modernity in the selected mosques.
4. Based on the Quran, the Hadith of Prophet Mohammed (PBOH), and previous studies, key mosque design objectives and requirements were identified for involvement in the study as dependent variables. These objectives were specifically aligned with the Sunni sect (Shafi'i Madhab), reflecting the dominant religious practice in the region (Figure 3). The objectives and requirements of mosque designs that might be affected by modern architecture styles are listed as followed:
    i. Avoiding cutting off rows with numerous columns or walls and eliminating view restrictions (expanding the bays);
    ii. Using plan forms that allow for longer rows, especially the first row (a rectangular shaped musalla with long Qibla wall);
    iii. Providing a quiet environment for concentration, reverence, and piety during prayer (tranquility);
    iv. Avoiding over-decoration that may interrupt prayers (reducing embellishments);

v. Using the recognizable form as a mosque (symbolic mosque elements, i.e., domes, minarets, sahns, arcades, mihrabs, minbars, calligraphy, water features, gateways, mosaics, and artworks) [20] (p. 16). These elements were weighted based on the opinion of experts in Islamic architecture to ascertain the degree of symbolism in the examined mosques.

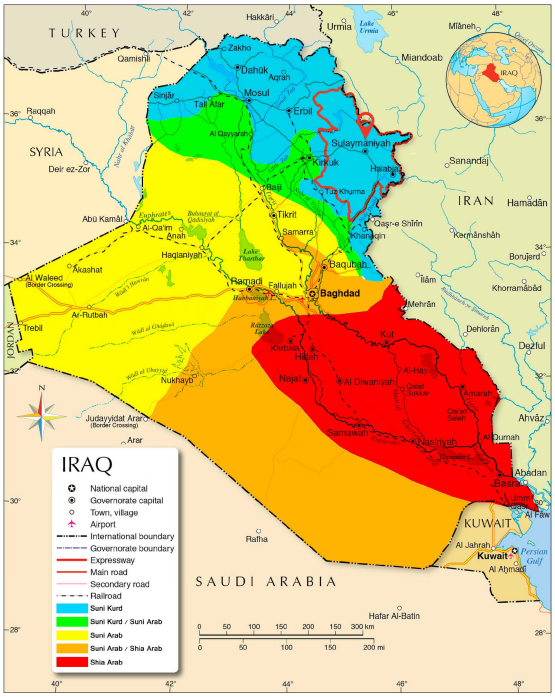
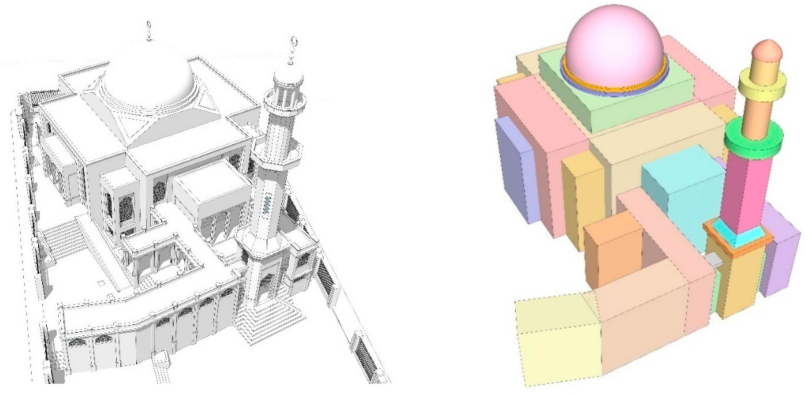


Figure 3. Sectarian and Ethnic Divisions in Iraq. Sources: [48] (p. 52) and https://www.nationsonline.org/oneworld/map/iraq_map.htm (accessed on 17 November 2024).

5. Graphical analysis was used to determine the modernity degree of the mosques based on key indicators of modern architectural styles. Specific tools, methods, and equations were employed for each indicator, using checklists for components and geometric calculations where needed. Numerical values were converted to indices using statistical equations to simplify and condense the data, aiding in comparisons and trend identification. Then, the achieved design objectives in the selected mosques were also calculated as numerical indicators and converted to indices. An example of the graphical analysis is illustrated with Rayyan Mosque (Figure 4).



(**a**) (**b**)

Figure 4. (**a**) Three-dimensional modeling of Rayyan Mosque, and (**b**) Basic volumetric geometric shapes that formed Rayyan Mosque (V = 25). Prepared by the authors.

Several formulas were developed to calculate the modernity index of mosques based on their architectural modern style indicators. The following sections explain these formulas in detail.

The formula to calculate the Simplified Geometric Shapes Index (I_{SGS}) is expressed as follows:

$$I_{SGS} = 1 - ((V - V_{MIN})/(V_{MAX} - V_{MIN})) \quad (1)$$

where V is the minimum number of basic volumetric geometric shapes that form the mosque (Figure 4), and V_{MIN} and V_{MAX} are the minimum and maximum V values among the selected mosques, respectively.

The formula to calculate the Using New Technology Index (I_{UNT}) is expressed as follows:

$$I_{UNT} = (X_{STR} + X_{IFM} + X_{EFM})/X_{MAX} \quad (2)$$

where X_{STR} is the numerical indicator of using new structures (concrete and steel) when constructing the musalla, dome, and minaret(s) of a mosque ($0 \leq X_{STR} \leq 3$); X_{IFM} is the numerical indicator of using new finishing materials in the internal walls, columns, and ceiling(s) of a mosque ($0 \leq X_{IFM} \leq 3$); X_{EFM} is the numerical indicator of using new finishing materials in the external walls of musalla, dome(s), and minaret(s) of a mosque ($0 \leq X_{EFM} \leq 3$); and X_{MAX} is the summation of the maximum possible X values of a mosque ($X_{MAX} = 9$).

The formula to calculate the Minimalism Index (I_M) is expressed as follows:

$$I_M = 1 - ((D_{INT\_MIHRAB} + D_{INT\_MINBAR} + D_{INT\_DOME} + D_{INT\_COLUMN} + D_{INT\_CEILING} + D_{INT\_DOOR} + D_{INT\_WINDOW} + D_{INT\_CHANDELIER} + D_{EXT\_WALL} + D_{EXT\_WINDOW} + D_{EXT\_COLUMN} + D_{EXT\_DOME} + D_{EXT\_MINARET})/D_{MAX}) \quad (3)$$

where D_{INT} is the numerical indicator of using interior decoration elements in the internal surfaces of the mihrab, minbar, dome(s), column(s), ceiling(s), doors, windows, and chandelier(s) in the musalla of a mosque (Figure 5a) ($0 \leq D_{INT} \leq 2$). $D_{INT} = 0$, $D_{INT} = 1$, and $D_{INT} = 2$ indicate no, medium, and full decoration, respectively. D_{EXT} is the numerical indicator of using exterior decoration elements in the external surfaces of the walls, windows, columns, dome(s), and minaret(s) of a mosque (Figure 5b) ($0 \leq D_{EXT} \leq 2$). $D_{EXT} = 0$, $D_{EXT} = 1$, and $D_{EXT} = 2$ indicate no, medium, and full decoration, respectively. D_{MAX} is the maximum possible sum of the D values of a mosque ($D_{MAX} = 26$).

(**a**) (**b**)

Figure 5. Rayyan Mosque. (**a**) Decoration on interior elements, and (**b**) decoration on exterior elements. Photos taken by the authors.

The formula to calculate the Open Floor Plan Index (I_{OFP}) is expressed as follows:

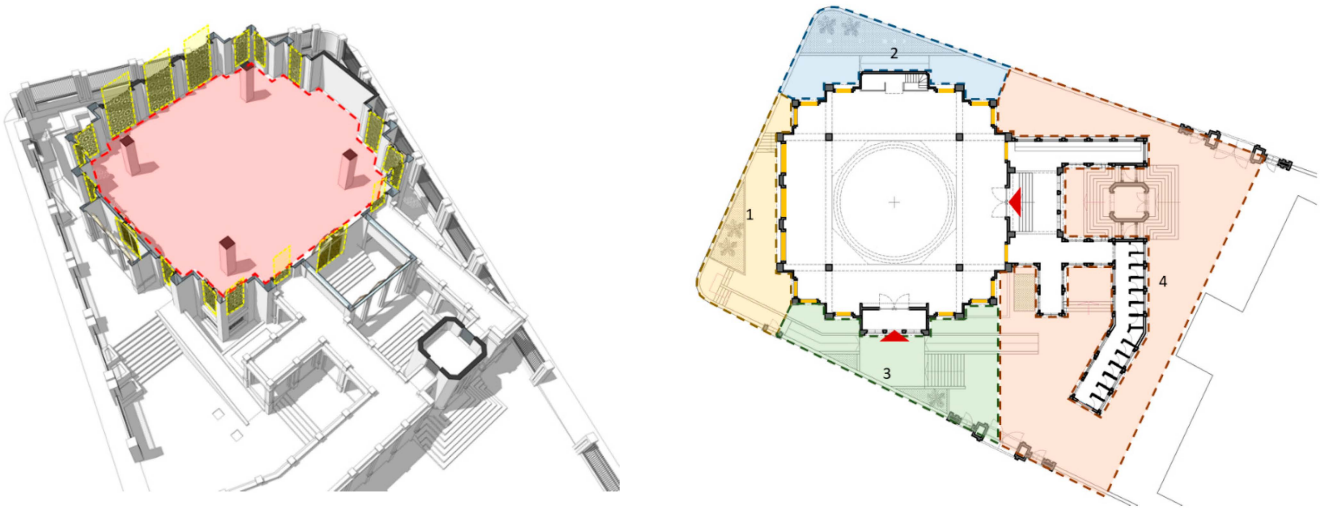
$$I_{OFP} = N_{CM}/N_M \quad (4)$$

where N_{CM} is the number of spatially connected musalla in a mosque, and N_M is the number of musalla in a mosque.

The formula to calculate the Emphasis on Natural Lighting Index (I_{ENL}) is expressed as follows:

$$I_{ENL} = (R - R_{MIN})/(R_{MAX} - R_{MIN})$$
$$R = A_{MG}/A_M \quad (5)$$

where R is the ratio of the glazing area to floor area in a mosque's musalla (Figure 6a), A_{MG} is the glazing area of a mosque's musalla, A_M is the area of a mosque's musalla, R_{MIN} is the minimum R value among the selected mosques, and R_{MAX} is the maximum R value among the selected mosques.



(**a**) (**b**)

Figure 6. (**a**) Three-dimensional plan of Rayyan Mosque, showing the glazing and musalla floor areas, and (**b**) the ground floor plan of Rayyan Mosque, showing two entrances and four open outdoor spaces surrounding the musalla. Prepared by the authors.

The formula to calculate the Flat Roof Index (I_{FR}) is expressed as follows:

$$I_{FR} = 1 - ((D + P)/2) \quad (6)$$

where D is a numerical indicator of having dome in a mosque. D = 0 when a mosque has no dome, and D = 1 when a mosque has at least a dome. P is a numerical indicator of having a pitched roof in a mosque. P = 0 when a mosque has no pitched roof, and P = 1 when a mosque has at least one pitched or sloped roof.

The formula to calculate the Extroverted Design Index (I_{ED}) is expressed as follows:

$$I_{ED} = (((S + E)/8) + I_{ENL})/2 \quad (7)$$

where S is the number of open outdoor spaces surrounding a mosque on all four sides (Figure 6b) ($0 \leq S \leq 4$), and E is the number of entrances to a mosque's musalla ($0 \leq E \leq 4$).

The formula for converting MAS indicators' values into a modernity index score (I_{MODERN}) is expressed as follows:

$$I_{MODERN} = I_{SGS}W_{SGS} + I_{UNT}W_{UNT} + I_MW_M + I_{OFP}W_{OFP} + I_{ENL}W_{ENL} + I_{FR}W_{FR} + I_{ED}W_{ED} \quad (8)$$

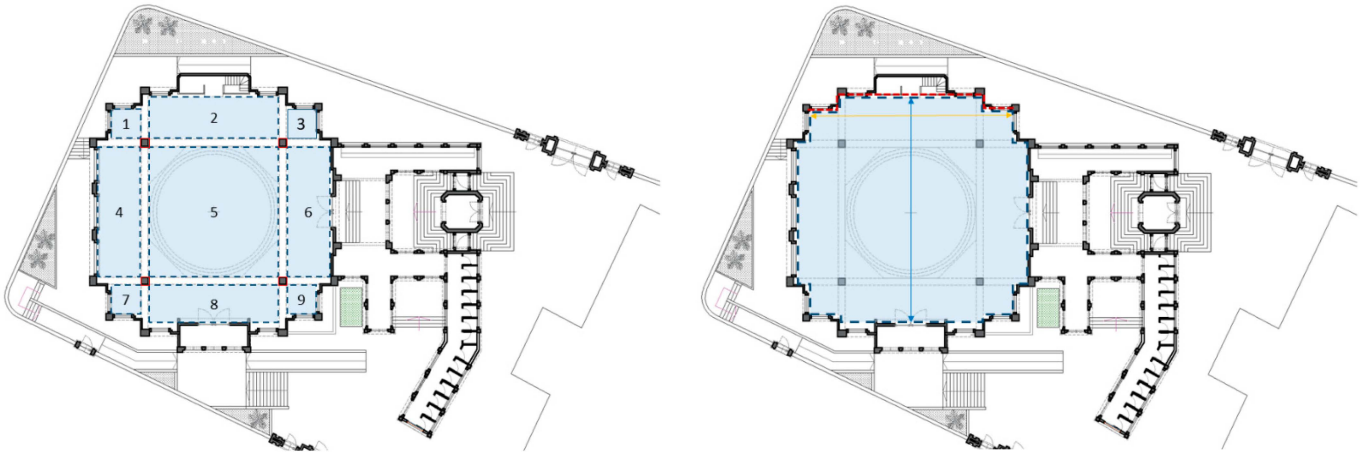
where W_{SGS} is the weight of the Simplified Geometric Shapes Index = 0.152, W_{UNT} is the weight of the Using New Technology Index = 0.176, W_M is the weight of the Minimalism Index = 0.168, W_{OFP} is the weight of the Open Floor Plan Index = 0.16, W_{ENL} is the weight of the Emphasis On Natural Light Index = 0.136, W_{FR} is the weight of the Flat Roof Index = 0.08, and W_{ED} is the weight of the Extroverted Design Index = 0.128.

Several formulas were developed to calculate the indices of a mosque's design objective indicators. The following sections explain these formulas in detail.

The formula to calculate the Bay Expanding Index (I_{BE}) is expressed as follows:

$$I_{BE} = (Y - Y_{MIN})/(Y_{MAX} - Y_{MIN})$$
$$Y = A_M/B \quad (9)$$

where Y is the ratio of a musalla area to the number of bays in the musalla of a mosque (Figure 7a), A_M is the area of the musalla, B is the number of the bays in the musalla, Y_{MIN} is the minimum Y value among the selected mosques, and Y_{MAX} is the maximum Y value among the selected mosques.



(**a**) (**b**)

Figure 7. Ground floor plan of Rayyan Mosque showing (**a**) four columns and nine bays, and (**b**) the Qibla wall (red line) and distance between the Qibla wall and the opposite wall (blue line) in the musalla. Prepared by authors.

The formula to calculate the Musalla Proportion Index (I_{MP}) is expressed as follows:

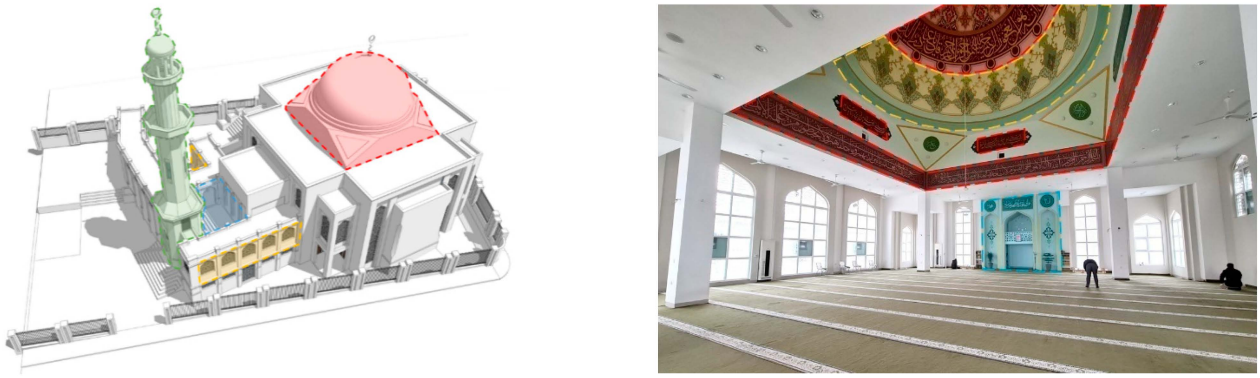
$$I_{MP} = (Z - Z_{MIN})/(Z_{MAX} - Z_{MIN})$$
$$Z = L_Q/L_S \quad (10)$$

where Z is the ratio of a Qibla wall length and the distance between the Qibla wall and the opposite wall (Figure 7b); L_Q is the Qibla wall length; L_S is the side wall length, which is the distance between the Qibla wall and the opposite wall; Z_{MIN} is the minimum Z value among the selected mosques; and Z_{MAX} is the maximum Z value among the selected mosques.

The formula to calculate the Symbolic Elements Index (I_{SE}) is expressed as follows:

$$I_{SE} = K_{DOM}W_{DOM} + K_{MINA}W_{MINA} + K_{SAH}W_{SAH} + K_{ARC}W_{ARC} + K_{MIH}W_{MIH} + K_{MINB}W_{MINB} + K_{CAL}W_{CAL} + K_{WAT}W_{WAT} + K_{GAT}W_{GAT} + K_{ART}W_{ART} \quad (11)$$

where K_{DOM}, K_{MINA}, K_{SAH}, K_{ARC}, K_{MIH}, K_{MINB}, K_{CAL}, K_{WAT}, K_{GAT}, and K_{ART} are numerical indicators of having domes, minarets, sahns, arcades, mihrabs, minbars, calligraphy, water features, gateways, and artworks in the mosque, respectively. K = 0 when the mosque does not have the relevant symbolic element, and K = 1 when the mosque has at least a relevant symbolic element (Figure 8). W_{DOM} is the weight of the K_{DOM} indicator = 0.129, W_{MINA} is the weight of the K_{MINA} indicator = 0.1677, W_{SAH} is the weight of the K_{SAH} indicator = 0.0839, W_{ARC} is the weight of the K_{ARC} indicator = 0.0581, W_{MIH} is the weight of the K_{MIH} indicator = 0.1484, W_{MINB} is the weight of the K_{MINB} indicator = 0.1484, W_{CAL} is the weight of the K_{CAL} indicator = 0.0968, W_{WAT} is the weight of the K_{WAT} indicator = 0.0452, W_{GAT} is the weight of the K_{GAT} indicator = 0.071, and W_{ART} is the weight of the K_{ART} indicator = 0.0516.



(**a**) (**b**)

Figure 8. Rayyan Mosque. (**a**) Three-dimensional model showing the exterior symbolic elements and, (**b**) photograph of the interior showing the internal symbolic elements. Prepared by the authors.

The formula to calculate the Tranquility Index (I_T) is expressed as follows:

$$\begin{gathered} I_T = ((1 - I_{TF}) + I_{EI})/2 \\ I_{TF} \text{ is the ratio of transparent facade to the floor area of musalla} = I_{ENL} \\ I_{EI} = ((\text{No. of back entrances} - \text{No. of front and side entrances}) + 4)/6 \end{gathered} \quad (12)$$

where I_{EI} is entrance impact indicator, in which front and side doors negatively impact the tranquility of a musalla (Figure 9). The assumed factors affecting tranquility of a musalla include glare, noise, visual distractions, and circulation within the space, all disrupting worshippers' concentration. Glare, noise, and visual distractions increase with larger glazing areas in a musalla. Additionally, front and side entrances amplify side circulation, leading to movement in front of worshippers and further disrupting their focus and reducing tranquility. These issues were observed in Sulaymaniyah mosques, as reported by Qaradaghi in his study [22] (p. 7).

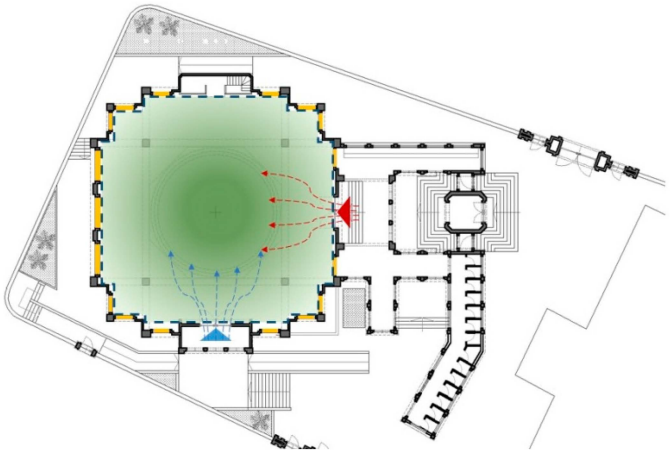


Figure 9. Ground floor plan of Rayyan Mosque, showing the back and side entrances and windows in the musalla. Prepared by the authors.

The formula to calculate the Reducing Embellishments Index (I_{RE}) is expressed as follows:

$$I_{RE} = 1 - ((D_{INT\_MIHRAB} + D_{INT\_MINBAR} + D_{INT\_DOME} + D_{INT\_COLUMN} + D_{INT\_CEILING} + D_{INT\_DOOR} + D_{INT\_WINDOW} + D_{INT\_CHANDELIER})/16) \quad (13)$$

6. The Pearson correlation coefficient (R) was executed to assess the linear correlation between mosque design objectives and the impact of modern architecture indicators

(Equation (14)). This linear model was also employed by Talpur [49] to validate the population-projection process in his study. The coefficient ranges from −1 (perfect negative correlation) to 1 (perfect positive correlation), with 0 indicating no correlation. Then, the Coefficient of Determination (R^2) was found to measures the proportion of variance in the dependent variable explained by the independent variables. Values closer to 1 indicate a better fit. The significance level (alpha) was set at 0.1. Thus, a *p*-value less than 0.1 indicates statistical significance, suggesting that the null hypothesis can be rejected. A *p*-value greater than 0.1 indicates no statistical significance, so the null hypothesis is not rejected. The alpha value was set at 0.1 due to the limited sample size, as smaller samples are less likely to accurately represent the whole group.

$$R = \Sigma \left((X_i - \overline{X}) \left(Y - \overline{X} \right) \right) / \sqrt{} \left((X_i - \overline{X})^2 \Sigma \left(Y_i - \overline{X} \right)^2 \right) \quad (14)$$

where R is the Pearson correlation coefficient. X_i and Y_i are individual sample points for variables X and Y respectively. $\overline{X}$ and $\overline{X}$ are the mean values of X and Y respectively.

4. Results and Discussions

4.1. Modernity Degrees of the Mosques

Figure 10 shows the modernity indices for the selected mosques, with values ranging from 0.32 to 0.59. Mosques like Imam Bukhari, Zanko, Ahmed Haji Ali, Haji Muhammadi Kollak, and Sardar Rabaty have lower indices (0.32–0.35). Indices increase with mosques such as Sheikh Tayib Qaiwani, Othmani Sarraf, and Barlut (0.37–0.40). Mosques like Mala Salih Zirgwezy, Qaiwan-Barzayakani Slemani, and Hijrat fall in the 0.41–0.43 range. Higher indices (0.43–0.49) are seen in Abubakir Musanif, Sharbazher, Sheikh Abdulqadir Gaylani, Rayyan, Dar Al-Salam, Kurdistan, and Hussainiya. Sayid Nizameddin, Ali Naji, University of Slemani New Campus, and Dayk exhibit the highest indices (0.51–0.59). These values highlight the diverse modernity levels among the mosques.

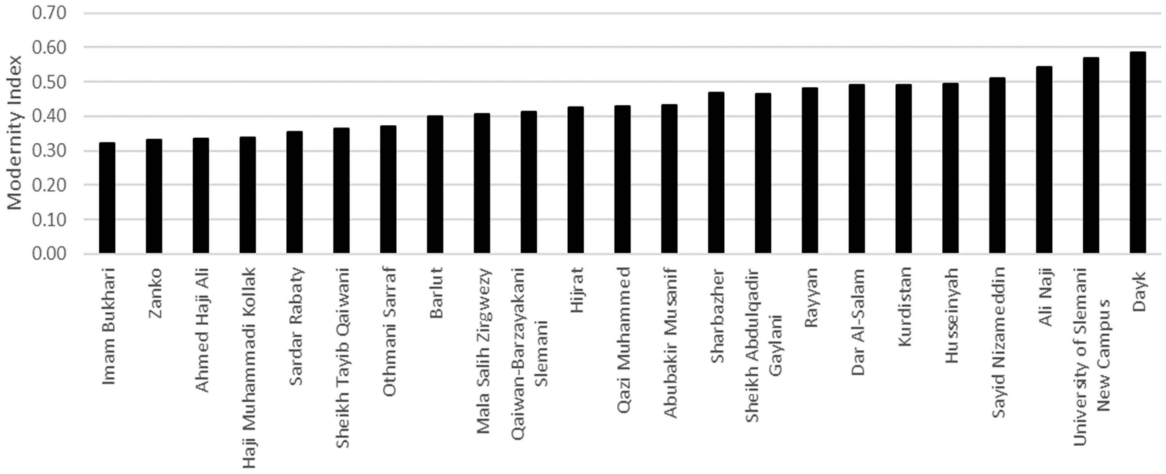


Figure 10. Modernity index of the selected mosques.

The small range of modernity indices (0.32 to 0.59) among the mosques likely stems from their shared contemporary nature. This coherence in modernity levels reflects the influence of common architectural trends and principles and the relatively short time frame of the construction of these mosques. The consistent and contemporaneous architectural approach suggests a unified contemporary style guided their construction, leading to a more uniform distribution of modernity indices.

The frequency distribution of the mosques, based on their Modernity Index presented in Figure 11, shows concentrations between 0.31 and 0.5. Frequencies decrease beyond a Modernity Index of 0.5, and no mosques fall below 0.31 or above 0.6. These frequencies demonstrate the distribution of modernity levels across the sampled mosques.

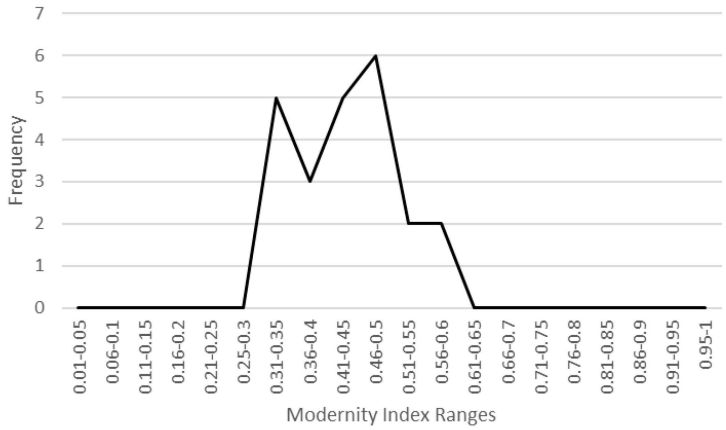


Figure 11. Frequency distribution of the mosques according to their modernity index.

Figure 12 illustrates the correlation between the construction year of the mosques and their corresponding Modernity Indices. Spanning from 1993 to 2023, the construction years of the mosques do not strictly correlate linearly with their modernity indices. For example, Imam Bukhari, constructed in 1999, shows a Modernity Index of 0.32, which is lower than more recently built mosques like University of Slemani New Campus (2013, Index = 0.57) and Dayk (2023, Index = 0.59). Conversely, mosques such as Sheikh Abdulqadir Gailani (1998, Index = 0.47) and Qazi Muhammed (1999, Index = 0.43) have higher Modernity Indices relative to their construction years. This suggests that factors beyond construction date, such as adherence to traditional styles, significantly influence the Modernity Index. The correlation reflects a blend of temporal and stylistic factors rather than a straightforward linear relationship with construction year alone.

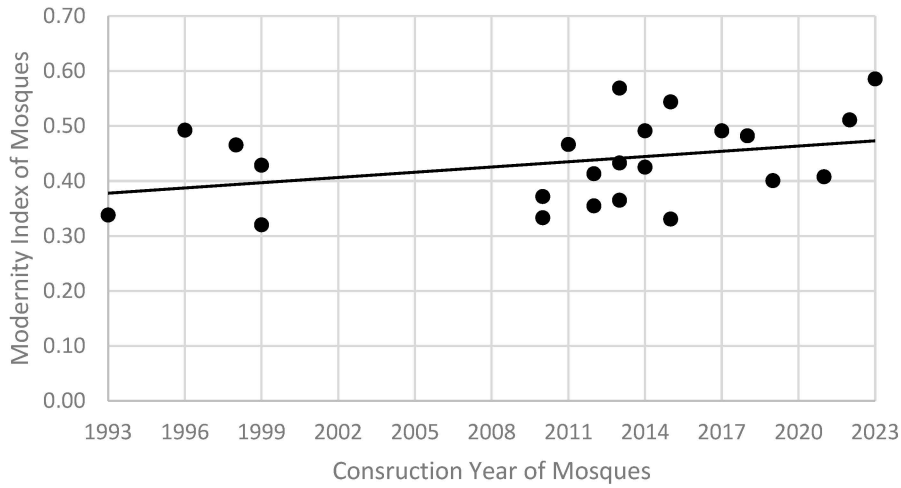


Figure 12. Linear regression of the Modernity Index scores of the mosques and their construction year.

Table 2 highlights the physical characteristics of the selected mosques. The majority of the mosques (60.87%) have a building area of less than 1000 m^2, while only one mosque exceeds 2000 m^2. Most musalla areas are also relatively small, with 65.22% of the mosques having less than a 500 m^2 musalla. In terms of structure, nearly half of the mosques (47.83%) have two floors, with single-floor and three-floor buildings equally represented at 26.09% each. Mosque types with one dome are common, with 69.57% of mosques having one dome; although, a small number have three (8.7%) or five (8.7%) domes, and 13.04% have none. In terms of the minaret, over half (56.52%) have a single minaret, 17.39% have two, and 8.7% have four minarets.

Table 2. Physical characteristics of the selected mosques.

Physical Characteristics	Frequency	Percentage
Building area (m^2)		
<1000	14	60.87%
1000–2000	8	34.78%
>2000	1	4.35
Musalla area (m^2)		
<500	15	65.22%
500–1000	6	26.09%
>1000	2	8.7%
Number of floors		
1	6	26.09%
2	11	47.83%
3	6	26.09%
Number of domes		
0	3	13.04%
1	16	69.57%
2	0	0%
3	2	8.7%
4	0	0%
5	2	8.7%
Number of minarets		
0	4	17.39%
1	13	56.52%
2	4	17.39%
3	0	0%
4	2	8.7%

This discussion presented the modernity degree and characteristics of the selected mosques and identified possible factors influencing their architectural style. From this point on, the statistical analysis results will be discussed concerning the study's first objective: clarifying the impact of modern architectural styles on contemporary mosques. Additionally, the second objective—evaluating the alignment of the evolved mosque features with the religious and symbolic objectives of mosque design—will also be addressed. The degree of impact on the mosques was determined by the presence or absence of each modern style indicator as a cause and the mosque objectives indicators as effects. A correlation analysis was then conducted to evaluate the statistical relationship between the causes and their effects.

4.2. The Impact of Modern Style on Bay Expanding

The expanding of bays is the indicator of reducing columns and walls to avoid cutting off the rows of worshipers and eliminate the view restrictions within musalla. Table 3 and Figure 13 present the correlations between the Bay Expanding Index, Indices of Modern Architecture Indicators, and the Modernity Index. The correlations are generally weak, as indicated by the low R-squared values and percentages of variance explained. Among the individual indicators, the Bay Expanding Index shows a slight positive correlation with simplified geometric shapes, but negative correlations with using new technology, minimalism, open floor plans, emphasis on natural light, flat roof, and extroverted design. However, none of these correlations are statistically significant at the 0.1 significance level, as indicated by *p*-values above 0.1, except in the Index of Emphasis on Natural Light. The overall Modernity Index also exhibits a negative correlation with the Bay Expanding Index ($R = -0.3689$), and this correlation demonstrates statistical significance (p-value = 0.0840). Overall, the Bay Expanding Index is strongly and negatively correlated with mosque modernity levels. It also shows a negative correlation with emphasizing natural light.

Table 3. Regression results of the modern architecture style indicators on expanding of bays in mosques' musalla. A value of 0.1 is assumed as the significant level.

	Simplified Geometric Shapes	Using New Technology	Minimalism	Open Floor Plans	Emphasis on Natural Light	Flat Roof	Extroverted Layout	Modernity
R	0.1529	−0.2566	−0.2977	−0.227	−0.3586	−0.0179	−0.1558	−0.3689
R^2	0.0234	0.0658	0.0886	0.0515	0.1286	0.0003	0.0243	0.1361
R^2 (%)	2.34%	6.58%	8.86%	5.15%	12.86%	0.03%	2.43%	13.61%
p Value	0.4861	0.2384	0.1688	0.2976	0.0935	0.9386	0.4801	0.0840

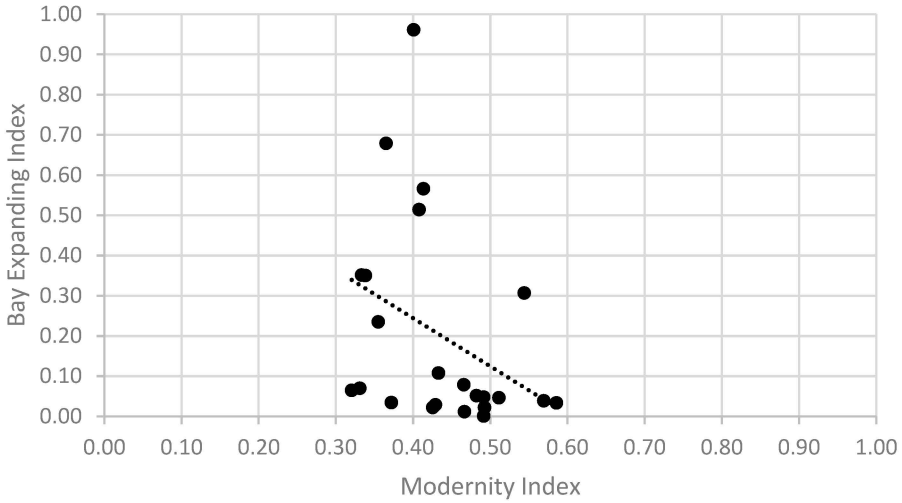


Figure 13. Negative correlation between the Modernity Index scores and Bay Expanding Index scores of the mosques.

The negative correlations can be justified by the fact that decision-makers who prioritize fulfilling the religious requirements of mosques, such as minimizing the number of columns in the musalla to avoid cutting off the prayer rows, are more inclined to favor traditional designs. For these decision-makers, increasing the number of bays (which results in reduced columns) is more important than increasing natural light. Their focus remains on creating a space conducive to prayer, aligning with traditional values, where visual continuity and uninterrupted prayer rows are prioritized over modern architectural features like enhanced natural lighting. There are additional factors that can contribute to altered interior dimensions. According to the collected data from the field surveys, the needs of the local Muslim community, particularly in larger communities, play a crucial role in influencing the dimensions and layout of the mosque's interior, emphasizing the importance of accommodating varying congregation sizes, such as Ahmed Haji Ali Mosque and Kurdistan Mosque. In addition, urban planning considerations, especially in densely populated areas with space constraints, may lead to creative solutions for musalla dimensions, such as the mosques of Ali Naji, Dar Alsalam, Mala Salih Zirgwezi, and Sardar Rabati (Appendix A). Furthermore, integrating technology within mosque spaces, including audio-visual aids and modern amenities, further influences interior layouts to meet contemporary needs. Moreover, community engagement and input in the design process contribute to a more tailored interior design, reflecting the preferences and requirements of the local community. Additionally, adherence to government regulations, building codes, and zoning requirements plays a significant role in shaping mosque design, including decisions related to interior dimensions.

4.3. The Impact of Modern Style on Acceptable Musalla Proportions

The acceptable musalla proportion is the indicator of musalla with a longer Qibla wall relative to the side walls, allowing for extended rows of worshippers, particularly in the

first row. Table 4 shows the correlations between the acceptable musalla proportions and the modern architecture indicators. These correlations are generally weak, as evidenced by the low R-squared values and percentages of variance explained. Among the individual indicators, there are negative correlations with emphasis on natural light (R = −0.362) and extroverted layout (R = −0.4109). The rest of the correlations are not statistically significant at the 0.1 significance level, as indicated by the *p*-values being above 0.1. There is a very weak positive and negative correlation with flat roof design and open floor plans, respectively. The overall Modernity Index also exhibits a weak negative correlation with the desired musalla proportions (R = −0.1802). Overall, the data suggest that the acceptable musalla proportions have a negative correlation with the emphasis on natural light and extroverted layout. Additionally, the degree of modernity in mosques does not significantly affect musalla proportions.

Table 4. Regression results of the modern architecture style indicators on the acceptable proportion of the musalla. A value of 0.1 is assumed as the significant level.

	Simplified Geometric Shapes	Using New Technology	Minimalism	Open Floor Plans	Emphasis on Natural Light	Flat Roof	Extroverted Layout	Modernity
R	0.0563	−0.1338	0.0303	−0.1762	−0.362	0.1253	−0.4109	−0.1802
R^2	0.0032	0.0179	0.0009	0.0310	0.1310	0.0157	0.1688	0.0325
R^2 (%)	0.32%	1.79%	0.09%	3.10%	13.10%	1.57%	16.88%	3.25%
p Value	0.7986	0.5452	0.8908	0.4218	0.0896	0.5689	0.0520	0.4112

Based on the collected data, an extroverted layout emphasizing natural light often includes large windows, courtyards, or open spaces. These features allow flexibility in the musalla layout and enable architects to design a prayer hall with varying proportions. This approach maintains a sense of openness, enhances connection to the external environment, and increases natural lighting. In addition, alterations or fluctuations in the acceptable musalla proportions are not solely connected to the changes in the degrees of modernity in mosques. The evidence in the collected data point to the likelihood that other factors or design considerations play a more influential role in determining the musalla proportion within the mosques under examination. Urban planning constraints and Qibla direction, particularly in densely populated urban settings, significantly impact the allowable size and shape of the musalla, necessitating creative design solutions to optimize available space, as evident in mosques like Dayk, Ali Naji, Dar Al-Salam, Mala Salih Zirgwezi, Sardar Rabati, Sharbazher, and Imam Bukhari. Furthermore, the size of the community and the users of the mosque influence the musalla proportions, with larger communities requiring more extensive prayer spaces and ignoring the shape and proportion of the musalla, such as Ahmed Haji Ali Mosque and Kurdistan Mosque, which serve larger communities. Esthetic preferences, as seen in Hussainiya Mosque and Rayyan Mosque, may also play a role, with some communities seeking a balance between esthetics and functionality (Appendix A). Furthermore, community engagement in decision-making fosters a tailored approach, reflecting congregants' preferences, which also affect the musalla shape. Moreover, adherence to government regulations and building codes, particularly those related to reduced distances, open areas, and green spaces, impacts musalla proportions in the mosques.

4.4. The Impact of Modern Style on Symbolism

The correlation between the symbolism index of the mosques and the modern architecture indicators is notably strong and statistically significant for several factors (Table 5 and Figure 14). There is a substantial negative correlation with simplified geometric shapes (R = −0.4378), indicating that as the use of geometric shapes decreases in mosques, the symbolism index also decreases. In addition, there is a significant negative correlation with minimalism (R = −0.7127), suggesting that mosques with a higher minimalism index are less likely to exhibit symbolic design elements. The overall Modernity Index also shows a strong negative correlation with the symbolism index (R = −0.4822), signifying that modern

mosques tend to have fewer symbolic elements. The *p*-values for these correlations are below the 0.1 significance level, indicating statistical significance.

Table 5. Regression results of the modern architecture style indicators on mosque symbolism. A value of 0.1 is assumed as the significant level.

	Simplified Geometric Shapes	Using New Technology	Minimalism	Open Floor Plans	Emphasis on Natural Light	Flat Roof	Extroverted Layout	Modernity
R	−0.4378	0.1437	−0.7127	−0.1345	0.4104	−0.2058	0.3758	−0.4822
R^2	0.1917	0.0206	0.5079	0.0181	0.1684	0.0424	0.1412	0.2325
R^2 (%)	19.17%	2.06%	50.79%	1.81%	16.84%	4.24%	14.12%	23.25%
p Value	0.0371	0.5130	0.0001	0.5422	0.0518	0.3481	0.0772	0.0199

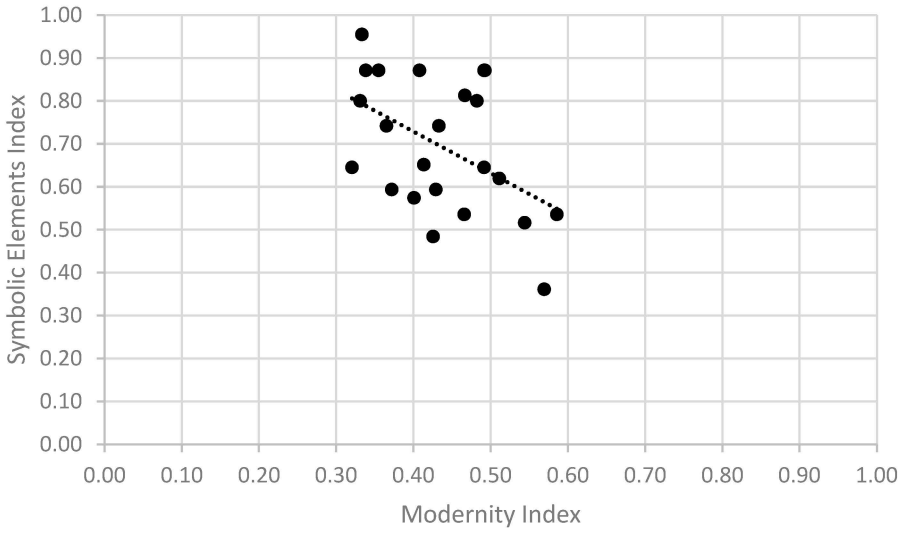


Figure 14. Significant negative correlation between the Modernity Index values and symbolism index values of the mosques.

Conversely, the correlation between the symbolism index and emphasizing natural light in the musalla is strong and positive, indicating that mosques emphasizing natural light tend to incorporate more symbolism. In addition, the correlation between the symbolism index and extroverted layout in mosques is strong and positive, suggesting mosques with extroverted layouts may exhibit higher degrees of symbolism. Moreover, the correlations between the symbolism index and the use of new technology, open floor plan, and flat roof in mosque design are weak and non-significant.

These notable and statistically significant correlations provide insights into the intricate dynamics of contemporary mosque designs. Strong negative correlations with simplified geometric shapes, minimalism, and the overall Modernity Index indicate that as these indices decrease, the number of symbolic features in mosques tend to increase. This is clearly seen in the mosques of Ahmed Haji Ali, Haji Muhammadi Kollak, Sardar Rabaty, and Zanko. From a mystical perspective, modernity, which leads to fewer symbolic features in mosque design, suggests a shift towards a more minimalistic esthetic, where elaborate symbolism takes a backseat to clean, modern designs. This reflects an evolving approach to spiritual representation in mosque architecture, emphasizing simplicity over ornate decoration, which prompted Omer [35] to criticize modern architecture for being anti-traditional and disconnected from spirituality. Critics argue that modern architecture disregards cultural, religious, and symbolic elements, leading to a mechanized and shallow design approach. In contrast to Islamic architecture, which is rooted in spiritual and traditional values, modernist architecture is seen as imposing a minimalist, extroverted, and human-centered approach, lacking the depth and connection to history and spirituality that Islamic architecture embodies.

Conversely, there is a positive tendency for mosques with a higher emphasis on natural light to have more symbolic features. The examples provided, such as Dar Al-Salam Mosque, Hussainiya, and Rayyan Mosque, exemplify this trend by showcasing how mosques with a greater emphasis on natural light tend to have a higher prevalence of symbolic features (Appendix A). This correlation suggests that the design choice to prioritize natural lighting may be associated with a deliberate intention to create a spiritually and esthetically enriching environment by incorporating symbolic elements within the mosque architecture. The findings suggest a nuanced interplay between symbolism and specific modern architectural attributes, highlighting the multifaceted nature of mosque design considerations. These insights contribute to a deeper understanding of the complex relationship between symbolism and contemporary architectural elements in mosque design.

4.5. The Impact of Modern Style on Tranquility

Table 6 highlights correlations between the index of tranquility within the musalla and the index of modern architectural indicators in a mosque. Notable findings include a strong negative correlation with extroverted layout (R = −0.5816) and emphasis on natural light (R = −0.4969), suggesting that these features reduce tranquility. Conversely, simplified geometric shapes positively correlate with tranquility (R = 0.3927). Correlations with minimalism, flat roof, and the Modernity Index are positive but not statistically significant. Weak and insignificant correlations are also found with the use of new technology and open floor plans. These findings reveal the complex relationship between tranquility and design elements in contemporary mosque architecture.

Table 6. Regression results of the modern architecture style indicators on tranquility in the musalla. A value of 0.1 is assumed as the significant level.

	Simplified Geometric Shapes	Using New Technology	Minimalism	Open Floor Plans	Emphasis on Natural Light	Flat Roof	Extroverted Layout	Modernity
R	0.3927	−0.1367	0.1149	−0.0659	−0.4969	0.1669	−0.5816	0.0143
R^2	0.1542	0.0187	0.0132	0.0043	0.2469	0.0279	0.3383	0.0002
R^2 (%)	15.42%	1.87%	1.32%	0.43%	24.69%	2.79%	33.83%	0.02%
p Value	0.0638	0.5361	0.6016	0.7683	0.0161	0.4466	0.0036	0.9484

These diverse findings suggest nuanced relationships with implications for architectural, spatial, and psychological interpretations. The strong negative correlation between the tranquility index and extroverted layout suggests that mosques with more extroverted architectural features, such as large open spaces, large glazing areas, and more entrances on different sides may prioritize visual, acoustic, and circulation impacts over creating tranquil environments such as the mosques of Dayk, Hussainiya, and Sardar Rabaty. Conversely, the positive correlation with simplified geometric shapes indicates that mosques employing simple and harmonious geometric forms may evoke a sense of calmness and serenity, such as the mosques of University of Sulaimani, Ali Naji, and Sayid Nizameddin. These architectural choices reflect a deliberate effort by designers to shape the spatial experience within a mosque, considering worshippers' psychological well-being. From the spatial point of view, the significant negative correlation with emphasizing natural light implies that mosques that tend to limit the use of natural lighting possibly create tranquil musalla with more subdued and intimate atmospheres, such as the mosques of Ahmed Haji Ali, Othmani Sarraf, and Qaiwan-Barzayakani Slemani (Appendix A). Natural light, typically achieved through windows, is a source of noise that disturbs the tranquil environment. This suggests that designers may opt for controlled lighting conditions, such as diffused or indirect lighting, to foster a sense of tranquility within the prayer space. In addition, the findings suggest that architectural features play a crucial role in shaping the psychological experience of worshippers within mosque environments. For instance, the negative correlation with extroverted layout implies that mosques with more visually stimulating and outward-oriented designs may evoke a sense of restlessness or distraction, potentially

hindering worshippers' ability to attain a state of inner calmness. Conversely, the positive correlation with simplified geometric shapes suggests that mosques characterized by simplicity and orderliness may facilitate a sense of mental clarity and tranquility, enhancing the overall spiritual experience for worshippers.

4.6. The Impact of Modern Style on the Reduction of Embellishments

The regression analysis reveals key insights into factors influencing the reduction of embellishments in mosque design (Table 7 and Figure 15). Simplified geometric shapes show a positive correlation with reduced ornamentation (R = 0.5132). Minimalism stands out with a very strong positive correlation (R = 0.9679), indicating its significant impact. The Modernity Index also demonstrates a positive correlation (R = 0.6522), linking higher degrees of modernity with fewer embellishments. Other indicators, like using new technology, open floor plans, emphasizing natural light, flat roof, and extroverted layout, show weak or insignificant correlations, suggesting a more complex or minimal impact.

Table 7. Regression results of the modern architecture style indicators on reducing embellishments in the mosques. A value of 0.1 is assumed as the significant level.

	Simplified Geometric Shapes	Using New Technology	Minimalism	Open Floor Plans	Emphasis on Natural Light	Flat Roof	Extroverted Layout	Modernity
R	0.5132	−0.2025	0.9679	0.0901	−0.1823	0.165	−0.3385	0.6522
R^2	0.2634	0.0410	0.9368	0.0081	0.0332	0.0272	0.1146	0.4254
R^2 (%)	26.34%	4.10%	93.68%	0.81%	3.32%	2.72%	11.46%	42.54%
p Value	0.0123	0.3553	0.0000	0.6827	0.4059	0.4518	0.1147	0.0007

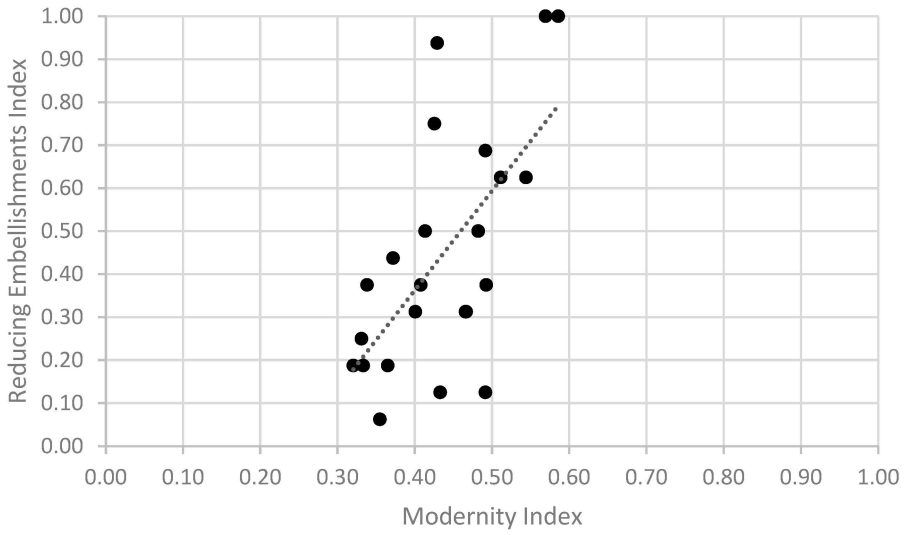


Figure 15. Significant positive correlation between the Modernity Index values and reducing embellishments index values of the mosques.

The positive correlation between the use of simplified geometric shapes and the reduction of embellishments suggests an esthetic preference for clean lines and geometric simplicity, resulting in a visually uncluttered and harmonious architectural composition within the mosque interiors. Furthermore, the dominance of minimalism underscores the profound influence of minimalist design principles on esthetic decision-making, emphasizing the importance of simplicity, clarity, and restraint in achieving a refined and elegant esthetic expression. Similarly, the strong positive correlation with the Modernity Index indicates a shift towards contemporary design sensibilities, which are characterized by a deliberate reduction in traditional ornamentation in favor of a more streamlined and contemporary esthetic language. The best examples for these positive correlations include the mosques of University of Sulaimani, Dayk, Ali Naji, and Sayid Nizameddin (Appendix A).

Reduced embellishments not only enhance the esthetic clarity of these mosque designs but also play a crucial role in minimizing distractions, thereby improving the concentration of worshippers during prayer.

This discussion successfully met the study's first objective by clarifying the various impacts of modern architecture on the mosques. Additionally, it achieved the second objective by assessing the potential alignment of the evolved mosque features with the intended objectives of mosque design.

4.7. Findings

The key findings are as follows:

i. The modern architectural style has led to an increase in columns or walls in the musalla in nearly 14% of the mosques, which is an undesirable feature as it cuts off rows and restricts views.
ii. The overall effect of the modern architectural style on the proportion of musalla is not significant.
iii. The modern style principles, emphasizing natural light and extroverted layouts, alter the acceptable musalla proportions in approximately 13% and 17% of the mosques, respectively.
iv. The modern architectural style has led to a decrease in symbolic elements in nearly 23% of the mosques.
v. The overall effect of the modern architectural style on the tranquility within the musalla is not significant.
vi. Simplified geometric shapes, a principle of modern style, increase tranquility in approximately 15% of the mosques' musallas.
vii. The modern style principles of emphasizing natural light and extroverted layouts decrease tranquility in nearly 25% and 34% of the mosques, respectively.
viii. The modern architectural style has led to a reduction in embellishments in 43% of the mosques, helping to avoid over-decoration that may distract worshippers.

Based on the findings, the alternate hypothesis is confirmed and the null hypothesis is rejected, as the incorporation of modern architectural features in contemporary mosques in Sulaymaniyah has been shown to negatively impact the fulfillment of religious and symbolic objectives in mosque designs.

4.8. Practical Implications and Future Recommendations

Our results provide guidance for revising the draft regulations for mosque designs recently released by the Ministry of Endowment and Religious Affairs of the Iraqi Kurdistan Region. The regulations applied to several recent mosque designs have led to religious, functional, and symbolic issues. The findings from this study can help align the regulations with the religious objectives of mosque designs, while also selectively limiting the adoption of modern architectural principles to ensure they align with a mosque's requirements.

The findings of this study provide valuable insights for designers to critically adopt modern design principles in mosque designs. The emphasis on minimalism and simplified forms, while valuable for creating clean, uncluttered spaces, should not overshadow the importance of symbolism, spiritual tranquility, and functional spaces within mosques. Our findings also assist decision-makers in ensuring that mosque designs fulfill the maximum religious requirements.

It is recommended that future research focus on exploring user perceptions in contemporary mosques and investigate the correlation between the recorded perceptions and the fulfillment of the religious objectives of the mosques. Future works should also explore the role of the dominant Islamic sect in a region and its influence on the contemporary mosque design evolution in that region. It is also recommended that the Ministry of Endowment and Religious Affairs establish a comprehensive database for mosques to provide data for research purposes.

4.9. Study Contributions

This study developed an approach to examine the possible effects of a phenomenon on the intended architectural changes. It also contributed to mosque architecture research by aligning mosque design objectives with Shari'ah (Islamic Law) and examining how modern architectural styles influenced these objectives. Furthermore, this study revealed additional factors, which were not examined in previous studies, influencing the existing negative changes in the contemporary mosques in Sulaymaniyah.

5. Conclusions

This study has thoroughly examined the impact of modern architectural styles on mosque design evolution in Sulaymaniyah, Iraq, focusing on how contemporary design aligns with—or challenges—religious and symbolic objectives. The study analyzed 23 mosques built over the past three decades. It revealed that while elements such as minimalism, simplified geometric shapes, and natural light offer functional and esthetic benefits, they often conflict with key religious and symbolic requirements. Specifically, there was a significant negative correlation between modern architectural elements and the presence of traditional symbolic features, with approximately 23% of the mosques showing a decrease in essential symbols like domes and minarets due to the minimalist design. Moreover, findings highlighted that while simplified geometric shapes positively correlated with tranquility, achieving a sense of calm in about 15% of the mosques, other elements—such as extensive glazing and extroverted features—reduced tranquility in 25% and 34% of the mosques, respectively, due to increased distractions. The presence of columns or walls disrupting prayer rows was also more common in mosques with modern layouts, affecting about 14% of the mosques and correlating negatively with the Bay Expanding Index. Although modern design principles like natural light and open layouts influenced musalla dimensions in 13% and 17% of all cases, the overall modern style impacts on maintaining traditional musalla proportions was statistically insignificant. Nonetheless, reduced ornamentation was evident in 43% of the mosques, where modernity levels increased, thus creating visually clear prayer spaces. These findings underscore the importance of a balanced design approach, where modern features are integrated carefully to respect and enhance religious and cultural significance. The results offer valuable insights for architects, designers, and policymakers in refining mosque design practices to align with both spiritual and functional objectives. It is recommended that mosque design guidelines from the Ministry of Endowment and Religious Affairs in the Iraqi Kurdistan Region be revised to reflect these insights. Additionally, a comprehensive mosque database generated by the Ministry would support future research, enhance design standards, and promote culturally attuned innovations. Future studies could explore user perceptions to further understand the alignment between contemporary mosque spaces and worshippers' spiritual requirements. This research contributes to preserving spiritual and cultural heritage embodied in mosque architecture, guiding modern designs that honor traditional functions and aesthetics.

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Conflicts of Interest: The authors declare no conflicts of interest.

Appendix A

Table A1. Statistical and graphical overview of the selected mosques, which are sorted from the least to most modern design. Prepared by authors.

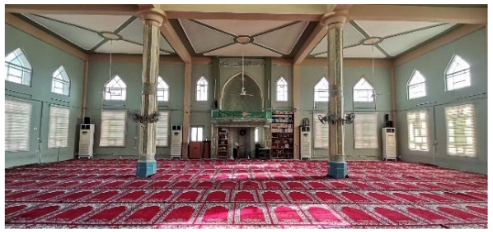
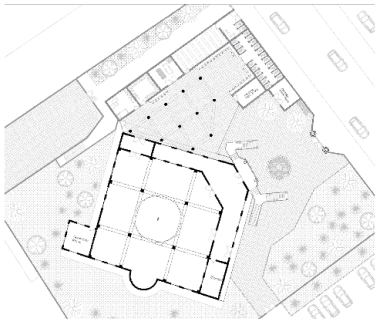
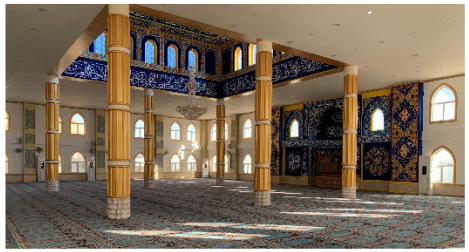
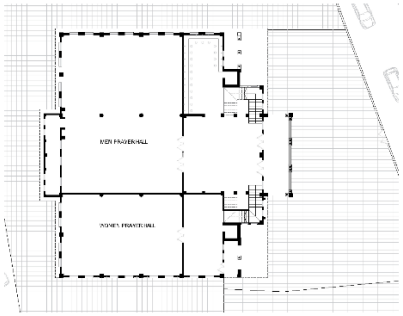
No	Mosque Name	I_M	Year	Building Area	No. of Floors	No. of Domes	No. of Minaretes	Exterior Photo	Interior Photo	Floor Plan
1	Imam Bukhari Mosque	0.32	1999	1181 m^2	2	1	4			
2	Zanko Mosque	0.33	2015	874 m^2	3	1	2			

Table A1. *Cont.*

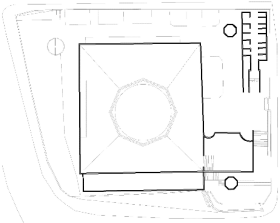
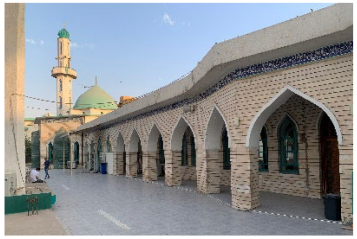
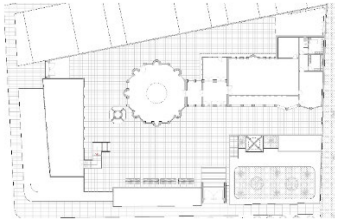
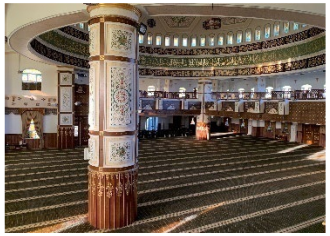
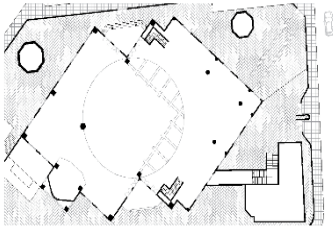
No	Mosque Name	I_M	Year	Building Area	No. of Floors	No. of Domes	No. of Minaretes	Exterior Photo	Interior Photo	Floor Plan
3	Ahmed Haji Ali Mosque	0.33	2010	3240 m^2	3	3	1			
4	Haji Mhamadi Kollak	0.34	1993	1020 m^2	1	1	1			
5	Sardar Rabati Mosque	0.35	2012	1900 m^2	3	1	2			

Table A1. *Cont.*

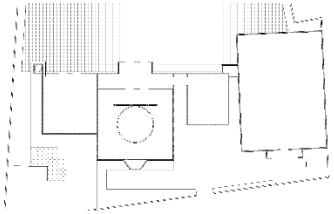
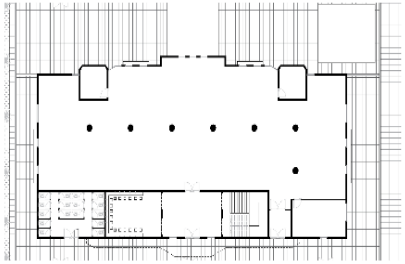
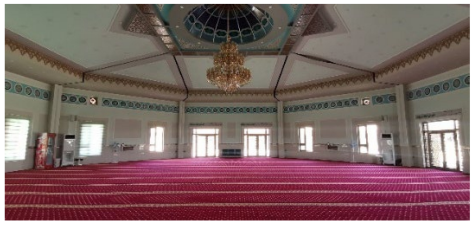
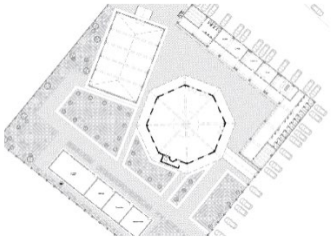
No	Mosque Name	I_M	Year	Building Area	No. of Floors	No. of Domes	No. of Minaretes	Exterior Photo	Interior Photo	Floor Plan
6	Sheikh Tayib Qaiwani Mosque	0.36	2013	755 m^2	1	1	1			
7	Othmani Sarraf	0.37	2010	1100 m^2	3	3	1			
8	Barlut Mosque	0.40	2019	1805 m^2	1	1	0			

Table A1. *Cont.*

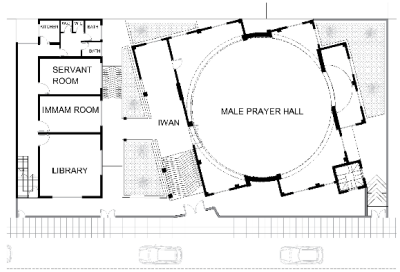
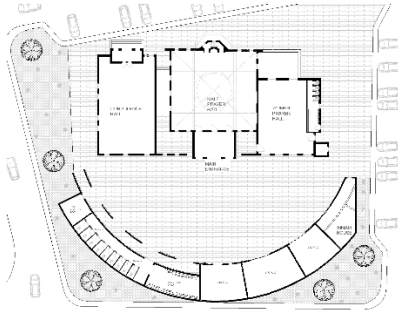
No	Mosque Name	I_M	Year	Building Area	No. of Floors	No. of Domes	No. of Minaretes	Exterior Photo	Interior Photo	Floor Plan
9	Mala Salih Zirgwezi	0.41	2021	459 m^2	3	1	1			
10	Qaiwan Mosque	0.41	2012	1500 m^2	1	1	1			

Table A1. *Cont.*

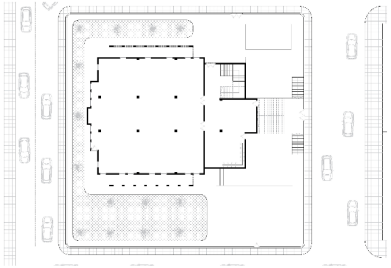
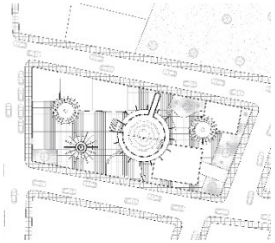
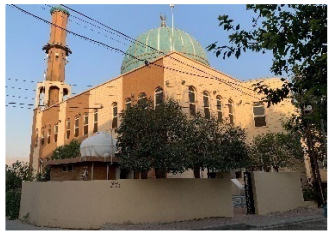
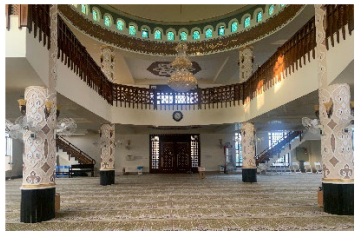
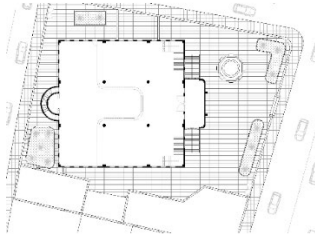
No	Mosque Name	I_M	Year	Building Area	No. of Floors	No. of Domes	No. of Minarets	Exterior Photo	Interior Photo	Floor Plan
11	Hijrat	0.43	2014	650 m^2	2	1	0			
12	Qazi Muhamed Mosque	0.43	1999	820 m^2	1	1	1			
13	Abubakir Musanif	0.43	2013	820 m^2	2	1	1			

Table A1. *Cont.*

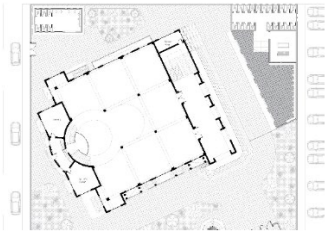
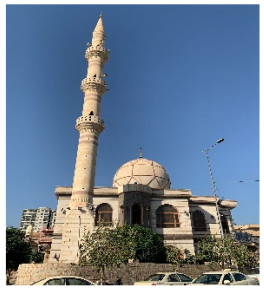
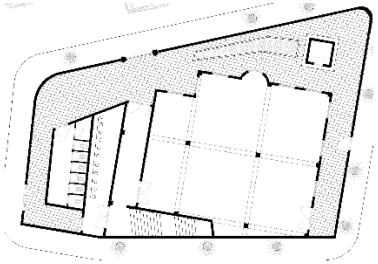
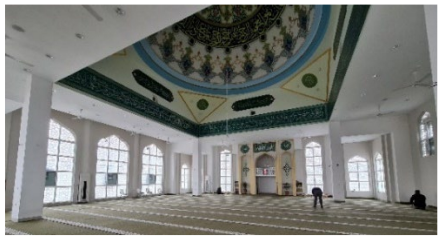
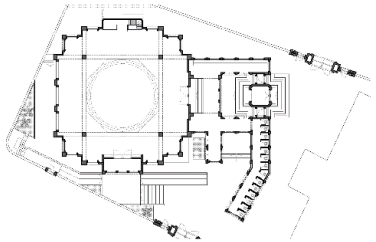
No	Mosque Name	I_M	Year	Building Area	No. of Floors	No. of Domes	No. of Minarets	Exterior Photo	Interior Photo	Floor Plan
14	Sheikh-Abdulaqadir Gailani Mosque	0.47	1998	1000 m^2	1	1	0			
15	Sharbazher Mosque	0.47	2011	400 m^2	2	1	1			
16	Rayyan Mosque	0.48	2018	615 m^2	2	1	1			

Table A1. *Cont.*

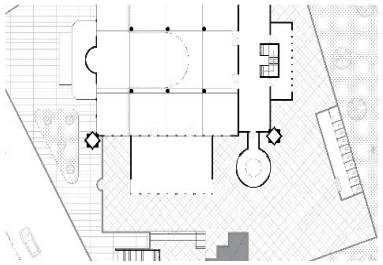
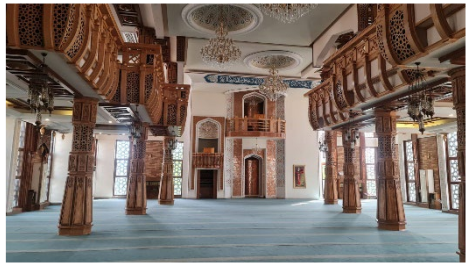
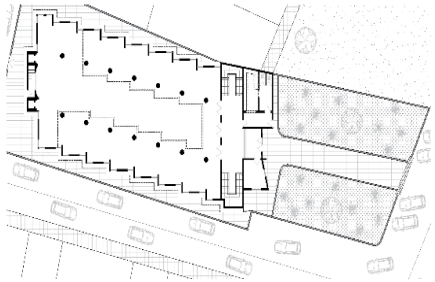
No	Mosque Name	I_M	Year	Building Area	No. of Floors	No. of Domes	No. of Minaretes	Exterior Photo	Interior Photo	Floor Plan
17	Kurdistan	0.49	2014	1700 m^2	2	1	4			
18	Dar Alsalam	0.49	2017	1000 m^2	2	5	1			

Table A1. *Cont.*

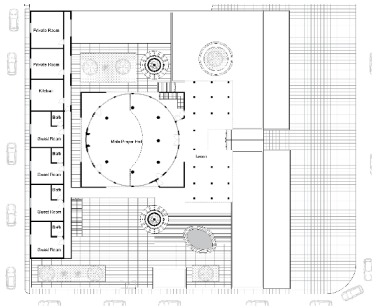
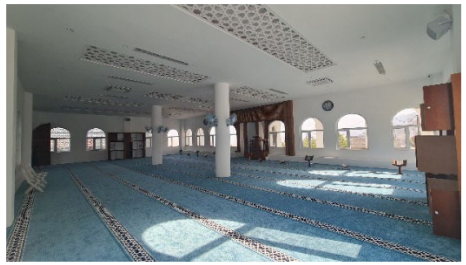
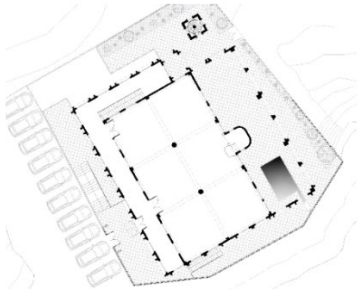
No	Mosque Name	I_M	Year	Building Area	No. of Floors	No. of Domes	No. of Minaretes	Exterior Photo	Interior Photo	Floor Plan
19	Hussainiya	0.49	1996	1500 m^2	2	1	2			
20	Sayid Nizameddin Mosque	0.51	2022	470 m^2	2	0	1			

Table A1. *Cont.*

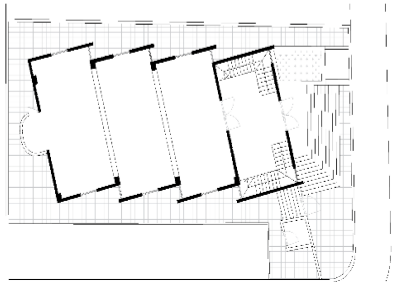
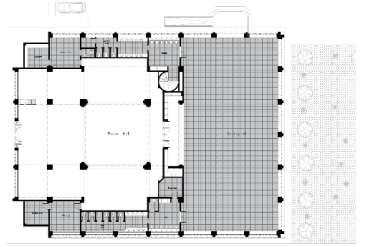
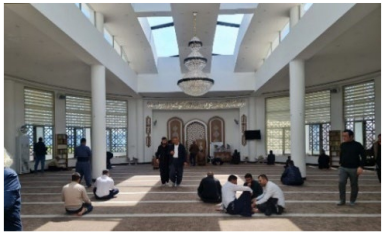
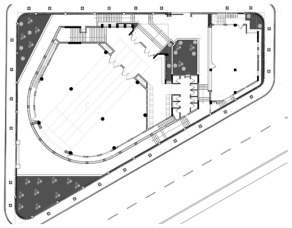
No	Mosque Name	I_M	Year	Building Area	No. of Floors	No. of Domes	No. of Minaretes	Exterior Photo	Interior Photo	Floor Plan
21	Ali Naji Mosque	0.54	2015	400 m^2	3	0	1			
22	University of Sulaimani Mosque	0.57	2013	780 m^2	1	1	0			
23	Dayk Mosque	0.59	2023	710 m^2	2	0	1			

Table A2. Index values of the modern architectural indicators of the selected mosques.

No.	Mosque Name	Simplified Geometric Shapes Index	Using New Technology Index	Minimalism Index	Open Floor Plans Index	Emphasis on Natural Light Index	Flat Roof Index	Extroverted Layout Index	Modernity Index
1	Imam Bukhari	0.00	0.33	0.27	0.67	0.07	0.50	0.47	0.32
2	Zanko	0.30	0.44	0.31	0.33	0.11	0.50	0.37	0.33
3	Ahmed Haji Ali	0.56	0.33	0.12	0.50	0.01	0.50	0.38	0.33
4	Haji Muhammadi Kollak	0.30	0.33	0.38	0.33	0.14	0.50	0.45	0.34
5	Sardar Rabaty	0.19	0.44	0.15	0.67	0.06	0.50	0.53	0.35
6	Sheikh Tayib Qaiwani	0.70	0.33	0.15	0.50	0.07	0.50	0.35	0.36
7	Othmani Sarraf	0.41	0.67	0.38	0.25	0.00	0.50	0.38	0.37
8	Barlut	0.67	0.33	0.38	0.50	0.00	0.50	0.44	0.40
9	Mala Salih Zirgwezy	0.67	0.33	0.35	0.50	0.15	0.50	0.39	0.41
10	Qaiwan-Barzayakan	0.59	0.33	0.54	0.50	0.03	0.50	0.39	0.41
11	Hijrat	0.59	0.33	0.62	0.50	0.03	0.50	0.39	0.43
12	Qazi Muhammed	0.74	0.33	0.77	0.50	0.04	0.00	0.33	0.43
13	Abubakir Musanif	0.59	0.33	0.23	0.67	0.25	0.50	0.50	0.43
14	Sharbazher	0.67	0.67	0.31	0.67	0.09	0.50	0.29	0.47
15	Sheikh Abdulqadir Gaylani	0.59	0.56	0.35	0.67	0.12	0.50	0.44	0.47
16	Rayyan	0.33	0.33	0.58	1.00	0.14	0.50	0.44	0.48
17	Dar Al-Salam	0.52	0.56	0.23	0.67	0.41	0.50	0.58	0.49
18	Kurdistan	0.19	0.78	0.65	0.67	0.15	0.50	0.39	0.49
19	Husseinyah	0.44	0.67	0.42	0.33	0.40	0.50	0.70	0.49
20	Sayid Nizameddin	0.81	0.22	0.69	0.50	0.12	1.00	0.43	0.51
21	Ali Naji	0.85	0.67	0.69	0.33	0.04	1.00	0.33	0.54
22	University of Slemani	0.85	0.22	0.92	1.00	0.03	0.50	0.33	0.57
23	Dayk	0.96	0.22	0.88	0.50	0.22	1.00	0.48	0.59

Table A3. Index values of the religious and symbolic objectives of the selected mosques.

No.	Mosque Name	Bay Expanding Index	Proportion Musalla Index	Symbolism Index	Tranquility Index	Reducing Embellishments Index
1	Imam Bukhari	0.07	0.42	0.65	0.72	0.19
2	Zanko	0.07	0.85	0.80	0.86	0.25
3	Ahmed Haji Ali	0.35	0.47	0.95	0.99	0.19
4	Haji Muhammadi Kollak	0.35	0.02	0.87	0.60	0.38
5	Sardar Rabaty	0.24	0.19	0.87	0.47	0.06
6	Sheikh Tayib Qaiwani	0.68	0.48	0.74	0.88	0.19
7	Othmani Sarraf	0.03	1.00	0.59	1.00	0.44
8	Barlut	0.96	0.09	0.57	0.92	0.31
9	Mala Salih Zirgwezy	0.51	0.52	0.87	0.84	0.38
10	Qaiwan-Barzayakan	0.57	0.48	0.65	0.98	0.50
11	Hijrat	0.02	0.50	0.48	0.82	0.75
12	Qazi Muhammed	0.03	0.36	0.59	0.73	0.94
13	Abubakir Musanif	0.11	0.42	0.74	0.71	0.13
14	Sharbazher	0.08	0.53	0.54	0.94	0.31
15	Sheikh Abdulqadir Gaylani	0.01	0.34	0.81	0.71	0.31
16	Rayyan	0.05	0.32	0.80	0.76	0.50
17	Dar Al-Salam	0.05	0.35	0.65	0.76	0.69
18	Kurdistan	0.00	0.08	0.87	0.80	0.13
19	Husseinyah	0.02	0.00	0.87	0.47	0.38
20	Sayid Nizameddin	0.05	0.96	0.62	0.94	0.63
21	Ali Naji	0.31	0.15	0.52	0.90	0.63
22	University of Slemani	0.04	0.35	0.36	0.90	1.00
23	Dayk	0.03	0.36	0.54	0.72	1.00

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