

**A NUMERICAL AND COMPUTATIONAL COMPARISON OF INTERIOR
DESIGN ELEMENTS IN SELECTED HERITAGE BUILDINGS AROUND
THE WORLD**

Ibtisam Ahmed Zeno^{1*}, Oday Qusay Abdulqader Alchalabi²

¹ (Department of Architectural Engineering, College of Engineering, University of Mosul
,Iraq).

² (Department of Architectural Engineering, College of Engineering, University of Mosul
,Iraq).

* Corresponding Author Email : ibtisam.23enp99@student.uomosul.edu.iq

Abstract

Heritage buildings are the memories and cultural identity of a community , and preserving them promotes sustainability by reducing demolition and reconstruction , thereby saving resources and energy. They also play a major role in sustainable tourism and supporting the local economy, connecting generations to the past to build a more sustainable future. This article aims to identify the most important elements that affect the heritage value of buildings, whether they are being reconstructed or newly built. The study focused on the weakness and lack of clarity in the strategy followed by interior designers to create or renovate heritage interior spaces. The study followed a qualitative approach, relying on visual observation of selected samples of heritage buildings around the world. The results showed that interior design elements were more distinctive, clear, recognisable, and visually and sensually rich, due to their connection to the viewer's mind. The building materials used vary according to time and place, and traditional interior architecture links design elements and building materials, reflecting cultural values and creativity. The results also show the human sense of craftsmanship and beauty in highlighting its principles through the value of its elements. Sustainability in these buildings can be found in interior design elements that reflect natural environmental solutions, such as traditional ventilation, which provides air quality without using energy, and thermal insulation achieved through thick walls. Windows and mashrabiya screens allow for balanced natural lighting, reducing dependence on electricity

Keywords :Interior design, Heritage buildings, Heritage elements, Aesthetic value and Sustainability.

1. Introduction

In heritage interior design, simple elements produce stunning heritage themes, where beauty lies in simplicity and authenticity. Each heritage element has a specific meaning and purpose, revealing the nation's identity in relationships, shapes, and configurations. Heritage interior design is usually rich in cultural elements, designed with environmentally friendly materials to suit climatic, economic, and social conditions and traditions [1]. The most important

elements are stated to be arches, columns, architectural openings, floors, ceilings, vaults, lanterns, cables, and muqarnas [2], [3]. Other elements such as sculptures, decorations, and arches have also been added [4]. [5] and [6] discussed heritage elements (mashrabiya, lantern, bell, inner courtyard, iwan, wind tower "malaqif", windows, openings, plants, and water). [7], [8] It was mentioned that the elements of structural beauty are represented by decorations, engravings, arches, vaults, windows, columns, column capitals, corridors, and balconies. Heritage furniture was added as a design element, as it was made of dark wood in shades of beige and brown, and Arabic decorations were carved on it.[9]

Nofal [10] classified mosque architectural elements in different functional groups, as shown in Figure 1. He claimed that these elements have their preferences from the Prophet's mosque and the earliest mosques in Islam, it includes the minaret as one of the main elements, while it excluded the dome [11]. Interior design principles are methods for linking, arranging, and organizing interior design elements to create beautiful compositions These principles include (unity, rhythm, balance, repetition, and proportion), as mentioned by[12], [13] [14]. [2] added colours, and [15] added abstraction.

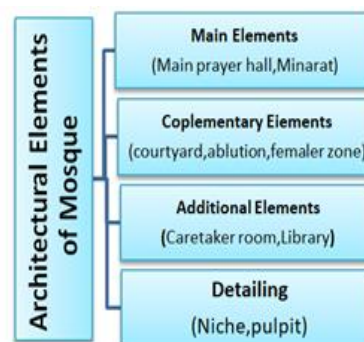


Figure 1: Architectural elements of the mosque, created by the researcher .

The study [8].added the human scale, while the study [16] confirmed the relationship between unity, repetition, and rhythm and their influence on each other in interior design. Rhythm exists when unity and balance are achieved. The main principles of interior design are balance, proportion, measurement, harmony, contrast, and attention to final details [17]. As shown in Figure (2).



Figure 2: Design principles from the researcher.

Design characteristics also include the relationships between elements, which can give new forms to heritage buildings. One or more of these relationships can be used in a composition [18]. These relationships include overlap [19, 20, 21, 22], intersection [19, 20, 21], proximity [22], and juxtaposition [19]. Locally available natural building materials (stone, marble, metal, glass, plaster, wood, and brick) are used in construction according to their properties and structural capabilities [23]. e. Building materials in Cairo include (limestone and red brick) [6]. While building materials in Mosul are (stone, plaster (Nura), iron, and wood), with an emphasis on Mosul marble [24] (Farsh) [25], which distinguished the city and gave it its special character [26]. Traditional building materials affect the image of heritage, and the use of new modern materials leads to the loss of the building's heritage value. Therefore, a special mechanism must be followed to add or change elements of heritage buildings when restoring or maintaining them.. Adding or changing elements to heritage buildings must follow a specific mechanism to avoid losing their heritage value. Using principles, elements, and factors to serve the characteristics of style, simplicity, privacy, and authenticity are among the most important things that design-ers must consider when designing and maintaining the interior spaces of these buildings. However, the diversity of elements of form, color, and design principles reflects the unity of the space and gives identity to the design style [27].

The value of heritage elements and their relationship to heritage are classified into:

1). Classification of heritage buildings by value: They are classified into three main categories (A, B, C) based on the importance of the heritage values associated with them. They are also classified according to their condition into: good, medium, weak, partially deteriorated, and completely deteriorated. This classification aims to determine priorities for dealing with heritage buildings. Different levels of intervention for heritage buildings can be determined based on what is decided by architectural heritage and restoration experts according to their category, as follows [28].

A. Heritage Building Category (A): This category is restored without any internal or external modifications except within the most limited limits

B. Heritage Building Category (B): This category allows a degree of flexibility in making some internal modifications..

C. Heritage Building Category (C): This category allows a great degree of flexibility, including demolition while retaining only the structure or exterior facade of the building and its complete rehabilitation or reconstruction of the interior.

2). Classification of Heritage Areas: A city, neighbourhood, square, or street, in its entirety or part, can be classified as a valuable heritage area. The heritage area must be vibrant and active, and is classified into three levels according to the required protection priorities, as follows: [29]

A. Heritage Area Level (A): Maximum protection area.

B. Heritage Area Level (B): Medium protection area.

C. Heritage Area Level (C): Transitional area between the two protection areas (maximum, medium, and normal).

The values of heritage buildings revolve around their historical, symbolic and architectural importance, in addition to their urban, so-cial and local values, as shown in Table (1).

Table 1: Basic values and criteria that distinguish heritage buildings from the researcher's work.

Basic criteria	Value
The building's connection to important historical events and values, and its expression of the history of its era.	Historic value (temporal)
The building's association with important figures or its being the product of an architectural design by a pioneer of architecture.	Symbolic value
The building is distinguished by a unique architectural style or a prominent and original architectural design.	Architectural value
The building is part of an integrated heritage architectural complex. The presence of a heritage park of historical and environmental importance A group of heritage buildings that are homogeneous in style and architectural style.	Urban value
The building's association with an important social function The building reflects the prevailing social traditions.	Social value
The building is part of the natural desert or rural architecture. Use of locally available and environmentally friendly materials Expression of cumulative experiences in traditional crafts	Local value (Traditional value)

2. Methodology

The research methodology was based on studying a group of world heritage buildings by analyzing and describing the architectural elements used in their construction, which overlapped with other structural elements. Information was gathered through observation and analysis to arrive at relevant references, and intensive monitoring of information available on social media sites. International and local samples were selected based on their heritage elements, the availability of information, documents and data about them, and the authenticity and importance of the elements. The samples were then analysed through visual observation to identify the most important elements, principles and materials and their heritage value. The number of samples reached 15 world and local heritage buildings, which are:

2.1. Case 1 - Muhammad Ali Mosque in Egypt

The mosque was built between 1830 and 1848 AD from the finest marble. It consists of an open courtyard and a prayer hall, consisting of a square area covered by a huge, decorated central dome resting on four large arches, surrounded by four semi-domes decorated with gilded relief motifs. The mosque has two pulpits, one made of wood painted in green and gold and is the original pulpit of the mosque. The other, made of marble, was added later. In the courtyard of the mosque, there is a copper tower containing a clock, a gift from Louis Philippe, King of France, to Muhammad Ali Pasha. The courtyard is surrounded by four arcades with arches resting on marble columns, above which are small domes covered with lead panels and engraved on the inside [30]. Engraved decorations were used in the columns, capitals, and ceiling of the ablution area, along with the distinctive colors of Islamic architecture, and the use of colourful geometric motifs [31]. Repetitive rhythm was prominent in the mosque's decorations, and repetition was evident in both simple and complex Islamic motifs. Rhythm depended on the recipient's senses and beliefs [16].

2.2. Case 2- The Great Mosque of Isfahan

It was built in 771 AD. It was registered by UNESCO as a World Heritage Site as one of the oldest and largest Iranian religious monuments. Bricks were used in the reconstruction of the muqarnas and entrances. The main dome of the mosque is considered one of its most prominent architectural features, as it is distinguished by its unique design, magnificent interior decorations, and the placement of four doors opposite each other, directed towards the central courtyard. This design is a common feature in Iranian architecture with the addition of muqarnas, the colour of the glazed tiles, and the columns between the iwans [32]. Among the most important aesthetic design principles in this mosque are (proportion and symmetry, multiplicity and diversity. Despite the unity of the design, there is diversity in the decorations and architectural styles in addition to rhythm and movement, as the arches and decorations create rhythm and visual movement inside the mosque) [33].

2.3. Case 3 - The Great Mosque of Kairouan in Tunisia

It was built in 670 AD and is one of the largest and oldest mosques in Africa. It contains a central courtyard surrounded by arcades on all sides. Its structural structure consists of columns and arches. The columns of the central aisle in the prayer hall are the highest and widest. It contains two domes, one above the entrance and the other above the mihrab. It was listed on the UNESCO World Heritage List in 1982 AD. It was the primary source of Andalusian and Moroccan architecture in terms of decoration and architecture [34].

2.4. Case 4- The ancient Al-Tahera Church of Syriac Catholic in Mosul

(1859-1862). Its construction is characterized by arches and columns. The floor and walls are made of Mosul marble. The aisles and domes are built of plaster and stone. The church features a high wooden door in front of the main altar with icons of the Virgin Mary and three-dimensional carvings on Mosul marble. The interior consists of (the altar, the baptismal font, the doors, and the pulpit) [35]. The church is the second prominent monument to be

reconstructed by UNESCO, which worked to restore the stones and use them in construction. Pieces that were unsuitable for construction purposes were replaced with new stones with the same old details. Its roof had collapsed, and large parts of the arcades, domes, and exterior walls were destroyed. [36]. However, it was rebuilt in 2022.

2.5. Case 5 - AL- Saaea Church in Old Mosul

This church and its annexes were built in (1866 AD) to be a religious, spiritual and service headquarters and center for the Dominican Fathers in the city of Mosul. It consists of a large courtyard and a huge gate. From the courtyard to a wide and large hall topped by a parallel line with two equal-sized domes. In the courtyard of the church there is an exact copy of the Grotto of Lourdes, which contains a large statue of Our Lady of Miracles, placed opposite the altar. As for its tower, which one can almost see from every corner of Old Mosul, it is topped by a huge clock with four faces, each face overlooking on a direction. It has been operated for more than a hundred years since its establishment. The interior of the church consists of Mosul marble, the apse (the semi-circular end of the church), and the sanctuary (the holy area where the altar is located). As for the exterior, it was covered with a sugar-colored stone cladding. These elements work together to create spaces for worship and community gatherings. The church was completely destroyed by ISIS. In this organized, barbaric attack, Mosul lost many of its rich architectural, historical and religious landmarks [37]. The actual reconstruction process began in 2022 [38].

				
case (5- AL-Saaea Church in Old Mosul Photographed by the researcher	case (4- The ancient Al-Tahera Church of Syriac Catholics in Mosul Photographed by the researcher	case (3- The Great Mosque of Kairouan in Tunisia https://ar.wikipedia.org/wiki	case (2) Isfahan Mosque /Iran the source https://www.aljazeera.net/wp-content/uploads/2	case (1) Muhammad Ali Mosque / Cairo . https://alain.com/article/mosque-of-mohamed-ali-pasha-egypt

2.6. Case 6 - Beit Ziada in Mosul (1870 AD)

Located in the Bab al-Beidh area near the walls of the old city of Mosul, the house was built in the Arab-Islamic style, contain inner courtyard in the middle. Preserving all its heritage characteristics, ancient materials, and authentic construction methods, the building preserves the identity and character of the old area [39]. The structural system includes a load-bearing system for the walls, in addition to the use of a structural system (columns) in the vaults and the use of vaults for roofing, which is characterized by its diverse forms. Plaster, stone, and Mosul marble were used as construction materials, as well as for covering and decorating surfaces. The interior walls were treated with decorative treatments and Mosul carpets, with a focus on the use of Mosul marble in building entrances, window frames, arches, and columns, in addition to the use of other materials in decorative work, such as plaster and iron. Its design included aesthetic elements such as marble wall engravings, accompanied by various plant and geometric motifs, as well as occasional animal and human sculptures [26]. It is characterized by balance thanks to the presence of the iwan, repetition and proportion thanks to the presence of openings, and a human scale through the size of the elements and blocks [13].

2.7. Case 7 - Beit Al-Suhaimi in Egypt (1648-1707 AD)

Is a prominent model of Mamluk architecture in Cairo and is distinguished by its harmonious interior design and wonderful artistic decorations. It is classified as part of the Islamic architectural heritage in Egypt and has great historical importance. The house was restored and preserved to become one of the important tourist attractions in Old Cairo. It is distinguished by multiple iwans open to the inner courtyard. The facades of the house are decorated with wooden mashrabiyyas. The walls and ceilings are beautifully decorated with wonderful geometric and plant motifs using carved plaster. Some floors and surfaces are decorated with colorful mosaics. As for the building materials, limestone was used to build the exterior walls of the house. The interior carpentry of the house was done using carved and decorated wood. Carved plaster was applied to the walls and ceilings to create beautiful decorations [40].

2.8. Case 8- The Alhambra Palace in Granada

It is an ancient palace (1238-1273) consisting of four parts. The most important monuments of Islamic architecture in Andalusia. The clear features of Islamic architecture in the palace buildings include the use of delicate decorative elements in geometric arrangements such as carpet decorations, the writing of Qur'anic verses and supplications. Some praises and descriptions, surrounded by decorations of colored plaster covering the walls, and colored faience tiles with geometric patterns, covering the lower parts of the walls with the use of fountains, plants, in large proportions. A mixture of clay, sand and red stones was used with adding a quantity of "gypsum" to strengthen the building material, which gives the building greater resistance. [41]. Bricks were used in building domes and arches, and in it are the splendor of the halls, and the unique plasterwork, and the domes studded with muqarnas, and the architecture of the gardens [42]. It was selected in 2007 as one of the Twelve Treasures of Spain. The Alhambra Palace, listed as a UNESCO World Heritage Site, is described as

one of the Seven Wonders of the World [43]. The World Heritage Committee has officially registered the Alhambra Palace in Granada on the World Heritage List.

2.9. Case 9- Khan Al-Ghouri in Cairo (1501-1516 AD)

It is considered as a complete model for archaeological places. The ground floor includes areas for sale, and the first floor for storage. The rectangular shaped halls are covered with a semi-cylindrical vault, and open onto the central courtyard that includes a fountain on the upper floors (second and third). There are 16 small residential units on two floors. the lower part is for services and the upper part is for housing. it is evidence of the progress of Arab architecture in the design of small multi-storey residential units, and the successful use of the inner courtyard as an environmental architectural solution that preserved the architectural and symbolic values of the group, which are in Architectural details, ornaments and design Internal. It has been restored and maintained over the years to preserve its architectural heritage [18]. Khan Al-Ghouri still stands and maintains its previous architectural character and heritage value .it is regarded as one of the most prominent architectural landmarks in old Cairo and It is classified as part of the Islamic cultural and architectural heritage in Egypt due to its historical importance. [44].

2.10. Case 10 - Khan Marjan (1358 AD)

Is one of the rare buildings in Baghdad. Its layout did not include an open central courtyard, but rather a covered central hall measuring 11.40 x 30.25 meters. This hall is devoid of any structural elements to allow the largest possible space for merchants to display their goods. Overlooking this inner hall are rooms on the ground floor. On the first floor, there are doors opening onto a corridor (balcony). These protrude from the walls by means of brick muqarnas, by one meter [12]. The hall is roofed by eight pointed arches, each 2.15 meters wide, built parallel to each other. At their highest point, these arches reach a height of approximately 14 meters. There are two main entrances to the inn, and words are carved into the brick at the top of the two entrances. It is distinguished by its high design effort and innovative decorations, through the use of various types of decorative brick strips attached to the walls, the ability to choose colors and determine their locations, and the application of a system of proportions to achieve the highest levels of harmony and compatibility between the building's elements and sizes and the efficiency in using various materials and the specificity of the compositional system so that its structural elements are tools that contribute to creating the beauty of the building and demonstrating its value, which made it a clear example of dazzling design additions with all diligence and mastery [45].



Case (10)Khan Marjan ,Baghdad :ONLINE.CO M -EAST - MIDD	Case (9)Khan al-Ghouri ,Egypt : (Hussein, 2019)	Case (8) Alhambra Palace / Andalusia https://www.aa.com.tr/ar	Case (7) Al- Suhaimi House in Egypt https://www.cairo.gov.eg/ar/Bank%20of%20Ideas/PublishingImages/Thaqafa_Fnoon/2-waghat/Culture_houses/sehem_y1.jpg	Case (6) Beit Ziyada, Mosul Photographed by the researcher
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2.11.Case 11- Khan Al-Kumruk in Old Mosul (1704 AD)

Was built in Mosul market and is surrounded by the Agha Mosque. It consists of a large courtyard and is reached through two arched entrances. It is surrounded by two floors, ground and upper. The ground floor includes shops, stables and courtyards. As for the upper floor, it consists of several rooms with corridors. The courtyard is trapezoidal and paved with cobblestones. It is entered through a long corridor and another small one from the side of the Minaret Market. The inn consists of (entrances, the courtyard, arcades, the basement, arches and vaults openings). Gypsum and stones were used in construction, and marble and white plaster were used in arches, capitals, columns, window frames, entrances, vaults and arcades [46].

2.12.Case 12 - Kılıç Ali Pasha Bath/Turkey (1584 AD)

Designed by the architect Sinan, it is considered one of the most important examples of traditional Ottoman architecture in Turkey. It is distinguished by its harmonious architectural design and magnificent interior decoration. Classified as part of the city's architectural and cultural heritage, the bathhouse is of great importance. The domes of the bathhouse are distinguished by their spherical design and magnificent interior decoration. The windows are harmoniously arranged on the bathhouse walls with decorative arches. The walls are decorated with geometric motifs rich in color and detail. The marble floors are decorated with geometric patterns. The bathhouse comprises several interconnected rooms. As for the building materials, limestone was used for the construction of the bathhouse's exterior walls. The interior of the bathhouse is built of brick, with marble for the floors and surfaces. The bathhouse is illuminated by small windows in the central dome, providing natural light and adequate humidity [47].

2.13.Case 13 - Hammam Nur ad-Din al-Shahid (bath)

One of the oldest baths in Old Damascus, it is listed as a UNESCO World Heritage Site. It was built in 1169 during the reign of Nur ad-Din Zangi. It is a historic building consisting of

rooms, bathing halls, a reception hall, and a rest area. The bath is located among several historic buildings and markets in the heart of Old Damascus. Like other Damascene baths, it consists of three sections: the cold (outer) section, which contains six identical rooms and is not subject to steam; the lukewarm (middle) section, which can be accessed through a corridor; and the hot (inner) section, which contains warm rooms, steam, and hot water for bathing [48]. As for bathroom furniture, it includes (administrative desk, dressing table, storage, and cabinets) [49].

2.14. Case 14 - Tilla-Kari School in Samarkand, Uzbekistan (1646-1660 CE)

The madrasa was built and converted into an Islamic university for students from all over Central Asia. Its name means "gilded." Inscribed as a UNESCO World Heritage Site in 2001, the madrasa has become a museum and one of Samarkand's most prominent tourist attractions. The madrasa has an iwan with student rooms. Its mihrab is made of richly colored marble, combining muqarnas, geometric patterns, and calligraphic inscriptions in Thuluth script. Its entrance measures 70 x 70 square meters. The madrasa's doors are made of ornate wood inlaid with marble. The madrasa also served as a mosque for a period of time, in addition to the spacious courtyard attached to the madrasa [50].

2.15. Case 15 - Sultan Hassan School

Is described as the jewel of Islamic architecture in the East. It was built by Sultan al-Nasir Hassan ibn al-Nasir Muhammad ibn Qalawun during the period (1356-1363 AD). The madrasa's design is based on the orthogonal method, comprising four arcades. In its center is an open courtyard with a fountain in the middle. It was planned to have four minarets. The dome's window sills were decorated with muqarnas and Arab arches, and were inlaid with tiled bands. Its corners were decorated with stone columns with Kufic inscriptions. The entrance was flanked by green marble muqarnas in geometric shapes. The door had two wooden shutters covered with copper engraving. It led to a square entrance consisting of three iwans. In the middle was a prayer hall covered in red stone, fronted by a mihrab covered with colored marble and decorated with ornaments. Adjacent to the mihrab was a marble pulpit [51].

				
Case (15) Sultan Hassan School In, Egypt Source: https://ar.wikipedia.org/	Case (14) Tilla Kari School in Samarkand, Uzbekistan : https://www.fa	Case (13) Nouredine al-Shahid Bath, Damascus-Syria,	Case (12) Kilic Ali Pasha Bath, Türkiye : https://s.raseef22.com/storage/a	Case (11)- Khan Al-Kumruk in Old Mosul : Photographed

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In conclusion, from the previous studies that the elements of interior design of heritage buildings are (Iwan, columns and supports, muqarnas, decorations and engravings, openings (doors, windows and entrances), furniture, plants and water). As for the design principles (repetition, rhythm, abstraction, unity, proportion, scale, colour), and the building materials are (wood, stone, plaster, bricks, marble, glass, faience tiles, lighting and roofing), and the value ranges between (good, average, complete, partial) as shown in Table 2.

Table 2: Cases and their interior design characteristics

Design principles								Building materials								The value of heritage elements and their relationship to heritage					Interior design element							Con diti on nu mb er	Religious buildings	
Scale	Balance	proportionality	the color	Unity	Abstraction	rhythm	Repetition	Engraving	faience tiles	Tiles	glass	marble	Brick	Noura	to forbid	wood	Partial	Complete	Weak	Medium	Good	Plants and water	Furniture	Openings	muqarnas	muqarnas	Contracts			Iwan
0	3	2	4	3	0	3	3	4	3	2	3	1	0	4	3	0	1	0	0	1	3	4	4	4	3	4	4	2		c a s e 1
0	4	4	4	3	0	4	4	1	4	2	2	3	0	4	3	0	1	0	0	1	2	4	4	3	4	2	2	4		c a s e 2
0	3	2	4	4	0	4	4	2	3	2	1	1	0	4	3	0	1	0	0	1	1	3	3	4	3	4	2	1		c a s e 3

Religious buildings

1439

1440

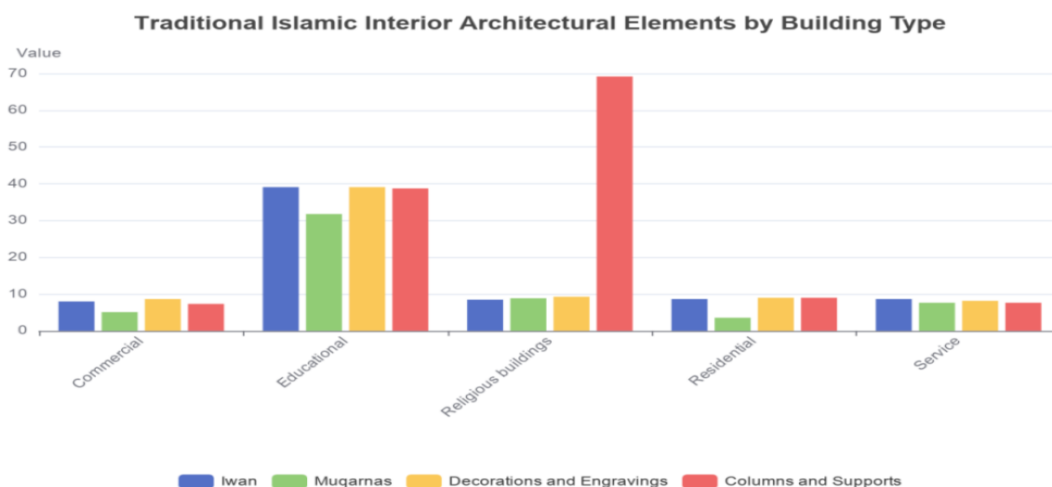
60	100	100	100	100	20	100	100	100	100	100	100	67	27	100	100	27	73.2	0	20	80	80	93.3	100	100	80	100	100	100	Total for ratios
0-Without use					-1- Narrow use (limited)					2- Fair use					3- Average use					4- Wide use (good)					Numbers				

3. Results

3.1.Comparison of Traditional Architectural Elements

Analysis of Traditional Architectural Elements:

This comparative analysis reveals significant variation in the application of traditional Islamic architectural elements across different building types. Religious buildings demonstrate exceptional emphasis on columns and supports (69.2), reflecting the structural and symbolic importance of these elements in Islamic heritage architecture. This focus on columns contributes to sustainability through providing long-term structural support and enhancing natural ventilation systems. Educational buildings exhibit excellent balance across all elements (Iwan: 39.1, Muqarnas: 32.1, decorations: 39.3), indicating comprehensive heritage preservation. This balance enhances cultural and environmental sustainability by maintaining traditional environmental control systems such as Iwan for natural cooling and Muqarnas for acoustic and light control. The moderate and uniform distribution across Commercial, Residential, and Service buildings (7-9 range) suggests standardized heritage integration approaches that maintain cultural identity while adapting to contemporary functional requirements. From a sustainability perspective, the dramatic variation between religious/educational buildings versus other typologies indicates untapped potential for transferring traditional environmental control systems to contemporary sustainable building practices. As shown in Fig.(3).

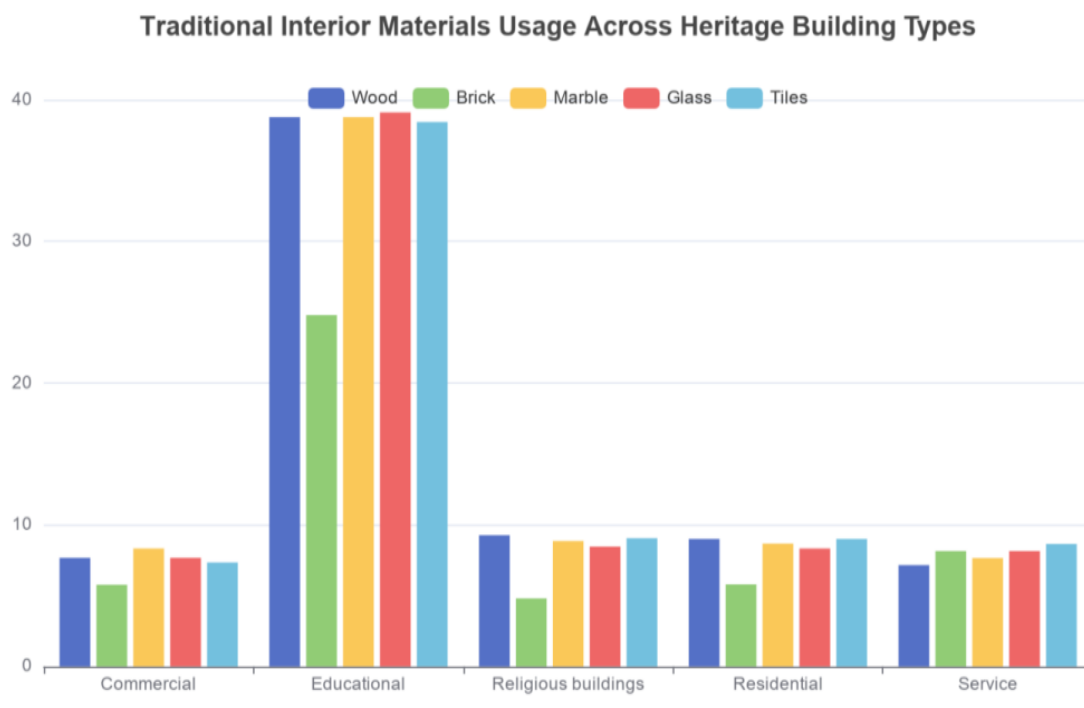


Figure(3):Traditional Islamic Interior Architectural Elements by Building Type

3.2.Comparison of Traditional Materials in Interior Design

Analysis of Traditional Materials in Interior Design:

In all categories, this comparative study demonstrates how well educational buildings incorporate traditional materials (wood: 38.8, marble: 38.8, glass: 39.1, tiles: 38.4), indicating the institution's commitment to preserving traditional craftsmanship knowledge and material performance qualities that are essential for the long-term preservation of cultural heritage. This material diversity encourages sustainability by utilizing locally produced materials with long lifespans and excellent thermal properties.. Traditional preferences for materials with superior acoustic qualities and spiritual symbolism are reflected in the balanced, moderate usage of religious buildings, with a slight preference for wood (9.3) and tiles (9.1). Marble offers thermal mass that helps control interior temperatures, while wood and tiles in historic buildings naturally insulate against heat loss and save energy.The standardized uniformity across Commercial, Residential, and Service buildings indicates unexploited potential for applying traditional material knowledge in contemporary sustainable practices. From a sustainability perspective, this comprehensive material palette in educational settings serves as living laboratories for understanding traditional material performance, thermal properties, and aging characteristics essential for sustainable heritage building practices. as shown in Fig.(4)

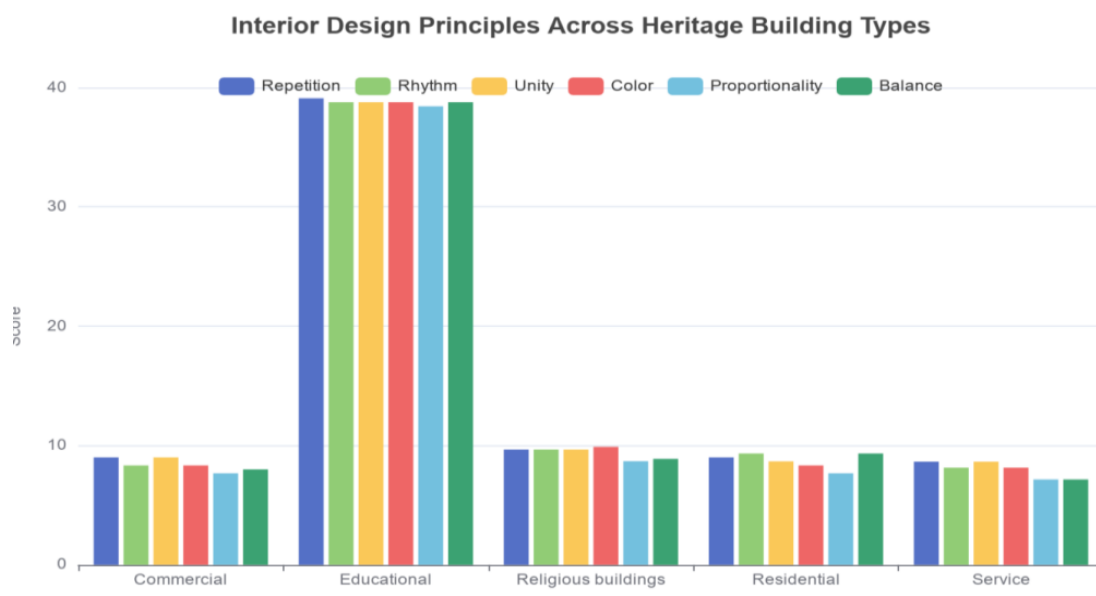


Figure(4): Traditional Interior Materials Usage Across Heritage Building types

3.3. Comparison of Heritage Interior Design Principles

Analysis of Heritage Interior Design Principles:

According to this comparative analysis, educational buildings perform exceptionally well in applying the principles of heritage interior design consistently across all elements (Repetition: 39.1, Rhythm: 38.8, Unity: 38.9, Color: 38.9, Proportionality: 38.4, Balance: 38.8). From the viewpoints of sustainability and environmental psychology, this all-encompassing design integration is the best use of traditional Islamic geometric principles, which through spatial proportionality, acoustic comfort, and visual harmony improve cognitive function, lower psychological stress, and increase learning effectiveness. Centuries of empirical observation have led to a sophisticated understanding of human-environment interaction, which is embodied in these design principles. With a focus on repetition (9.7) and balance (8.9), religious buildings exhibit a moderate but balanced implementation (8.7-9.7 range), mirroring traditional Islamic interior design methodologies that create contemplative environments through geometric harmony and proportional relationships essential for spiritual architecture.. Residential buildings excel specifically in Balance (9.3), indicating successful adaptation of traditional design principles to human-scale domestic interiors that prioritize occupant comfort and spatial harmony. This balance in interior design contributes to energy efficiency through optimal distribution of natural light and ventilation. The standardized uniformity across Commercial and Service buildings suggests potential for enhanced application of traditional environmental psychology principles in contemporary sustainable building design. As shown in Fig.(5)

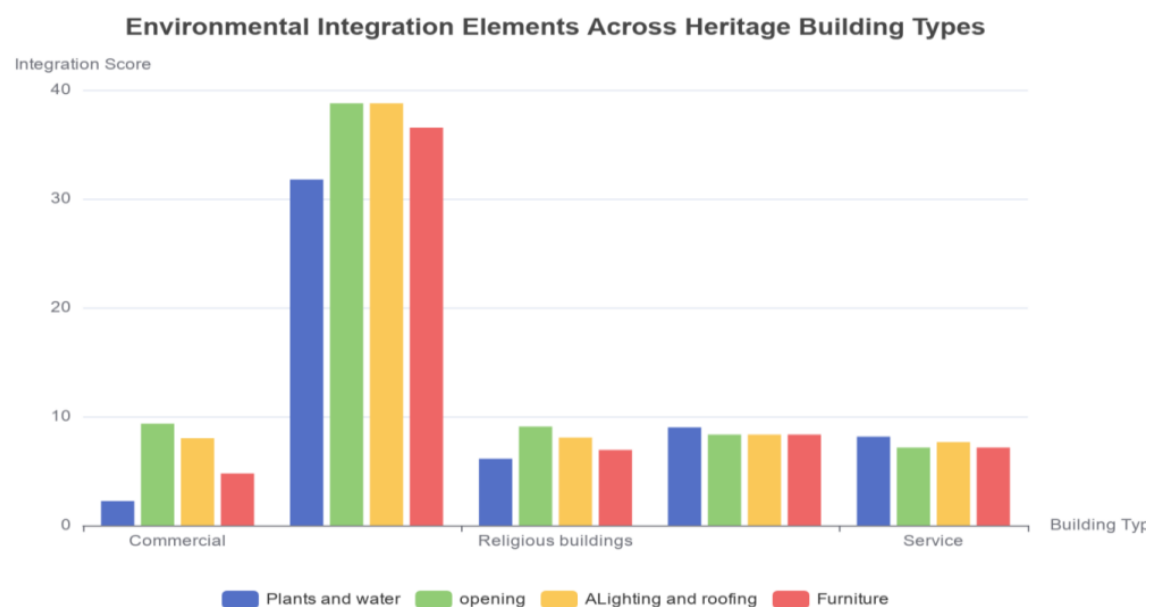


Figure(5): Interior Design Principles Across Heritage Building Types

3.4. Comparison of Environmental Integration and Natural Elements

Analysis of Environmental Integration and Natural Elements:

The analysis indicates how effectively educational buildings integrate with the environment in all areas (plants and water: 31.8, opening: 38.8, lighting and roofing: 38.8, furniture: 36.5), showing the best possible implementation of typical biophilic design principles in historic settings. Through enhanced air quality in the home, natural cooling coming from plants and water features, and improved natural lighting that uses less energy, this comprehensive integration increases environmental sustainability. These educational buildings serve as living laboratories that show that modern environmental performance standards are compatible with traditional Islamic courtyard systems, mashrabiya screening, and fountain integration. Significant environmental deficiencies are seen in commercial buildings, especially in the biophilic elements (Plants and water: 2.2). These problems indicate at missed chances to merge traditional Islamic environmental systems like courtyard microclimates, water features for evaporative cooling, and green elements that are vital for occupant well-being and energy efficiency. Residential buildings successfully adapt traditional domestic environmental systems, like roof gardens, private courtyards, and natural ventilation procedures, to achieve balanced environmental performance and moderate biophilic integration (Plants and water: 9). The consistent moderate scores of religious and service buildings indicate standardized environmental practices that maintain fundamental traditional systems while possibly underutilizing the entire range of Islamic environmental design strategies essential to the performance of sustainable heritage buildings and occupant comfort. As shown in Fig.(6)

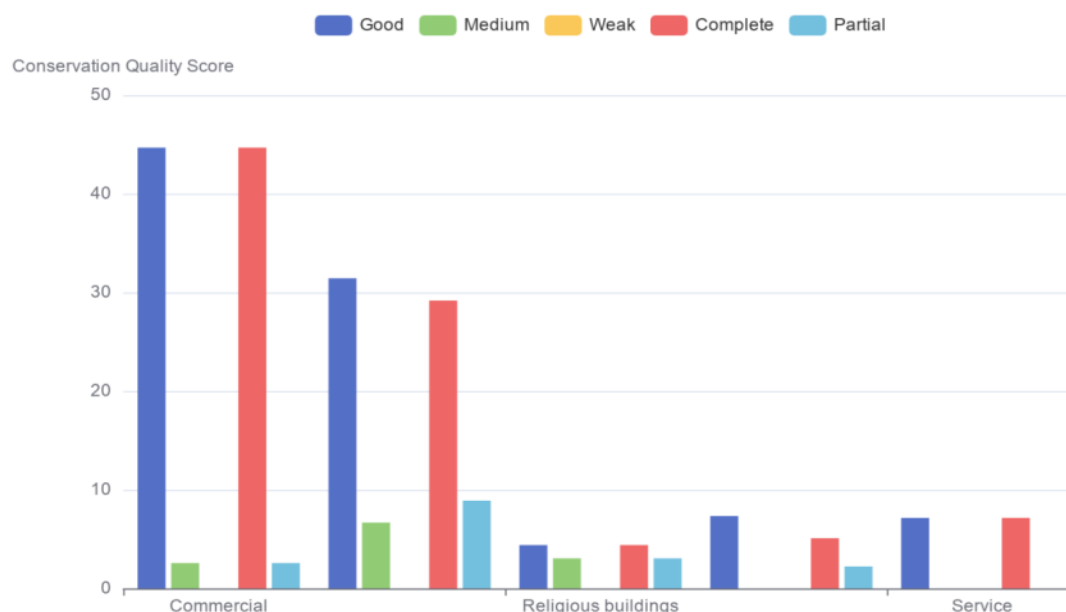


Figure(6):Environmental Integration Elements Across Heritage Building Types

3.5. Comparison of Heritage Conservation Quality

Analysis of Heritage Conservation Quality:

This conservation quality assessment reveals significant disparities in heritage preservation outcomes across building types that directly impact sustainable building performance and longevity. Commercial buildings demonstrate exceptional conservation performance with the highest Good ratings (44.7%) and Completing preservation status (44.7%) , indicating superior maintenance resources, professional conservation management, and economic incentives for heritage preservation that align with sustainable engineering principles of building longevity and adaptive reuse. This outstanding performance contributes to sustainability by extending building lifespan and reducing the need for reconstruction, thereby saving energy and materials. Educational buildings achieve substantial Good ratings (31.4%) but show the highest Medium scores (6.7%) and Partial completion rates (8.9%) , suggeste institutional commitment to heritage preservation with ongoing conservation challenges , possibly reflecting budget constraints and the complexity of maintaining educational heritage buildings while meeting contemporary accessibility and safety requirements. religious buildings demonstrate concerning conservation outcomes with low Good ratings (4.4%) and significant Medium (3.1%) and Partial (3.1%) scores, indicating urgent need for enhanced conservation strategies despite their paramount cultural significance as repositories of traditional architectural knowledge. The absence of "Weak" ratings across all building types suggests baseline conservation standards exist , while the dramatic performance differential between Commercial and Religious buildings highlights the critical role of economic resources and institutional capacity in sustainable heritage conservation practices As shown in Fig.(7).



4. Conclusions

1. **Functional Diversity Determines Heritage Design Priorities:** Each building type develops specialized strengths in heritage interior design elements that align with its primary function , reflecting intelligent adaptation of architectural heritage to different function-al requirements . This diversity enhances sustainability by improving functional performance of each building and reducing energy consumption.
2. **Educational Buildings as Repositories of Heritage Knowledge:** These buildings represent ideal models for comprehensive preservation of heritage interior design elements , making them important centres for transferring traditional knowledge to future generations. Cultural sustainability is achieved through this educational and documentation role .
3. **Gap Between Quality and Environmental Integration:** Commercial buildings achieve high conservation quality but lack environ-mental integration, indicating the need for more comprehensive approaches that balance structural preservation with environmental performance. Heritage interior design elements carry proven environmental solutions that can be applied to improve sustainability.
4. **Financial Challenges in Religious Heritage Conservation:** Despite the great cultural importance of religious buildings, they show clear challenges in conservation quality, requiring specialized support mechanisms. Economic sustainability of heritage conservation requires innovative financing models.

5. Recommendations

1. **Emergency Conservation Program for Religious Heritage Buildings:** Establish a specialized fund for preserving religious buildings with focus on interior design elements that carry important cultural and functional values. Application of heritage sustainability techniques such as natural ventilation systems and local materials can reduce long-term operational costs.
2. **Mandatory Environmental Integration in Commercial Heritage Buildings:** Set mandatory standards for applying heritage biophilic elements in commercial buildings, such as interior courtyards, water features, and vertical gardens. These elements improve sustainability by reducing energy consumption and improving indoor air quality.
3. **Research Network in Educational Heritage Buildings :** Develop a research network that utilizes educational buildings as living laboratories for studying heritage interior design elements and their sustainable applications, documenting best practices and transferring them to other building types.
4. **Performance Standards for Heritage Materials:** Develop contemporary standards for evaluating heritage materials (wood, marble, tiles, brick) in terms of environmental sustainability and thermal efficiency, creating databases for physical and environmental properties of these materials.

5. Revival of Traditional Environmental Control Systems: Develop research and application programs to revive and develop traditional environmental control systems such as Iwan, Muqarnas, and natural ventilation systems, adapting them to contemporary building requirements. These systems represent proven sustainable solutions tested over centuries.

6. Knowledge Transfer Between Building Types: Establish systematic mechanisms for transferring successful practices in heritage interior design elements from educational buildings to other building types, especially religious and residential buildings that need enhanced application of these elements.

7. Integration in Architectural Education: Integrate the study of heritage interior design elements and their sustainable applications into architectural and engineering education curricula, focusing on the relationship between heritage and sustainability and how to apply traditional solutions in contemporary design.

These recommendations aim to enhance comprehensive sustainability of heritage buildings through preserving and developing traditional interior design elements to meet contemporary requirements, ensuring continuity of architectural heritage as a source of sustainable solutions and cultural identity.

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