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## The Contribution of Heritage Houses in the City of Mosul to Enhancing Sustainable Environmental and Economic Development

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**Abstract**

This study aims to examine the heritage houses in the city of Mosul and analyze their role in achieving sustainable environmental development, with a focus on the innovative architectural treatments employed by Mosuli architects from the early Islamic periods through the Ottoman era. The research demonstrates that traditional building elements, including windows, entrances, mashrabiyas (projected balconies), iwans and side rooms, internal courtyards with fountains, cellars and underground passages, as well as blind vaults, were intelligently designed to achieve energy efficiency, thermal insulation, natural ventilation, evaporative cooling, and lighting modulation, while ensuring aesthetic quality, privacy, and security for the residents.

The study further shows that Mosuli architecture successfully utilized these elements to achieve environmental, social, and economic sustainability by reducing resource consumption, protecting buildings from climatic factors, improving air quality, and organizing interior and exterior spaces in an integrated manner. Moreover, these architectural treatments contributed to enriching the urban fabric of streets and alleys by providing shade, enhancing visual aesthetics, and maintaining privacy, reflecting the heritage architects' awareness of sustainable development principles.

The research concludes that the heritage houses in Mosul represent a practical and exemplary model of traditional architecture capable of combining beauty, functionality, and environmental and social performance. This underscores the importance of preserving these buildings and utilizing their architectural expertise in modern urban planning to promote sustainable environmental development while safeguarding the city's cultural and architectural identity.

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## Introduction

Heritage houses in the city of Mosul constitute some of the most distinctive urban testimonies that embody the city's cultural and social identity. Through their architectural styles, building materials, and design approaches, they reflect a cumulative civilizational legacy extending across successive historical periods. These houses represent added value not only from historical and aesthetic perspectives, but also from environmental, social, and economic viewpoints, owing to their architectural characteristics that are consistent with principles of sustainability, such as natural ventilation, thermal insulation, and the use of local materials.

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The significance of these houses lies in their dual value—both material and symbolic. From a material perspective, they are unique architectural examples that reflect a synthesis of Islamic, Ottoman, and local influences. They demonstrate a high degree of climatic adaptability through internal courtyards, shanashil (projecting wooden balconies), and carefully designed openings, in addition to their reliance on local materials such as stone, gypsum, and wood, which has endowed them with authenticity and structural durability. From a symbolic perspective, these houses carry profound meanings as vessels of cultural identity and collective memory for the people of Mosul. They also serve as social markers reflecting the status and traditions of Mosuli families, alongside their aesthetic and spiritual dimensions manifested in decorative elements, carvings, and courtyards. Consequently, they are not merely residential buildings, but rather urban icons that connect the past with the present and form an essential component of the city's urban and human heritage. With the growing global interest in sustainable development concepts, it has become necessary to re-examine these urban legacies as key pillars for achieving a balance between preserving heritage identity and meeting contemporary development requirements. Accordingly, this study aims to shed light on heritage houses in Mosul and their role in promoting sustainable development across its various dimensions.

## Research Problem

Despite the historical and architectural importance of heritage houses in the city of Mosul, they currently face numerous challenges, including neglect, urban deterioration, lack of regular maintenance, and declining community awareness of their value. These challenges are compounded by pressures from urban and economic expansion, which threaten their disappearance. Moreover, their potential contribution to achieving sustainable development has not been examined in sufficient depth. This gives rise to a central research question: How can heritage houses in Mosul contribute to sustainable development, and what mechanisms can ensure their preservation and effective integration into contemporary society?

## Significance of the Research

The significance of this research lies in its attempt to highlight heritage houses in the city of Mosul as active elements capable of contributing to sustainable development in its various dimensions. These buildings should not be regarded merely as remnants of the past, but rather as a valuable civilizational asset that embodies architectural, environmental, social, and economic values worthy of investment. The distinctiveness of this study stems from its effort to link the preservation of the city's historical identity with the requirements of contemporary development, by examining how modern urban contexts can benefit from traditional construction techniques characterized by efficiency and environmental harmony. Furthermore, the research emphasizes the importance of protecting these houses from neglect and loss, and advocates their practical reuse in ways that positively impact society and the local economy, thereby transforming them into sustainable resources for future generations.

## Research Methodology

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The study adopts a descriptive–analytical approach through the analysis of the architectural and environmental elements of heritage houses in Mosul, alongside a review of previous studies related to sustainable development and urban heritage. It also draws upon international experiences in the reconstruction of heritage cities in post-war contexts.

## Research Objectives

1. To analyze the architectural treatments of heritage houses in Mosul and their role in improving energy efficiency, ventilation, and lighting.
2. To evaluate the contribution of heritage houses to achieving environmental sustainability and reducing the consumption of natural resources.
3. To examine the economic impact of heritage houses, including cost reduction and support for heritage tourism and related activities.
4. To study the influence of heritage houses on urban space and local communities in terms of privacy, security, and social interaction.
5. To propose recommendations for utilizing traditional architectural expertise in contemporary urban planning to enhance sustainable environmental and economic development.

## The Concept of Sustainable Environmental and Economic Development

Sustainable development represents a comprehensive strategic framework aimed at achieving a fundamental integration between the requirements of economic development and the necessity of environmental conservation, within a balanced vision that meets the needs of the present generation without compromising the ability of future generations to meet their own needs. Sustainable development adopts an advanced approach to enhancing efficiency in the management of natural resources through the application of circular economy principles, the rational use of resources, and the reduction of all forms of pollution, alongside the conservation of biodiversity. It also supports the increasing reliance on renewable energy sources, ensuring the sustainability of ecosystems and their continued capacity to support human activity. Furthermore, sustainable development seeks to achieve long-term economic growth based on the optimal investment of resources and a transition toward a green economy through the adoption of cleaner production technologies and the use of innovation to reduce operational costs and minimize environmental footprints, while also encouraging economic diversification and enhancing value-chain efficiency (Al-Labadi, 2015, p. 21; Abu Al-Nasr & Muhammad, 2017, pp. 92–98).

The integrative relationship between the two dimensions is evident in the fact that achieving sustainable economic development is contingent upon preserving natural capital, while environmental protection requires financial and technical resources supported by strong economies. Accordingly, sustainable development constitutes an integrated model that promotes economic progress while safeguarding natural resources, thereby ensuring societal well-being across successive generations.

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## The Contribution of Heritage Cities to Sustainable Environmental and Economic Development

Cities are vital centers of ideas, creativity, commerce, culture, and knowledge, and they function as primary drivers of social and economic development. However, urban expansion and increasing population density have generated numerous challenges, including pressure on resources, environmental pollution, infrastructure degradation, and shortages in essential services. Ensuring urban sustainability therefore requires innovative solutions that enhance quality of life, promote equity in service distribution, and support the rational use of natural resources.

Within this context, urban and architectural heritage emerges as an important developmental asset capable of contributing effectively to overcoming these challenges. On the environmental level, heritage houses in Mosul have contributed to climatic balance through the use of locally sourced, environmentally friendly building materials and the application of architectural treatments such as internal courtyards, basements, and shanashil, which provided natural ventilation and reduced indoor temperatures. This, in turn, minimized reliance on modern energy sources and contributed to resource sustainability (see Figure 1).

Figure (1)
Dar al-Sayyida Fabronia
After Al-Alloush, p. 246.

At the economic level, urban heritage represents a strategic resource that can be invested in through multiple approaches. It forms a fundamental basis for the development of cultural tourism, which contributes to the local economy and generates employment opportunities. In addition, it supports the revival of traditional crafts associated with construction, ornamentation, and handicrafts, thereby preserving the economic identity of the community. Furthermore, the adaptive reuse of heritage buildings for contemporary functions—such as cultural, touristic, or commercial centers—enhances their market value and transforms them into productive economic assets. Accordingly, the integration of modern development requirements with the revitalization of sustainable urban heritage enables the

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creation of more sustainable cities and communities—cities that preserve their cultural identity, utilize their resources efficiently, and provide a healthy environment and a prosperous economy for present and future generations (Nassif, George Magdy et al., *Heritage Craft Districts as an Approach to Preserving Historic City Centers*, Journal of Urban Studies, Vol. 47, No. 4, 2023, p. 21).

## The Impact of Reconstructing Heritage Houses on Society

The reconstruction of heritage houses in post-conflict contexts has become a key issue of growing interest in urban and heritage studies, due to its multidimensional implications that extend beyond the material dimension to encompass cultural, social, economic, and environmental aspects. On the one hand, it contributes to preserving historical identity and collective memory through the restoration of authentic architectural and artistic styles and the safeguarding of traditional crafts threatened with extinction. On the other hand, it enhances social cohesion by reactivating heritage neighborhoods as vibrant centers of human interaction and restoring the social fabric damaged by conflict. Economically, this process serves as a catalyst for sustainable development by revitalizing heritage tourism and creating job opportunities in restoration, construction, and handicrafts. From an environmental perspective, it is reflected in the reuse of buildings characterized by sustainable climatic features that reduce energy consumption and promote harmony with the local environment. Thus, the reconstruction of heritage houses after wars constitutes a strategic pathway for reviving both tangible and intangible heritage, achieving comprehensive development, and enhancing stability in post-conflict societies **(Ahmed & Al-Suwaidani, 2017, p. 7)**

## Heritage Houses in the City of Mosul and Environmental and Architectural Treatments

Heritage houses are among the most prominent urban testimonies that embody historical, aesthetic, and social dimensions. They are not merely old buildings, but rather integrated architectural systems that reflect human ingenuity in adapting to the environment through innovative methods and locally sourced, environmentally friendly materials. In the city of Mosul, these houses represent a unique model of traditional architecture that combines functional authenticity with symbolic value, contributing significantly to the formation of the city's distinctive urban identity.

In light of contemporary environmental challenges, the study of these houses from the perspective of sustainable environmental development gains particular importance. Their design characteristics reveal architectural solutions that were ahead of their time in the fields of natural ventilation, spatial organization, and thermal comfort, in a manner that harmonizes with the surrounding environment and ensures resource sustainability. Accordingly, this study seeks to explore how the environmental and architectural characteristics of heritage houses can be utilized as key pillars of sustainable development, focusing on the analysis of selected models and investigating mechanisms that can contribute to their preservation and adaptive reuse in ways that serve both society and the environment.

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## First: Entrances

Entrances typically consist of an opening topped by an upper lintel and flanked by side jambs, and are closed by a single-leaf or double-leaf door. Each component of this composition serves a specific function: the lower threshold prevents the infiltration of rainwater and insects and contributes to stabilizing the entrance frame, while the upper lintel provides additional structural strength through interlocking voussoirs that reduce the risk of fracture. In Mosul's architecture, two main types of entrances are identified: the straight-axis entrance, characterized by simplicity and clarity, and the bent-axis entrance (*bashura*), which played a social role in protecting residents' privacy by preventing direct visual penetration into the interior of the house. It also possessed historical defensive dimensions, particularly evident in fortifications and citadels (Al-Ubaidi, 2024, pp. 95–97; Ghalib, 1988, p. 357; Al-Jum'a, 1975, p. 61; Abou, 1992, p. 412; Al-Ma'adidi, 2002, p. 152; Khudair, 1983, p. 108)

The role of entrances was not limited to their structural function; they also played a vital role in shaping the identity of Mosul's urban alleyways. Entrances were constructed using Mosuli limestone blocks and framed by semicircular or pointed arches, and were adorned with rich vegetal and geometric decorations, which added aesthetic value and enriched the urban fabric, imparting vitality to the narrow alleys. One notable indication of the Mosuli architect's environmental awareness is the elevation of entrances above alley level by means of a lower threshold, which reduced the risks of flooding and rainwater infiltration into houses **(Al-Nu'aimi, 2015, pp. 64–66; Al-Allaf, 2014, p. 72)**

Within the framework of sustainable environmental development, heritage entrances in Mosul embodied integrated architectural solutions that balanced social privacy with environmental equilibrium. The bent-axis entrance, for example, helped reduce the infiltration of hot air and dust into interior courtyards and functioned as a buffer zone between the harsh external environment and internal living spaces. This aligns with the principles of sustainable architecture in reducing energy consumption and improving indoor environmental quality. Moreover, the use of local materials in entrance construction, such as Mosuli stone, reflects an awareness of the importance of natural resources and reinforces the continuity of the city's environmental and urban identity (see Figure 2).

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**Figure (2)**
*Facade of a Heritage House*
Photograph by the researcher.

## Second: The Courtyard

The internal courtyard is considered one of the most prominent architectural elements in heritage houses. It is an open space located at the heart of the dwelling, surrounded by rooms, iwans, and arcades, and functions as the central axis of social and environmental activity within the building. The courtyard was carefully designed to achieve a balance between social, aesthetic, and environmental functions, effectively forming a small ecological system that enhances air quality and thermal comfort inside the house.

From an environmental and climatic perspective, the internal courtyard plays a pivotal role in improving natural ventilation. During the daytime, cooler air tends to accumulate at lower levels and is directed into the surrounding rooms, while warmer air rises upward, thereby enhancing internal air circulation and reducing the buildup of heat and humidity. In addition, the courtyard provides a shaded open space that mitigates the impact of direct solar radiation on surrounding walls and roofs, which in turn reduces indoor temperatures and limits the expansion and contraction of building materials caused by thermal fluctuations. This contributes significantly to the long-term durability and sustainability of the building **(Raouf, 1975, pp. 438–439)**

The environmental adaptability of the courtyard is further enhanced through the incorporation of fountains, which are among the most distinctive features of traditional interior spaces. Fountains contribute to air cooling through evaporation; as air passes over flowing water, cooler air currents are generated and distributed throughout the courtyard and adjacent rooms. This reduces the need for mechanical cooling and alleviates heat during the hot summer months. Moreover, fountains increase air humidity in arid environments and improve air quality by reducing dust and suspended particles, reflecting the ability of traditional architecture to integrate aesthetic appeal with sustainable environmental solutions.

From a social and cultural standpoint, the courtyard provides a space for family interaction and social gatherings, allowing daily activities to take place within the house without the need to move into the street. This enhances privacy and security and reduces reliance on exposed public spaces that may be affected by intense sunlight or dust-laden winds. The presence of fountains and small gardens also creates a visually and acoustically comfortable environment, contributing to improved quality of life and psychological well-being for residents.

In terms of architectural and economic sustainability, the internal courtyard reduces the need for building extensions or additional cooling spaces and lowers energy consumption through natural ventilation, shading, and evaporative cooling. Its integrated design with other architectural elements of the house—such as mashrabiyas (shanasheel), windows, arcades, and iwans—achieves functional and environmental harmony consistent with the principles of sustainable architecture. This enables the building to adapt to climatic changes over time without exhausting natural resources. Consequently, the internal courtyard, together with fountains, represents an advanced model of environmental treatment in heritage architecture,

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combining climatic performance, aesthetic value, and social functionality. It contributes to sustainable environmental development through the efficient use of natural resources, enhancement of residents' quality of life, and reduction of the building's long-term environmental impact **(Al-Nu'aimi, 2015, pp. 138–144; Dhanoun et al., 1995, p. 6)**

## Third: The Iwan and Side Rooms

The iwan functions as a primary architectural device for reducing acquired thermal loads and providing passive cooling during the summer season. It relies on the principles of thermal time lag and thermal mass storage. During the daytime, cooler air entering from outside is cooled further upon contact with the dense floors and walls of the iwan, which have retained the coolness of the night. The thermal mass of the iwan thus acts as a thermal reservoir, releasing stored coolness into the adjoining spaces. The iwan is often constructed at a level lower than the courtyard floor, which helps prevent hot air in contact with exposed surfaces from entering directly.

The iwan's outstanding performance as an environmental control element is attributed to the intelligent use of thermal mass and the properties of local construction materials that provide passive and sustainable solutions for cooling and heating. It is typically built using high-density materials with substantial heat capacity, such as stone, and features thick walls that enhance its thermal performance **(Al-Sab'awi, 2021, pp. 37–38; Al Ja'far, 2002, pp. 19–20)**

This massive thermal mass enables the iwan to store large amounts of heat during hot daytime periods. The walls absorb heat very slowly, preventing it from penetrating into the interior—a phenomenon known as thermal time lag, whereby peak heat takes several hours to reach the inner surface. This stored thermal energy is then released during the cooler night hours, allowing walls and floors to dissipate heat into the surrounding air, rendering them cool and ready to absorb heat again the following day. The iwan floor is often level with or slightly lower than the courtyard, or designed in such a way as to prevent hot air near upper surfaces from entering. The carefully considered elevation of floor openings, as previously discussed, not only protects against rainwater infiltration (a structural measure to preserve material integrity), but also helps direct denser cool air to remain at lower levels, while lighter hot air rises and is expelled through ventilation mechanisms.

Furthermore, the use of traditional building materials with good porosity, combined with the provision of a transitional space such as the iwan, contributes to regulating humidity levels. This physical regulation reduces the likelihood of surface condensation on walls, thereby protecting construction materials from long-term deterioration **(Al-Nu'aimi, 2015, pp. 147–150)**

The depth of the iwan is carefully designed to function as an effective solar barrier, ensuring that shade covers the entire internal space during peak summer sun. This geometric relationship between depth and height represents a deliberate constructional treatment that guarantees optimal thermal performance. In designs where the iwan ceiling is relatively low, this feature also reduces dead loads on foundations and lower walls compared to higher ceilings, thereby decreasing structural stress and extending the overall lifespan of the building. In this way, the iwan demonstrates a high degree of structural and physical integration, where

material selection (such as stone) and geometric detailing (depth, height, and openings) serve a unified objective: achieving the thermal sustainability of the building (see Figure 3).

**Figure (3)**
*House of Sayyid Abd al-Rahman al-Jalabi*
After Al-Sab‘awi, p. 292.

## Fourth: The Arcade (Riwaq)

The architect employed the upper floors as thermally insulating zones or transitional spaces, whereby the arcade (riwaq) functioned as a structural treatment aimed at reducing the acquired thermal load. It acted as a solar shading device that blocks direct solar radiation during peak hours, thereby limiting heat transfer through the building’s walls and openings and contributing to the stabilization of the internal microclimate. The openings were carefully designed to create pressure differentials that facilitate controlled airflow; the reduced air pressure generated inside the rooms—resulting from air movement or thermal draft—draws fresh air in an organized manner through lower ventilation openings integrated into the base of the walls or within the arcade itself.

These lower air intake openings are typically constructed at a height ranging between 10 and 20 cm above floor level. This height represents a deliberate structural detail intended to protect the building base and prevent the infiltration or backflow of surface rainwater into interior spaces or the courtyard, thus ensuring the durability and cleanliness of internal components **(Al-Haddad, 2004, p. 7; Al-Nu‘aimi, 2015, p. 161)**

In addition, the arcade serves as a dual-performance protective element in response to seasonal variations. During winter (passive heating), the extension of the arcade allows low-angle solar rays to penetrate deeper into interior spaces, contributing to passive solar heating by raising the temperature of the structural mass, while also providing protection from rainfall.

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In summer (passive cooling), the design of the arcade ensures the generation of dense shade over the façades when the sun's angle is high. This structural treatment in heritage houses prevents direct solar heat gain and significantly reduces the cooling load required for the building, thereby enhancing its environmental efficiency and long-term sustainability (see Figure 4).

**Figure (4)**
*Arcade of Mar Toma Church*
After Al-Sab'awi, p. 355.

## Fifth: Basements (Sirdabs) and Subterranean Spaces (Raharat)

The basement (sirdab) constituted a distinctive architectural element in traditional Islamic architecture, particularly in heritage houses, where it represented a fundamental component of spatial organization and internal planning, especially in the residences of affluent families. Its significance derives from the multiplicity of its intermediate functions, which integrate environmental, structural, and service-related aspects. Within the urban context of the city of Mosul, the basement typically appears as a deeply sunken underground structure, constructed using vaulted systems or semi-spherical domes that provide effective thermal insulation. This space was primarily utilized for passive cooling during the summer season, in addition to serving as a storage area for food supplies and provisions.

The basement was often connected to a main ventilation opening oriented toward the north in order to capture cooler prevailing winds and distribute them throughout the interior spaces. From a planning perspective, the basement could be designed as an elongated hall beneath the central courtyard or below arcades, and was usually equipped with small openings for natural lighting and ventilation. These openings were sometimes treated with metal grilles or perforated decorative elements to ensure protection while allowing airflow. The basement is characterized by varied dimensions, which may assume rectangular or semi-circular forms depending on functional requirements and ventilation considerations **(Al-Nu'aimi, 2024, pp. 117–118)**

Accordingly, it becomes evident that the basement was not merely a service space, but rather a comprehensive architectural system that embodies the adaptation of Islamic

architecture to the local climate through sustainable structural and environmental solutions (see Figure 5).

**Figure (5)**
*Basements of the Tuma (Thomas) School*
After Al-Nu‘aimi, p. 194.

## Sixth: Windows

Windows are among the fundamental architectural elements that shape building façades and regulate the character of interior spaces. They are not merely openings in walls, but integrated design systems that allow light and air to penetrate the building while simultaneously establishing a visual relationship between interior and exterior spaces. The location, dimensions, and forms of windows play a decisive role in defining architectural space in terms of lighting, privacy, and degrees of openness or enclosure. Windows also contributed to reducing structural loads on walls and foundations and represented an economical means of decreasing the quantity of construction materials used, reflecting an early dimension of sustainability in traditional architecture.

Moreover, windows constituted one of the most important architectural solutions for responding to the local climate, as they provided natural daylight and continuous ventilation, thereby moderating indoor conditions and reducing reliance on artificial cooling systems. At the same time, windows added a distinctive aesthetic value to Mosuli façades, particularly when combined with refined decorative details such as arches, voussoirs, and finely carved marble ornaments, which endowed Mosul’s architecture with its uniqueness and visual richness.

What distinguishes windows in Mosul’s heritage houses is that they were not designed independently of prevailing social and religious values. The Mosuli architect adhered to jurisprudential principles and local customs aimed at preserving privacy, which was reflected

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in the form and placement of windows. Large openings were avoided on the ground floor and replaced with small circular apertures (ṭāqa), while windows were more widely distributed on upper floors. In this way, the sanctity of the houses was protected from passersby, and the alignment of opposing windows in narrow alleys was deliberately avoided to maintain family privacy—an indication of advanced social awareness in urban design.

From both security and aesthetic perspectives, external windows were fitted with iron grilles and closed internally with wooden shutters, while the openings were framed with ornamented marble surrounds that enhanced façade aesthetics and contributed to shaping the visual fabric of Mosul's alleys. This balance between functional, social, and aesthetic considerations rendered windows one of the elements that integrate environmental, economic, and cultural sustainability **(Al-'Ani, 2015, pp. 82–83)**

Through inherited expertise, the Mosuli architect succeeded in achieving—via window design—a practical model of sustainable architecture that preceded its time, combining the functional, social, and spiritual needs of inhabitants with respect for the local environment and optimal use of available resources. Accordingly, windows in Mosul's traditional architecture stand as a clear example of how simple architectural elements can serve comprehensive sustainable development.

## Seventh: Wind Catchers (Badgīr)

The study of wind catchers (badgīr) and underground air channels clearly reveals the depth of environmental and engineering thought that characterized Islamic architecture—thought that anticipated concepts such as *environmental sustainability* and *green architecture* by centuries. Muslim architects succeeded in creating an integrated natural ventilation and cooling system based on directing winds and exploiting thermal gradients between interior and exterior air, without any reliance on industrial energy sources. These systems represent one of the earliest practical applications of the zero-energy principle, achieving thermal and air comfort solely through natural forces, in full harmony with the local environment and its climatic characteristics.

From a structural perspective, wind catchers were not merely decorative or ventilating elements; rather, they were spatial systems with precise functional and structural performance, designed to withstand wind forces and lateral loads while maintaining the building's overall structural balance. Builders employed local materials with high thermal mass—such as gypsum and limestone—which helped store coolness during the day and release it gradually at night. This integration between material and function constituted the core of Islamic structural thought, uniting material durability, climatic efficiency, and refined visual harmony **(Al-Nu'aimi, 2024, pp. 104–105; Al-Nu'aimi, 2015, pp. 194–195)**

From an environmental and developmental standpoint, wind catchers and air channels provided a practical model of what is now known as passive climatic design and sustainable energy management in buildings. These systems significantly reduce electricity consumption for cooling and ventilation and limit carbon dioxide emissions, making them among the most prominent historical examples of applying sustainable development principles in construction and housing. They can also be regarded as a core component of *architectural environmental economics*, which relies on reducing operating costs through improved natural climatic performance.

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Furthermore, re-inspiring the concept of wind catchers and air channels in contemporary building design in Iraq and the Arab region represents a promising engineering approach. These systems may be innovatively adapted within modern design standards, such as integrating wind catchers with smart mechanical ventilation systems or developing advanced underground air channels using insulation and evaporative cooling technologies to enhance energy efficiency in public and residential buildings. Re-employing these heritage elements in contemporary design also achieves cultural sustainability by preserving Islamic–Arab architectural identity and linking a distinguished scientific past with a technologically advanced present **(Al-Jawadi & Darwish, 2016, p. 13)**

In conclusion, wind catchers and Islamic ventilation channels are not merely archaeological remnants, but comprehensive models of intelligent environmental architecture, representing a design school grounded in precise physical and structural principles and an advanced ecological vision. Reinterpreting and developing them according to contemporary scientific research constitutes a fundamental step toward achieving sustainable environmental and economic development in Arab cities, particularly in hot climates such as Iraq, where these authentic solutions can effectively contribute to building a sustainable urban future rooted in heritage yet advanced in performance.

## Eighth: Shanasheel (Mashrabiyas)

Shanasheel are among the most prominent heritage architectural elements that distinguish Mosul's architecture. The term is of Persian origin, derived from *Shah-nishin* ("the king's seat"), and came to denote rooms projecting from the upper floor beyond the house façade. In other Arab regions, they are known as *mashrabiyas*. Their concept is based on creating a wooden projection supported by stone or wooden corbels, incorporating windows adorned with fine wooden latticework.

This architectural element fulfilled multiple functions and was far more than a decorative feature. Environmentally, shanasheel moderated indoor climate by providing shade, reducing direct solar radiation, and regulating ventilation through wooden lattice openings that allow air to pass while filtering dust, thereby reducing dependence on artificial cooling systems. They also protected ground floors from rain and weathering and contributed to creating a comfortable urban environment based on climatic adaptation—one of the core principles of environmental sustainability.

Urbanistically, shanasheel addressed the irregularity of upper floors resulting from winding alleys, enabling architects to expand interior spaces by projecting upper floors outward, increasing room area while shaping a cohesive urban fabric. They provided extended shading and enhanced the sense of enclosure in narrow passages, giving the old city a distinctive visual and functional character.

Socially, shanasheel embodied one of the most important means of preserving privacy in Mosuli houses, allowing residents to observe street life without being seen, in accordance with Islamic social and religious values that emphasize the sanctity of the home **(Rahi, 2006, pp. 9–17, 35–36)**

Aesthetically, shanasheel formed a striking decorative element on façades through intricate geometric and vegetal patterns carved into wooden screens, creating artistic contrasts of light and shadow that enriched alleyways visually. This integration of environmental, social,

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and aesthetic functions reflects the philosophy of Mosuli architecture, which prioritized substance over form while nevertheless offering significant visual value **(Al-Nu'aimi, 2015, pp. 184–193)**

Thus, shanasheel—with their innovative environmental solutions and social and cultural considerations—represent a pioneering model of climate-responsive architecture and a vital source of inspiration for contemporary sustainable architectural practices.

## Ninth: Al-Shakhīm

*Shakhīm* refers to the architectural void formed between the external curvatures of roofs and walls. It is a subtle spatial element that formed a distinctive part of the structural composition of Islamic architecture, particularly in traditional buildings with vaulted roofs or high arches. Characterized by its relative height and smooth gradations, this space creates air pockets that help moderate interior temperatures and reduce heat transfer from roofs to lower spaces.

Linguistically, the term derives from the root *(sh-kh-m)*, connoting elevation or bulging, an apt description of this space resulting from vaulted or domed forms. Gypsum was commonly used to coat shakhīm surfaces due to its light-reflective and heat-reducing properties, giving the space both a bright appearance and an effective environmental function **(Al-Nu'aimi, 2015, p. 199).**

Historically, shakhīm was not merely decorative; it played structural, environmental, and social roles. It functioned as a thermal buffer, enhanced load distribution, facilitated rainwater drainage, reduced wind impact, improved acoustic comfort, and sometimes served as storage for household tools and dry goods due to its stable thermal conditions. In certain cases, it even functioned as a refuge during periods of unrest, attesting to its solidity and protective capacity **(Al-Nu'aimi, 2015, p. 200).**

Accordingly, shakhīm in Islamic architecture represents an integrated structural and environmental element that unites thermal, aesthetic, and constructive functions, reflecting a profound understanding of sustainable architecture as practiced by Muslim builders through the intelligent use of traditional building components.

## Results

1. The study demonstrates that Mosul's heritage houses possess authentic architectural and environmental characteristics that position them as advanced models of sustainable architecture long before the modern concept of sustainability emerged.
2. The findings confirm that reliance on local materials and traditional construction techniques contributed to environmental balance by reducing energy consumption and adapting buildings to the climate.
3. These houses exhibit clear economic potential that can be invested in heritage tourism and cultural activities, thereby strengthening the local economy and creating new employment opportunities.
4. The symbolic and material value of heritage houses exceeds their historical dimension, as they represent an urban resource adaptable to present and future needs.

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5. The study identifies key challenges hindering the investment of this heritage, including weak legislation, limited funding for restoration, and low levels of public awareness.
6. Integrating heritage houses into sustainable development strategies enhances environmental–economic synergy and reinforces the continuity of the city's architectural identity.
7. Ensuring the continuity of these buildings requires scientific and institutional approaches grounded in academic research and collaboration between the state and local community.
8. Treatments of entrances in Mosuli architecture reveal a deep architectural and social understanding of environmental and societal requirements, transforming entrances into functional, aesthetic, and social elements that contribute to sustainable architectural and environmental concepts.

## Recommendations

1. Preserve and maintain heritage houses through national and local plans for continuous restoration using materials and construction methods compatible with the local environment.
2. Integrate heritage houses into environmental and economic development strategies to enhance their value as investable cultural and economic resources.
3. Reuse these houses as cultural centers, small museums, or heritage guesthouses to create local employment and stimulate the economy.
4. Utilize digital documentation, 3D modeling, and clean energy technologies in conservation and adaptive reuse processes.
5. Promote heritage awareness through educational curricula and media programs to strengthen community ties to architectural heritage.
6. Enhance cooperation among universities, municipalities, cultural and environmental organizations, and civil society institutions.
7. Adopt the principle of rehabilitation and adaptive reuse while preserving historical identity.
8. Develop the original environmental features of heritage houses (thermal insulation, basements, courtyards) to meet contemporary sustainability requirements.
9. Establish dedicated funding mechanisms and enforce laws preventing demolition or replacement with modern buildings.
10. Encourage specialized scientific studies on traditional construction techniques and their role in sustainable development.

## Conclusion

The study confirms that heritage houses in Mosul constitute a valuable urban and cultural asset with renewable environmental and economic dimensions capable of effectively contributing to sustainable development. Their architectural and environmental features—such as courtyards, basements, and local building materials—offer practical solutions for reducing energy consumption and adapting buildings to climate, reinforcing their viability as sustainable architectural models. The study also highlights their potential for economic investment through cultural tourism and adaptive reuse, supporting local economic vitality and heritage continuity.

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Nevertheless, significant challenges remain, including weak protective legislation, insufficient funding for restoration, and the spread of uncontrolled modern construction that threatens the historic urban landscape. Limited public awareness further constrains long-term integration into development strategies.

Accordingly, heritage houses should be understood not as mere remnants of the past, but as living components capable of addressing contemporary environmental and economic challenges when managed within a comprehensive development vision supported by clear policies and active community participation—ensuring their continuity as an essential part of the city's identity and a sustainable resource for future generations.

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