International Journal of Sustainable Development and Planning
Vol. 20, No. 8, August, 2025, pp. 3187-3197
Journal homepage: http://iieta.org/journals/ijsdp

From Decay to Delight: Space Syntax-Based Framework for Sustainable Adaptive Reuse for Iraq's Heritage Urban Fabric

Ali Saad Al-Rubaye[1], Muna Alsallal[1,2], Sattar Jabbar Mansour[3], Ali Samir A.[4,5*], Hasan Jumaah Mrayeh[6]

[1] Architectural Engineering Department, College of Engineering, Al-Muthanna University, Samawah 66001, Iraq
[2] Department of Medical Physics and Radiation Therapy, College of Engineering Technology, Sawa University, Samawah 66001, Iraq
[3] Architectural Engineering Department, AlSafwa University College, Karbala 56001, Iraq
[4] Chemical Engineering Department, College of Engineering, Al-Muthanna University, Samawah 66001, Iraq
[5] College of Engineering, Al-Ayen University, Thi-Qar 64001, Iraq
[6] Department of Chemistry, College of Science, Al-Muthanna University, Samawah 66001, Iraq

Corresponding Author Email: Ali.Samir@mu.edu.iq

https://doi.org/10.18280/ijsdp.200803

Received: 1 June 2025
Revised: 9 August 2025
Accepted: 12 August 2025
Available online: 31 August 2025

Keywords:
heritage preservation, adaptive reuse, space syntax, sustainable urbanism, Iraqi heritage architecture

ABSTRACT

This study investigates the sustainable adaptive reuse of decaying heritage structures in Iraq through the analytical lens of space syntax. Using the Abul Latif Al-Jiblawi house in Samawah as a case study, functional, aesthetic, and syntactic dimensions of its revitalization are examined. Through the application of integration metrics, legibility assessment, and community engagement, a comprehensive framework is proposed that harmonizes heritage preservation with contemporary urban needs. The findings underscore the significance of embracing innovative approaches in revitalizing heritage houses, which also support community identity, and offer practical guidelines for policymakers, conservationists, and architects operating in conflict-affected heritage zones.

1. INTRODUCTION

1.1 Background on heritage preservation challenges in Iraq

The preservation of heritage houses and the revitalization of urban settings through innovative conservation approaches are necessitates important for Iraq's cultural and ensuring the transmission process to future generations [1]. The deterioration of heritage houses and buildings is considered a significant challenge that leaves no choice but to the development and implement new, effective methods for conservation. Heritage houses, as recognized by UNESCO, reflect the deep value of cultural and historical themes and meaning [2]. However, many of these invaluable structures face escalating threats from both natural factors, such as adverse climate conditions and natural disasters, and human factors, including cultural shifts and inadequate maintenance. These combined pressures gradually lead to the deterioration and eventual loss [3], thereby confirming the need for innovative conservation strategies that can overcome unconventional challenges they face in the process of heritage house sustainability in the long term.

1.2 Importance of sustainable adaptive reuse

In the last few decades, there has been an awareness of the importance of Heritage preservation of buildings and houses, for cultural economic and social value reasons [4]. While the traditional preservation methods have shown a good result in some cases, they often do not reach the required results due to limitations in planning, adapted design preferences, and different spaces' usability [5]. This highlights a compelling need to investigate novel strategies that integrate between modern functional needs and the preservation of potential heritage values. It should be noted that it states in the case study analysis of Iraqi heritage house, especially where it shows the adaptive transformation of the decayed houses and buildings into a functional architectural space, preserving its spirit while applying modern functions [6]. Furthermore, this study will explore the use of conservation methods that grant the sustainable preservation of heritage buildings and houses. For example, the judicious use of eco-friendly construction materials and energy-efficient systems can reduce the environmental impact for restoration projects, and additionally, the application of monitoring systems and digital documentation will lead to the exact documentation of heritage structures' ongoing maintenance and preservation efforts [7]. The aim of heritage management is shifting from physical preservation to a more community-integrated approach. This approach recognizes that the value of heritage extends beyond its architectural form to include the role in contributing to cultural legacy, generating economic developments, and strengthening social bond within

communities [8]. The emphasis on public involvement and digitalization underscores this broader perspective, demonstrating that successful heritage initiatives are not merely architectural restorations but dynamic processes that integrate heritage into the social and economic of urban life [9]. The heritage building and houses deterioration, due to both natural and human factors, leads to an innovative conservation strategy. This issue directly leads to the examination of adaptive reuse, integrated by space syntax analysis, as an applicable solution. By transforming decaying heritage into functional spaces, this viewpoint addresses the core challenge of preserving cultural assets while ensuring their continued link and utility in society [10]. This approach also shows that heritage preservation is not solely a cultural effort but a multifaceted commitment with worthy economic and social effects, necessitating interdisciplinary approaches. Highlighting these diverse values requires a comprehensive strategy that synthesizes architectural, engineering, and heritage moving beyond isolated solutions to foster sustainable outcomes [11].

1.3 Introduction of space syntax as an analytical tool

Space syntax, a quantitative method, which used in this study to evaluate urban metrics such as visibility, integration, choice, and connectivity [12]. These criteria are instrumental in assessing a heritage Building and house's spatial role within the broader urban fabric. By exploring architectural engineering, heritage, and sustainability aspects, this paper seeks to identify sustainable preservation methods and creative reuse strategies. Finally, the goal is to reconcile modern functionality with traditional values, ensuring that the structural and cultural identity of heritage houses is preserved.

1.4 Clear articulation of the study's objectives and contribution

This article addresses the importance of innovative methods of conservation, public involvement, and digitalization as main tools in the sustainable protection of cultural buildings.

2. LITERATURE REVIEW

2.1 Introduction to adaptive reuse

The developed field of transforming neglected heritage houses into functionally and aesthetically worthy architectural assets through adaptive reuse has saved significant attention in the literature. Adaptive reuse, in this context, involves repurposing existing buildings, particularly those of heritage significance, to serve modern functions, thereby ensuring both their physical preservation and continued relevance in contemporary urban life.

2.2 Challenges and considerations in adaptive reuse

A comprehensive review of the literature reveals a multitude of challenges and considerations inherent in adaptive reuse projects. Key issues consistently highlighted include the imperative of maintaining architectural integrity, ensuring structural stability, and seamlessly integrating modern utilities, all while meticulously preserving the cultural and historical authenticity of the original structure. Studies and real-life case examples from diverse geographic contexts illuminate the broad spectrum of approaches, obstacles, and achievements associated with rehabilitating deteriorated heritage buildings.

2.3 Multifaceted importance and threats to heritage houses

Several scholarly contributions underscore the multifaceted importance of heritage houses. Panzera [13] emphasized their profound cultural value and historical significance, highlighting their crucial role in expressing communal identity. However, these invaluable assets face numerous threats. Abbas et al. [14] identified neglect, natural disasters, urbanization, and a lack of dedicated stewardship as significant challenges, bringing to light the difficulties encountered in the long-term preservation of heritage houses.

2.4 Conservation methodologies and technological integration

Effective conservation necessitates a thorough understanding of heritage impact assessments. Labadi et al. [15] discussed the critical need for such assessments in the conservation of cultural heritage, emphasizing the importance of integrating conservation activities within broader cultural heritage frameworks. Furthermore, the choice of restoration techniques and materials is paramount. Franco-Castillo et al. [16] provided a concise description of traditional techniques for the restoration and conservation of wood and masonry building materials, asserting that only proper methods and materials can guarantee the long-term safety of historical buildings [17].

The literature also forecasts the increasing utilization of innovative, up-to-date devices and green approaches for the proper conservation of unique heritage buildings. For instance, recent innovations in compact and cost-effective air purification systems have demonstrated the potential to mitigate airborne diseases and allergens in dense, reused indoor environments, offering a model for healthier and more sustainable adaptive reuse applications in heritage settings [18]. In line with this, Zhang and Dong [19] discussed the application of Building Information Modeling (BIM) methods in the protection of historic buildings, emphasizing BIM's advantages in documenting and conserving these structures for extended periods. Della Torre [20] provided a historical overview outlining the main principles of architectural conservation, analyzing conservation processes, and determining the need for the preservation of architectural masterpieces.

2.5 Sustainable and culturally sensitive strategies

Beyond traditional methods, contemporary research explores sustainable and culturally sensitive strategies. Hosseini et al. [21] focused on timber and traditional construction in heritage buildings, advocating for scalable conservation strategies that are both culturally sensitive and environmentally sustainable. Additionally, Al-Rubaye et al. [22] explored the use of Izocrete blocks as an alternative construction material for sustainability, citing benefits such as low weight, thermal insulation, and economic efficiency.

2.6 Conclusion of literature review and research gap

The literature consistently affirms that adaptive reuse plays a crucial role in maintaining the architectural and cultural significance of heritage buildings. Scholars and practitioners increasingly advocate for an interdisciplinary approach that combines architecture, history, sustainability science, digital technologies, and community involvement. These integrated strategies contribute not only to the physical preservation of structures but also to the social and economic revitalization of urban environments. Moreover, researchers emphasize that successful adaptive reuse must not only meet contemporary functional needs but also meticulously respect the building's original character and context.

This dual aim—preserving identity while supporting modern use—is the fundamental function of sustainable heritage regeneration.

While the preceding sections broadly outline the problem of heritage deterioration in Iraq and introduce space syntax as a potential analytical tool, and the literature review provides a comprehensive overview of existing knowledge, tools, and challenges in adaptive reuse, there remains a notable gap. There is a need for an integrated framework that systematically combines spatial analysis (such as space syntax), detailed architectural conservation, community engagement, and digital documentation into a single, empirically validated approach specifically tailored for the Iraqi context. The existing literature highlights individual components of heritage conservation but lacks a comprehensive demonstration of their synergistic application and real-world impact within conflict-affected heritage zones. This study endeavors to bridge this gap by presenting and evaluating such a framework through a specific case study.

The evolution of heritage conservation is evident in this review, moving from a purely technical restoration focus to a more holistic, socio-economic, and technologically integrated approach. Initially, adaptive reuse was primarily defined by its ability to repurpose buildings for "modern functions" while maintaining "architectural integrity" and "structural stability." However, the field has expanded to include "integrating modern utilities and preserving cultural and historical authenticity. The combination of green approaches, BIM, and community involvement states a clear progression. This indicates that heritage is now understood as a dynamic asset with economic, social, and technological dimensions, requiring a comprehensive and interdisciplinary approach. This progress also reflects a methodological advancement. The observation that traditional renovation methods usually fall short directly correlates with the evolution of innovative, up-to-date devices and green methods and the adoption of BIM. This demonstrates that the increasing scale and complexity of heritage challenges, including climate change impacts, necessitate more developed, data-driven, and environmentally aware solutions.

3. METHODOLOGY

3.1 Study aim

This article aims to demonstrate effective method for how deteriorating heritage house could be transformed into vibrant urban assets while preserving its essential values. It also aims to evaluate the sustainability resulting from interviews and observations, complemented by quantitative spatial analysis using space syntax tools.

3.2 Data collection

Main data were collected through a series of interviews with house owners, heritage conservation experts, and architects directly involved in the case studies. These interviews were designed to provide a comprehensive understanding of the preservation techniques employed and their perceived effectiveness. In addition to interviews, multiple site visits were conducted to document the physical transformation of the case study heritage house. The preservation team noticed and recorded the materials, tools, and methods used on-site.

For spatial analysis, a high-resolution image from a satellite for the urban area was downloaded using Google Earth Pro. This image was processed and converted into a DFX file using Auto-CAD 2022. This process was crucial for allowing accurate mapping of the urban fabric, which is needed for the space syntax analysis.

3.3 Data analysis

Qualitative data from interviews and field notes were transcribed and thematically analyzed to identify patterns in preservation techniques and reuse strategies. Each finding was evaluated based on its contribution to the overall transformation and sustainability of the heritage building.

Quotative spatial analysis was conducted using UCL Depth Map software, a tool widely used in space syntax studies. The software was used to assess spatial relationships in the traditional urban fabric surrounding the heritage house. Key indicators such as integration, connectivity, visibility and choice were calculated and interpreted to determine the spatial role and accessibility of the heritage structure within its neighborhood context as mentioned before [23, 24].

3.4 Synthesis and framework development

Findings from both qualitative and quantitative analyses were synthesized to develop a comprehensive strategy for heritage preservation and adaptive reuse. This strategy is founded on three core components:

- Digital Documentation: A complete digital record of the house was created using photogrammetry and video capture. This data was subsequently utilized to generate a Building Information Model (BIM).
- Community Engagement: Public participation was actively encouraged through educational programs, local events, and social media campaigns. This initiative aimed to raise awareness about the importance of heritage conservation and to increase public involvement.
- Heritage Revitalization: The project integrated cultural tourism, museum exhibitions, and national festivals to activate the site and restore its role as a community landmark. Educational programs, including classes and workshops, were also utilized to promote the cultural and architectural value of heritage preservation.

This multi-sides approach ensured that the case-study was not just physically preserved but also effectively reintegrated into Samawah's social and economic events.

The methodology employed in this paper shows a remarkable trend towards combining qualitative and quantitative methods for a robust, multi-sides understanding

of heritage conservation of the house. By combining site observations and structured interviews with developed spatial analysis using UCL Depth Map, the study gets a comprehensive perspective that transcends the limitations of each single methodological approach. The strategy of mixed-methods contributes both in-depth contextual understanding and measurable spatial data, leading to much more empirically grounded results. Clear sequential processes were followed for the spatial analysis: the requirement for precise urban fabric mapping necessitated the acquisition of high-resolution images from Google Earth Pro, which pass through conversion process into a DFX file by using AutoCAD 2022, then served as the essential input for the UCL Depth Map software. This systematic pipeline ensures the integrity and reliability of the spatial analysis results. Moreover, the collaborative work involving the building owner, the Department of Architecture at Muthanna University, and independent architects represents an important methodological strength. This stakeholder's approach to data collection and project execution inherently validates the community engagement component of the framework. This collaboration led to the successful restoration of the house, providing empirical evidence that diverse stakeholders can effectively contribute to heritage projects, reinforcing the practical feasibility and importance of community involvement as a core element of the framework. This methodology serves as a model for interdisciplinary heritage research, combining architectural, social, and spatial analysis techniques. By integrating qualitative data on social aspects and architectural observations with quantitative spatial analysis, the study provides a comprehensive framework that can be integrated with similar complex heritage conservation projects.

3.5 Case study of Abul Latif Al-Jiblawi house

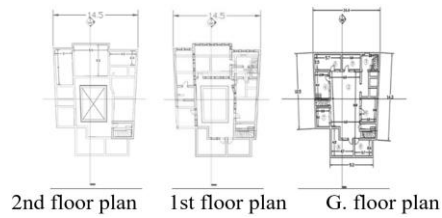


Figure 1. 2D documentation of Abul Latif Al-Jiblawi house by advisory team of university plans

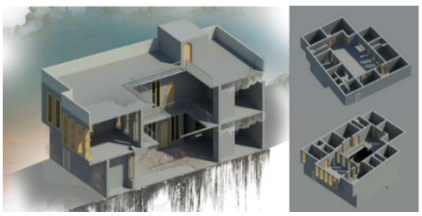


Figure 2. 3D documentation of Abul Latif Al-Jiblawi house by advisory team from Al-Muthanna University

The location of Abul Latif Al-Jiblawi House (case study) is in the center of Samawah, Al-Muthanna Governorate in Iraq. This project involved a traditional residence of significant architectural and historical importance. Between 2017 and 2018, a collaborative effort involving the house owner, Muthanna University's department of architecture, and independent architects led to the successful restoration of the building, which is locally referred to as the "house of memories." This initiative serves as a compelling demonstration of how academic institutions, local communities, and heritage professionals can effectively collaborate to achieve sustainable outcomes in cultural conservation (Figures 1 and 2).

3.6 Urban importance of the site

The house is strategically located in the southern part of al-Samawah's old city center, along with historical Bata Street (first opened in 1965 and expanded in 1995). Its proximity to the famous Suq Al-Masquf, a 19th-century traditional market renowned for copper craftsmanship, significantly enhances its cultural and economic value.

The house's location near commercial and tourist attractions makes it an ideal candidate for adaptive reuse, serving both preservation and economic development goals. Its integration into the city's active zones positions it as a model for future heritage revitalization projects (Figure 3).

Figure 3. The satellite image shows the location of the case study

3.7 Documentation and adaptive reuse process

The documentation process began with collecting all existing records, including photographs, maps, and oral histories. Hand-drawn maps were created on-site and later digitized. Workers were trained in specialized techniques for preserving intricate architectural details such as woodwork, masonry, and gypsum decorations.

The collaborative team meticulously defined clear roles and responsibilities and developed a project timeline to ensure efficient execution. Adaptive reuse strategies primarily focused on restoring key structural elements and making the space function for modern use while rigorously retaining its historical authenticity.

4. ADAPTIVE REUSE AND COMMUNITY IMPACT

4.1 Space syntax principles

Space syntax, as defined by Bill Hillier, is a set of analytical techniques applied for understand spatial configurations and their effects on social behavior, movement patterns, and land use. The representation of urban fabric as a matrix of lines, or an axial map, that can predict urban movement, land uses, and building destinies in organic urban fabric [25].

In this study, space syntax was applied to analyze the surrounding urban area of the Abul Latif Al-Jiblawi House, aiming to measure spatial characteristics such as integration, connectivity, choice, and visibility. These metrics help determine the spatial performance of the site in terms of accessibility, circulation potential, and legibility within the larger urban context [26].

4.2 Adaptive reuse of heritage elements

Adaptive reuse in this context emphasizes the use of traditional construction material and methods, ensuring that the original character of the building is preserved [27]. The restoration process utilized a combination of historic and modern techniques to strengthen integrity and support long-term sustainability.

Four key components of the renovation included (see Figures 4 and 5):

- Wood frame restoration: damaged wood frames, such as windows, doors, and roof trusses, were carefully repaired or replaced using traditional carpentry methods.
- Steel frame installation: steel reinforcement was used strategically to support weakened structural components and provide temporary support during restoration.
- Brick renovation: damaged exterior and interior brickwork were rebuilt using historically accurate materials and bonding techniques to preserve authenticity.
- Decorative gypsum renovation: This has involved repairing and replacing damaged gypsum plasterwork, such as ornamental moldings and ceilings.

Figure 4. Abul Latif Al-Jiblawi house before renovation work with wood, steel, decorative gypsum, and brick

Figure 5. Abul Latif Al-Jiblawi house after the renovation work ended

4.3 Recognition and community impact

The Abul Latif Al-Jiblawi house and the renovation team were recognized with the Tamayouz Award. The recognition was announced during the annual ceremony and presented by Dr. Rasem Badran, who emphasized the value of collaborative heritage initiatives.

- The Client: Mr. Abdul Latif Al-Jiblawi.
- Documentation: Department of Architecture at Muthanna University.
- Consulting Architect: Mr. Mohamed Shakir.

This recognition validates the project's approach as a model of best practice in architectural preservation and reuse.

4.4 Activate revitalization through social engagement

Following the adaptive reuse, the house served as a platform for community-oriented events that supported revitalization. These activities included:

- Fundraisers: potluck dinners, silent auctions, and traditional music events to raise funds for ongoing heritage projects.
- Business partnership: local enterprises contributed resources in exchange for publicity, enhancing public-private collaboration.
- Admission-based events: fees from festivals and exhibitions helped generate revenue for maintenance and programming.
- Volunteer involvement: community members contributed their time and skills to organize and support cultural events.

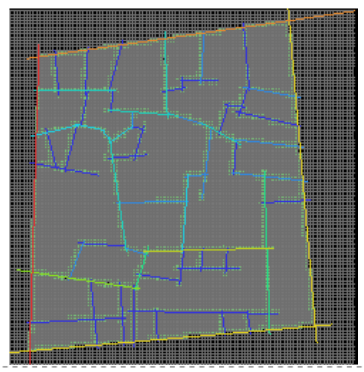
Examples of proposed community events included farmers' markets, arts and crafts fairs, poetry nights, local film production, and educational workshops—all hosted within the heritage space to promote cultural identity and economic sustainability.

5. SPACE SYNTAX ANALYSIS: METRICS AND INTERPRETATION

5.1 Space syntax analysis tools and metrics

The space syntax analysis utilized UCL Depth Map X to generate quantitative spatial data [28, 29]. The following indicators were derived and interpreted:

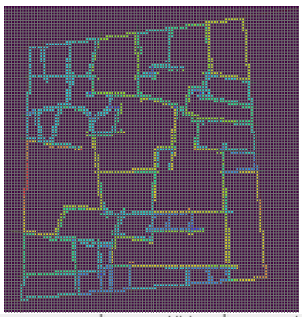
- Connectivity: a local metric that measures how many directly connected spaces a given space has. High connectivity suggests active pedestrian flow and accessibility.
- Global integration: reflects how integrated a space is within the overall urban system. Higher values suggest higher accessibility and centrality.
- Chic: indicates how frequently a space is likely to be traversed on the shortest paths between all other spaces in the system. It reflects potential pedestrian glow or through movements.
- Visibility Graph Analysis (VGA): used to assess how visually accessible areas are from any given point, highlighting visual openness and spatial intelligibility.



Attribute	Minimum	Average	Maximum
Choice	0	198.156	1136
Choice [Connectivity Wgt]	378	2205.91	12280
Choice [Connectivity Wgt][Norm]	0.0192837	0.112535	0.626467
Choice [Norm]	0	0.101462	0.581669

Figure 6. Space syntax analysis: Choice values across the street network

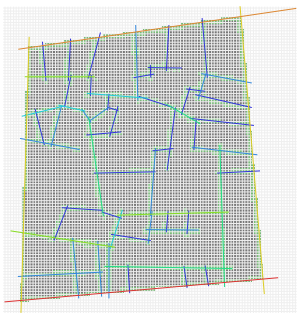
Figure 6 illustrates the potential pedestrian flow and through movements within the urban network surrounding the heritage house, providing empirical data on how the site is positioned for potential activity.



Attribute	Minimum	Average	Maximum
Connectivity	1	49.8906	115
Point First Moment	0.07	45.9025	160.615
Point Second Moment	0.0049	60.203	321.087

Figure 7. Space syntax analysis: Visibility analysis and connectivity values

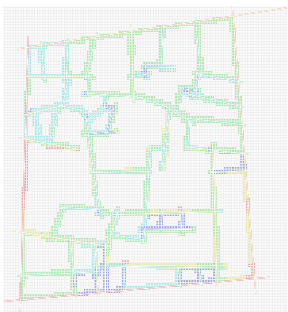
Figure 7 shows the visual accessibility and direct connections of spaces, which are crucial for understanding legibility and immediate interaction within the urban environment.



Attribute	Minimum	Average	Maximum
Connectivity	2	3.09375	9
Control	0.291667	1	3.11905
Controllability	0.166667	0.315113	0.6
Entropy	2.27793	2.5273	2.85224
Harmonic Mean Depth	3.64426	5.84289	11.1437

Figure 8. Space syntax analysis: Connectivity, control, and mean depth values in UCL Depth Map

Figure 8 provides insights into the local and global spatial relationships, indicating how easily different parts of the network can be reached and controlled.



Attribute	Minimum	Average	Maximum
Integration [HH]	0.753911	1.16418	1.82298
Integration [P-value]	0.753911	1.16418	1.82298
Integration [Tekl]	0.603834	0.652372	0.714815

Figure 9. Space syntax analysis: Integration analysis and values in UCL Depth Map

Figure 9 depicts the global accessibility and centrality of spaces within the urban system, which is crucial for understanding how well the heritage house is integrated into the broader city network.

Figures 6-9 illustrate the outputs of the space syntax analysis, while Figures 10-13 below present the scatter plots for interpretation.

5.2 Interpretation of spatial indicators and scatter plots

Space syntax analysis is a method used to validate qualitative design goals, such as balancing privacy and urban integration, by quantitatively assessing the spatial layout of a heritage property. This approach explains elements like heritage revival and community involvement, which require making the home accessible while maintaining its distinctive character. Criteria like visibility, choice, integration, and connectedness are used to provide quantifiable, objective proof. The success of adaptive reuse in incorporating heritage properties into urban life is directly impacted by the spatial layout, which affects accessibility, readability, and movement patterns. Metrics like "connectivity," "integration," and "choice" are used to evaluate the heritage house's position within the larger urban fabric and assess its accessibility, circulation potential, and legibility. The scatter plots' interpretations highlight the direct relationship between these spatial characteristics and visitor engagement, highlighting the connection between the functional effectiveness of the adaptive reuse project and the assessed spatial qualities.

- Intelligibility (Integration vs. connectivity):
  - Interpretation: The relationship between integration and connectivity reveals a coherent spatial structure. Public streets exhibit higher integration values, while the house itself maintains a more introverted character. This balance effectively supports spatial legibility at the neighborhood scale (Figure 10).
  - Significance: This balance is crucial for heritage sites, as it allows them to be understood and navigated within the urban fabric while preserving their distinct, often private, character. It ensures that the house, despite its adaptive reuse for public engagement, maintains a level of privacy consistent with its original residential function and cultural norms. The finding that "public streets display higher integration, while the house retains a more introverted character" is particularly significant. It demonstrates that space syntax validates the cultural sensitivity of the adaptive reuse, respecting the traditional Iraqi residential architecture's emphasis on privacy while still allowing for controlled public access and cultural activation. This nuanced balance, quantitatively supported by space syntax, highlights a key success factor for heritage projects in culturally sensitive contexts.
- Permeability (Line length vs. connectivity):
  - Interpretation: The scatter plot analysis indicates that the surrounding street network is highly permeable, facilitating seamless access into the heritage fabric through multiple entry points and visual corridors (Figure 11).
  - Significance: High permeability is vital for urban revitalization as it facilitates movement and access, drawing people towards the heritage site and integrating it into the city's active zones. This directly supports the economic and social goals of adaptive reuse by making the site easily reachable and encouraging public

interaction.

- Accessibility (Integration vs. control):
  - Interpretation: The correlation between integration and control highlights that more integrated streets serve as key access routes. The house is indirectly linked to these through semi-private connectors, which enhance controlled accessibility (Figure 12).
  - Significance: This controlled accessibility represents a deliberate design outcome, effectively balancing the need for public engagement with the preservation of the house's private essence. It allows the site to attract visitors and host events without becoming overwhelmingly public, which is particularly important for traditional residential heritage structures.
- Local dimension (Connectivity vs. control):
  - Interpretation: The analysis reveals a spatial system specifically designed to support privacy, which is a defining feature of traditional Iraqi residential architecture. This inherent characteristic makes such homes ideal for private adaptive reuse models that respect cultural norms (Figure 13).
  - Significance: This finding underscores the cultural sensitivity embedded within the adaptive reuse project. By demonstrating that the spatial configuration inherently supports privacy, the study validates the choice of the Abul Latif Al-Jiblawi house for a reuse model that respects traditional values while accommodating modern functions.

Space syntax provides an objective, data-driven method to inform and evaluate urban design and heritage conservation decisions, moving beyond subjective assessments. The methodology states that space syntax "was used to analyze the surrounding urban... aiming to measure spatial characteristics" and that "These indicators help assess the heritage house's role as spatial element". The results section further emphasizes that "The space syntax analysis provides strong spatial evidence supporting this transformation". This positions space syntax as a scientific, quantitative tool that offers empirical validation for design and conservation choices, providing an objective basis for decision-making that is often lacking in more qualitative-focused heritage studies.

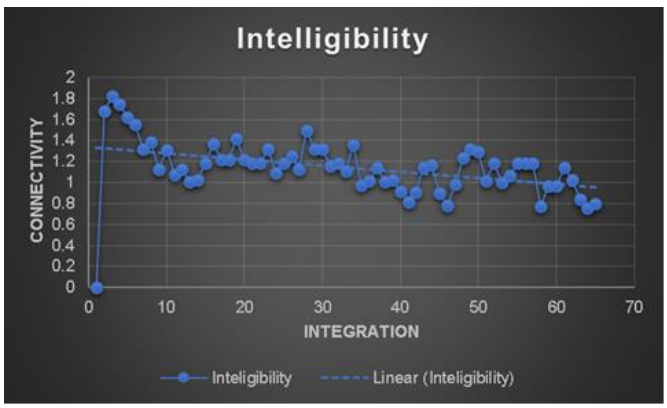


Figure 10. Intelligibility scatter plot: Relationship between integration and connectivity

Figure 10 visually represents the correlation between integration and connectivity, providing empirical evidence for the spatial legibility of the urban fabric. This plot is essential for interpreting how.

Figure 11 illustrates the permeability of the surrounding street network, showing how easily different areas are accessed. This is vital for understanding the flow of movement into and around the heritage site.

Figure 12 demonstrates how integrated streets serve as key access routes and how the house is linked to them. This plot supports the discussion on controlled accessibility and the hierarchical nature of the urban network.

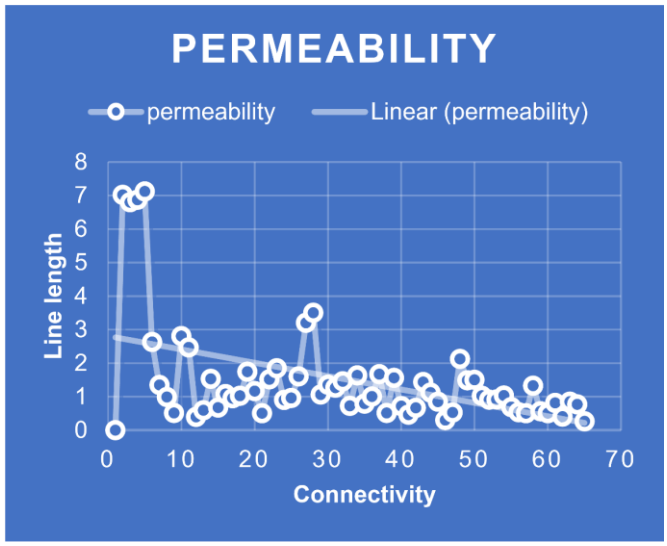


Figure 11. Permeability scatter plot: Relationship between line length and connectivity

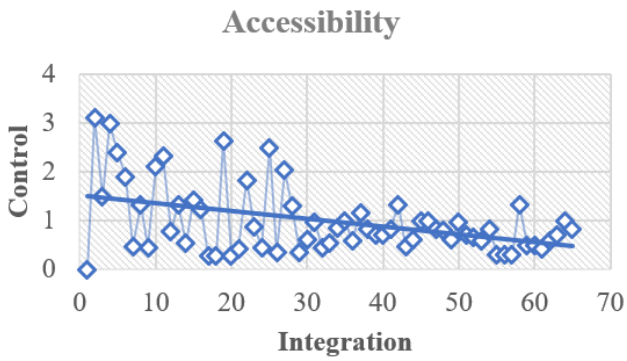


Figure 12. Accessibility scatter plot: Relationship between integration and control

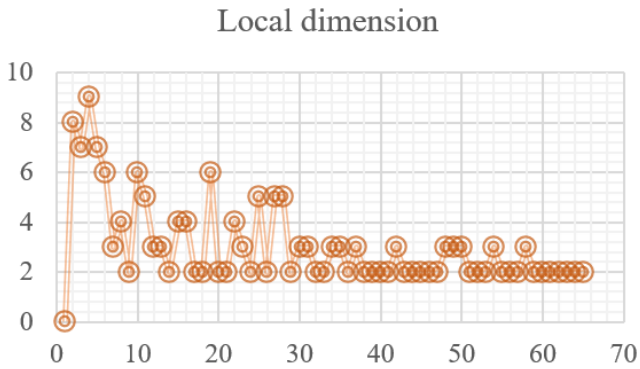


Figure 13. Local dimension scatter plot: Relationship between connectivity and control

This figure reveals the spatial system's design for privacy, a defining feature of traditional Iraqi residential architecture. This plot provides quantitative evidence for the cultural

appropriateness of the adaptive reuse, showing how the spatial design supports cultural norms.

6. RESULTS AND DISCUSSION

6.1 Effectiveness of adaptive reuse and urban revitalization

The study demonstrates that adaptive reuse is a successful method for restoring historic structures and revitalizing urban areas. The Abul Latif Al-Jiblawi home exemplifies how community involvement, architectural preservation, and spatial integration can support sustainable heritage management. Achieving comprehensive heritage results requires a synergistic interaction between social involvement, physical intervention, and spatial planning. Effective cultural revival is fueled by their combined application, suggesting a systematic strategy where various components support one another. This highlights the importance of a synergistic approach to cultural revival.

6.2 Significance of social awareness and local identity

The study highlights the significance of local identity and social consciousness in determining the success of reuse projects. Adaptive reuse fosters community among individuals, transforming historic locations into urban hubs, promoting cultural continuity and shared memory, and goes beyond mere preservation of physical structures.

6.3 Effectiveness of collaborative efforts

The research highlights the successful collaboration between colleges, real estate owners, and architects, which facilitates the exchange of resources and experience, enabling projects to effectively address contemporary functional requirements and conservation imperatives. The collaborative effort demonstrates history preservation as a community-centered enterprise, indicating a paradigm shift in heritage finance and governance, with significant policy implications. The text advocates for a shift in heritage projects' start, financing, and operation from government-centric to community-centered approaches, enabling grassroots, decentralized efforts to influence policy and gain wider support, a crucial strategic factor for decision-makers.

6.4 Spatial evidence from space syntax analysis

The space syntactic analysis provides strong spatial evidence for the observed change, confirming the heritage house's proper placement within the urban system to support private usage and public accessibility through metrics like integration, choice, and connectedness. The high integration values observed along street boundaries signify active zones, while the comparatively lower integration of the house itself supports privacy, aligning perfectly with its function as a residential heritage site. The integrated framework, comprising adaptive reuse, space syntax analysis, and community engagement, directly leads to sustainable heritage management and urban revitalization. The results section explicitly states that "adaptive reuse is an effective strategy for renovation... and the revitalization of their surrounding urban environments." This success is directly attributed to the combination of "spatial integration, architectural conservation, and community engagement," with space syntax analysis providing "strong spatial evidence supporting this transformation." This sequence clearly establishes the proposed framework as the cause and sustainable heritage management and urban revitalization as the desired effect.

6.5 Replicability and need for comparative studies

Although this research focused on a single case study, the comprehensive framework developed here is demonstrably replicable in other heritage-rich cities across Iraq. The findings align consistently with similar urban and cultural patterns observed in cities such as Mosul, Baghdad, Basra, and Erbil, where decaying heritage structures also present immense potential for revitalization through community-inclusive approaches. However, to further refine and scale the proposed methods, more comparative studies are needed across diverse geographic and socio-cultural contexts. Such investigations can effectively identify local variations in spatial behavior, public perception, and construction techniques, ultimately enriching the national strategy for heritage conservation. This framework offers a transferable model for addressing urban decay and cultural loss in similar contexts globally, particularly in conflict-affected regions. The explicit mention of "replicability in other heritage-rich cities across Iraq" and the alignment of findings with patterns in "Mosul, Baghdad, Basra, and Erbil" extend the applicability beyond the immediate case study. Given Iraq's history of conflict, the success of this model in Samawah implicitly suggests its potential for other regions recovering from similar challenges, making it a globally relevant model for post-conflict heritage revitalization.

7. CONCLUSIONS

This study robustly demonstrated that adaptive reuse, when strategically supported by spatial analysis and robust community engagement, serves as a highly sustainable strategy for the preservation of heritage structures and the comprehensive revitalization of historic urban environments. The specific case of the Abul Latif Al-Jiblawi house provides a compelling illustration of how decaying heritage assets can be transformed into functional and culturally vibrant spaces without compromising their inherent historical integrity.

The use of space syntax techniques provided a precise scientific framework for evaluating the spatial behavior and urban role of the heritage buildings. Criteria such as integration, connectivity, and intelligibility were systematically used to assess the problematic relationship between the houses and their surrounding urban context. These analyses expose how the house could effectively maintain the private residential role while simultaneously contributing to the urban flow and cultural life of Samawah’s historic core.

The key conclusions drawn from this study underscore several critical aspects: adaptive reuse is a practical and sustainable approach to heritage preservation that allows historical buildings to accommodate contemporary needs while safeguarding their cultural value; social and cultural revitalization can be effectively achieved through well-planned community events and public engagement, which are instrumental in generating funding and building public support for heritage conservation; collaboration between universities,

private owners, and architects is critical to the success of adaptive reuse projects, as these partnerships foster knowledge-sharing and resource pooling, enabling cost-effective and technically sound solutions; heritage management should ideally begin at the grassroots level, with small-scale initiatives between property owners and professionals, as successful demonstrations can then pave the way for government support and urban-scale policy frameworks to amplify and scale success; and finally, spatial legibility, permeability, and accessibility must be meticulously considered during the planning of adaptive reuse interventions to ensure that heritage sites remain meaningfully integrated into their urban settings.

7.1 Broader implications

The study highlights the growing urban structures in Iraq and the urgent need for revitalization of historic zones through cultural and physical interventions. It suggests that these tactics could be a transferable model for other nations struggling with declining heritage stocks. The study emphasizes the potential of heritage assets in promoting sustainable development, urban resilience, and cultural continuity in rapidly evolving urban environments. It links the micro-level case study to macro-level urban development issues, emphasizing the urgency of reactivating heritage zones due to the ongoing expansion of Iraqi urban structures. The case study's significance extends beyond its immediate context, suggesting that the proposed framework is crucial for addressing the nation's broader urban planning and heritage issues, particularly in light of rapid urbanization. The study contributes to the global conversation on cultural heritage and sustainable urban development by offering practical solutions for challenging situations. It highlights that the challenges faced in Iraq are shared by many countries with deteriorating heritage stocks, suggesting these strategies can serve as global models. The study provides valuable insights for global heritage conservation initiatives addressing similar issues in a global scholarly and applied context.

7.2 Limitations of the study

Despite its valuable contributions, this study has certain limitations. The primary limitation is its reliance on a single case study, the Abul Latif Al-Jiblawi house. While this allowed for an in-depth analysis, the generalizability of the findings to all heritage structures in Iraq or other regions may be limited due to variations in architectural styles, socio-cultural contexts, and urban dynamics. Additionally, the study's focus on spatial analysis using space syntax, while robust, does not fully encompass all dimensions of sustainability, such as detailed economic feasibility studies or long-term environmental impact assessments beyond the initial restoration. The qualitative data, derived from interviews and observations, provide valuable insights but could be further strengthened by a larger sample size of stakeholders and more longitudinal studies to track the sustained impact of the revitalization efforts over time.

7.3 Directions for future research

Building upon the insights gained from this study, several clear directions for future research emerge:

- Comparative case studies: Conduct comparative studies across diverse geographic and socio-cultural contexts within Iraq (e.g., Mosul, Baghdad, Basra, and Erbil) and in other countries facing similar heritage preservation challenges. This would help identify local variations in spatial behavior, public perception, and construction techniques, refining and scaling the proposed methods for broader applicability.
- Longitudinal impact assessment: Implement long-term monitoring and evaluation frameworks to assess the sustained social, cultural, and economic impacts of adaptive reuse projects. This would provide empirical data on the longevity of revitalization efforts, community engagement levels, and the economic viability of such initiatives over time.
- Holistic sustainability assessment: Expand the assessment of adaptive reuse projects to include a more comprehensive range of sustainability indicators, such as detailed life-cycle assessments of materials, energy performance monitoring post-renovation, and socio-economic impact analyses on local communities.
- Advanced digital technologies: Explore the integration of more advanced digital documentation and monitoring systems, such as 3D laser scanning, drone photogrammetry, and Building Information Modeling (BIM) for heritage (HBIM), to create highly accurate digital twins of heritage structures. This could facilitate more precise preservation, predictive maintenance, and virtual public engagement.
- Policy and governance frameworks: Investigate the development of specific policy and governance frameworks that support and incentivize adaptive reuse initiatives at both local and national levels. This research could explore best practices for public-private partnerships, funding mechanisms, and regulatory adjustments necessary to facilitate sustainable heritage conservation.
- Community-led design and co-creation: Explore methodologies for deeper community involvement in the design and planning phases of adaptive reuse projects, moving beyond engagement to co-creation. This could lead to more culturally resonant and socially impactful transformations that truly reflect community needs and aspirations.

REFERENCES

[1] Selim, G., Farhan, S.L. (2024). Reactivating voices of the youth in safeguarding cultural heritage in Iraq: The challenges and tools. Journal of Social Archaeology, 24(1): 58-78. https://doi.org/10.1177/14696053231224037

[2] Lerario, A. (2022). The role of built heritage for sustainable development goals: From statement to action. Heritage, 5(3): 2444-2463. https://doi.org/10.3390/heritage5030127

[3] Sesana, E., Gagnon, A.S., Ciantelli, C., Cassar, J., Hughes, J.J. (2021). Climate change impacts on cultural heritage: A literature review. Wiley Interdisciplinary Reviews: Climate Change, 12(4): e710. https://doi.org/10.1002/wcc.710

[4] Tejedor, B., Lucchi, E., Bienvenido-Huertas, D., Nardi, I. (2022). Non-destructive techniques (NDT) for the diagnosis of heritage buildings: Traditional procedures

and futures perspectives. Energy and Buildings, 263: 112029. https://doi.org/10.1016/j.enbuild.2022.112029
[5] Arfa, F.H., Zijlstra, H., Lubelli, B., Quist, W. (2022). Adaptive reuse of heritage buildings: From a literature review to a model of practice. The Historic Environment: Policy and Practice, 13(2): 148-170. https://doi.org/10.1080/17567505.2022.2058551
[6] Casillo, M., Colace, F., Gaeta, R., Lorusso, A., Santaniello, D., Valentino, C. (2024). Revolutionizing cultural heritage preservation: An innovative IoT-based framework for protecting historical buildings. Evolutionary Intelligence, 17(5): 3815-3831. https://doi.org/10.1007/s12065-024-00959-y
[7] Abera, Y.A. (2024). Sustainable building materials: A comprehensive study on eco-friendly alternatives for construction. Composites and Advanced Materials, 33: 26349833241255957. http://doi.org/10.1177/26349833241255957
[8] Colangelo, F., Farina, I., Travaglioni, M., Salzano, C., Cioffi, R., Petrillo, A. (2021). Innovative materials in Italy for eco-friendly and sustainable buildings. Materials, 14(8): 2048. https://doi.org/10.3390/ma14082048
[9] Mrayeh, H.J., Aneed, A.S., Alakoul, K.A., Jaber, I.A.H., Al-Huseeny, A.N.H., Hamid, A., Al-Naseri, H. (2025). Enhancing energy efficiency in Iraqi homes: Evaluating the impact of adaptive thermal comfort and improved building envelopes. International Journal of Heat and Technology, 43(2): 553-560. https://doi.org/10.18280/ijht.430217
[10] Marra, A., Trizio, I., Fabbrocino, G. (2021). Digital tools for the knowledge and safeguard of historical heritage. International Workshop on Civil Structural Health Monitoring, pp. 645-662. https://doi.org/10.1007/978-3-030-74258-4_41
[11] Masciotta, M.G., Morais, M.J., Ramos, L.F., Oliveira, D.V., Sanchez-Aparicio, L.J., González-Aguilera, D. (2021). A digital-based integrated methodology for the preventive conservation of cultural heritage: The experience of HeritageCare project. International Journal of Architectural Heritage, 15(6): 844-863. https://doi.org/10.1080/15583058.2019.1668985
[12] Mekonnen, H., Bires, Z., Berhanu, K. (2022). Practices and challenges of cultural heritage conservation in historical and religious heritage sites: Evidence from North Shoa Zone, Amhara Region, Ethiopia. Heritage Science, 10(1): 172. https://doi.org/10.1186/s40494-022-00802-6
[13] Panzera, E. (2022). Cultural Heritage and Territorial Identity. Springer International Publishing.
[14] Abbas, J., Mamirkulova, G., Al-Sulaiti, I., Al-Sulaiti, K.I., Dar, I.B. (2025). Mega-infrastructure development, tourism sustainability and quality of life assessment at world heritage sites: Catering to COVID-19 challenges. Kybernetes, 54(4): 1993-2018. https://doi.org/10.1108/K-07-2023-1345
[15] Labadi, S., Giliberto, F., Rosetti, I., Shetabi, L., Yildirim, E. (2021). Heritage and the sustainable development goals: Policy guidance for heritage and development actors. International Journal of Heritage Studies. https://openarchive.icomos.org/id/eprint/2453.
[16] Franco-Castillo, I., Hierro, L., de la Fuente, J.M., Seral-Ascaso, A., Mitchell, S.G. (2021). Perspectives for antimicrobial nanomaterials in cultural heritage conservation. Chem, 7(3): 629-669. https://doi.org/10.1016/j.chempr.2021.01.006
[17] Mora, R., Sánchez-Aparicio, L.J., Maté-González, M.Á., García-Álvarez, J., Sánchez-Aparicio, M., González-Aguilera, D. (2021). A historical building information modelling approach for the preventive conservation of historical constructions: Application to the Historical Library of Salamanca. Automation in Construction, 121: 103449. https://doi.org/10.1016/j.autcon.2020.103449
[18] Ali Samir, A., Mrayeh, H. J., Al-Absi, S. M., Vadászné Bognár, G., Abed, A. A. (2025). Developing an efficient air purification system: Focus on airborne disease and allergen control. Journal of Mechanics of Continua and Mathematical Sciences, 20(6): 168-192. https://doi.org/10.26782/jmcms.2025.06.00011
[19] Zhang, Y., Dong, W. (2021). Determining minimum intervention in the preservation of heritage buildings. International Journal of Architectural Heritage, 15(5): 698-712. https://doi.org/10.1080/15583058.2019.1645237
[20] Della Torre, S. (2021). Italian perspective on the planned preventive conservation of architectural heritage. Frontiers of Architectural Research, 10(1): 108-116. https://doi.org/10.1016/j.foar.2020.07.008
[21] Hosseini, K., Stefaniec, A., Hosseini, S.P. (2021). World heritage sites in developing countries: Assessing impacts and handling complexities toward sustainable tourism. Journal of Destination Marketing and Management, 20: 100616. https://doi.org/10.1016/j.jdmm.2021.100616
[22] Al-Rubaye, A.S., Shamil, D., Samir, A., Sultan, H.K. (2025). Sustainable rehabilitation strategies for traditional Iraqi homes: Mitigating thermal challenges with innovative materials. International Journal of Sustainable Development and Planning, 20(3): 1053-1059. https://doi.org/10.18280/ijsdp.200312
[23] Sampaio, A.Z., Gomes, A.M., Sánchez-Lite, A., Zulueta, P., González-Gaya, C. (2021). Analysis of BIM methodology applied to practical cases in the preservation of heritage buildings. Sustainability, 13(6): 3129. https://doi.org/10.3390/su13063129
[24] Othman, A.A.E., Mahmoud, N. A. (2022). Public-private partnerships as an approach for alleviating risks associated with adaptive reuse of heritage buildings in Egypt. International Journal of Construction Management, 22(9): 1713-1735. https://doi.org/10.1080/15623599.2020.1742626
[25] Chegeni, F., Didehban, M., Hessari, P. (2021). Space configuration cognation in contemporary and traditional housing using space syntax technique (Case study: Borujerd Sufian Neighborhood). Journal of Architectural Thought, 5(9): 166-183. https://doi.org/10.30479/at.2020.13095.1490
[26] Albabely, S., Alobaydi, D. (2024). Impact of street network properties on urban pedestrian movement densities: Insights from Iraq. International Society for the Study of Vernacular Settlements, 11(2): 136-151. http://doi.org/10.61275/ISVSej-2024-11-02-09
[27] Alsheikh Mahmoud, S., Bin Hashim, H., Shamsudin, M. F., Alsheikh Mahmoud, H. (2024). Effective preservation of traditional Malay houses: A review of current practices and challenges. Sustainability, 16(11): 4773. https://doi.org/10.3390/su16114773
[28] Lima, F.T., Brown, N.C., Duarte, J.P. (2022). A grammar-based optimization approach for walkable

urban fabrics considering pedestrian accessibility and infrastructure cost. Environment and Planning B: Urban Analytics and City Science, 49(5): 1489-1506. https://doi.org/10.3390/buildings12081157

[29] Yamu, C., Van Nes, A., Garau, C. (2021). Bill Hillier's legacy: Space syntax—A synopsis of basic concepts, measures, and empirical application. Sustainability, 13(6): 3394. https://doi.org/10.3390/su13063394