Edelweiss Applied Science and Technology
ISSN: 2576-8484
Vol. 9, No. 6, 16-36
2025
Publisher: Learning Gate
DOI: 10.55214/25768484.v9i6.7748

The impact of cultural aspects on sustainability in residential houses: Sulaymaniyah city as a case study

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Abstract: This study aims to address the gap in the literature regarding the interplay between cultural identity and sustainable housing, particularly in Sulaymaniyah, a city in Iraq's Kurdistan region. The city, known for its rich traditional Kurdish architecture, has experienced rapid urbanization, leading to an increased demand for modern housing solutions. However, this shift toward modern housing has often compromised the preservation of the region's architectural heritage, prioritizing functionality and aesthetic appeal over cultural and environmental sustainability. This transformation threatens both the cultural integrity of the city and the efficient use of its natural resources. While the environmental impacts of contemporary housing have been well-researched, few studies have explicitly examined how cultural factors influence the sustainability of residential housing in Sulaymaniyah. Through a mixed-method approach, including case studies, field observation, and questionnaires with architects and urban planners, this research investigates how traditional housing elements have adapted to contemporary influences. It aims to explore the role of cultural identity in sustainable design and to propose a hybrid approach that blends modern energy-efficient technologies with traditional architectural practices and materials. By highlighting the importance of integrating cultural values with sustainability efforts, this study provides valuable insights for policymakers, architects, and urban planners working to develop housing solutions that are both environmentally and culturally sustainable.

Keywords: *Architectural elements, Cultural sustainability, Mixed methods, Modernisation, Residential housing.*

1. Introduction

These anomalies can be observed in cities where the transition to modern style of living compromises cultural and environmental sustainability. These shifts can sometimes be seen where environmental concerns and global urbanization are progressing on a rapid scale. It envisions a world where the economic and environmental crises are resolved while integrating the cultural aspects that are paramount to every community's identity and legacy. Modern housing is a challenge around the world, as populations continue to grow, making it more difficult to preserve local architecture and traditional heritage.

A city of Iraq's Kurdistan region, Sulaymaniyah is noteworthy given its features. Traditional Kurdish architecture is the backbone of Sulaymaniyah's heritage, but the city has greatly expanded in the recent past which increased its demand for more modernized housing solutions. Unfortunately, these new initiatives put more emphasis on functionality, profitability, and an appealing modern look instead of preserving the architectural character of the region. Such a transformation poses the threat of losing cultural value, which in turn deteriorates the efficient use of the environment, and distances the community from its social structure. This brings to focus the concern regarding the sustainability of buildings designed for habitation.

Even though sustainable design has been researched thoroughly, only a minority of studies have explicitly examined the impact of cultural components on residential housing sustainability in

History: Received: 12 March 2025; Revised: 25 April 2025; Accepted: 29 April 2025; Published: 2 June 2025
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Sulaymaniyah. Past research evaluated the environmental impact of contemporary architecture, the historical design features relating to energy efficiency, and sustainable building methods. Still, knowledge is lacking about how to integrate cultural sustainability into modern building practices, particularly in Sulaymaniyah. Previous studies, including those by Rapoport [1]; Rapoport [2]; Barrie [3]; Iwuanyanwu, et al. [4]; Formolly and Saraei [5]; Golany [6]; Kaur [7] and Zhang [8] have extensively explored the significance of culture in shaping housing forms, particularly in the context of cultural identity, traditional design, and environmental sustainability. However, these studies are wholly situated in broader contexts and do not include the unique situations of cities like Sulaymaniyah, where cultural heritage, fast modernisation, and environment sustainability focus raise unique issues. This consequently speaks to an emergent need for the exploration of a cultural identity and modern sustainable housing practices in Sulaymaniyah.

This study aims to fill this gap by investigating the role of cultural factors in the sustainability of residential housing in Sulaymaniyah between 1980 and 2020. The primary objectives of this research are:

- To identify key cultural elements in traditional Kurdish housing that contribute to sustainability.
- To assess how modernisation and globalisation have influenced the design and sustainability of housing in Sulaymaniyah.
- To investigate the opportunity of combining the traditional architectural elements and modern architectural factors into culturally and environmentally sustainable housing solutions.
- To come up with a set of recommendations for policymakers, architects, and urban developers on maintaining cultural identity while achieving sustainability in housing development.

This study's significance lies in the potential role that it could play as a possible framework for harmonizing cultural heritage with the modern-day practice of sustainability. Because the focus involves the unique architectural heritage of Sulaymaniyah, this paper is likely to add value to the practice of sustainable architecture and be replicable for other cities facing similar challenges. Most of all, it will prove invaluable in accentuating the significance in corporate cultural sustainability with the strategies of the urban plan and housing to ensure that future housing developments consider environmental and cultural aspects.

2. Cultural Sustainability in Architecture

In architecture, cultural sustainability means valorization and incorporation of cultural identity in contemporary architectural practice. Traditional architecture is said to be sustainable because it is externally driven within the scope of the climate, society, and region's culture Hassani [9]. Rapoport [1] reminds us that different cultural practices shape the form and space of family houses and emphasizes that the artefacts created represent the culture, values, and societal social structure. Similarly, Zhang [8] notes that all vernacular styles of housing around the globe solve problems and are conditioned by the social culture of that society. These studies suggest that integrating cultural practice into modern architecture increases sustainability because the designs are more accepted than traditional construction methodologies.

The cultural heritage in Sulaymaniyah is interrelated with sustainable living, which can be seen in the small windows and thick walls of the traditional Kurdish houses built for thermal comfort [10]. In order to achieve sustainable development, there is a need to ensure that diversity and identity are maintained through the preservation of cultural heritage. Furthermore, the culture of Sulaymaniyah, alongside traditional construction and building methods, must also be protected. Different and novel forms of construction can be achieved by utilizing general knowledge and modern sustainability approaches alongside traditional sustainability practices [11]. Different forms of building practices can also achieve culturally sustainable development by modernizing the structure's planning using the old design and actively engaging the community to make builders, designers and even the residents more

Edelweiss Applied Science and Technology
ISSN: 2576-8484
Vol. 9, No. 6: 16-36, 2025
DOI: 10.55214/25768484.v9i6.7748

conscious [12]. The integration of locally available materials and construction methods can serve as motivation for sustaining and promoting culturally appropriate housing developments [13, 14].

In Sulaymaniyah, the role of cultural factors in sustaining this city appears to have waned with time. Typically, courtyards and thick walls, which were used in the past, were rarely used in the early period (1980–2000). Furthermore, in the recent period (2001–2020), rapid process and westernisation have led to better use of present materials and designs, burying traditional elements in climate. This shift teaches us the importance of balancing context with sustainable production.

3. Impact of Globalisation on Local Architectural Practices

According to Canizaro [15] the globalization of the building industry tends to replace the local building identities with standardised construction types that consume more resources as it removes indigenous practices. This is further supported by Wang and Zakaria [16] who argue that modernisation has brought in more advanced building technologies but, at the same time, has denied the cultural variance that is intrinsic to building traditions in developing countries. Dash and Shetty [17] argue that globalisation has energised the process of architectural standardisation to a level where culturally distinct housing patterns are increasingly challenging to distinguish.

This trend was still sceptical, and some constitute other researchers, such as Opoku [18] for the above-mentioned hybrid architectural approach using the old architectural orientation with new sustainability standards. These models promote retaining select vernacular architecture with its technological improvements and are a possible compromise.

On the intro of Sulaymaniyah, foreign building materials and Western architectural trends have further contributed toward the decline of traditional architectural elements. Findings by Ali, et al. [19] on socio-economic changes in Sulaymaniyah's housing market show that residential satisfaction has also transformed as the demand for modern elements has increased. These Westernised architectural forms have changed the fabric of communities in South Africa, as they also introduced isolated, individualistic housing layouts, unlike the earlier community layouts. This transition raises concerns about cultural sustainability, as the loss of traditional architectural features diminishes the sense of community identity.

The process of internationalisation, which is the integration of global standards and practices in local settings, is facilitating housing and sustainability in Sulaymaniyah with certain pros and cons. On one hand, it brings new construction methods that enhance value and efficiency, but on the other, it poses a danger to established traditional Kurdish building methods that have served communities for hundreds of years. Certain hurdles towards enforcing international benchmarks of sustainability while sustaining traditional methods have to be resolved, including varying regulations, willingness to use new technologies, and general culture [20].

For these reasons, it is important for sustainable residential growth in Sulaymaniyah to aim for integration between traditional values and global modern development. Taking into account this duality, there are some ways to develop workable solutions, for example, by combining modern engineering techniques with the elements of Kurdish cultural design. This allows for the construction of energy-efficient structures that incorporate the preservation of courtyards and thick walls, thus meeting the needs of contemporary construction while respecting cultural heritage [21]. Moreover, the active involvement of the community in the design process ensures that new developments are sensitive to the users' needs and their sociocultural context [22].

4. Integrating Tradition with Modern Sustainability Practices

Numerous studies have established the necessity of a hybrid approach to sustainable housing that combines both traditional and modern housing elements in one practice [18, 23, 24]. In other cases, combining the passive cooling techniques from traditional courtyard houses and modern energy-efficiency technologies can produce prorustian housing solutions that are culturally relevant and environmentally sustainable [25].

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McMinn and Polo [20] argue that sustainable design strategies must enhance environmental performance and integrate cultural values for better community well-being. Similarly, Keshavarz Ghadimi, et al. [26] study how digital technologies contribute to maintaining cultural heritage in sustainable architectural designs. The researchers found that virtual design tools combined with 3D modeling enable modern residential projects to incorporate historical architectural details which helps preserve cultural identity through technological progress.

Tyrrell [27] maintains that sustainable architecture requires cultural context as its foundation to ensure long-term sustainability. The author's research demonstrates the importance of maintaining historical architecture and design principles through the integration of modern green technologies. This sentiment is echoed by Adebayo, et al. [22] who emphasize that true architectural sustainability requires cultural sensitivity because built environments need to embody their regions' social and historical attributes.

The Middle East has provided recent case studies showing that traditional and modern housing methods can be combined successfully. According to Al-Kodmany and Ali [28] sustainable housing combines traditional materials like adobe and stone with modern energy-efficient construction methods. The research shows that community involvement in housing design is crucial for maintaining cultural values in new developments.

5. The Role of Culture in Sustainable Housing

Sustainable housing is influenced by culture in areas such as design, material selection, and construction methods. Traditional architecture in various communities has been carefully adapted for many years to suit local conditions and societal needs. Cultural values often support these activities, making them sustainable [29]. The architecture of Sulaymaniyah showcases a combination of cultural heritage and sustainable practices. Features like stone walls, small openings, and courtyards reflect a deep understanding of the local environment, providing thermal comfort without relying on energy consumption. These design elements, which are both functional and culturally relevant, contribute to the well-being of families and communities. Additionally, the use of indigenous construction materials and techniques highlights the positive impact of cultural practices on the environment and economy [30]. Despite the presence of modern materials and methods, many designers in Sulaymaniyah are incorporating these traditional elements into their work.

Kurdish architectural elements into their new creations. Indigenous climate-responsive architecture safeguards culture and enhances building efficiency [28].

Sustainable housing, including cultural features, provides advantages beyond environmental considerations. Initially, it causes local structures to embody their beliefs and traditions, enhancing acceptance and value. Successful housing initiatives necessitate social endorsement [31, 32]. Secondly, multicultural housing frequently benefits the environment. Traditional architecture is durable due to its compatibility with local conditions. Contemporary sustainable construction can enhance its environmental impact without excessive reliance on temporary technologies [33].

Cultural housing elements promote community identity and continuity by preserving and promoting cultural heritage. In a globalised world, architecture that values local culture may promote social cohesion and cultural pride, where culture defines identity [34]. In sustainable housing, culture has pros and cons. For instance, combining tradition and innovation is hard. Traditional methods may hinder the adoption of sustainable technologies. Although sustainable, stones and adobe may not meet new building standards or perform well [35].

The economic viability of culturally sustainable housing is another issue. Cost and time may make traditional construction methods more expensive. Subsidies or incentives for traditional materials and methods could reduce the cost gap and make culturally sustainable housing more profitable [13].

There is often a gap in understanding the long-term benefits of integrating cultural elements into housing among building industry professionals and the general public. Raising awareness about such

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integration's environmental, social, and cultural benefits through education and community engagement is essential for the broader adoption of these practices [36].

Correia, et al. [37] mentioned that one of the three pillars of sustainable development that is being discussed increasingly in modern architectural discourse is culture, which has deep roots in vernacular architecture. A conversation on sustainable architecture might benefit from a plan that blends privacy and community [37]. The built environment has been the primary focus of sustainable architecture research and practice, with little attention given to the interplay between place, culture, and climate. Tyrrell [27] work's central hypothesis is that implicit references to the cultural domain are necessary for architectural proposals to reflect genuinely sustainable design solutions. According to examinations of ancient cultures, this complex relationship, architecture, culture, and sustainability has been thoroughly considered to determine an appropriate synthesis in the formation of place [27].

Sustainable architecture has long been considered a matter of efficiency in terms of technology and energy use, according to Bauer, et al. [38]. However, sustainability can only take root and produce results when seen in the context of the wide cultural range it so obviously represents.

Table 1 and 2, provide insights into the relationship between culture and sustainability in architecture. Table 1 outlines key indicators such as locality, traditional architecture, and sustainability elements like courtyards and green spaces [39] showing how culture and sustainability intertwine in architectural design. Table 2 summarises literature contributions, highlighting studies on heritage preservation, sustainable practices, and the impact of culture on architecture. Research emphasises the importance of maintaining cultural identity, adapting to modern needs, and integrating environmental sustainability into architectural forms, all while respecting local traditions and social contexts.

The traditional architectural features of Sulaymaniyah which include courtyards, green spaces, use of local building materials, thick walls and flat roofs have helped in preserving and sustaining the environment's comprehensive constructions over time. These elements were created to capture natural resources, minimize energy usage, and achieve balance with nature. Looking particularly into the timeline from 1980 to 2000, it is important to analyze how these socio-cultural features were incorporated in new structures during this period. It allows us to analyze manner in which traditional construction practices were used, their techniques were transformed or altogether discarded for new construction practices. This approach helps to understand the implications of cultural sustainability on the constructed environment. The research will shed light on how the local design traditions were adapted or maintained in the contemporary setting and the impact, if any, it had on architectural character during this period of change.

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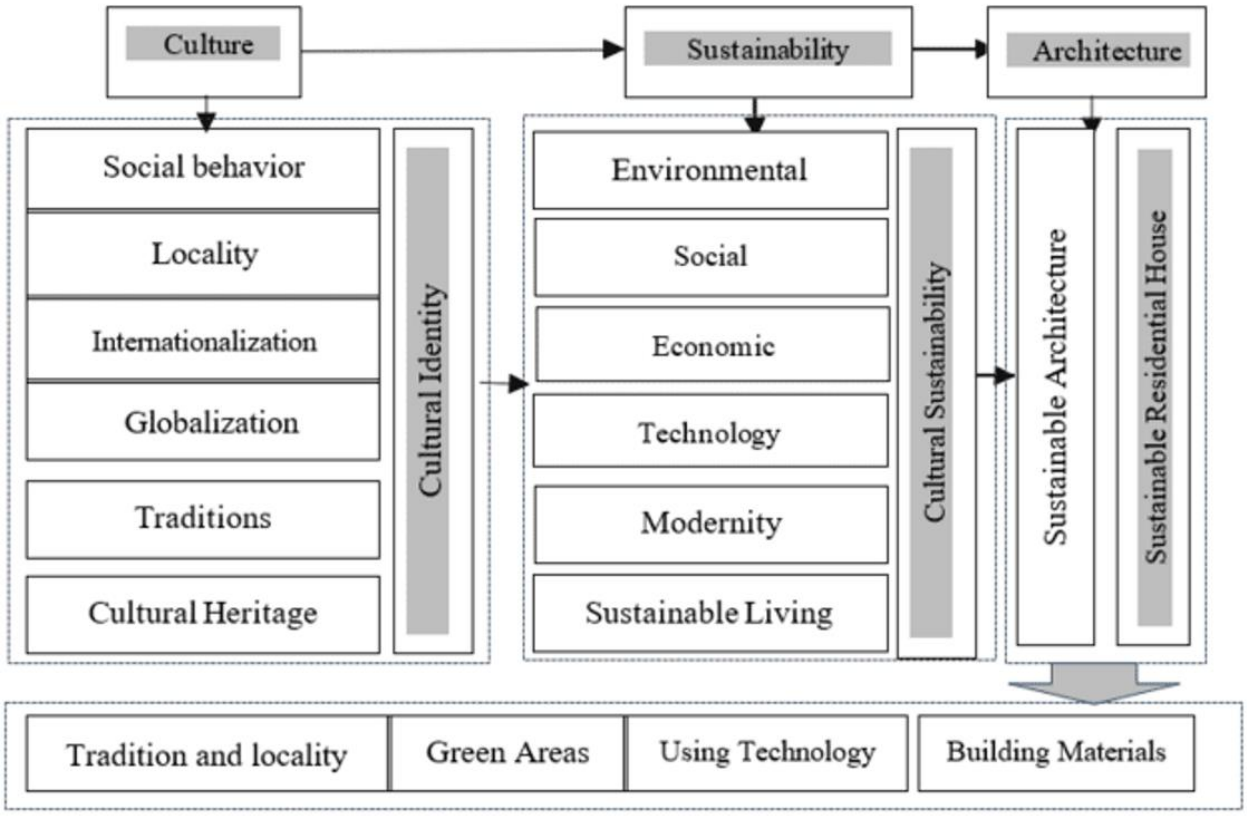

Figure 1.
The relationship between culture, sustainability and residential houses.

6. Methodology

This research adopted a case study strategy by using mixed method approach. literature review, site visits, and mix-ended questionnaire were conducted to study the cultural impacts of Sulaymaniyah's sustainable housing. Multi-samples in case method strategy framework allows for studying the socio-architectural and cultural changes of the residential buildings over a period of forty years in depth [40].

The sample of the case studies is eight residential houses selected based on the above criteria. These houses mark two-time phases: four houses built between 1980 and 2000 that incorporated elements of traditional Kurdish architecture and another four houses built between 2001 and 2020 that are more contemporary in style. This analysis verifies the gradual changes in housing sustainability and cultural identity resulting from globalisation. These eight houses were chosen from different city locations for a more holistic view of the city's urbanization.

6.1.1. Data Collection Methods

6.1.1.1. Literature Review Documentation

An analysis of the cultural sustainability pertaining to housing design in Sulaymaniyah alongside the previously existing research has been shown above. Archival materials such as municipal planning documents, historic photographs, and former architectural surveys were carefully scrutinized in order to shed light on the evolution of residential housing and its changes over time.

In summary, it is evident that these cultural indicators, cultural sustainability, and residential houses are represented in Tables 1 and 2.

Edelweiss Applied Science and Technology
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DOI: 10.55214/25768484.v9i6.7748

Table 1.
The main and sub-indicators of culture and sustainability.

Sub - Indicators	General Indicators
Locality, Intentionality, Globalization	Culture
Traditional Architecture, New Architecture	Continuous between New and Tradition
Time Belonging, Place Belonging	Architectural Identity
Voids and Opens, Vertical and Horizontal Elements	Architectural Elements
Courtyards, Green Areas, Building Materials and Technology, Environmental suitability.	Sustainable Architecture

The relations of sub-indicators and general indicators are depicted in terms of the functional structures concerning the overall architectural impact of globalization on housing sustainability, as well as the cultural identity of the region. This integrates the construct of culture, architectural identity, and sustainability with significant architectural features such as the site, building forms, and even environmental integration and modernism. The table proves the link between these parameters and the evolution of housing design throughout the ages.

Similarly, Table 2 summarises key research articles that delve into the intersection of culture, architecture, and sustainability. These articles explore the impact of architectural conservation on heritage preservation, customer satisfaction with residential flats, the role of culture in sustainable architecture, and the influence of virtual media on the sense of place. Together, these tables provide a comprehensive framework for understanding how globalisation, cultural identity, and sustainability are interconnected in the evolution of architectural practices.

Table 2.
Assessment of the relevant literature on culture and sustainability.

Author	Year	Title	Major Contribution
Muhealddin and Ali [41]	2019	The Impact of Architec- tural Conservation Poli- cies on the Continuance of Heritage Buildings- Study of Conservation in Sulaimani Governorate	The study suggests ways to improve architectural conservation, preserve Kurdish heritage, and raise community awareness of the importance of preserving ancestors' legacy for future generations. The main and secondary indicators used to assess architectural identity and originality conservation in Sulaymaniyah or elsewhere were analysed to determine the results.
Ali, et al. [19]	2021	Factors Shaping Cus- tomer Satisfaction with Residential Flats: Evi- dence from Sulay- maniyah City	The study's results show a positive impact, suggesting that residents will be more satisfied and, as a result, demand for residential apartments will rise if both the indoor and outdoor factors are improved.
Dash and Shetty [17]	2020	Cultural Identity in Sus- tainable Architecture	Aspects of sustainable culture and architecture are the focus of this paper. Several facets of sustainable architecture are covered in Part 1's discussion of eco-cultural architecture. Part 3 delves into a case study of sustainable solutions to local issues in Turkey, while Part 2 examines world-class construction practices as eco-cultural reasoning practices.
Keshavarz Ghadimi, et al. [26]	2022	Rethinking the Power of place in the Age of Vir- tual social media	The findings indicate that virtual media directly impacts place sense in the modern era. Even though the elements of a sense of place in physical and virtual environments are similar, there are some key distinctions as well, such as the absence of temporal or spatial restrictions and the power of indirect but impactful interactions and experiences.
Kultur [42]	2012	Role of Culture in Sustainable Architecture	Sustainable architecture, which includes all previous architectural approaches, is environmentally responsive from morphological perspectives and social, cultural, and economic infrastructure.
Lawrence [43]	2005	Sustainable Architecture as a Cultural Project	This paper discusses how sustainable architecture strategies can enrich architectural culture. This is part of 41 to 66: Regional Responses to Sustainable Architecture in Canada,

			which studies how sustainable building practices affect regional architectural and material cultural traditions.
Hays [44]	2023	Analysis of Physical Identity via House Typol- ogy (Case Study: Sabze- var City)	The results show that Sabzevar has fifteen types of housing from the Qajar to the present, five of which are Qajar, five of which are first Pahlavi, two of which are second Pahlavi, and three of which are Islamic Republic. Typology analysis of Sabzevar city's houses shows that they have distinction, change, and plurality due to time and have lost their physical identity.
Opoku [18]	2015	The Role of Culture in a Sustainable Built Environment	Culture affects people's views of the built and natural environments, making it essential to sustainable development. Sustainable development is part of society and culture, affecting all built environment operations. This article explores cul- ture's role as the fourth dimension of sustainability and an essential part of environmental, economic, and social sustain- ability.
Tyrrell [27]	2003	Culture Climate Place, Cultural Perspective of Sustainable Architecture	This paper claims that Ken Yeang in Malaysia has developed this conceptual framework. The place's climate and culture meet an emerging nation's needs. Yeang's towers are vertical Longhouses that invite social interaction and meet climate and economic needs.
Varnum and Grossmann [45]	2017	CulturalChange: The How and the Why	Ecological and cultural evolutionary insights can explain cul- tural change. The authors conclude by addressing the value of cultural shift research for current societal shifts and high- lighting several significant obstacles and future directions for cross-temporal culture and psychology research.
Zhang [8]	2015	Classical Courtyard Houses of Beijing: Architecture as a Cultural Artefact	The author proposes a courtyard garden house model that honours Chinese architecture while incorporating modern amenities for modern living. The privacy-community scheme may contribute to sustainable architecture discussions.

6.1.2. Field Observation Analyses

Field observations were conducted to document the selected case study houses' architectural elements, material usage, and design patterns. The observations focused on:

- The presence and functionality of traditional design features such as courtyards, thick walls, and natural ventilation systems.
- The integration (or lack thereof) of local materials in construction.
- Spatial organisation and how it aligns with traditional Kurdish social structures.
- Modifications over time reflect shifts in cultural and environmental priorities.

These observations were supplemented with photographic documentation, detailed architectural sketches, and technical evaluations of structural elements.

6.1.3. Mix-Ended Questionnaire

To gain expert insights into integrating cultural sustainability within contemporary housing designs, mix-ended questionnaires were conducted with 20 participants, including architects, urban planners, and local policymakers (Figure 2). These interviews focused on:

- The role of cultural heritage in sustainable housing design.
- Challenges in integrating traditional architectural elements in modern housing developments.
- The impact of globalisation on local housing trends.
- Potential strategies for balancing cultural preservation with sustainable urban expansion.

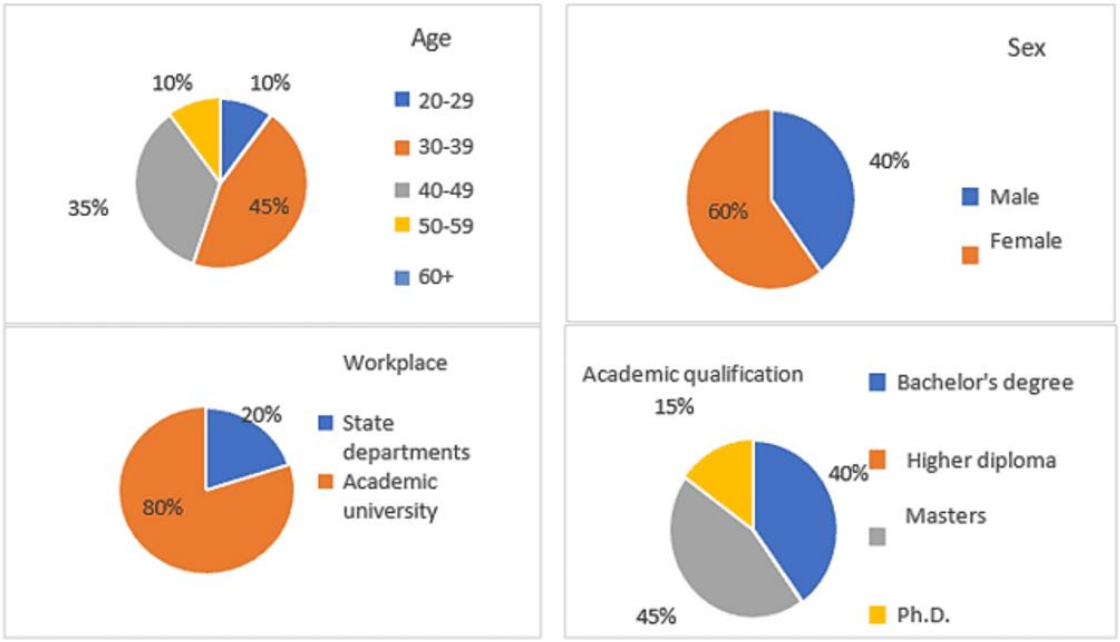

Figure 2.
The information in the questionnaires (age, sex, workplace, academic qualifications).

The questionnaire includes questions related to the cultural aspect of sustainability in residential units in Sulaymaniyah, focusing on eight housing units built between 1980 and 2020, divided into two periods: A (1980-2000) and B (2001-2020). The indicators were evaluated using an evaluation form, and the results were extracted statistically and presented in the chart (Figure 3). The evaluation of effectiveness and relationships is categorised as follows: 0% (none), 25% (weak), 50% (medium), 75% (high), and 100% (very high). The questionnaire results were analysed statistically using SPSS and Excel, and the findings were discussed to draw the research conclusions.

Edelweiss Applied Science and Technology
ISSN: 2576-8484
Vol. 9, No. 6: 16-36, 2025
DOI: 10.55214/25768484.v9i6.7748

Table 3.
The evaluation form for the questionnaire in the field.

		Sub - Indicators				
General Indicators	Culture	Locality				
		Internationality				
		Globalization				
	Int. & Loc.	Traditional Arch.				
		New Arch.				
	Arch Identity	Time Belonging				
		Place Belonging				
	Arch Elements	Voids and opens				
		Ver. And Hor. Elements				
	Sustainability	Court yards				
		Green Areas				
		Tech. & Build. Materials				
		Env. Compatibility				

Conclusion:	For statical analysis	
		0
		%25
		%50
		%75
		%100

7. Case Study

7.1. Cultural Aspects in Sulaymaniyah Residential Houses

Traditional Kurdish homes in Sulaymaniyah embody the region's cultural heritage. Their defining features—central courtyards, sturdy walls, and locally sourced materials—reflect Kurdish identity and functional design principles. These architectural elements are essential for preserving cultural continuity and maintaining a strong regional identity [46, 47].

The loss of privacy in contemporary architecture cannot be viewed only as a methodological disadvantage, as there are social and cultural values and beliefs dictated through the architecture of a region or even a home. In Sulaymaniyah, for example, traditional Kurdish houses are constructed with the extended family structure in mind, while still preserving the concepts of cultural privacy and social etiquette [48]. This suggests that the social architecture linkages remain relevant in the design of the communal living traditions [49].

Kurdistan is mostly considered to be a tribal society where family values and bonds have social relationships and obligations such as marriages which have provided a structure and guidance towards a tribal formation. This allows us to understand how architecture can help and understand the values of a society or community [50]. It enables us to comprehend the evolution that the society, technology, and culture will go [51].

The concept of place belonging underscores the importance of architecture's integration within its geographical and cultural context. Architecture bridges tradition and modernity by reinforcing local identity and ensuring continuity [52]. Ultimately, architectural identity, time, and place converge to encapsulate and express human experience across spatial and temporal dimensions.

Table 4.
Traditional architectural elements in Sulaymaniyah and their contribution to sustainability.

Traditional Architectural Element	Contribution to Sustainability
Courtyards	Provide natural ventilation, reduce energy use, and offer spaces for social interaction, contributing to a sustainable living environment.
Green Areas	Promote biodiversity, reduce the urban heat island effect, and improve air quality.
Building Materials (Local Stones, Clay)	The use of locally sourced materials reduces the carbon footprint and promotes the preservation of local building traditions.
Thick Walls	Insulate the interiors, reducing the need for artificial heating and cooling.
Flat Roofs	Utilised for rainwater collection, improving water conservation.
Orientation and Layout	Strategic building orientation to optimise natural light and heat, reducing energy consumption.
Wooden Shutters and Screens	Provide shade, control indoor temperature, and reduce the need for mechanical cooling.
Arched and Vaulted Ceilings	It helps regulate temperature, provides natural cooling, and reduces energy use.

Table 4 highlights various traditional architectural elements in Sulaymaniyah and their contributions to sustainability. These elements, such as courtyards, green areas, and local building materials, reduce energy consumption, promote environmental conservation, and support social interaction and cultural heritage. By incorporating these sustainable practices, traditional architecture in Sulaymaniyah effectively balances environmental, economic, and social factors.

7.2. Architectural Form of Houses

Kurdish architecture in Sulaymaniyah is based on practicality, using local materials like stone and clay to adapt to the region's climate. Solid walls, small windows, and central courtyards improve thermal comfort and privacy, showing an architectural approach that is both environmentally friendly and resource-efficient [53]. These design decisions support sustainability while demonstrating a thorough awareness of the local environment. Furthermore, extended family living is given priority in traditional floor patterns, which promotes social contact and strengthens group values.

As is the case in many cultures throughout the world, Kurdish dwellings have changed over time to make room for smaller nuclear families. Jain and Rana [54] ascribe this trend to the need for space-efficient architecture and cultural shifts brought about by globalisation.

The architecture of Sulaymaniyah is shaped in part by culture. Kurdish homes continue to reflect community values even as modern and global influences become more noticeable. Strong walls, courtyards, and gender-specific living areas are still essential components of modern architecture, upholding social conventions and customs [55].

To define space, architectural design carefully strikes a balance between vertical and horizontal features. Columns and spires are examples of vertical elements that direct the eye upward, conveying a sense of grandeur and desire [55]. In contrast, horizontal elements, including beams and flooring, provide stability and cohesion within the structure [56]. The dynamic interaction between mass and void is equally significant—the relationship between solid, inhabited areas and open spaces determines a building's volume and usability. This interplay influences aesthetics and functionality, shaping the human experience within the built environment and fostering a dialogue between architecture and its occupants [57] (Figure 3).

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Figure 3.
Traditional houses in Sulaymaniyah Shexhan and Sabunkaran district

The diversity in Sulaymaniyah's housing styles reflects both architectural continuity and transformation. Traditional Kurdish homes prioritise sustainability by conserving energy and fostering communal living, while modern homes emphasise efficiency, convenience, and aesthetics, often at the expense of cultural and environmental considerations [58]. Achieving sustainable and culturally significant housing requires a careful balance between these approaches.

Architectural identity refers to the distinct characteristics that define a built environment within a specific cultural and historical context [59, 60]. Unlike cultural identity, which encompasses broader social and traditional elements, architectural identity specifically relates to the visual, structural, and material aspects that shape a region's built environment. This study adopts Torabi and Brahman [60] framework to examine how modernisation has influenced the evolution of Sulaymaniyah's architectural identity.

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Figure 4.
Sulaymaniyah city's position and residential houses distribution in Iraq and Sulaymaniya.

8. Results

Through statistical analysis of the indicators of the influence of the cultural factor on the concept of a sustainable residential house in the city of Sulaymaniyah for the period 1980-2020, 13 indicators were analysed for eight residential architectural samples.

The selection of these two periods is based on major socio-political and economic changes that directly influenced housing trends in Sulaymaniyah.

- 1980-2000: This period reflects when traditional Kurdish architectural elements, such as thick walls, courtyards, and local materials, were still prevalent. Cultural and environmental adaptations largely influenced housing designs, and modernisation was slower due to political instability.
- 2001-2020: This period marks a shift towards globalisation, modernisation, and the increased use of imported materials and technologies in construction. The post-2000 economic recovery and political developments led to rapid urban expansion, significantly altering the architectural landscape.

The findings indicate that architectural identity in Sulaymaniyah has undergone significant transformations, particularly in material choices and spatial configurations. While traditional elements such as courtyards and thick walls were central to residential design before 1980-2000, they gradually diminished in the period 2001-2020. This aligns with Torabi and Brahman [60] who argue that socio-economic factors and shifts in cultural perception influence architectural identity.

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The percentages for all samples and questionnaire community respondents (20 architects and planners) were extracted. The results were then compared. The analysis of the impact of the cultural aspect on the sustainability of the selected residential homes was arranged as follows:

- In the cultural field, the analysis of the cultural influences revealed varying trends in lo- calism, internationalism, and globalisation. Local culture strongly influenced the architectural models in the first period (1980-2000), with an average of 45.35% (represented as a period 'A'). This influence decreased in the second period (2001-2020) to an average of 31.7% (represented as period 'B'). Internationalism maintained a moderate influence across both periods, with 62.8% in the first period and 77.3% in the second. Conversely, the influence of globalisation increased from a moderate 45.45% in the first period to a strong effect of 66.7% in the second period (Figure 5).

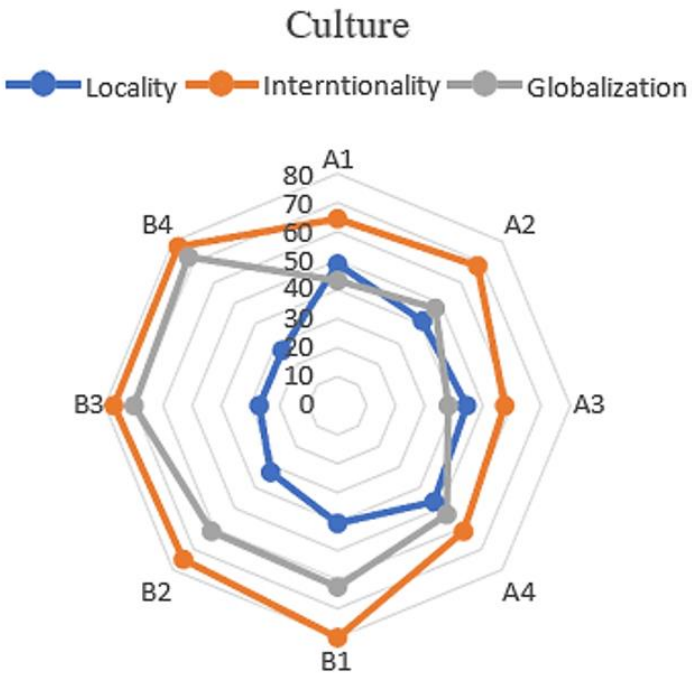

Figure 5.
Analysing the indicators of culture.

- The analysis also examined the use of traditional and contemporary architectural styles. Traditional architecture was consistently employed to a very low degree across periods.
- A and B, with 24.25% in the first period (A) and 17.82% in the second period (B). In contrast, contemporary architecture showed a significant increase in usage, rising from a moderate 52.85% in the first period (A) to a very high 78.1% in the second period (B). (Figure 6).
- The influence of cultural aspects was moderate regarding architectural identity and its connection to place and time. There was a moderate decline in place and time belonging in the first period, with 47.2% for the former and 41.2% for the latter. However, this influence decreased in the second period, resulting in a low degree of place and time belonging, with 35.65% and 32.5% respectively (Figure 6).

Edelweiss Applied Science and Technology
ISSN: 2576-8484
Vol. 9, No. 6: 16-36, 2025
DOI: 10.55214/25768484.v9i6.7748

Figure 6.
Analysing the indicators of Architectural Identity and locality and internationality.

- As for the architectural elements (mass and opens) and the (vertical and horizontal elements), they varied in the samples between weak and medium, with 47.8% average to A and B for mass and opens, and medium average for using vertical and horizontal elements 62.6% and 67.1% which means that the embodiment of the indicators of compositional relationships and architectural relations was between average and weak. (Figure 7).

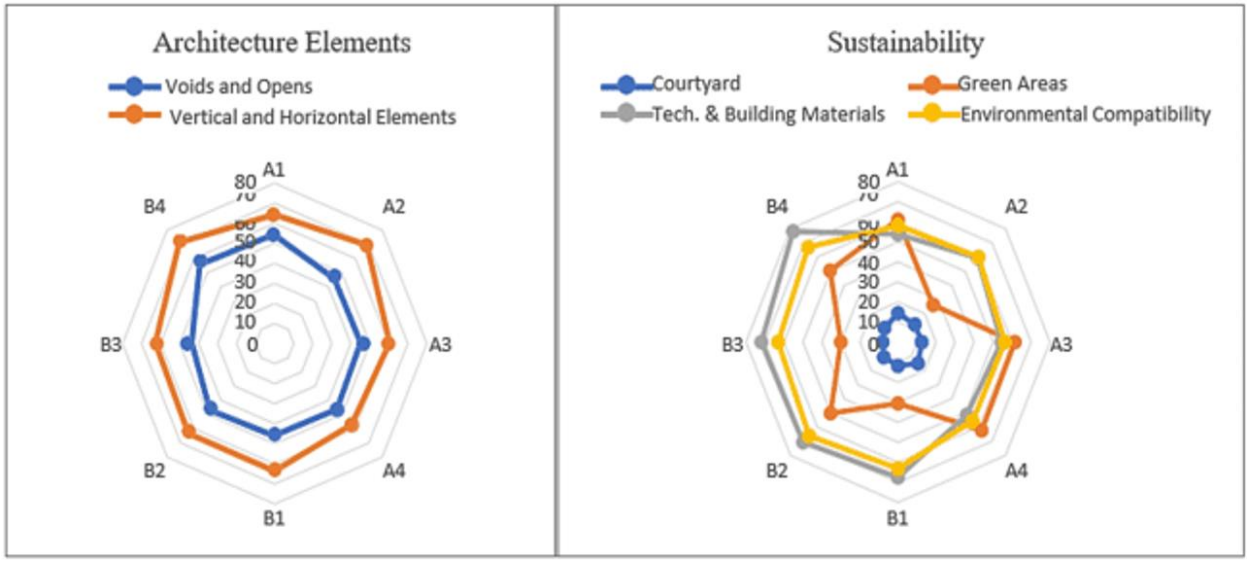

Figure 7.
Analyzing the indicators of Architectural elements and Sustainability.

- In the field of sustainability for residential units, the analysis revealed varying trends. The incorporation of courtyards was consistently weak across both periods, with 13.6% in the first period (A) and 10.15% in the second period (B). The use of green spaces was moderate in the first period (52.7% for A) but decreased to a weak level in the second (40.35% for B).

Edelweiss Applied Science and Technology
ISSN: 2576-8484
Vol. 9, No. 6: 16-36, 2025
DOI: 10.55214/25768484.v9i6.7748

Table 5.
Analysing the indicators of Architectural elements and Sustainability.

4B	3B	2B	1B	4A	3A	2A	1A	Sub-indicators	General indicators
26.9	26.9	32.5	40.6	46.9	44.4	41.3	48.8	Locality	Cultural
77.5	76.9	75	80	61.3	57.5	68.1	64.4	Intentionality	
72.5	70	61.3	62.5	53.1	38.1	47.5	43.1	Globalisation	
15	19.4	16.3	20.6	21.3	26.9	22.5	26.3	Traditional Architecture	Local & Internationality
83.1	75.6	80.6	73.1	53.8	47.5	53.8	56.3	New Architecture	
38.1	26.9	36.3	41.3	44.4	48.1	43.8	52.5	Time Belonging	Architectural Identity
35	24.4	31.3	37.5	36.9	40	42.5	45.6	Place Belonging	
55	43.1	47.5	46.3	46.9	45.6	45	53.8	Voids and opens	
70.6	62.5	63.8	63.8	57.5	60.6	68.8	63.8	Vert.& Horizontal Elements	Architectural Elements
10	8.1	10.6	11.9	15	12.5	12.5	14.4	Courtyards	
50.5	30.1	50.2	30.6	62.3	61.5	26.2	61.1	Green Areas	
78.1	71.9	70.6	67.5	51.3	54.4	59.4	53.8	Tech.& Build. materials	Sustainability
66.9	63.1	66.1	63.1	55.6	56.3	60	58.1	Environmental suitability	

Conversely, the integration of technology and sustainable building materials showed a significant increase, rising from a moderate 54.72% in the first period (A) to a high 72.02% in the second (B). Environmental suitability also improved, with a moderate rating of 57.5% in the first period (A) and a high rating of 64.8% in the second period (B) (Figure 7). See Table 5, Figures 8.

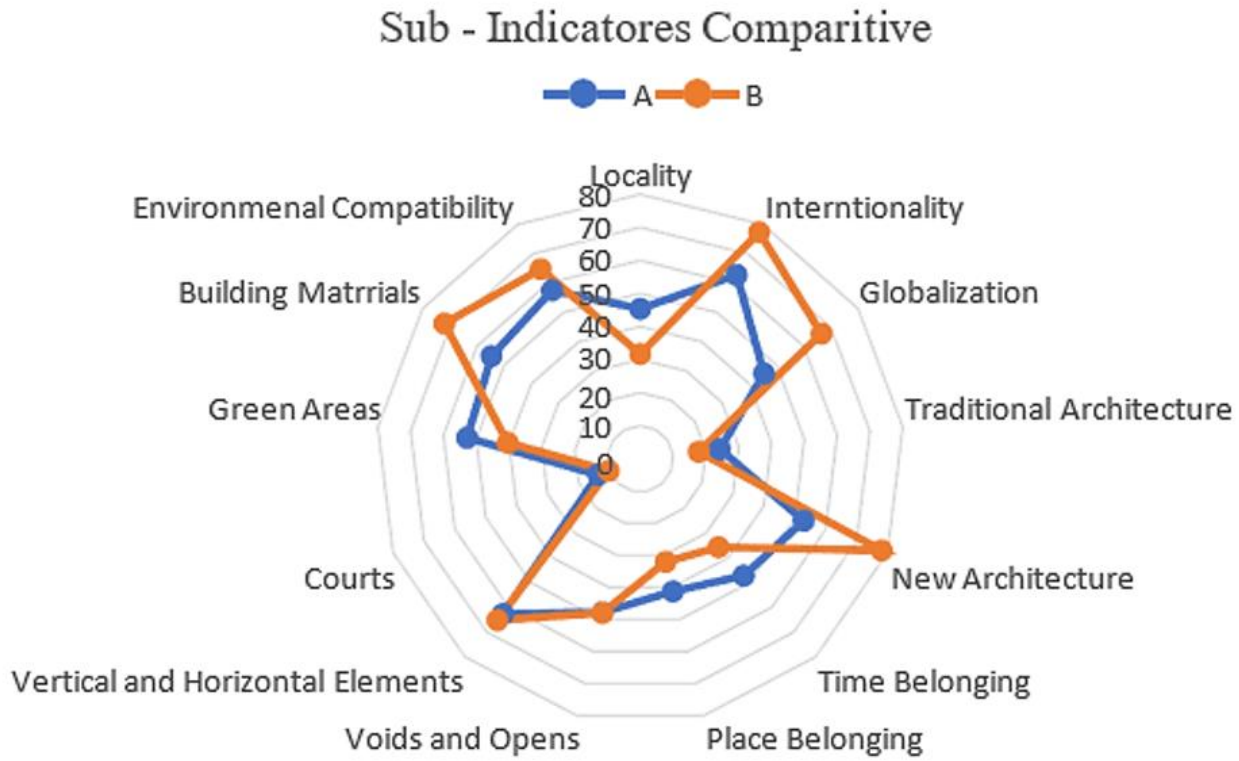

Figure 8.
The comparative and the relationship between the indicators of Culture and Sustainability in different periods A and B.

The results of this study highlight a decline in the integration of cultural elements in residential architecture in Sulaymaniyah, mirroring broader global trends where modernisation often leads to cultural homogenization [20]. Similar studies in other regions, such as Zhang [8] on Beijing's courtyard houses, have demonstrated that urbanisation reduces traditional housing practices. However,

Edelweiss Applied Science and Technology
ISSN: 2576-8484
Vol. 9, No. 6: 16-36, 2025
DOI: 10.55214/25768484.v9i6.7748

unlike previous research primarily focused on spatial and material changes, this study provides an integrated perspective combining cultural identity, sustainability, and modernisation.

Moreover, the findings align with the argument by Opoku [18] who emphasises that cultural sustainability should be considered the "fourth pillar" of sustainability, alongside economic, social, and environmental factors. The observed shift in Sulaymaniyah's housing patterns suggests that sustainability policies should incorporate cultural considerations rather than focusing solely on environmental and economic factors. This reinforces the necessity of hybrid housing models that preserve cultural identity while leveraging modern energy-efficient technologies.

9. Discussions

9.1. Transformation of Residential Housing in Sulaymaniyah

The results of this study indicate a significant transformation in Sulaymaniyah's residential housing patterns between 1980 and 2020. Traditional Kurdish architectural features, such as thick walls, internal courtyards, and locally sourced materials, were dominant in the 1980-2000. However, from 2001 onwards, there has been a rapid adoption of modern housing designs characterised by open floor plans, imported materials, and energy-intensive construction techniques.

The field observations revealed that while some houses still incorporate traditional elements, their functionality has diminished due to changes in lifestyle, construction regulations, and urban planning policies. Additionally, the increased reliance on reinforced concrete and glass in modern buildings has impacted energy efficiency, often leading to higher cooling and heating demands.

9.2. Cultural Identity and Architectural Evolution

A thematic analysis of interview responses revealed concerns among architects and urban planners about the waning architectural identity of Sulaymaniyah. Old housing types were built to accommodate social interaction as well as climate needs, while current housing focuses on modern taste instead of cultural relevance. Several interviewees observed that many new housing developments, for example, lack design features that make natural ventilation more feasible and thus detract from their sustainability.

Comparative analysis between traditional and modern housing revealed:

- A decline in the use of indigenous materials, such as stone and adobe, was replaced by concrete and glass.
- A shift from inward-facing courtyards to outward-facing balconies and terraces alters social dynamics.
- Reduced integration of passive cooling techniques, increasing reliance on mechanical HVAC systems.

These findings indicate that while modernisation has brought efficiency and economic benefits, it has also led to the loss of cultural values embedded in traditional housing structures.

9.3. Sustainability Performance of Traditional vs. Modern Housing

The results of a visual and geographical examination of the houses that were chosen for the case study revealed insights into the performance of various types of housing systems in terms of sustainability. Traditional homes with thick walls and courtyards demonstrated better thermal comfort and lower energy consumption than modern homes relying on artificial cooling and heating.

The evaluation of environmental suitability included the following:

- Thermal Comfort: Traditional homes maintained more stable indoor temperatures due to their thermal mass, whereas modern homes exhibited higher temperature fluctuations.
- Energy Efficiency: Houses from 1980-2000 showed lower energy consumption, while newer constructions depended more on non-renewable energy sources.

Edelweiss Applied Science and Technology
ISSN: 2576-8484
Vol. 9, No. 6: 16-36, 2025
DOI: 10.55214/25768484.v9i6.7748

- Material Sustainability**:** Locally sourced materials reduced carbon footprints in older homes, whereas modern constructions relied on imported, high-carbon-emission materials.

These results suggest that integrating traditional sustainable practices into modern designs could enhance energy efficiency and environmental compatibility.

9.4. The Role of Globalization in Housing Changes

Globalisation has played a critical role in shaping Sulaymaniyah's housing trends. The influence of international construction techniques and materials has led to a standardisation of residential architecture, making it less reflective of local identity. The study's archival research showed that prior to 2000, most houses were built following traditional methods that evolved over centuries to suit local climatic conditions. However, since the early 2000s, foreign architectural influences have gained prominence, leading to:

- Increased use of prefabricated materials: These materials, while cost-effective, often do not align with the region's environmental conditions.
- Adoption of Western-style layouts: Many new residential buildings prioritise open floor concepts, reducing the natural ventilation and cooling effects present in traditional homes.
- Emphasis on high-rise living: Though addressing population growth, vertical housing solutions often disconnect residents from traditional community-based structures.

While globalisation has introduced technological advancements, it has also increased the need for culturally sensitive housing solutions that integrate local traditions with modern functionality.

9.5. Proposed Framework for Sustainable Cultural Housing

This study proposes a hybrid housing model incorporating traditional and modern sustainability practices based on the findings. Key recommendations include:

Table 6.
Proposed Framework for Sustainable Cultural Housing - A hybrid model blending traditional and modern sustainability practices.

Recommendation	Description
Reintroducing Passive Design Strategies	Utilise thick walls, shaded courtyards, and cross-ventilation to enhance energy efficiency.
Using Local Materials	Encourage the use of locally available, low-impact materials to reduce the carbon footprint.
Promoting Cultural Identity	Integrate traditional Kurdish architectural elements into contemporary designs, such as carved wooden doors and patterned brickwork.
Enhancing Community-Oriented Design	Promote housing layouts that foster social interactions and collective living spaces, similar to traditional courtyard designs.

The hare the ideas of modern simplicity contrast with the rich heritage, leading to a disturbed environment within the residential spaces, which remember the womb at home. In this sense, on the one hand, these modern housing developments in Sulaymaniyah have brought some comfort and efficiency into people's lives; however, on the other hand, a disconnect with culture and environmental impact comes with those developments as well. Urban development strategies that balance the preservation of Sulaymaniyah's architectural heritage with the advancement of new technologies for sustainability should be the goal of policymakers and architecture professionals.

Furthermore, the use of culturally relevant architectural features has the potential to increase the sense of identity and belonging that residences have, thus establishing closer relationships with the community. In the future, housing policy should include incentives for environmentally responsible building approaches based on the area's cultural traditions and local knowledge.

Edelweiss Applied Science and Technology
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10. Conclusion

The present study investigates this aspect and the impact of cultural elements on the sustainability of residential housing in the Iraqi city of Sulaymaniyah during the years 1980–2020. Local cultural influences have largely guided the region's residential architecture in the past, but this has reduced considerably in favour of globalisation and technology. This transition poses challenges for preserving cultural sustainability, as modern construction techniques often overshadow traditional design principles.

The main result of the research is a balanced strategy that harmoniously includes traditional and contemporary sustainable systems. For decades, the environment has been characterized by technological advancements, and their application should also cover the residential sector. From a technological point of view, what was sustainable and inexpensive in the past, like building houses of mud and enjoying sunshine, is hard to find today. However utilizing innovation to combine modern and traditional architecture can be a win-win, where the environmental conservation benefits will be realized, and cultural identity will be preserved.

This study's findings are expected to call for culturally responsive housing development that respects, protects, and celebrates the region's Indigenous heritage and responds to future needs. This in itself are a challenge for decision-makers, architects or urban planners to maintain the cultural identity of the communities and set realistic plans for sustainable concepts in residential housing within the sulfur city. Future studies should explore ways to accomplish this balance.

Transparency:

The authors confirm that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.

Copyright:

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