



## Article

# Sustainable Urban Heritage: Assessing Baghdad's Historic Centre of Old Rusafa

Mazin Al-Saffar

Manchester School of Architecture, Manchester Metropolitan University, Manchester M1 7ED, UK;  
m.al-saffar@mmu.ac.uk

**Abstract:** Baghdad's historical centre is Old Rusafa, which has a long history dating back over a thousand years. The area enclosed within the old wall is approximately 5.4 square kilometres and contains nearly 15,700 buildings. The city's old core contains significant heritage buildings that belong to the Abbasid Empire (762–1258) and the Ottoman Period (1638–1917). This paper assesses Baghdad's historical centre and urban heritage. It addresses how the urban fabric has faced irreparable damage, a weak definition of demands, and an ambiguous formulation of what to preserve. The research examines Old Rusafa's dense irregular fabric, significant old souqs, heritage mosques, historical buildings, and traditional Baghdadi courtyard houses. The research implements various research strategies at different levels to evaluate the current condition of the built heritage in the city centre. It adopts a mixed methodological research approach that brings information from both qualitative and quantitative methods to address the research problems. The paper argues that achieving sustainable urban heritage requires considering efficient and sustainable strategies that drive urban evolution and encourage historic centre revitalisation towards sustainable heritage conservation. The outcomes of this paper raise awareness of the significance of safeguarding Baghdad's Islamic architecture and the sustainable reuse of its uniquely built heritage stock.

**Keywords:** sustainable heritage conservation; urban heritage; architecture heritage; city centre; historic city; sustainable future; conservation and participation; critical heritage theory; cultural heritage and intangible heritage; tangible and intangible heritage



**Citation:** Al-Saffar, M. Sustainable Urban Heritage: Assessing Baghdad's Historic Centre of Old Rusafa.

*Architecture* **2024**, *4*, 571–593. <https://doi.org/10.3390/architecture4030030>

Academic Editor: Avi Friedman

Received: 26 April 2024

Revised: 23 July 2024

Accepted: 7 August 2024

Published: 9 August 2024



**Copyright:** © 2024 by the author. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

## 1. Introduction

Baghdad is one of the leading cultural centres in the Middle East. It has been a centre of political and economic operations since it was chosen by Caliph Al-Mansur as his capital city for the Abbasid Empire in 762 CE. Up to the 21st century, the city had been occupied multiple times by different groups, such as Mongol leader Hülegü in 1258, the Ottomans (1638–1917), the British (1917–1932), and the Americans (2003), who have all left their marks in varying degrees. Baghdad's social structure is complex and has different types of communities that construct the city's cultural identity. During the 20th and 21st centuries, civil wars, migration out of the city, and an unstable political climate heavily affected Baghdad's cultural heritage. Since the 1950s, the internal and external immigration of original communities out of Baghdad's city centre—such as Muslims, Christians, and Jews—has been one of the issues that impacted the social demographic change in the city, where they left behind many heritage buildings and houses. Some of these heritage assets are still empty and have ultimately deteriorated or face the threat of demolition.

Over the last five decades, many studies and projects have been carried out by UNESCO, ICOMOS, and other organisations to conserve historic places in the world's cities. Iraq has participated in the efforts of UNESCO for the preservation of its cultural heritage by proposing several sites for inscription to the World Heritage Committee as having outstanding universal value and some of the most important archaeological collections in the world (Hatra, Ashur, Samarra, traditional Iraqi houses, and the Iraqi Museum) [1]. A

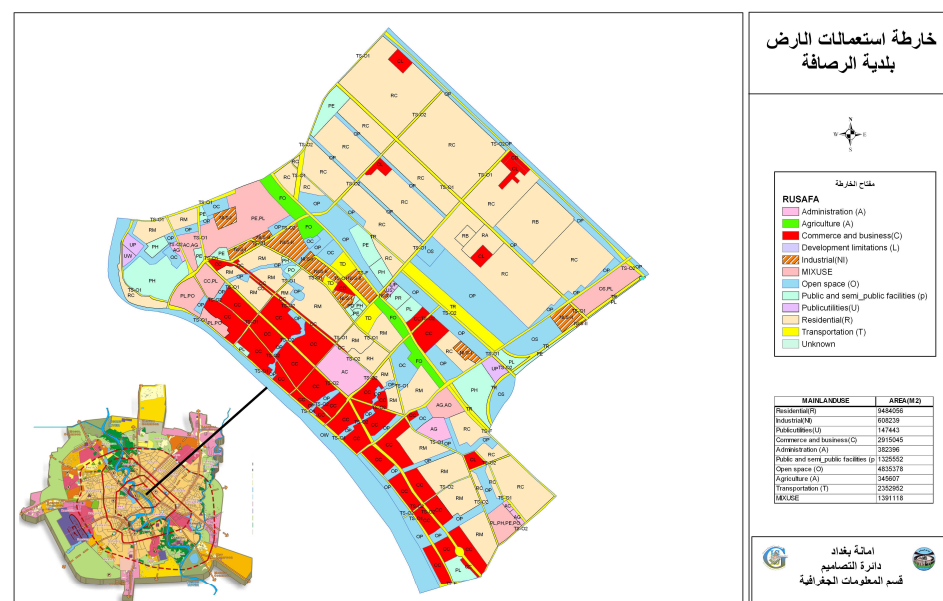
total of 20,000 sites were estimated by Iraqi heritage experts to require protection due to the risk of significant deterioration. So far, about 700 archaeological sites have been discovered in Baghdad alone [2,3]. Therefore, the preservation of Iraq's and Baghdad's heritage is quite complex and faces multiple challenges. This paper addresses some of these challenges and assesses how they impact the built heritage of Baghdad. In addition, the paper also explores the relationship between urban heritage and socio-economic constraints. It argues that a better understanding of urban heritage will depend upon understanding both its heritage context, the categories of heritage values, and influences from more contextualised socio-economic and environmental forces.

### 1.1. Materials and Methods

This research is based on a combination of theoretical and empirical data to ensure that research questions are answered by using appropriate methodologies. A mixed methodology is applied, which combines quantitative and qualitative processes of analysis to assess the old centre of Baghdad's current situation, problems, and challenges [4,5]. In addition, a case study method is employed as a research tool to analyse the Old Rusafa built heritage [6].

Specifically, this paper focusses on the physical built heritage in an area located between Al-Rashid Street and the Tigris Riverfront in Old Rusafa. In this research, various assessment strategies are implemented, including a walking method, a serial vision method, and an observation ethnographic approach—all of which assess the built heritage situated within the old centre [7]. Qualitative and quantitative approaches are ultimately two different methodological systems selected to accomplish the aim of the research study [8]. The nature of this study can be defined as a multi-strategy approach, where each method integrates and builds on the strength of the other [9].

In this paper, the information has been collected from diverse sources associated with the various departments of the Municipalities of Baghdad, the Presidency of the Mayorality of Baghdad, the Baghdad Heritage Department, the Urban Planning Department of Baghdad, the University of Technology, and the University of Baghdad. In all phases of the case, a wide variety of data from different sources has been integrated; however, the source and type of data depend on the case and its nature [4]. Therefore, investigating the historic centre of Old Rusafa (the area between Al-Rashid Street and the Riverfront) as a case study area can produce a comprehensive understanding of the particular needs for sustainable urban heritage development in one of the significant historical zones (Figure 1).



**Figure 1.** Rusafa District—Old Rusafa land use. Source: author, according to [10].



### *1.2. Conservation and Cultural Built Heritage*

Substantial changes in the urbanised world have led to the formation and necessity of architectural and urban conservation. Many challenges emerge in the conservation of built heritage, but the main one is concerning how original uses can be changed while still conserving the importance of the area and its buildings [11]. Conservation aims to be part of a broad set of procedures for promoting the existing physical built environment and affects all citizens in a community. Architectural conservation is something that embraces different forms and subjects such as urban design, housing, environmental issues, and renewal [12]. Built heritage can also create conflict between issues unrelated to built heritage when applying conservation methods. Undeniably, conserving built heritage is a complex process that requires consideration of socio-economic and environmental dimensions [13].

Culture is a necessity and can play an essential role in conserving Baghdad's city centre's urban heritage. People's interest in dwelling in historic city centres is not only due to socio-economic factors but also different activities and the various cultural and urban strata [14]. The challenge in Old Rusafa is whether urban heritage conservation plays a significant role in promoting social life and motivating new generations to move back to the city centre. The key question is how can the preservation of the physical built heritage sustain conservation strategies in light of multiple challenges: poor management, deteriorating built heritage, and migration? Heritage conservation in Baghdad is impacted by different elements such as architectural, urban planning, socio-cultural, economic, and property rights aspects. These aspects have been identified as essential elements in "heritage disputes surrounding proposals to develop built-heritage properties, and as such, they are instrumental in grounding a conceptual frame" [13]. Conserving Baghdad's built heritage can play an important role in promoting the city's aesthetic value, identity, cultural value, significance of place, as well as economic and commercial value [15]. It also develops the city's historical physical environment and ensures its continuity as an attractive place to live. Urban conservation has become a policy of redevelopment in historic places and social-economic advancement in various cities in the world, such as Johannesburg in South Africa, Penang in Malaysia, Singapore, and Hong Kong [16]. Therefore, urban conservation in Baghdad's old centre requires comprehensive spatial analyses and investigations devoted to the evaluation of urban historic areas [16–18].

During the 19th and 20th centuries, the traditional compact urban fabric and cultural heritage in Baghdad suffered from poverty, migration, overpopulation, unemployment, and segregation [19]. However, historical buildings going back to the early 13th century, such as the Al Mustansiriya School, the Abbasid Palace, and the Al Khulafa Mosque, have all resisted these challenges and new forms of transformation. In the 20th century, the Municipality of Baghdad, due to a lack of expertise, financial constraints, wars, civil wars, and unstable political situations, did not consider the importance of revitalising the built heritage that represents the city's social, economic, and environmental values embedded in its heritage. Consequently, this has led to irreparable damage to the built heritage of the city. Many heritage buildings have been neglected and pulled down in Baghdad without clear conservation strategies to conserve the city's built and cultural heritage.

### *1.3. Sustainable Built Heritage and Conservation*

The beginning of international initiatives to combine both sustainability and conservation was in 1972 by the United Nations (UN) and UNESCO. These initiatives did not emphasise the words sustainability and conservation at that time, as the emphasis was primarily on the environment and protection [20]. The concept of sustainable built heritage has been examined in ways to investigate the advantages of the integration of sustainability principles and built heritage conservation processes and policies [21–24]. The built heritage can be considered a main aspect of sustainable built environment management by participating in the domains of socio-economic and environmental sustainability [25].

The urban environment in Baghdad has been faced with unprecedented change in the last century. Many elements are leading to change in the urban environment, such as demo-

graphic changes, globalisation, uncontrolled development, and economics, which directly affect the conservation of historic urban environments [26]. Therefore, the conservation of Baghdad's built heritage can offer sustainable solutions to many problems that afflict traditional areas, such as social, economic, and environmental problems [27]. Sustainable urban heritage in Baghdad can be accomplished through creative ideas and community engagements in the city's future urban planning [24].

#### *1.4. Built Heritage Conservation and Citizen Participation*

In recent years, governments, practitioners, experts, academics, and international organisations have considered heritage as urban areas rather than single monuments. They moved towards utilising citizen participation to preserve, manage, and control urban conservation plans. The traditional urban fabric in historic cities in developing countries suffers from similar cases. Firstly, they are currently facing fast population growth, poor infrastructure, and demolitions of urban heritage. Secondly, and most importantly, they ignore the significance of citizen participation and opinion as an essential element to resolving problems that might appear in the decision-making and policy-making processes. The bottom-up approach has become an essential factor in cultural heritage issues, creating new opportunities for citizens' participation in the decision-making process of urban conservation. Citizen participation can improve the practice of urban conservation and assist policy-makers in identifying opportunities and challenges [28].

Nowadays, enhancing the concept of identity and traditional social values is a tendency in Old Rusafa. Baghdad's old centre is represented by the important role of culture, religion, and the most significant element of social structure. The physical and social situations are depressed in this traditional area; however, it is still the source of cultural inspiration for citizens, and people still prefer to go back and live in the traditional neighbourhoods where they grew up. This area has community representatives who could participate in and promote conservation processes more than the official administrative body in such areas [27]. Politics and top-down decision-making issues in Baghdad make it more difficult to formulate a plan for urban modernity that is consistent, specific, and unanimously accepted [29].

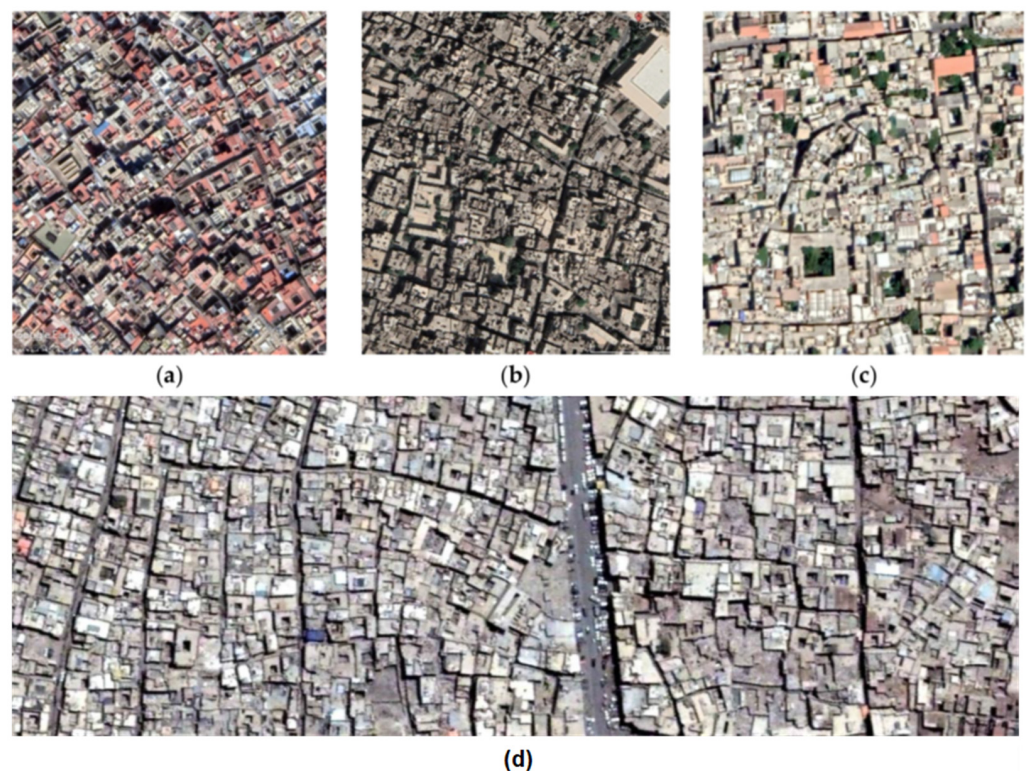
The Iraqi Government and the Municipality of Baghdad, between 1956 and 2011, appointed various international architects and planners, such as P.W. Macfarlane in 1956, Doxiadis in 1958, Polservice in 1973, and JCCF in 1987, to prepare Baghdad's future development master plan. However, these initiatives did not consider citizens' participation as a main element in the city's sustainable future development [5,27]. These plans have concentrated instead on demolishing big parts of the built heritage in the city and on simulating Western countries' methods of urban growth. Consequently, Baghdad's old centre-built heritage, traditional urban fabric, and heritage buildings have deteriorated and been left without any form of preservation strategy, with many heritage properties being demolished to make way for contemporary buildings that have little cultural relation to Baghdad's culture and identity. Academic research has urged decision-makers to promote public consultations in the field of heritage, yet this strategy has not been extensively applied in Baghdad. Active community engagement in preserving heritage can enhance sustainable urban heritage development [30]. Thus, the Municipality of Baghdad should consider Baghdad residents' participation or a bottom-up system in the city's future development plans if they want to conserve the city's urban heritage sustainably.

#### *1.5. Conservation Heritage in Arab Cities*

To understand existing challenges and possible tools to be used in heritage protection, a comparative perspective can be useful. Comparison in heritage studies can help explore existing problems in a larger context while overcoming the problem of policy insularity [15,31,32]. Thus, lessons gleaned from nearby Arab cities are of importance.

Arab cities, especially in the historical city centres, share some similarities, such as compact urban fabric, narrow passageways, and courtyard houses. Despite their differences

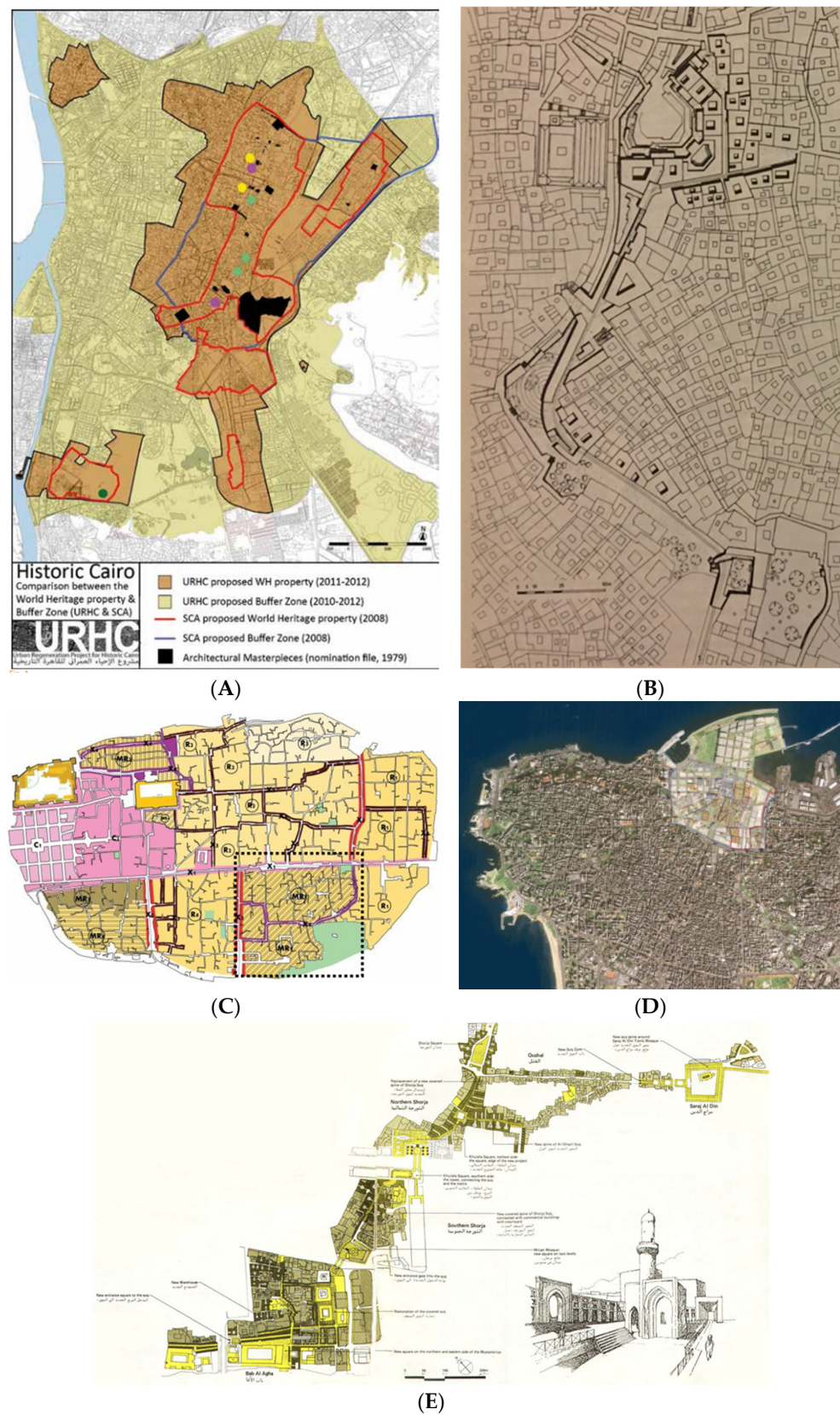
in geographical topography, climate, and location, they share the same socio-cultural characteristics and local construction materials and systems (Figure 2) [33]. The Islamic urban heritage that formed Arab cities' heritage centres faced many challenges of modern development and destruction of the heritage-built environment. Most of these historical centres are rich with many heritage buildings and traditional architectural values that have been destroyed and replaced by modern high-rise buildings [34,35]. The owners of heritage buildings lost interest in preserving their properties and moved out to new modern areas, as can be seen in the cases of Baghdad, Cairo, Tunis, downtown Beirut, and Damascus [36]. Many properties in Baghdad's city centre were abandoned, and some were expropriated and confiscated by the state following the hollowing out of the city centres, the out-migration of a huge Jewish community in the 1950s, and Christians and Muslims throughout the 20th century. Thus, improving the quality of urban areas in recent years has become a response to the challenges displayed by citizens' mobility, which require the physical renewal of declining inner urban spaces flexibly.



**Figure 2.** Arab cities' historic urban fabric. Four cities having the same inner-oriented openings and narrow irregular shaded pedestrian networks: (a) Rabat historic urban fabric; (b) Cairo historic urban fabric; (c) Damascus historic urban fabric; (d) Baghdad historic urban fabric. Source: author 2024, according to [33].

In the Arab world, many countries have witnessed a spectacular rapid urban evolution after gaining independence in the 1950s and 1960s. Arab cities' municipalities such as Cairo, Tunis, downtown Beirut, Damascus, and Sana'a have shown that they cannot afford to preserve and rehabilitate the majority of their urban heritage and monuments [36]. Thus, international initiatives proposed to preserve some heritage in Arab cities such as Baghdad, Cairo, Tunis, downtown Beirut, Damascus, Fez, and Aleppo by their city governments (Figure 3). Studies by international organisations, such as the United Nations (UN) and UNESCO, the World Heritage Committee (WHCom), and ICOMOS, indicate that Arab cities have lost some of their built heritage and require an urgent sustainable conservation plan to protect the reset [36–38].





**Figure 3.** Arab cities rehabilitation plan. Source: author, according to [37–41]. (A) Historic Cairo rehabilitation plan. Source: [37]. (B) Fez rehabilitation plan. Source: [38]. (C) Old City of Damascus plan. Source: [40]. (D) Solidere master plan: Beirut. Source: [41]. (E) Conservation of main souks of Old Rusafa, Baghdad, JCP Plan 1984. Source: [39].

Cultural heritage and intangible heritage in historic Arab cities have suffered from many problems in recent years, such as fast population growth, poor infrastructure demolition and neglected urban heritage. Arab cities' city councils ignore the significance of citizen participation and opinion as an essential element in resolving problems that might appear in the decision-making, policy-making process and urban heritage conservation. Many built heritage conservation plans prepared to conserve these traditional areas were neither successful nor sustainable due to the narrow scope of urban heritage projects, lack of funds and unsuitable conservation methods adopted. Urban conservation methods that have been considered to face these challenges did not participate in conserving Arab cities' heritage context professionally and sustainably [33].

The process of physical growth in most historic Muslim cities over the past eight decades was determined by the colonial powers in setting out their new modern area. The possible range of urban interventions was defined by two extremes "One consisted in superimposing the new city on the old historic fabric by cutting out large new roads and sites for major public buildings-an approach which entailed the progressive demolition of historic urban structures by the expanding new facilities. The other one consisted of setting up completely new colonial cities on virgin land, without seeking any interface with pre-existing urban structures" [38] (p. 177).

The context and the abovementioned challenges in preserving the built heritage of Arab cities, also explain the multiple hurdles faced by decision-makers and preservationists in Baghdad. A first step towards securing the future of heritage in Baghdad is mapping the existing inventory of heritage structures in the urban historic centre. In addition, it is essential to understand existing policies and heritage plans, their strategies, the cultural elements they protect, and the instruments they utilise to achieve sustainable and long-term heritage protection.

## 2. Assessing Baghdad's Urban Heritage

The capital, Baghdad, is the largest city in Iraq and contains four historic areas: Old Rusafa, Al-Karkh, Al-Adhamiya, and Al-Kadhimiya (Figure 4). The area of Old Rusafa represents the main historic centre and is an integral part of the central business district located on the eastern bank of the Tigris River. The importance of the historical centre is not only local but also regional and national dimensions. The old centre comprises the largest concentrations of historical workshops and souqs, as well as some of the important mosques and government buildings in the country. The main significant features in the historic part of Baghdad are narrow alleys, natural shading, human-scale patterns, high density/low-rise living, the hierarchy between public and private space, mixed-use, a walkable, and a zero-carbon environment that provides an extraordinary base towards achieving sustainable urban heritage. Old Rusafa contains several significant historic buildings: 132 monuments are listed, twenty-one of which belong to the Abbasid Empire (762–1258) and the rest to the Ottoman Period (1638–1917). Therefore, it is considered an important heritage that demands emergency protection for its historical value [39].

The old core of Baghdad is a unique traditional area, and historic components that survive to this day consist of important heritage buildings, spines, and monuments in clusters that show the traditional urban sense of the city (Figure 5). The heritage value represented by the traditional urban fabric contains many significant mosques, such as the Morjan Mosque, which was built in 1356 AD; monumental buildings, such as Al-Mustansirya School, Abbasid Palace, and churches, including St. Joseph's Cathedral, Jewish heritage schools, such as Masooda Saliman School for boys, and traditional markets such as Al-Sharjah Souk (Figure 6). The traditional Baghdadi house is another type of historic building in the old centre. These houses are now squeezed into the inner part of Old Rusafa, between the service and industrial parts of Sheik Omer Street and the predominantly commercial and business part of Al-Rashid Street.



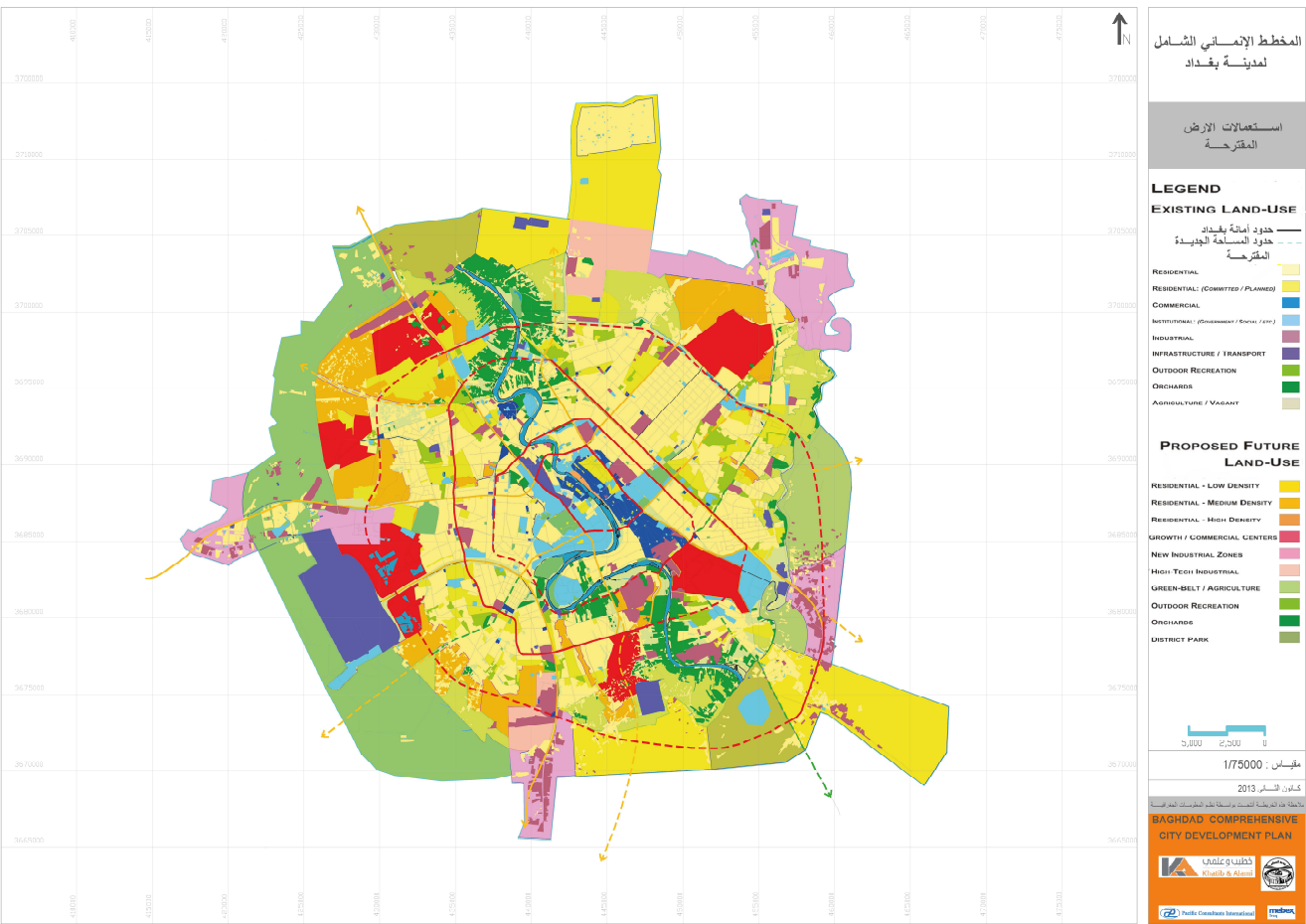


Figure 4. Baghdad's comprehensive development plan for 2030. Source: author, according to [10].

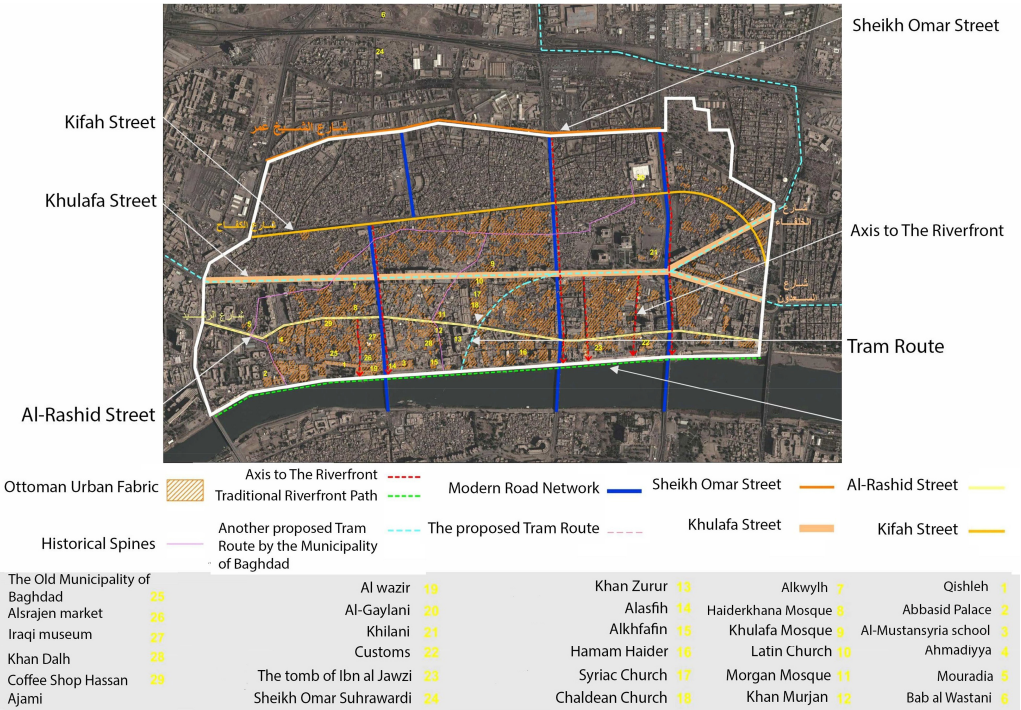
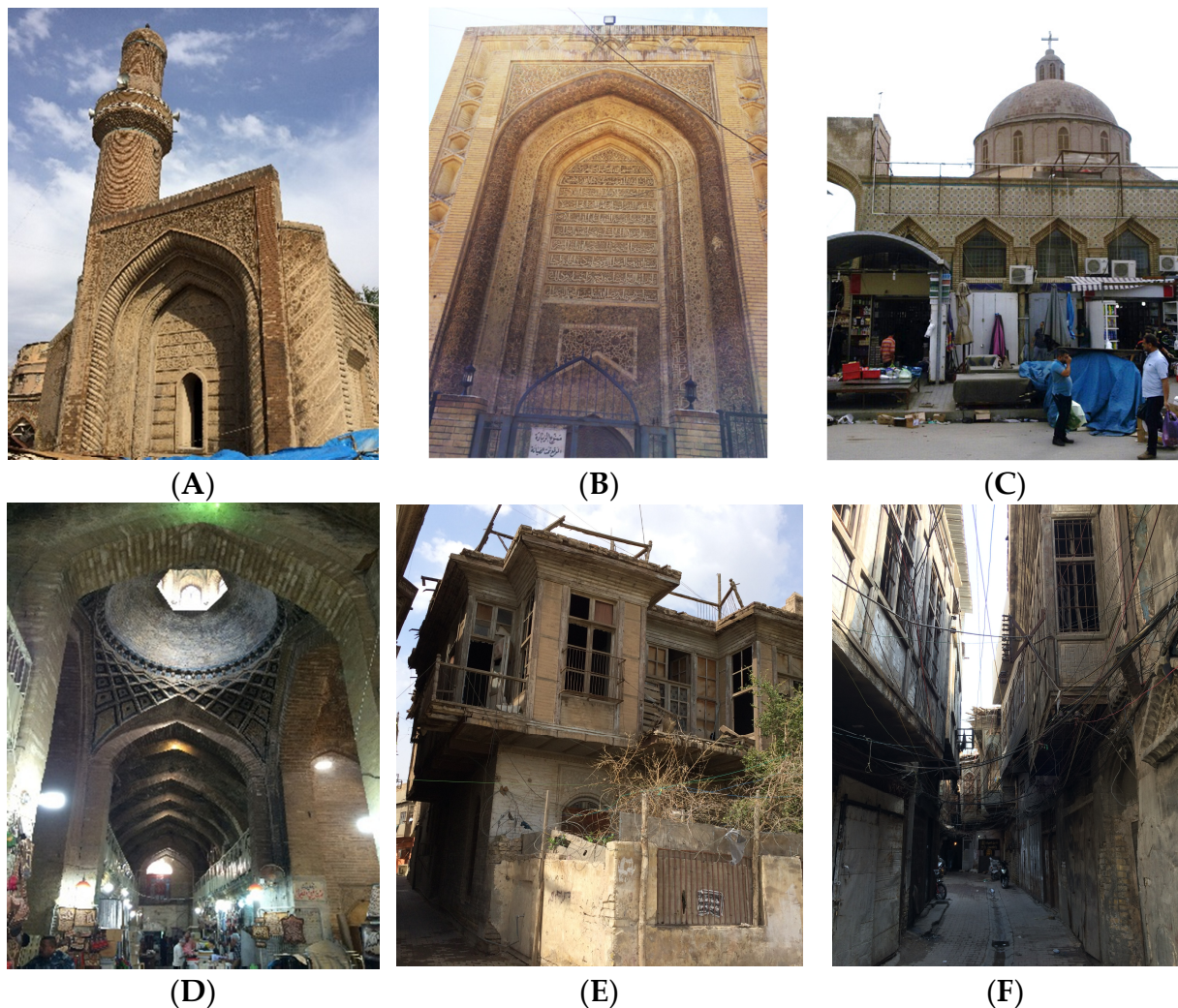


Figure 5. Built heritage in Old Rusafa. Source: author, according to [42].



**Figure 6.** Built heritage in Old Rusafa. Source: author's original images. (A) Morjan Mosque (1356 AD). (B) Al-Mustansiriya School (1227 CE). (C) St. Joseph's Cathedral (1643–1848). (D) Traditional souks. (E) Traditional Baghdadi house. (F) Traditional urban fabric-form.

During the last few decades, Old Rusafa has suffered both from its monuments and historic neighborhoods; however, enough fabric remains to evoke its past grandeur. The JCP Master Plan in 1984 was a significant plan prepared to preserve Old Rusafa urban heritage (Figure 7). The comprehensive surveys by JCP in 1984 showed that the historic area contains 3900 houses, which mostly belong to the late 19th and early 20th centuries, sixty-three mosques, five tombs, six madrassas, eleven khans, six hammams, four churches, nine souqs, and three gates. Of the listed 132 monuments in the old area of Rusafa, only 21 monuments belong to the Abbasid Empire (762–1258), while the majority are from the Ottoman Period (1638–1917) [39]. The *State of Iraq Cities Report* (SICR) 2006–2007 reported that “the structures of historic areas have been modified, with many buildings evolving towards commercial and government use. The city has many seriously deteriorated structures without infrastructure, leading to poor internal sanitation, drainage problems and effluences” [27]. This has led to the migration of many families from the old centre into new, modern areas in Baghdad. More than 50% of all buildings in the case study were in poor or very poor structural condition. The main reason for the deterioration of the physical and environmental heritage conditions of Old Rusafa is the insufficiency of a comprehensive master plan that can adapt sustainable urban heritage design strategies. Moreover, high population densities, clearances for new roads, neglect of the historic urban fabric, and the

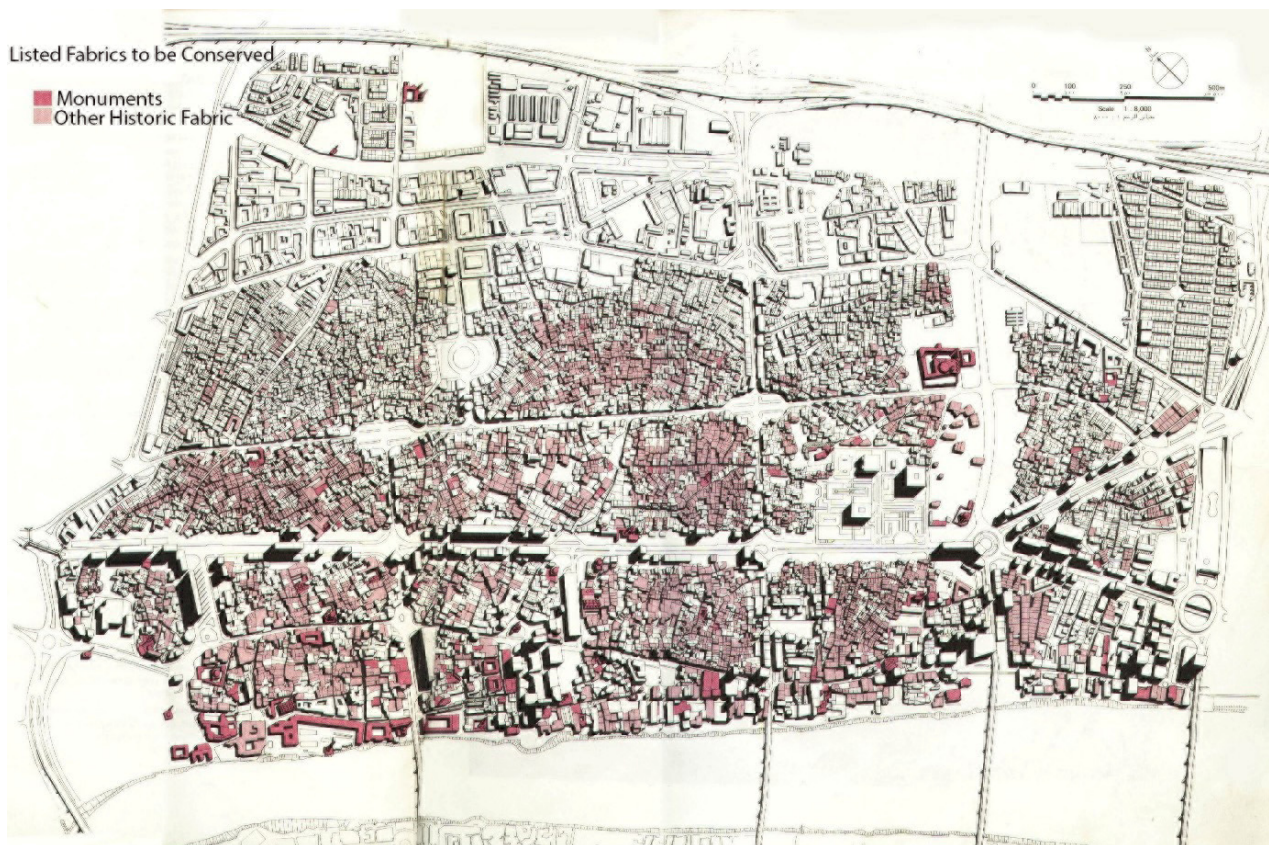






sides of these new roads that were given over to wholesale redevelopment. Huge areas of old urban fabric were demolished, and the rest of the traditional urban fabric was ignored. The method of transforming the city centre from the traditional to the modern has been affected not only physically but also socially by the departure of the original people of Old Rusafa into new modern areas. A new community from rural areas searching for employment and a better life filled the social vacuum in the old city by renting traditional houses, usually one family per room. Furthermore, property owners were not interested anymore in preserving their properties. These circumstances have led to the acceleration of physical deterioration.

Consequently, in most of the traditional areas in Baghdad, especially the area of Old Rusafa, the younger generation is abandoning these areas due to the lack of standard infrastructure, the deteriorating built environment, rundown houses, air pollution, and a lack of modern facilities. Thus, the traditional centre needs significant conservation processes under new sustainable methods to preserve city culture and urban heritage (Figure 9).



**Figure 9.** Listed fabrics to be conserved in Old Rusafa. Source: [39].

### 3. Assessing the Old Rusafa Historical Centre: The Area between Rashid Street and the Riverfront

Old Rusafa is the historic centre of Baghdad, and due to that, its fabric has been under pressure from modern development and has suffered tremendous losses in its traditional form. However, there is still an opportunity to preserve the rest of the unique fabric by promoting these areas with new facilities and fixing broken structures (Figure 10). Thus, this research investigates the historic centre of Old Rusafa as a case study area, which can produce a comprehensive understanding of the need for sustainable urban heritage development. Fieldwork was the method used to gather information for this research. The data was collected from diverse sources associated with the various municipality departments of Baghdad, the Presidency of the Mayoralty of Baghdad, the Baghdad Heritage

Department, the Urban Planning Department of Baghdad, the University of Technology, and the University of Baghdad [4,6,9,43].



Urban Heritage Structure 1983: ■ Existent Heritage Urban Fabric ■ Modern Project

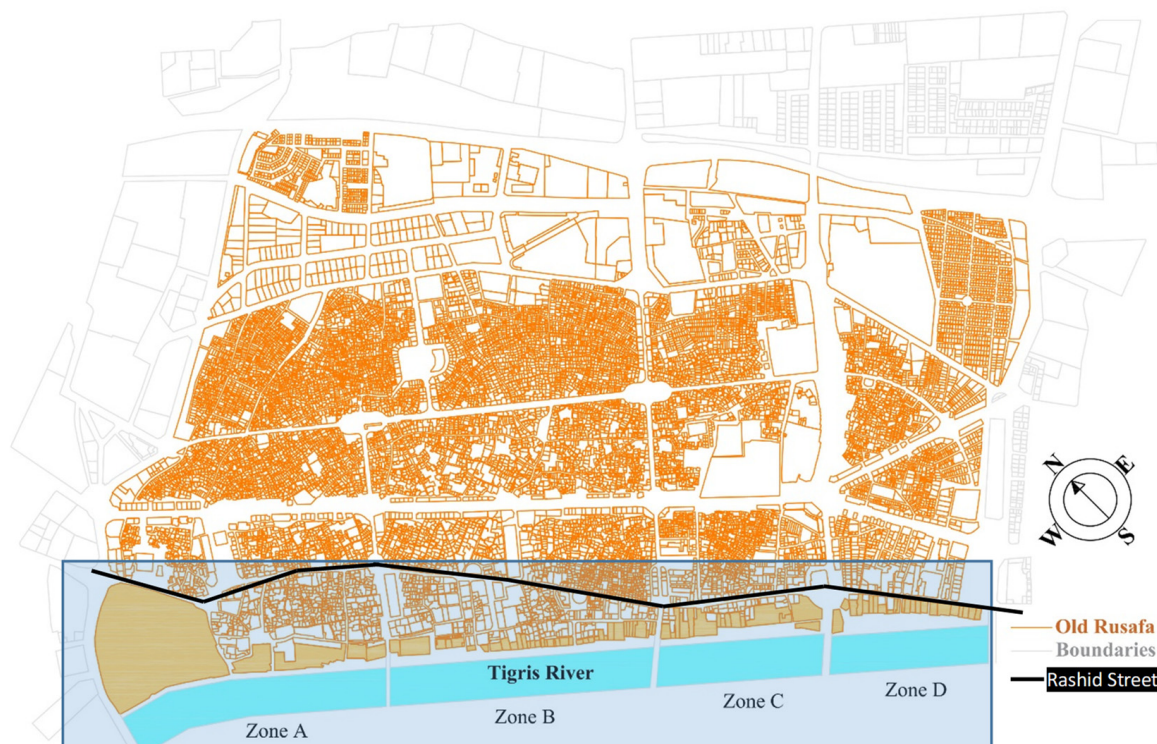


Urban Heritage Structure 2009: ■ Modern Project ■ Lost Urban Heritage ■ Heritage Urban Fabric

**Figure 10.** Heritage urban fabric of the area between Al-Rashid Street and the Tigris riverfront in Old Rusafa between 1983 and 2009. Source: Author 2024, according to [44].

The area between Al-Rashid Street and the Riverfront is a very important part of Old Rusafa that might pose both conservation and development problems. The Municipality of Baghdad prepared several proposals to rehabilitate the area, which include detailed assessments of the existing architectural heritage and general design guidelines. One of the significant comprehensive urban conservation master plans for Old Rusafa was submitted by JCP (Japanese planners, architects, and consulting engineers) in 1984. This research examines the area between Al-Rashid Street and the Tigris Riverfront in Old Rusafa. The area consists of a longitudinal strip extending approximately four kilometres between Bab Al-Moatham and Bab Al-Sharqi; therefore, the research focusses on assessing Zone A's built heritage as an example of other zones in the area [2] (Figure 11).





**Figure 11.** The area between Rashid Street and the riverfront in Old Rusafa. Source: author's original image.

### 3.1. Historical Background of Al-Rashid Street and Squares

In the late 19th century, the Ottomans began to cut the first axis in the traditional urban areas and attempted to import Westernisation into the urban evolution pattern [45]. The opening of Al-Rashid Street in 1915, completed by the British in 1917, was the first change in the traditional urban fabric [46]. The traditional-style buildings on Al-Rashid Street had a consistent type, which gave the street a continuous character (Figure 9). However, its unique character is now threatened by numerous high-rise office blocks, traffic jams, parking on the street, and the neglect of its fabric [45]. The street became the most significant feature and the centre of business in Baghdad for decades.

In the urban planning scene, Al-Rashid Street has not only been considered the first modern street in Baghdad but also in Iraq. The traditional street is about 3120 m long and about 12 m wide. It was started by Khalil Pasha in 1915 and completed by the British around 1917. The street linked the two old gates of Old Rusafa and was characterised by its colonnaded paths, traditional two-floor buildings, human scale, architectural unity, and convenient shading paths for pedestrians. The traditional buildings and the variety of architectural styles on both sides of Al-Rashid Street show the story of the development of the old city over the last one hundred years. Its building can be characterised by the workmanship and traditional materials, which have been quite remarkable assets to good design and detailing (Figure 12). The arcade of these traditional buildings along both sides provides a colonnaded walkway approximately 3.5 m wide and 5 m high. Physically and morphologically, this street is divided into four main areas due to the construction of bridges from 1939 to the present that resulted in physically cutting Al-Rashid Street into these parts. Nowadays, there are several highly modern buildings that penetrate the traditional street of Old Rusafa, ignoring the unique character of the street and confusing the urban scene of the historic centre. This has been happening since the 1950s because of a lack of efficient urban design policies and urban development controls. Al-Rashid Street has represented the commercial and cultural centre of Baghdad for many decades, and today it is a part of the CBD area of the capital city [39].





**Figure 12.** Sustainable future development initiative in Al-Rashid Street. Source: [47].

Many significant historical and traditional buildings are located in Al-Rashid Street Zone A, such as Haydar Khana Mosque, which was built by Dawood Pasha in 1827 AD (Figure 13). Heritage buildings in Zone A require short- and long-term sustainable conservation strategies to preserve their heritage as they suffer from deteriorated structures and poor maintenance. In Zone A, several important heritage buildings have unique architectural styles that represent the street and city's cultural heritage. The buildings' heights along Al-Rashid Street, on both sides of Zone A, are between two to three floors with a shaded arcade [2] (Figure 14).



**Figure 13.** Al-Rashid streets A historical buildings and Haydar Khana Mosque. Source: author's original images.



**Figure 14.** Al-Rashid Street architectural styles in Zone A. Source: author's original images.

### 3.2. Historical Background of Tigris Riverfront

The Tigris River is one of the most important natural aspects that have played a significant role in promoting the prosperity of Baghdad from the past centuries until now. It has

been considered the main source of irrigation and development in the surrounding agricultural areas of the capital city of Iraq; furthermore, it has become a space of entertainment and an element of connection with other cities. Three boat bridges crossed the Tigris River and connected Old Rusafa and Al-Karkh during the late Abbasid period (1055–1258), when Old Rusafa expanded into its familiar rectangular form [39].

The morphology of Old Rusafa was influenced by the Tigris and all-important functions that were located on its bank or very close to it, such as the Citadel, traditional souqs, mosques, and monumental buildings. The riverfront is divided into separate areas with various architectural features [48]. However, the riverfront nowadays is almost neglected, and its character has been disturbed by numerous tall buildings that have been built near some magnificent buildings, such as the Al-Mustansiriya School, which was built in 1227.

The Old Rusafa Tigris Riverfront historical buildings may be an attractive area that plays an essential role in promoting city culture and socio-economic and environmental aspects. The Riverfront heritage requires implementing sustainable urban heritage design strategies to conserve its built heritage.

#### Observation Survey for Tigris Riverfront Zone A

In Tigris Riverfront Zone A, a combination of the observation, walking and serial vision methods has been adopted as a qualitative approach for gathering information to evaluate the existing physical urban heritage context and form (Figure 15). In Figure 15A, the Ministry of Defence Building is one of the significant buildings in the area that also represents the old citadel area. During the civil war in 2007, the building was surrounded by a concrete wall to prevent any outside attack, this has led to the separation of the riverfront and the destruction of the continuity and walking activity along the riverbank. The next heritage building to the Ministry of Defence buildings is the Abbasid Palace built between 1180 and 1225 AD (Figure 15B). The traditional building is neglected and suffers from poor conservation of its architectural heritage features and identity, even the area and open spaces between the Abbasid palace and the Tigris Riverfront show poor design strategies that could be developed to attract visitors and tourists and influence the area's socio-economic and environmental aspects. Another important building on the riverbank that is called the traditional school building, its white elevations and structure have been well preserved (Figure 15C).

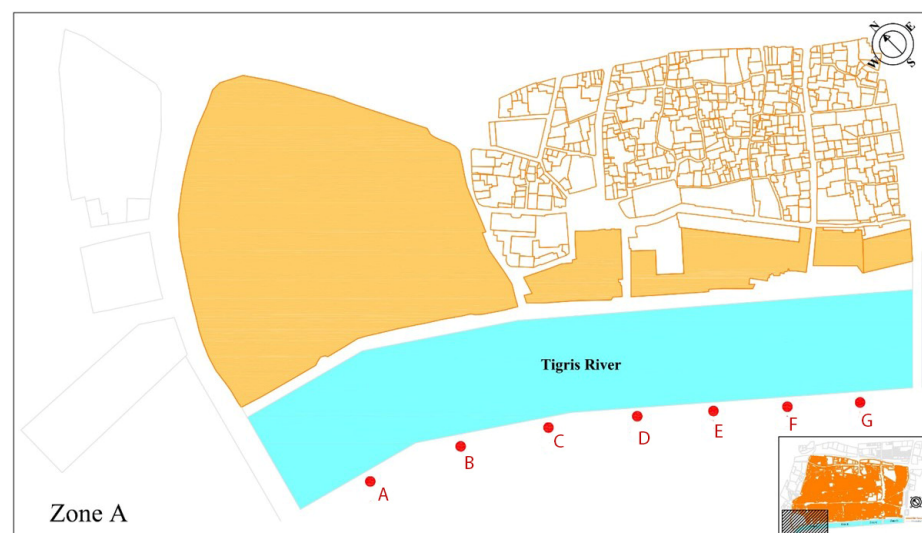


Figure 15. Cont.





**Figure 15.** (A–G): Observation survey for Tigris Riverfront Zone A. Source: author’s original image.

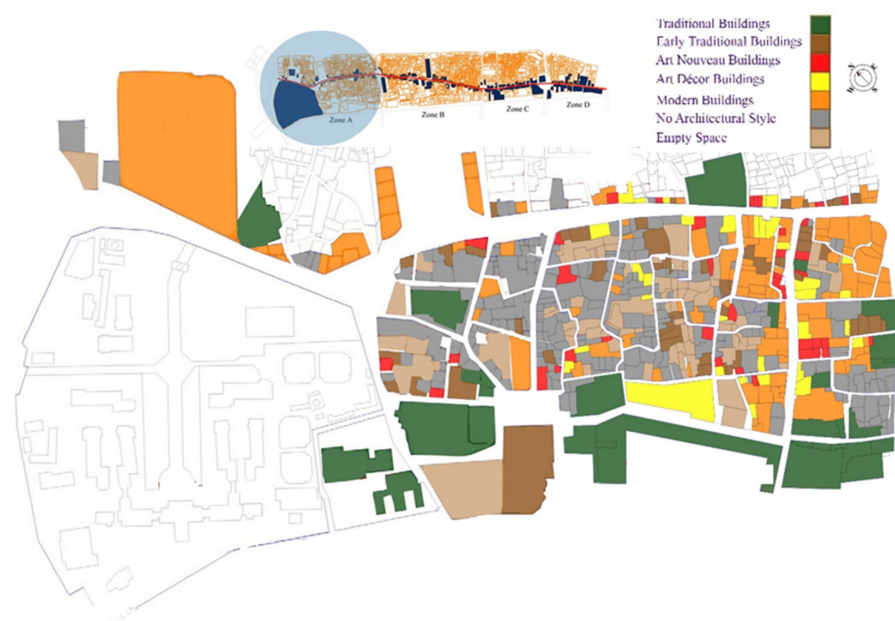
In recent years, a new building was constructed with yellow brick and arched windows (Figure 15D) next to the heritage-listed building called the House of the Governor, which is connected to a mosque from its left side. This historic building is another building that requires intensive conservation work for its architecture and built heritage (Figure 15E). The famous Al-Qishla Clock Tower is surrounded by the Al-Sarai heritage building, both

buildings were built in 1869 (Figure 15F). Cultural Baghdadi Centre and Al-Wazir Mosque were two main traditional buildings at the end of Zone A. Al-Wazir Mosque was built by Hassan Pasha in 1600 and rebuilt again by the Awqaf in 1957 after being ruined by the severe floods of 1831 [2] (Figure 15G).

The outcomes of riverfront observation reveal that no sustainable conservation strategies have been adopted to preserve the area's open spaces, riverbank, and most importantly, the built heritage. Many heritage buildings in Zone A suffered from poor structural conditions and require urgent architectural feature maintenance. Therefore, Baghdad and the Old Rusafa area especially require a future development plan that adopts sustainable urban heritage conservation strategies to protect the city-built heritage sustainably.

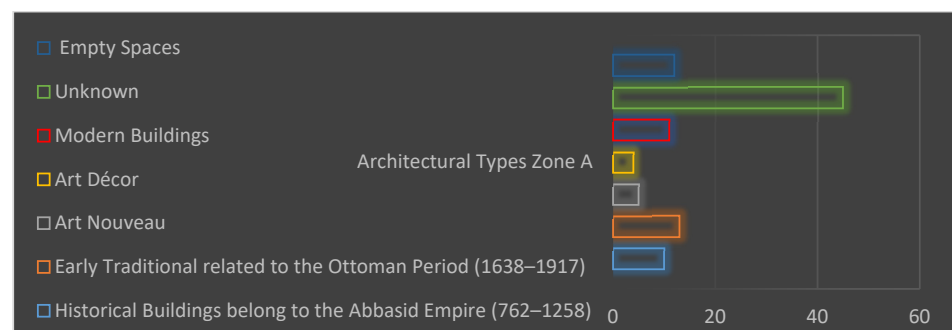
### 3.3. Historic and Architectural Value in Zone A (Architectural Types)

Historic and architectural value is one of the significant elements in the examination of the case study area to achieve sustainable indicators. Therefore, Zone A buildings have been examined in the field investigation according to their historical and architectural importance, dividing them into seven categories (historic buildings, early traditional, art nouveau, art décor, modern buildings, empty spaces, and unknown) (Figures 16 and 17). The vast majority (45%) of five hundred and fifty buildings have no architectural style according to the outcomes of the field survey of the historical and architectural value in Zone A, whereas historical buildings belonging to the Abbasid Empire (762–1258) were recorded at 10% in this survey. The traditional buildings related to the Ottoman Period (1638–1917) accounted for 13% of all buildings in the case study area Zone A (Figures 16 and 17). The results also asserted that modern buildings in Zone A were recorded at 11%. Art Nouveau (Art Nouveau is the type of building constructed with brick and steel I sections going back to the late 1920s and early 1930s and is characterised by its organic lines that were influenced by European style that began to reach Iraq at the time) was another important element that was assessed by the field survey of the old centre of Baghdad, which accounted for 5% of all buildings in Zone A. Art Déco is another category in Old Rusafa; this category's buildings are constructed with brick and steel I sections, with a geometric decoration of the brick material and use of iron material in the balconies. This type is characterised by straight lines and angles in the architectural elements of its elevations, going back to the 1930s and early 1940s), and accounted for 4% of this examination. The field survey also shows that empty spaces were recorded at 12% in Zone A of Al-Rashid Street [44,47].



**Figure 16.** Historic and architectural value in the Zone A (architectural types). Source: author, according to [44,47].





**Figure 17.** The percentage of historic and architectural building types in Zone A. Source: author, according to [44,47].

### 3.4. Historic and Traditional Buildings in Zone A

This field examination of Old Rusafa Zone A revealed that there were thirty-five buildings considered traditional buildings within Zone A, denoting a particular use (Khan Al-Mdallal and Al-Rasheedia School). Moreover, this part of Al-Rashid Street has included fourteen historical buildings, denoting a particular use (the Saray building and its Qushla clock tower, which was built in 1869; the Al-Srajeen Souq was built in 1802; and the court zone) (Figure 18). Zone A contains several significant souqs, such as Mutanabi Street, which includes the book market, and Saray Souq, which sells stationery. This zone of Old Rusafa has embraced many traditional mosques, such as the Ahmadiya mosque, which was built by Ahmad Pasha in 1769; the Numaniya mosque, which was built in 1772 by Fatima Biktash al-Sayid Wali to memorialise her husband, Numan Agha Ibrahim; and the Saray Mosque, which was built in 1704 by Hasan Pasha. The Zone A district, as it was asserted by this survey, contained significant traditional buildings, such as the Baghdadi Museum, which was built in 1910. Moreover, this part of the case study area includes traditional Baghdadi houses like the Kihami house, which was built in 1920, and the Salima Daud house, which was built in 1900 [44,47].



**Figure 18.** Historic and traditional buildings in Zone A. Source: author, according to [44,47].

#### 4. Sustainable Urban Heritage in the Historic Centre of Baghdad

Baghdad's urban heritage areas are characterised by human scale, natural shading, privacy, mixed-use, walkable, natural environment, and organic narrow alleys with a homogeneous arrangement of housing plots (Figure 19). Old Rusafa is well-defined by its unique traditional urban fabric and is surrounded by a modern urban pattern and roads, which replaced their walls. The features of the old urban fabric represent the main principles of environmental sustainability and show how individuals in the past built a sustainable environment to face the tough climate. Through their design, they achieved equity, a clean environment, an efficient use of resources, safety, low use of energy, and a low rate of pollution. Sustainable urban heritage in Old Rusafa should be able to provide appropriate solutions to regenerate the traditional fabric in terms of urban form, land use, local environment, and transportation, as well as create a new vision to deal with socio-economic and environmental processes. Based on existing scholarly publications, it is possible to assert that sustainability can become an essential strategy for heritage protection. Preserving Baghdad's urban heritage can aid in sustainable solutions to many problems that afflict the historic core, such as socio-economic and environmental issues. Achieving sustainable urban heritage in the city can participate in developing people's quality of life, promoting city diversity, and enhancing the old centre built and cultural heritage environments at local and regional levels [20]. For example, the preservation of old and narrow alleys can contribute to the city's sustainability by providing shade to pedestrians and human-scale development.



**Figure 19.** A narrow alley with natural shading in the historic part of Baghdad. Source: author's original image.

The main challenge for architects, urban designers, and policy-makers in conserving Baghdad's built heritage is to develop a sustainable urban heritage framework and design strategies for urban heritage conservation. To achieve this, the Municipality of Baghdad needs to integrate socio-economic and environmental aspects into sustainable urban heritage conservation to improve Baghdadi people's quality of life and develop a better place to live and work [49].

#### 5. Discussion

Urban heritage conservation is "increasingly perceived as a generator of income which extends to its function as a tourist attraction and item of leisure consumption, and this constitutes the dilemma of dissonant heritage. Very often, this leads to conservation and revitalisation projects having conflict with the cultural role of heritage and loss of social continuity" [49]. Many challenges emerge in the conservation of built heritage, but the main one is that the original uses may change while preserving the importance of the area and its buildings, which are related to the area's new economic development projects that led to deculturing and destruction of many cities' urban heritage. In Old Rusafa, for example, several listed buildings have been transformed from their original land use into



new uses. Many listed Khans have transformed into restaurants and cafes, and several traditional Baghdadi houses have been transformed into art centres and museums. As a result, the area's heritage identity and land use characteristics have been changed, which has impacted the area's social aspect.

Maintenance and repair of community properties are one of the traditional systems that have been used by Islamic society, and this was established within a kind of endowment called waqf. This system was a result of the relation of Islamic philosophy to equity. The waqf system depends on voluntary contributions to administer properties such as public and social services, mosques, caravanserais, and schools. This system has continued through to modern times in many Islamic countries, such as Iraq, Morocco, and Egypt, guaranteeing the repair of traditional buildings and preventing the division of larger properties between several inheritors, and has laid the groundwork for common social responsibility [50]. The Waqf system in Baghdad was established in the time of Harun Al-Rashid as a system to maintain and preserve important city places and buildings. Nowadays, waqf plays a limited role in maintaining or preserving its own heritage and modern buildings in Old Rusafa. The Municipality of Baghdad has taken on this role to prepare and manage conservation plans for Baghdad's built heritage.

One of the main challenges in the case study of this research today is how to find a platform that could solve the battlefield between various architectural styles and ideologies. The lack of a comprehensive conservation master plan to preserve Old Rusafa built heritage has led to a conflict between, on the one hand, the modern development that shows no consideration for the traditional urban context and, on the other, the large stock of abandoned, decaying, or misused traditional buildings in the case study area. The main causes of the present lack of consistency in traditional urban fabric are as follows:

- Urban growth that has shown little opportunity for continuity and organic expansion.
- Insufficiency of a comprehensive master plan that can adapt urban design methods related to the special features of the historic core.
- The new architectural evolution projects that have been built in Old Rusafa have ignored and isolated the existing traditional urban fabric.
- There is a lack of clear conservation methods that can implement the renovation, preservation, rehabilitation, and promotion of traditional buildings.
- The lack of clear policy and development schemes that would improve and give a positive motive to advance methods that would be applicable in other locations.
- The ongoing conflict and political instability in Iraq, particularly in Baghdad.

The Municipality of Baghdad lacks a clear vision and regulations regarding urban conservation, and this usually creates many obstacles when they want to prepare a plan for conserving traditional areas. The heritage urban fabric in Old Rusafa has witnessed irreparable damage due to the weak definition of functions and an ambiguous formulation of what to preserve, political issues, top-down systems, and wars. These are some of the reasons why most urban conservation plans prepared by different groups for the city centre have not been implemented successfully, such as the initiative prepared by the Union of Architectural Heritage in 2010 to rescue Baghdad's architectural heritage [27].

Therefore, to create an effective sustainable urban conservation plan to protect Old Rusafa's built heritage, the Municipality of Baghdad, architects, and urban designers should map heritage at risk, unravel its unique qualities that promote sustainability, run a better inventory of heritage assets, and think of sustainable and durable policies (including incentives) that encourage rehabilitation. The Municipality of Baghdad should work closely and develop a collaboration platform with the World Heritage Committee (WHCom), UNESCO, the United Nations (UN), and ICOMOS to protect Baghdad's city heritage. Finally, it would also need to learn lessons from the Arab world countries that have faced many challenges in preserving their city cores, such as Cairo, Damascus, Beirut, Aleppo, and Fez.

The Municipality of Baghdad, Iraqi architects, professionals, and urban planners should develop their attitudes towards preservation strategies and adopt some lessons in

sustainable urban conservation from near Arab cities. The Old Rusafa sustainable urban heritage conservation process requires a political environment of development where Old Rusafa is rehabilitated for its heritage value. Furthermore, to achieve sustainable urban heritage preservation in Baghdad's old centre, society and civic organisations should participate in preserving their heritage properties that are not under the Municipality of Baghdad's listed heritage buildings. The Old Rusafa residents must be educated to understand the importance of rehabilitating the area and develop a sense of self-identity to prevent the area from modernisation and gain sustainable urban heritage in Baghdad's city centre.

## 6. Conclusions

This article investigates how we might achieve sustainable urban heritage conservation in Baghdad's historical centre, Old Rusafa. It has asserted that "conservation, on an urban scale, is concerned with the urban fabric as a whole and not with architecture alone. The successful conservation project will make use of quantitative analyses and will be aided by comparative and economic studies" [14] (p. 13). Thus, the paper argues that the fundamental features of cities demand tangible conservation of their urban fabric to maintain its unique characteristics [16]. Furthermore, the paper illustrated that urban conservation offers a sustainable solution to social and economic problems, promotes the historic environment, creates new opportunities, and brings new life to run-down areas [51].

This research has examined the main challenges in the case study, such as the conflict between modern development that shows no consideration for the traditional urban context and the large stock of abandoned, decaying, or misused traditional buildings that have led to confusion and chaos in Old Rusafa. The paper presented the data gathered by the field survey of the area between Al-Rashid Street and the Tigris Riverfront in Old Rusafa. The field survey was conducted to assess the current situation of the existing physical built heritage of the area between Al-Rashid Street and the Tigris Riverfront in Old Rusafa and define the potentialities and constraints of this area. The field investigation illustrated the architectural value of traditional buildings in the case study area.

Ultimately, the analysis suggests that to tackle the deterioration of existing built fabric, public administrators and decision-makers should adopt a variety of strategies to ensure the long-term sustainability of efforts to regenerate the historic core, including continuous mapping, damage control, finding economic anchors, incentives, and durable policies that can mitigate the longstanding impacts of multiple socio-economic challenges faced by the city.

**Funding:** This research received no external funding.

**Institutional Review Board Statement:** Not applicable.

**Informed Consent Statement:** Not applicable.

**Data Availability Statement:** No new data were created or analysed in this study. Data sharing is not applicable to this article.

**Conflicts of Interest:** The author declares no conflicts of interest.

## References

1. Al-Saffar, M. Toward an Integrated Sustainable Urban Design Framework in the Historic Center of Baghdad. *Int. J. Environ. Sustain.* **2016**, *13*, 31–52. [\[CrossRef\]](#)
2. Al-Saffar, M. *Toward an Integrated Smart and Sustainable Urbanism Framework in the Historic Centre of Baghdad. (Old Rusafa as a Case Study)*; Manchester Metropolitan University: Manchester, UK, 2018.
3. Global Heritage Fund (GHF). *Iraqi Heritage Experts Call on Government to Preserve Heritage Sites 2012*; Global Heritage Fund (GHF): San Francisco, CA, USA, 2012.
4. Scholz, R.W.; Tietje, O. *Embedded Case Study Methods: Integrating Quantitative and Qualitative Knowledge*; SAGE: London, UK; Thousand Oaks, CA, USA, 2002.
5. Al-Saffar, M. Baghdad: The city of cultural heritage and monumental Islamic architecture. *Disegnarecon* **2020**, *13*, 1–5.

6. Khalifehei, H. *Social Sustainability and the Future in the Iranian Historic Neighbourhoods' Townscape*; University of Sheffield: Sheffield, UK, 2014.
7. Leech, N.L.; Onwuegbuzie, A.J. A typology of mixed methods research designs. *Qual. Quant.* **2009**, *43*, 265–275. [\[CrossRef\]](#)
8. Al-Saffar, M.; Bathsha, A.; Chang, C.-H.; Ge, H.; Huang, X.; Shi, K.; Lu, Y.; Peng, Z.; Sun, W.; Wang, H.; et al. How to Enhance the Future of Urban Environments Through Smart Sustainable Urban Infrastructures? *Disegnarecon* **2019**, *12*, 14.1–14.4.
9. Wilson, V. Research Methods: Design, Methods, Case Study. . . oh my! *Evid. Based Libr. Inf. Pract.* **2016**, *11*, 39–40. [\[CrossRef\]](#)
10. The Municipality of Baghdad. *Baghdad City Comprehensive Development Plan (2030)*; The Municipality of Baghdad: Baghdad, Iraq, 2013.
11. Al-Saffar, M. Urban Heritage and Conservation in The Historic Centre of Baghdad. *Int. J. Herit. Archit.* **2018**, *2*, 13. [\[CrossRef\]](#)
12. Glendinning, M. *The Conservation Movement: A History of Architectural Preservation: Antiquity to Modernity*; Routledge: London, UK, 2013.
13. Mualam, A. Architecture is not everything: A multi-faceted conceptual framework for evaluating heritage protection policies and disputes. *Int. J. Cult. Policy* **2020**, *26*, 291–311. [\[CrossRef\]](#)
14. Cohen, N. *Urban Conservation*; MIT: Cambridge, MA, USA; London, UK, 1999.
15. Everard, A.J.; Pickard, R.D. *Can Urban Conservation Be Left to the Market? The Value of Partnership-Led Conservation Regeneration Strategies*; WIT Press: Southampton, UK, 1997; pp. 619–632.
16. Su, X. Urban conservation in Lijiang, China: Power structure and funding systems. *Cities* **2010**, *27*, 164–171. [\[CrossRef\]](#)
17. Pendlebury, J.; Strange, I. Urban conservation and the shaping of the English city. *Town Plan. Rev.* **2011**, *82*, 361. [\[CrossRef\]](#)
18. Koramaz, T.K.; Gulersoy, N.Z. (Eds.) Users' Responses to 2D and 3D Visualization Techniques in Urban Conservation Process. In *Proceedings of the 2011 15th International Conference on Information Visualisation*, London, UK, 13–15 July 2011.
19. Selim, G. *Unfinished Places*; Ache, P., Ed.; Routledge: New York, NY, USA, 2017.
20. Rodwell, D. *Conservation and Sustainability in Historic Cities*; John Wiley & Sons, Inc.: Hoboken, NJ, USA, 2008.
21. Alexandru, B.; Dorina, C.; Dana Maria, C.; Tudor, B.; Constantin, C.B.; Lucian, C. Heritage Building Preservation in the Process of Sustainable Urban Development: The Case of Brasov Medieval City, Romania. *Sustainability* **2022**, *14*, 6959. [\[CrossRef\]](#)
22. Étienne, B.; Juste, R.; Georges, A.T. Using sustainability indicators for Urban Heritage Management: A review of 25 case studies. *Int. J. Herit. Sustain. Dev.* **2015**, *4*, 23–34.
23. Maria, L.; Wouter, V. Sustainability Assessment of Urban Heritage Sites. *Buildings* **2018**, *8*, 107. [\[CrossRef\]](#)
24. Sanober, N.; Salman, S. The Role of Cultural Heritage in Promoting Urban Sustainability: A Brief Review. *Land* **2022**, *11*, 1508. [\[CrossRef\]](#)
25. Ragheb, A.; Aly, R.; Ahmed, G. Toward sustainable urban development of historical cities: Case study of Fouh City, Egypt. *Ain Shams Eng. J.* **2021**, *13*, 101520. [\[CrossRef\]](#)
26. Paul, J. *Historic Urban Environment Conservation Challenges and Priorities for Action*; The Getty Conservation Institute: Los Angeles, CA, USA, 2010.
27. Al-Akkam, A. Urban Heritage in Baghdad: Toward a Comprehensive Sustainable Framework. *J. Sustain. Dev.* **2013**, *6*, 39–55. [\[CrossRef\]](#)
28. Tigran, H.; Krister, O. Urban Heritage, Planning and Design and Development. *Sustainability* **2023**, *15*, 12359. [\[CrossRef\]](#)
29. Pieri, C. Baghdad 1921–1958. Reflections on History as a “Strategy of Vigilance”. 2014; Volume 8, pp. 69–93. Available online: <https://hal.archives-ouvertes.fr/halshs-00941214/document> (accessed on 23 July 2024).
30. Ferdous, F.; Lawless, J.; Silva, K.D. Sustainable urbanism and urban heritage conservation. In *The Routledge Handbook on Historic Urban Landscapes in the Asia-Pacific*; Routledge: London, UK, 2020; pp. 363–376.
31. Ryberg-Webster, S.; Kinahan, K.L. Historic preservation in declining city neighbourhoods: Analysing rehabilitation tax credit investments in six US cities. *Urban Stud.* **2017**, *54*, 1673–1691. [\[CrossRef\]](#)
32. Nir, M.; Nir, B. Evaluating Comparative Research: Mapping and Assessing Current Trends in Built Heritage Studies. *Sustainability* **2019**, *11*, 677. [\[CrossRef\]](#)
33. Ahmed Mohamed, S. Current Trends in Urban Heritage Conservation: Medieval Historic Arab City Centers. *Sustainability* **2022**, *14*, 607. [\[CrossRef\]](#)
34. Boussaa, D. Islamic urban heritage: Blight or blessing? In *Proceedings of the International Conference on Islamic Heritage Architecture and Art (Islamic Heritage Architecture 2016)*, Valencia, Spain, 17–19 May 2016; WIT Press: Southampton, UK, 2017; pp. 344–354.
35. Al-Saffar, M. Assessment of the process of urban transformation in Baghdad city form and function. In *City and Territory in the Globalization Age*; Editorial Universitat Politècnica de València: Valencia, Spain, 2018; pp. 709–718.
36. Steinberg, F. Conservation and rehabilitation of urban heritage in developing countries. *Habitat Int.* **1996**, *20*, 463–475. [\[CrossRef\]](#)
37. Angl, J. *Historic Cairo—A Plea for World Heritage in Danger*; World Heritage Watch e.V.: Berlin, Germany, 2018.
38. Bianca, S. *Urban form in the Arab World: Past and Present*; Thames & Hudson: London, UK, 2000.
39. JCP. *Study on Conservation and Redevelopment of Historical Center of Baghdad City*; Amanat al Asisema: Baghdad, Iraq, 1984.
40. Aboukhater, R. Culture-led urban development initiative in a world heritage city: The case study of the old city of Damascus in Syria. *Int. Arch. Photogramm. Remote Sens. Spat. Inf. Sci.* **2020**, *2020*, 573–580. [\[CrossRef\]](#)
41. Ragab, T.S. The crisis of cultural identity in rehabilitating historic Beirut-downtown. *Cities* **2011**, *28*, 107–114. [\[CrossRef\]](#)
42. The Municipality of Baghdad, Cartographer. *Land Uses Plane of Baghdad*; The Municipality of Baghdad: Baghdad, Iraq, 2016.
43. Rashed, H. *Sustainable Urban Development in Historic Cairo*; University of Nottingham: Nottingham, UK, 2013.



44. The Municipality of Baghdad. *The Development of Al-Rasheed Street and the Tigris River Area Development Project*; The Municipality of Baghdad: Baghdad, Iraq, 2009.
45. Al-Hasani, M. Urban space transformation in old city of Baghdad--integration and management. *Megaron Archit.* **2012**, *7*, 79.
46. Al-Silq, G. Baghdad-Image and Memories. In *DC PAPERS: Revista de Crítica y Teoría de la Arquitectura*; Escola Tècnica Superior d'Arquitectura de Barcelona: Barcelona, Spain, 2008; pp. 46–65.
47. The Municipality of Baghdad. *The Development of Al-Rasheed Street and the Area between Al-Rashid Street and the Tigris Riverfront*; The Municipality of Baghdad: Baghdad, Iraq, 2011.
48. Al-Akkam, A. Towards Environmentally Sustainable Urban Regeneration: A Framework for Baghdad City Centre. *J. Sustain. Dev.* **2012**, *5*, 58. [[CrossRef](#)]
49. Hiu, Y.; Hon, C. Critical social sustainability factors in urban conservation: The case of the central police station compound in Hong Kong. *Facilities* **2012**, *30*, 396–416.
50. Jokilehto, J. *A History of Architectural Conservation*; Butterworth-Heinemann: Oxford, UK, 1999.
51. EH. *Heritage Counts 2004: The State of England's Historic Environment*; Historic England: London, UK, 2004.

**Disclaimer/Publisher's Note:** The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of MDPI and/or the editor(s). MDPI and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.