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World Heritage Potential: the Role of Heritage Sites on the Development of Hilla's City Center

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World Heritage Potential: the Role of Heritage Sites on the Development of Hilla's City Center

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Abstract

Cultural heritage areas (World Heritage Sites) have long stood as prominent symbols of historical and cultural civilizations in their respective environments and today serve as a strong incentive for attracting both local and international tourists. However, the urban expansion driven by rapid population growth has led to challenges, including the differentiation of their urban fabric. This highlights an urgent need to develop these cultural and tourist urban nodes and integrate them into the urban development trends of the city. Sustainable development has become a pressing agenda for such cities to protect and revitalize cultural areas and enhance accessibility to them. The study aims to evaluate the spatial configuration of the city of Babylon (within the center of Al-Hillah city, including the World Heritage Site of Babylon) over a twenty-year period (2004-2024). The research addresses a knowledge gap: The absence of precise quantitative analysis of the study area within both local and global studies, which provides a true impression of the urban development trajectory experienced by the city over the past two decades and assesses the effectiveness of the World Heritage Site as a dynamic urban node within the city. The study applied the method of space syntax and conducted axial and segment analyses based on the city's street network data for the years 2004 and 2024, measuring Depthmap X 0.8.0 program indicators related to the research vocabularies (choice, connectivity, integration, intelligibility, synergy). The analysis results indicated that the current spatial configuration of the city achieved higher values in the choice and connectivity indicators. However, the integration indicator recorded a higher value in the past, due to the significant expansion that the center of Al-Hillah city witnessed towards the south of the historic city, while the eastern and western directions achieved medium values. This underscores the development axes that should be focused on to activate and enhance land use in the areas surrounding and adjacent to the historical site.

Keywords: cultural heritage landscapes; Depthmap X 0.8.0, space syntax; sustainable urbanism; synergy.

Introduction

Many studies have linked the theory of space syntax with the exploration of the social and cultural dimensions embedded in spatial systems of global historical and archaeological significance. Spatial analysis provides a connection between the tangible and intangible aspects of spatial culture, which implies, in urban heritage studies, a consideration beyond the value of buildings as individual formations in the emergent order of social space. The Space Syntax serves as a quantitative language that explores the reciprocal relationships between spatial composition and human society by analyzing the structural characteristics of cities, buildings, and landscapes. Therefore, employing spatial analysis to study the built environment of historical and heritage areas can partially reveal inherent mobility patterns and the distinctive characteristics of local urban inhabitants,

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and it allows the identification of the most active multifunctional districts in the cities, and it analyzes how they change over time; thus, it could be used for evaluating the activation of world heritage sites, etc. (Palaiologou & Griffiths, 2019).

Zeng & Dewancker (2022) utilized quantitative spatial analysis of the urban form of the ancient city of Lude, China, to investigate the morphological characteristics and spatial analysis of the area before and after development. The goal was to explore the potential for protecting and renewing traditional areas to achieve tourism development by measuring integration, accessibility, and intelligibility. Meanwhile, Lyu et al. (2023) propose a new approach for revitalizing historical urban areas through the adoption of spatial analysis methodology to invigorate the urban environment while preserving the heritage fabric of historic urban areas in China. Spatial analysis can partially reveal inherent mobility patterns and characteristics of the local population in the historic Yushan area of China.

Mohamed et al. (2020) examined the formation of urban heritage routes in the heritage city of Al-Ula using space syntax techniques to improve the spatial experience of tourists by analyzing tourist routes and the factors influencing them. The study used spatial analysis to propose the most suitable pedestrian path according to the constraints imposed by the existing historical fabric by measuring variables such as connectivity, choice, and intelligibility and comparing them with the results of the proposed development analysis for the area.

Şahin Körmeçli (2024) aimed to examine accessibility to historical tourism centers within UNESCO World Heritage areas in Karabük, Turkey, and analyze the spatial configuration of the street network within the city. Axial and sectoral analyses were conducted based on current street network data using spatial analysis, allowing for the identification of strategic axes for development and change in the city's historical center and the potential to propose specific design solutions to revitalize the area.

The research identified its specific knowledge gap, which includes: The absence of precise quantitative analysis of the study area within both local and global studies, which provides a true impression of the urban development trajectory experienced by the city over the past two decades, and assesses the effectiveness of the World Heritage Site (Particularly, the focus is on highlighting the ancient city of Babylon as a local case study and examining its impact on the development of the city of Hilla). So, the study applied space syntax approach and conducted axial and segment analyses based on the city's street network data for the years 2004,2024 (These two decades were selected because Iraq experienced significant political, economic, and social transformations across all sectors following the 2003 war. These changes led to a notable shift in the urban development of Iraqi cities in general, and the city of Babylon in particular. As for the year 2024, it represents the present time during which this research is being conducted), measuring Depthmap X 0.8.0 program indicators related to the research vocabularies (choice, connectivity, integration, intelligibility, synergy). These specific program indicators were selected due to their direct relevance to the research variables and their alignment with the study's objectives and purpose, while other program indicators were excluded from the quantitative analysis.

Research contextualization

The term "heritage" has been defined by several organizations and relevant entities. According to the UNESCO World Heritage Centre, it is described as "the legacy of humanity from the past, what people live with today, and what will be passed on to future generations." Similarly, the United Nations Educational, Scientific and Cultural Organization (UNESCO) defines heritage as "what we inherit from our ancestors and what we will transmit to future generations, and in the present, it forms our identity." (Akagawa & Sirisrisak, 2008).

World Heritage Sites represent a type of shared global heritage because they embody collective values for humanity, not just for the specific countries in which these sites are located. What distinguishes them from any other site is their "Outstanding Universal Value." These sites are

selected for inclusion on the World Heritage List and described as among the best examples of natural and cultural heritage sites (Kamel, 2011).

World Heritage Sites are classified either thematically or regionally. The thematic analysis by the International Union for Conservation of Nature (IUCN) categorizes global sites into the following categories (Lennon, Ken Taylor, 2012; Irani Behbahani et al., 2017):

1. Archaeological World Heritage Sites
2. World Heritage Cities
3. Monumental and Memorial Buildings
4. Modern Heritage Buildings
5. Cultural Landscapes
6. World Heritage Forests
7. Marine and Mountain World Heritage Sites
8. Geological and Geomorphological World Heritage Sites

The cultural landscape can be defined as a geographic area that encompasses cultural and natural resources and is associated with historical events, certain activities, or people, or that displays cultural and aesthetic values of the region. The first international initiative aimed at preserving cultural landscapes was the establishment of the International Scientific Committee on Cultural Landscapes (ICOMOS) and the International Federation of Landscape Architects (IFLA) in 1970 (Settmini, 2020).

The cultural heritage landscape is a spatial form representing the physical settings of the built environment that have been shaped and formed through the shared beliefs and diverse activities of a specific community. It comprises both the components of the built and natural environments that require study (Pajouh et al., 2013).

In 1992, the UNESCO World Heritage Committee identified three types of cultural landscapes (Akagawa & Sirisrisak, 2008):

1. Designed Landscapes that have been intentionally created (including gardens, complexes, and estates).
2. Evolving Landscapes over time (also known as vernacular landscapes), which can be either organic or organically modified over time.

Historic cultural heritage environments in cities represent areas for transferring heritage from the past to the present. These historic centers are vital urban nodes, carrying cultural, social, symbolic, and civic values, and they represent the collective memory of the city (Şahin Körmeçli, 2024).

Currently, there is an increasing interest in protecting urban cultural heritage in the context of urban renewal strategies. Urban cultural heritage can be preserved, activated, and made accessible to people while retaining the memories and traditions embedded within it, simultaneously enhancing the city's cultural uniqueness and vitality. Within this context, concepts such as cultural tourism have become more active. The recent expansion in this sector has had economic impacts on the communities of cultural heritage cities, and their competitive status on a global scale is increasingly linked to the promotion and sustainable use of their urban cultural heritage (Antonić & Djukić, 2024).

Method

The quantitative approach was adopted in this research by utilizing space syntax methodology and conducting axial and segmental analyses (Axial and Segment maps were chosen because segment analysis enables the incorporation of multiple radii and the extraction of analytical results. This approach provides an accurate representation of the transition from pedestrian movement patterns to vehicular traffic flow, ultimately illustrating the broader street network of the city as

the selected radius value changes). Its choice a set of indicators and metrics from the Depthmap X 0.8.0 software, including choice, connectivity, integration (local and global), intelligibility, and synergy for the city of Babylon see (Fig.1). This approach aimed to achieve several key objectives:

- Conduct a quantitative analysis of the city of Babylon based on spatial configuration maps.
- Demonstrate the effectiveness of World Heritage Sites as active urban nodes in the city's development.
- Assess the application of sustainable urban development concepts to develop city centers based on cultural tourism.
- Highlight the city of Babylon as one of Iraq's World Heritage Sites, given the scarcity or absence of studies addressing this city and analyzing its spatial configuration quantitatively.

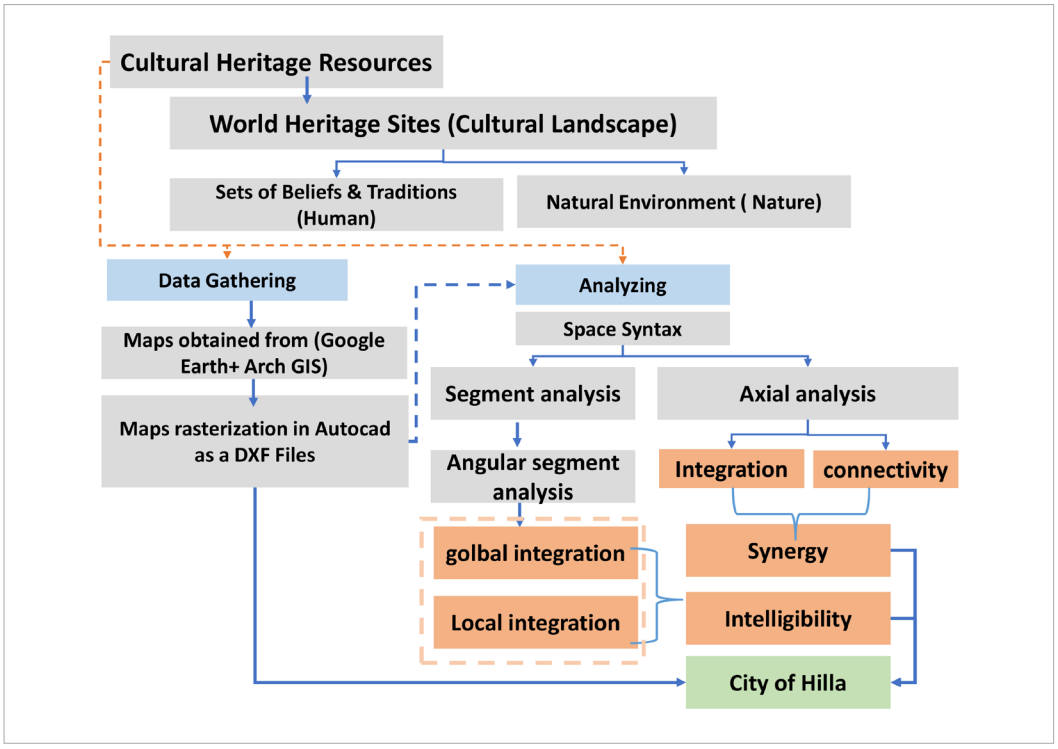


Fig. 1
The general structure of the research.
Source: authors

Study area (ancient city of Babylon)

The ancient city of Babylon is located at the intersection of longitude (442525) east and latitude (323230) north, within the villages of Kuweirish, Jumu, and Barnun, which are part of the center of Al-Hillah city. The ancient city spans multiple plots of land within the district of Jumu'ah Al-Shamali (19). The archaeological site is surrounded by agricultural lands and orchards on all sides, along with residential units. The area of the ancient city covers 4,478 dunams, extending over oval-shaped lands and situated at an elevation of 22 meters above sea level and approximately 18 meters above the surrounding lands. The prominent architectural landmarks include palaces, temples, ziggurats, walls, residential buildings, ancient streets, and theaters. The ancient city of Babylon is approximately 90 kilometers south of Baghdad and about 10 kilometers north of Al-Hillah. Babylon is one of the most famous ancient cities mentioned in religious texts (Aboudi & Abdul Razzak, 2020).

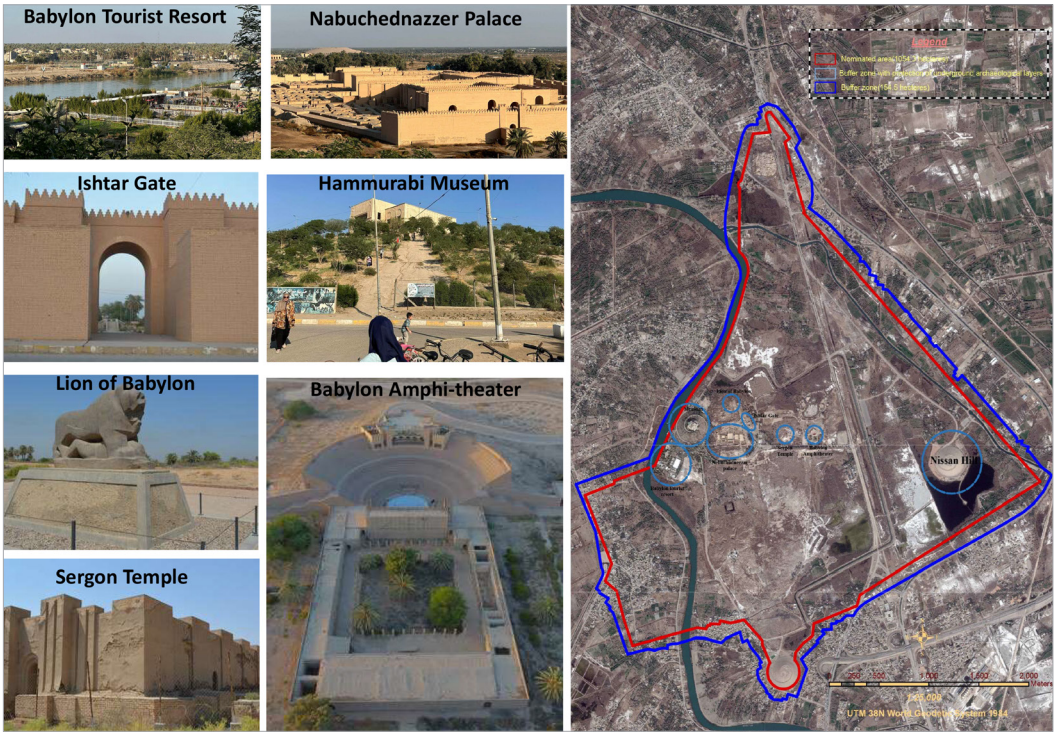
The city of Babylon serves as tangible evidence of the creativity of the Neo-Babylonian Empire and is associated with one of the Seven Wonders of the Ancient World—the Hanging Gardens. Babylon represents an archaeological site of one of the most powerful empires in the ancient

world and is the largest settlement in Mesopotamia and the Middle East. Babylon possesses distinctive historical, cultural, and heritage landmarks of outstanding universal value, representing the multifaceted legend that stood as a symbol for over two thousand years. The buildings and urban landmarks within the boundaries of the archaeological city (including the inner and outer city walls, palaces, gates, temples, including the ziggurat and the Tower of Babylon) with their authentic characteristics are a testament to the new Babylonian civilization. Approximately 85% of the area remains unexcavated, providing an essential opportunity to enhance the site's universal value through further research and preservation efforts (Şahin Körmeçli, 2024).

The city falls under the Iraqi Antiquities and Heritage Law (No. 55 of 2002), aimed at preserving, protecting, and managing all archaeological sites in Iraq. The law covers the survey, excavation, documentation, and public display of these sites to both local and international audiences and is implemented by the Iraqi State Board of Antiquities and Heritage (a body affiliated with the Ministry of Culture, Tourism, and Antiquities). A comprehensive management plan for the archaeological sites was developed through an in-depth consultative process involving local and national stakeholders starting in 2011, and it was approved in 2018. The federal and local governments have demonstrated their commitment by providing adequate funding to ensure the preservation, development, and study of the properties in accordance with the prescribed international standards, while protecting its outstanding universal value. The site was inscribed on the World Heritage List during the 43rd session of the World Heritage Committee in Baku, Azerbaijan, in July 2019, see Fig.2 (UNESCO, 2019; Aboudi & Abdul Razzak, 2020).

Fig. 2

The distinctive architectural and natural feature in archeological city of Babylon, source: authors based on Babylon - UNESCO World Heritage Centre



Space syntax & cultural heritage context

Space Syntax is based on the principle that the organization of a city's street network plays a significant role in determining the fluidity of movement within urban spaces. Here, the idea emerges that geometric and topographical complexity directly affects how people navigate the urban network. The results obtained through the spatial syntax methodology are cumulative reflections of

the behaviors of city inhabitants. Therefore, it remains unclear to what extent these results are influenced by individual spatial decisions or if they merely represent mathematical probabilities arising from network effects. These are statistical impacts generated by the structural layout of urban networks, independent of individual movement choices or psychological factors (Abbas, 2023).

The space syntax methodology relies on the morphological analysis of urban structures using the topological spatial relationships of urban environment elements. These relationships are analyzed through mathematical tools that connect these elements within a specific range, referred to as spatial configuration (Hillier, 2007).

Spatial configuration serves as the fundamental concept of Space Syntax Theory. It represents the study of relationships among the components of the urban environment, considering both global and local relationships through the application of Graph Theory. Through this concept, Space Syntax Theory has introduced a set of principles that explain spatial relationships, notably the integration measure, which emphasizes the correlation between spatial integration and pedestrian movement. Some of these theories include:

1. Theory of Movement Attraction: This theory explains movement within the urban environment as originating and ending at various building masses with differing levels of attraction. It emphasizes the extent to which these masses can generate movement.
2. Theory of Natural Movement: This theory focuses on the organizational characteristics of urban space, positioning them as the primary environmental factors influencing movement patterns. It suggests that most movement within urban environments is shaped more by the structure of the urban network itself than by specific points of attraction or movement generation. According to this theory, the spatial representation of the urban environment serves as the primary driver of pedestrian movement patterns. Movement between any two points in an urban space does not depend on the attractiveness of those points but entirely on the nature of the urban network representation, particularly the degree of spatial accessibility.
3. Theory of the Economy of Movement: According to this theory, the structure of the urban network is a fundamental factor influencing movement patterns and the distribution of attraction points, which in turn generate increased movement within the network, creating a compounding effect. Hillier argues that the primary principle linking the network structure to movement patterns is not only based on the main lines within and outside the city but also on the finer structural details. This results in multiple interrelationships between network structure, land use, densities, and even the urban perception of well-being and fear (Basee, 2016).

The analysis relies on a variety of metrics, based on the methodology used to achieve the expected results from quantitative measurement, relying on the temporal phases of city development. Morphological analysis is conducted using several topological and segmental metric diagrams, based on the Depthmap X 0.8.0 software. The software provides measurements of various metrics, including (connectivity, integration, control, choice, density, intelligibility, and synergy). See **Table 1**, assigning specific values represented by a particular color gradient. These colors represent numerical values, thereby offering a clear visualization of relationships within spatial networks. The program's analytical capabilities are based on the theory of the city, generating the concept of "distributed centrality," which is fundamental to the syntactic view of cities with a sustainable nature. The program demonstrates its ability to reveal fine local structures that may not be visibly apparent by selecting angles for metric radii, thereby elucidating the syntactic understanding of the city (Xu et al., 2020).

Table 1

The definition of Depthmap X0.8.0 metrics (Basee, 2016)

Metrics	Definition
Connectivity	The number of direct connections each axis possesses represents its connectivity. Lines with high connectivity values indicate areas with dense movement. Connectivity measures the number of streets directly linked to a specific street, highlighting the importance of that axis within the overall urban structure.
Integration	The measure of relative asymmetry in a Graph Network evaluates the spatial depth specifically for urban patterns. The global integration measure reflects the degree of spatial depth or shallowness based on its relationship with other spaces. Through this measure, spaces can be classified from the most integrated to the most isolated. Typically, the integration measure indicates the likelihood of people being present in a space and is believed to correspond with the frequency of social interactions and commercial activities. The integration core refers to the set of spaces representing the top (10%, 25%, or 50%) most integrated areas within an urban system. The integration core can take various forms, including an artery-like shape, a distorted wheel, a dispersed pattern, or a centralized configuration.
Choice	This measure identifies the flow of movement through spaces. Spaces with high global choice values are located along the shortest paths from all origins to all destinations. Choice serves as a reliable indicator for predicting pedestrian and vehicular movement potential. It determines the likelihood of a specific axial line (street segment) being traversed along the shortest paths from all other spaces within the entire urban system or within a predefined radius.
Intensity	This measure represents the relative asymmetry within the spatial structure. Its purpose is to evaluate the efficiency of movement in relation to the distance an individual must travel within the urban network. It also reflects the relative importance of an axial line, highlighting the axes with high user density. This provides a clear understanding of the hierarchical arrangement of axes, distinguishing primary roads from secondary ones, even when they may have similar levels of usage density.
Intelligibility	This is a correlation coefficient designed to measure the relationship between axial connectivity and global integration. A high degree of intelligibility indicates the ability to understand the whole system through its parts. It serves as an indicator of the relationship between the part and the whole; the closer its value is to (1), the higher the level of intelligibility, while values approaching (0) represent a higher degree of ambiguity. Therefore, it acts as a measure of how well the structure of the urban fabric is comprehended and perceived.
Synergy	It represents the relationship between the smallest and largest integration radii. It provides an impression of the efficiency and cohesion of the urban fabric's components in relation to one another.

Results

The analysis and comparison of the study area were conducted by examining results from two time periods (2004 and 2024) to extract key indicators regarding the impact of historical heritage areas as significant urban nodes in the sustainable urban development of city centers. A set of indicators related to the research elements, including connectivity, integration, choice, intelligibility, and synergy, were measured. The following are the key results quantitatively measured using Depthmap X 0.8.0:

- **Choice:** The analysis results for the choice indicator in the study area for (2004) show that the highest value was (24,099) on the section of the central Al-Hillah Street near the city center. This is due to the diversity and permeability of visual and movement axes from the surrounding areas. This was followed by a medium value on a section of the Hillah-Karbala Street, with a value of (22,305). The Baghdad-Hillah Street had an indicator value of (7,163) due to fewer connections, although it remains the main movement axis connecting to the historical archaeological area. The value for Street 60, an extension of Baghdad-Hillah Street and the main axis in the city center, was (6,022). Finally, the street running through the archaeological area recorded a value of (6,162). In the year (2024), the highest choice indicator value recorded was (107,143) on a section of the Hillah-Karbala Street near the city center, followed by a medium value of (55,716) on Street 60. The Baghdad-Hillah Street recorded a value of 45,948, and the street running through the archaeological area connected to the previously mentioned street recorded a value of (275,454), see Fig.3.

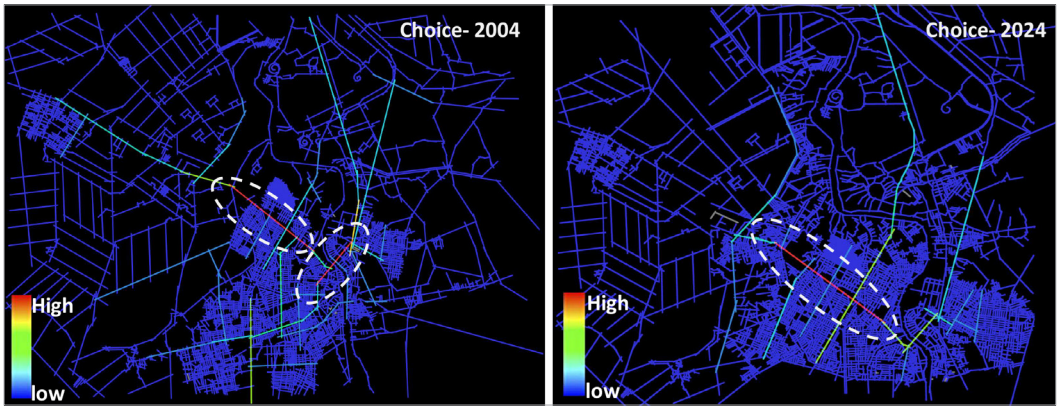


Fig. 3

The metric choice, source: authors depending on the results of the Axial analysis

- **Connectivity:** The connectivity indicator for the study area in the year (2004) recorded the highest value of (32) on Street 40 due to its prominent commercial value within the city center, characterized by high accessibility for pedestrians and vehicles. The central Al-Hillah Street recorded a medium value of (30), Baghdad-Hillah Street recorded (24), and Hillah-Karbala Street recorded (27), owing to its good connections with Al-Hillah's city center toward Karbala. The street passing through the archaeological area recorded a value of (24). In the year (2024), the highest connectivity value was recorded as (55) on Street 80, a major arterial within the city center, while the street passing through the archaeological area recorded (18), see Fig.4.
- **Integration:** The analysis of the integration coefficient in the year (2004) indicated that the highest value was (1.52) on the section of Hillah-Karbala Street near Al-Hillah's city center. This is attributed to increased axial and movement connections with the external environment, as well as its connections to the city center and other spaces (primary and secondary arteries). Baghdad-Hillah street and Street 60 both recorded values of (1.41), while the road through the archaeological city recorded a value of (1.14). The year of (2024) analysis showed that the highest integration value was (1.41) on Street 60, with Hillah-Karbala Street recording (1.20) and Baghdad-Hillah Street recording (1.07). Finally, the street passing through the archaeological city recorded a value of (0.60), see **Fig.5**.

Fig. 4

The connectivity, source: authors depending on the results of the Axial analysis

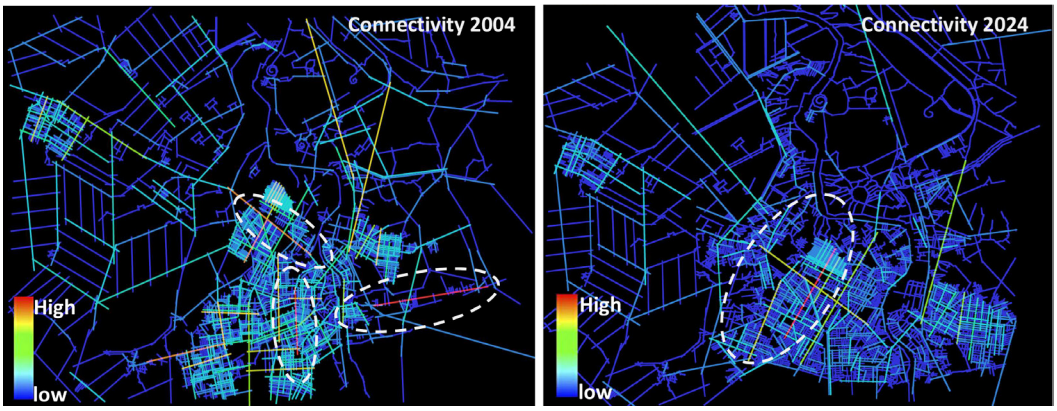
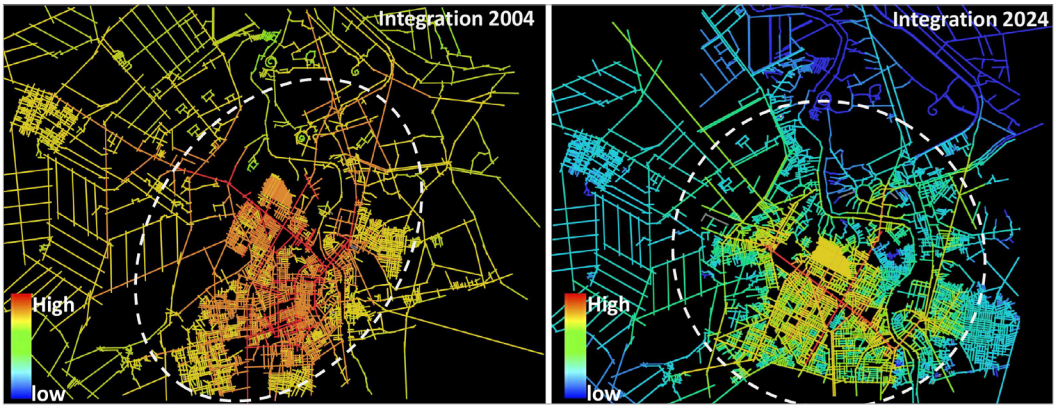


Fig. 5

The Integration HH, source: authors depending on the results of the Axial analysis



- **Segment metric Integration:** The metric integration indicator across radii of (400, 800, 1200, and 1600 meters) revealed that in both years, the highest value for the (400-meter radius) was in the residential grid-planned area near the Hillah-Karbala Road, representing the beginning of Al-Hillah's city center expansion. The (800-meter radius) recorded the highest value in Al-Hillah's city center within the Street 40 and Al-Jam'iyah Street areas due to their commercial and service-oriented nature. For the (1200-meter radius), the integration zone extended to wider parts of Al-Hillah's center toward the Wardiya area, characterized by grid-planned residential patterns, with medium integration values on the western and southeastern edges of the archaeological city. The (1600-meter radius) recorded the highest integration values for both years, indicating good integration values for the archaeological city and its surroundings, despite the current functions not aligning with the area's nature. This suggests that the area surrounding the archaeological city has developed into a well-integrated urban node with good social interaction potential and multiple land-use possibilities to stimulate tourism movement within the archaeological city. As the distance within the radius increases for the observer, the alternatives and options for accessing the study area expand, see Fig.6.
- **Intelligibility:** the value for the year 2004 is recorded at (0.163), while in 2024, it drops to a lower value of (0.097). This decline indicates a reduced ability to perceive a cohesive urban scene through its individual components. The reason for this can be attributed to the hybrid urban fabric of the city, characterized by the transition from the layout of the ancient city to the grid-like pattern in the center of Hilla. Consequently, a clear and comprehensive image of the city fails to emerge, see Fig.7.

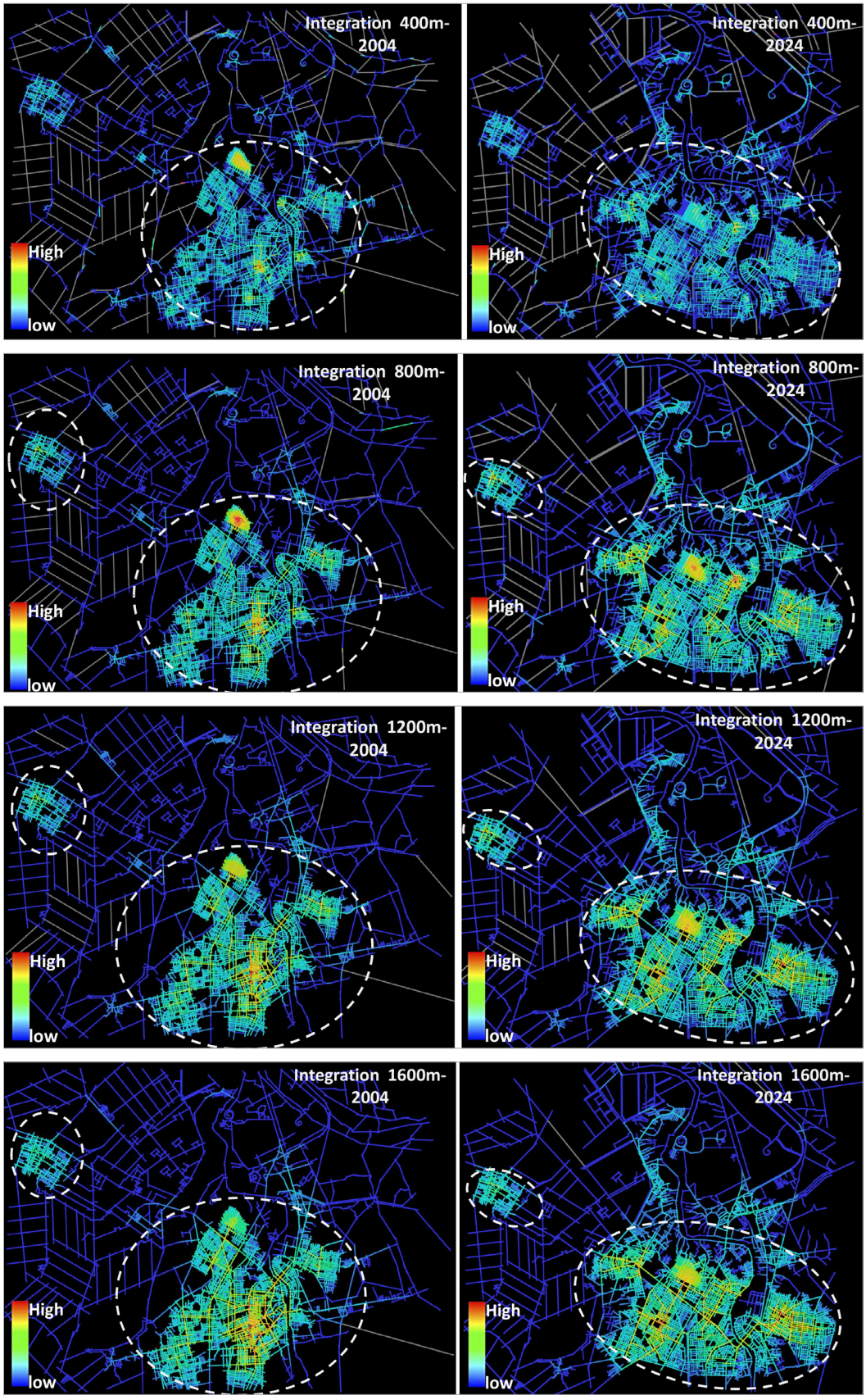
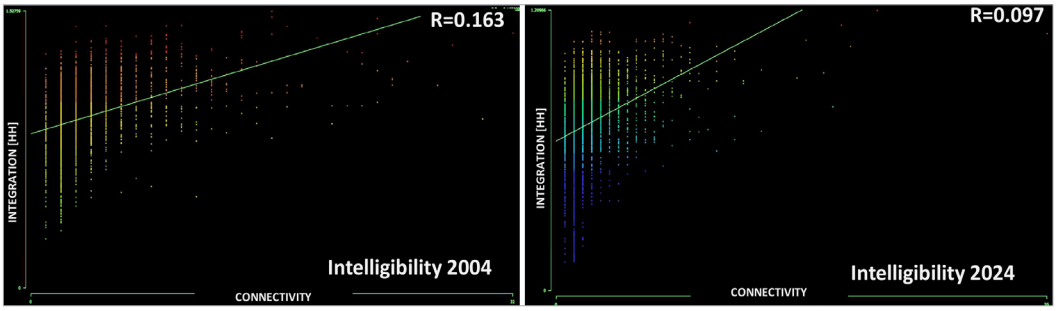


Fig. 6

The segment metric Integration with radius (400,800.1200.1600m), source: authors depending on the results of the Segment analysis

Fig. 7

The Intelligibility value, source: authors depending on the results of the Axial analysis



_ **Synergy:** The synergy value was recorded at (0.458) in 2004, while in 2024, it decreased slightly to (0.428). This indicates that the urban network exhibited a slightly higher degree of cohesion and balance in the past compared to the present, see Fig.8, Table 2.

Fig. 8

The Synergy value, source: authors depending on the results of the Segment analysis

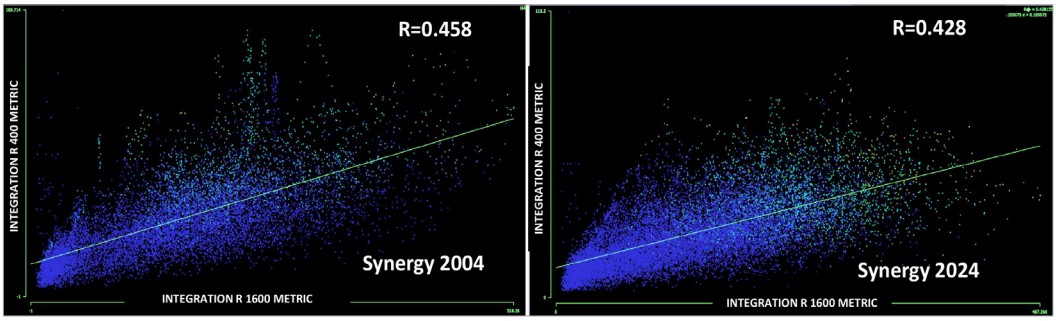


Table 2

The highest value of indicators according to Axial & Segment analysis, source: authors

Indicators	High value (2004)	High value (2024)
Choice	24099	10714
Connectivity	32	55
Integration HH	1.52	1.41
Intelligibility	0.163	0.163
Synergy	0.458	0.458

Discussion

The findings from the analysis of Babylon's spatial configuration highlight the transformative impact of heritage areas on urban development. The substantial increase in the choice indicator from 2004 to 2024, especially along the Hillah-Karbala Street, underscores the area's growing connectivity and accessibility, suggesting that such historical sites can significantly enhance urban permeability and facilitate movement. This increase indicates that urban planning strategies have effectively leveraged the city's historical and cultural assets, turning them into dynamic nodes that attract both social and economic activities. However, the decline in integration values in some areas, particularly the archaeological sections, signals potential challenges in balancing preservation with modern urban demands.

This decrease may be due to urban sprawl and changes in land use that have not adequately integrated these heritage sites into the broader city fabric. The consistently low intelligibility values point to a complex urban landscape where the coexistence of ancient and modern layouts has created a disjointed urban experience. This highlights a need for more cohesive planning efforts that bridge historical significance with contemporary urbanism.

The medium synergy levels further suggest that while there is some coherence within the urban network, there is room for improvement in creating more harmonious interactions between different urban components. These insights underscore the importance of developing comprehensive

urban strategies that not only protect the historical integrity of heritage sites but also integrate them into the city's development framework, ensuring they serve as active catalysts for urban sustainability and cultural identity preservation.

Conclusions

The study of Babylon's spatial dynamics provides critical insights into the multifaceted role of cultural heritage sites in contemporary urban development. The analysis revealed that the ancient city's historical assets significantly contribute to its urban vitality, as evidenced by increased choice and connectivity metrics over the twenty-year period from 2004 to 2024.

The choice indicator reveals that its highest value in 2004 was recorded along Al-Hillah Central Street, whereas in 2024, it shifted to Hillah-Karbala Street. This shift indicates a transformation in urban mobility patterns. The increase in the choice value reflects high movement intensity and visual permeability along specific axes, highlighting the evolution of urban dynamics and the emergence of new focal points of activity.

The connectivity indicator shows that its highest value in 2004 was recorded on Street 40, located in the city center, due to its commercial significance. In 2024, the highest value shifted to Street 80. The decline in connectivity values along the historical route indicates reduced integration and limited accessibility within heritage areas.

The integration values within a radius of (400 and 800 meters) are concentrated around historical and residential areas near the city center. At a radius of (1200 and 1600 meters), integration extends towards the archaeological city, indicating potential for social and tourism-related functions despite the inconsistency in land use patterns. Spatial analysis results reveal that as spatial distance increases, accessibility options expand. However, the overall integration values in 2024 remain lower compared to those in 2004.

The decline in intelligibility values across the two time periods indicates a reduced clarity in perceiving the urban structure as a cohesive whole. The hybrid urban fabric, transitioning from the ancient archaeological layout to grid-like patterns in the city center, has contributed to fragmenting the urban readability. Meanwhile, the slight decrease in synergy values reflects a minor reduction in the cohesion of the urban structure. This suggests that while the urban network remains relatively intact, the integration of its various components has weakened over time.

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