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Street Patterns, Visual Permeability, and Spatial Accessibility of Downtown: The Case of Baghdad

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ABSTRACT

Urban forms and configurations are very influential in building up urban life; they affect street configuration, visual permeability, and spatial accessibility. However, the importance of this in impacting the performance and vibrancy of urban spaces has not been comprehended so far. Thus, the following paper takes a closer look at the key areas within downtown Baghdad, namely Alshorja and Bab AlSharqi, to analyze their urban characteristics. A comprehensive methodology was developed for this research that combined qualitative and quantitative methods, including field survey, GIS digitization, and space syntax analysis, which enabled an in-depth investigation into the street pattern, visual permeability, and spatial accessibility of the chosen case studies. The findings show sharp differences between the organic, random street pattern of AlShorja—which tries to make pedestrians move and socialize more easily—compared to Bab AlSharqi's grid system, which tries to promote an extensive flow of vehicles and businesses. AlShorja, therefore, has higher local connectivity and street vitality in its condensed layout than Bab AlSharqi, which comes with higher visual permeability and spatial accessibility and presents the image of a CBD.
The study concluded that the blending of historical context with contemporary needs should be considered to develop livable urban environments. Pedestrian-friendly features to integrate in AlShorja combined with the principles of accessibility and navigability in Bab AlSharqi will, in turn, enhance urban vitality and connectivity. More diversified methods in future research will enrich urban planning and design for cities like Baghdad, including wider metropolitan areas.

Keywords: Space syntax, Streets, Permeability, Accessibility, Downtown.

1. INTRODUCTION

Urbanity represents the quality of life within the city. The physical form of the city, along with its social life, economic life, and cultural life. Downtown, or CBD, locations often

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constitute the financial, cultural, and historical core of cities and are thus at the center of their urbanity. The CBD is usually referred to as the heart of a city's economy **(Rannells, 1956)**. This area is known for hosting many industries including banks, commercial centers, and head offices of various corporations. The location has also been transformed into both a cultural and social core with facilities such as movie houses, galleries, and hotels among others that promote interaction among people thus promoting cultural diversity **(Mitchell, 2001; Kim, 2011)**. It still remains that CBD includes good transport systems; thereby making trade operations easier as well as enabling users or goods to move in and out faster thus enhancing city life **(Brown and Neog, 2012)**.

The study investigates the urban structure of Downtown Baghdad specifically focusing on AlShorja and Bab AlSharqi areas in Iraq. This study aims to reveal the potential of urban characteristics (including street patterns, visual permeability, and spatial accessibility) in shaping city life. These two areas, with different urban characteristics, provide an excellent context in which to explain the relationship between street patterns, visual permeability, and spatial accessibility, see **Fig. 1**.

Figure 1. Vienna Downtown is a historic core (on the left) while Toronto Downtown represents a modern city center (on the right) **(Al-Saffar, 2022)**.

Commercial downtowns have been the locus of urban life; from the oldest marketplaces, they have evolved to become modern commercial centers. The Greek Agora and the Roman Forum are good examples of this; central spaces within the city where social, economic, and political activities come together. Similarly, the Roman Forum, ringed with temples, basilicas, and marketplaces, was a multifunctional urban core. The Agora was a rectangular open space enclosed by colonnaded streets and provided a very high degree of access and interaction befitting a civic heart in Greek cities **(Mbisso, 2011; Taghizadehvahed, 2015)**. The historical precedents of these features gave importance to urban form in shaping social and economic life within the city, see **Fig. 2**.

In Baghdad, AlShorja and Bab AlSharqi represent two different typologies of urban development. AlShorja dates back to the Abbasid era and has narrow, winding streets that have evolved into a dense and intricate urban fabric. This locality had a very historical commercial importance, and this is still evident from the crowded markets and traditional suqs that give an impression of this area's continued role in urban life in Baghdad over time. These areas remain important for commerce but are instead characterized by bustling markets and traditional souks, thus showing their long-lasting part in the city life of Baghdad.

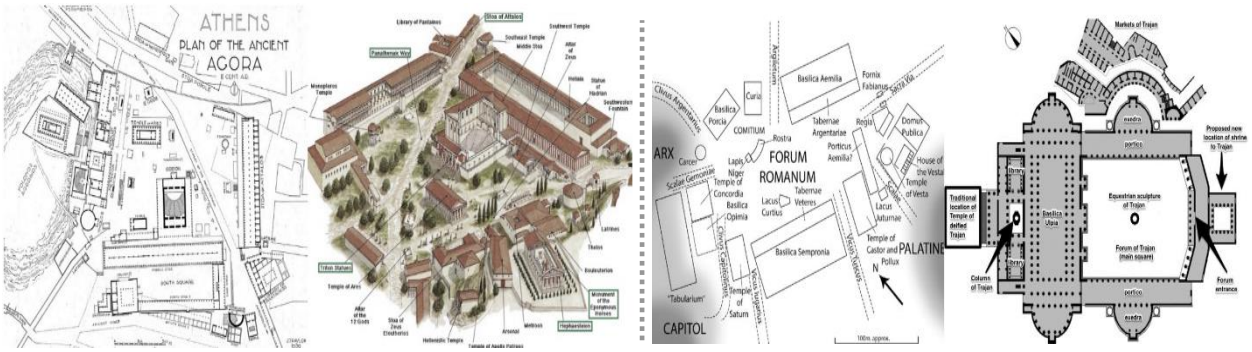


Figure 2. Agora of Greece represents the historic downtown (on the left) and the Forum of Romans is another historic downtown (on the right) **(Camp, 2003; Russel, 2014; 2016)**.

In contrast, Bab Al Sharqi, developed in the mid-20th century, reflected modern urban planning principles widely applied at that period within most of the modern districts and neighborhoods **(Awad, 1989; Alobaydi and Rashid, 2024a; Alobaydi and Rashid, 2024b; Al-Saaidy and Alobaydi, 2021a; Albabely and Alobaydi, 2024)**, see **Fig. 3**, including an ordered grid pattern of streets with wider streets to support vehicular movements and commercial activities. This planned urban form reflects the socio-economic shifts in Baghdad during its development. It aimed at creating a modern central business district **(ALslik and Majeed, 2014; Alobaydi and Rashid, 2017; Al-Saaidy, 2020; Alsaffar and Alobaydi, 2023)**.

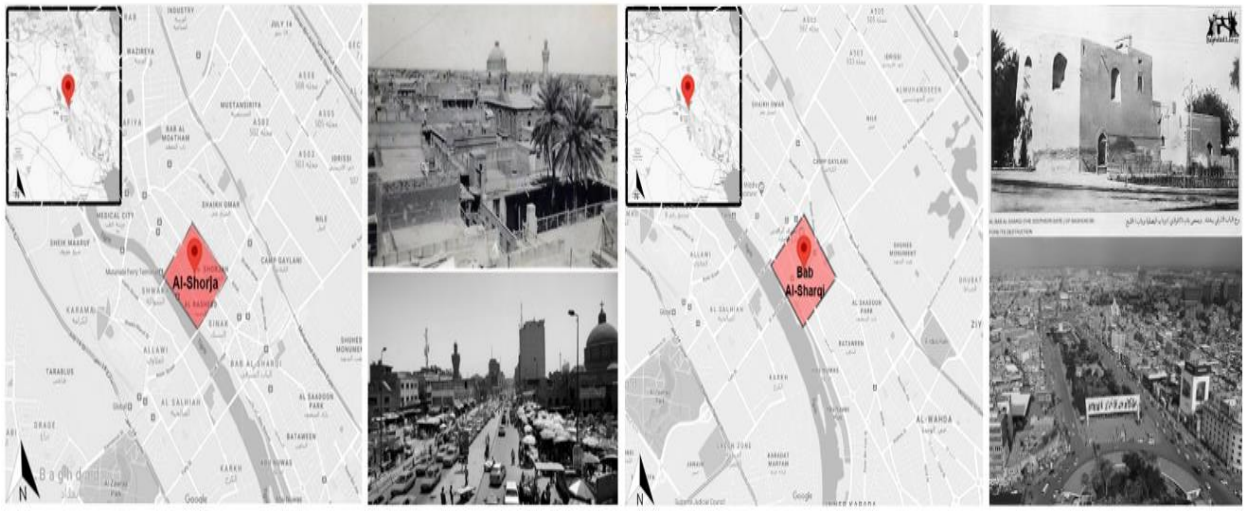


Figure 3. Shows Agora of Greek represents the historic downtown (on the left) and the Forum of Romans is another historic downtown (on the right) **(Camp, 2003; Russel, 2014; 2016)**.

Street patterns in AlShorja and Bab AlSharqi have a great impact on their urbanity. The street structure of AlShorja is irregular; the irregularity encourages pedestrian movement and helps create an intimate social life **(Al-Saaidy and Alobaydi, 2021b)**.
The narrow streets and lanes give an enclosed and surprising feeling, favoring exploration and lively street life **(Hakim, 1994, 2007; Mohammed and Alobaydi, 2020a)**, see **Fig. 4**. An organic street pattern is a norm in traditional old cores, wherein pedestrian accessibility

remains the first priority **(Kiet, 2011; Farhan et al., 2022; Al Hashimi and Alobaydi, 2023)**. In Bab AlSharqi, however, there is a regular grid street pattern allowing smooth movement of traffic with less inconvenience of wayfinding. These wide streets and open spaces make the area visually connected and accessible, thereby ensuring ease of movement for the users, see **Fig. 5**. Still, at times, this can also reduce the level of pedestrian interaction and urban vitality that is achieved by a more organic pattern of development **(Erbas, 2013; Hakim, 2013; Ozuduru et al., 2021; Kayanan, 2022)**.

Features of the aspect of urbanity would be incomplete without discussing visual permeability and spatial accessibility. Visual permeability involves the extent to which people can see through spaces, which, in turn, affects their orientation and sense of security in a place. In AlShorja, though, the visual permeability is relatively low because of the dense and convoluted street layout. This low permeability adds to a unique urban experience, characterized by the feeling of curiosity and discovery **(Pourjafar et al., 2014; Akar, 2024; Nabi et al., 2024)**. Greater visual permeability at Bab AlSharqi exists due to the wider streets, big open spaces where one can see clearly across, and much greater connections visually, which increases the ease of navigation and orientation for pedestrians. Spatial accessibility, via techniques such as Space Syntax, incarnates mobility and grasping into the different areas of the city tissue. For AlShorja, the local integration is high; it builds up the pedestrian quality in which local integration values determine the highest rates of social interactions. In contrast, Bab AlSharqi has higher global integration values and would be a central business district within this broader urban network, accommodating significant amounts of vehicular traffic and connectivity **(Hillier, 1997; 2007; Rashid and Alobaydi, 2015; Rashid, 2017; Alobaydi et al., 2020)**.

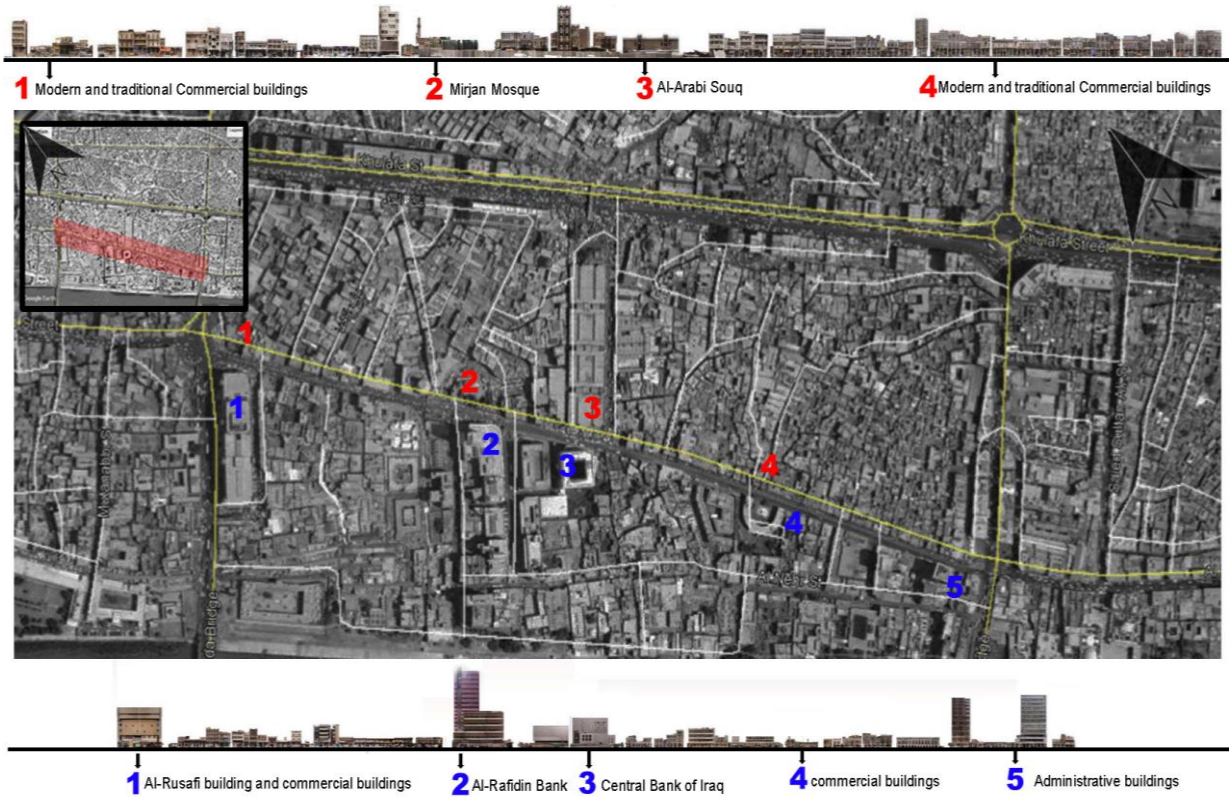


Figure 4. The section in the AlShorja area **(Al-Hasani, 2021; Al-Saffar, 2022)**.

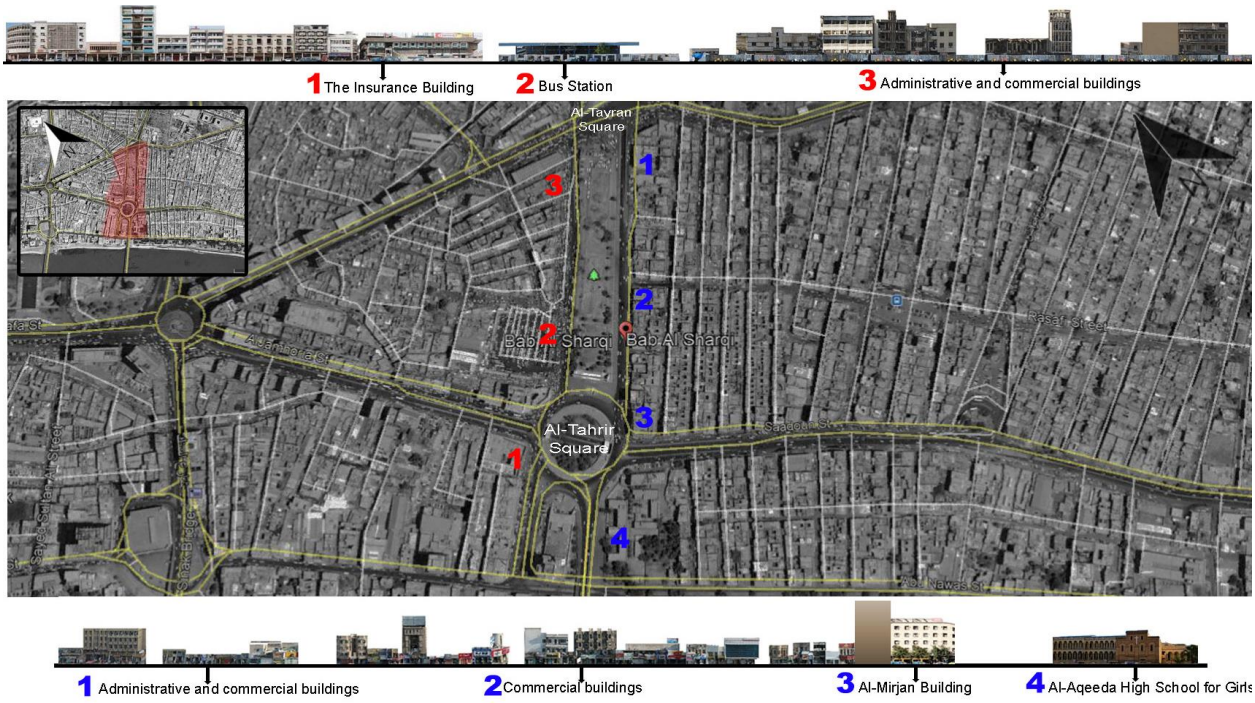


Figure 5. The section in Bab AlSharqi area **(Al-Hasani, 2021; Al-Saffar, 2022)**.

2. METHODOLOGY

The very detailed methodological framework used for this research work studies the urban characteristics of Downtown Baghdad, particularly AlShorja and Bab AlSharqi. This methodology has been designed to achieve the balance of qualitative and quantitative methods through multiple analytic approaches for a more holistic understanding of urban form and function. The methods are in three main phases: case description, data processing, and interpretation, each specifically designed to bring out meaningful insights about street patterns, visual permeability, and spatial accessibility.

2.1 Cases Description

AlShorja area occupies the historical core of Baghdad city with dense, irregular street patterns. It has a very long history back to the Abbasid era and remained a vital commercial hub. Its narrow, winding streets and its busy markets look like in earlier centuries; today, too, this area sustains continuous urban activity. The complex street network supports a high pedestrian flow and portrays a vibrant and active urban realm.

Bab AlSharqi Area: Bab AlSharqi was developed in the mid-20th century and stands for the modern central business district of Baghdad. It has a more organized gridiron system with broader streets that can hold a good amount of vehicular traffic and allow commercial activity at the same time. The planned urban form is thus entirely in contrast with the AlShorja, representing the social and economic changes in Baghdad during the times of its development. The layout of Bab AlSharqi aims at making the place more navigable and accessible and therefore has become a central node in the urban network of the city.

2.2 Methods and Techniques

2.2.1 Data Collection

The data gathering processes included primary and secondary data collection. Information based on primary data was collected from field surveys and photographic documentation on street patterns. The researchers had thoroughly done the groundwork in AlShorja and Bab AlSharqi, capturing detailed images with notes, and showing the physical layout and urban activities. The secondary sources for the data included historical maps urban plans and spatial data provided by local authorities, which give background information regarding the data to be analyzed.

2.2.2 Data Digitization

Digitizing was undertaken through the GIS software. The historical maps and the results from field surveys were transformed into digital format, and it became possible to prepare correct base maps for any selected area with high accuracy and detail. This involved the process of geo-referencing historical maps to fit the contemporary spatial data in a manner that was both consistent and accurate.

2.2.3 Data Analysis

In the assessment stage, Space syntax methods were utilized to estimate the level of spatial accessibility and visual permeability. Space syntax gives a collection of analytic devices to help in the recognition of the design of urban spaces and its performance concerning pedestrian motion and social communication **(Hillier and Hanson, 1989; Hillier, 1989; Hillier et al., 1993; Mohammed and Alobaydi, 2020b).** The DepthmapX software application program was utilized to perform the exams, which returned assimilation and selection values for the corresponding road networks in both regions **(Penn et al., 1998; Hillier, 1999a; 2005)**.

2.2.4 Spatial Metrics

Calculations involved specific metrics, such as global and local integration values, connectivity, and visual permeability indices, which measure the degree to which different areas are accessible and visually connected. More clarifications in works by Hillier and Hanson **(Hillier, 1989, 1999b; Hillier and Hanson, 1989)**. For instance, global integration measures the accessibility of a street throughout the whole network, and local integration measures it locally **(Hillier and Iida, 2005; Turner et al., 2005; Hillier and Vaughan, 2007)**.

2.2.5 Morphological Analysis

The morphological analysis identified the major street patterns, plot layouts, and land uses of AlShorja and Bab AlSharqi. The results depict the major geometric characteristics and spatial configurations, which define each area. The results were plotted into maps and graphs illustrating the spatial properties of the urban form: similar analyses can be found in the works by Conzen and Whitehand, see **(Conzen, 1960; 1975; Whitehand, 1977; 2007)**.

2.3 Interpretation

In the final phase, the results of the spatial and morphological analysis were interpreted: the results were discussed in terms of historical development, socio-economic activities, and urban planning principles, which tend to interpret the role of street patterns, visual permeability, and spatial accessibility about urban life in AlShorja and Bab AlSharqi. The integration of Space syntax and GIS formed the backbone for such an interpretation. This combination of both Space syntax and GIS methodologies posed a robust framework for the analysis of spatial properties in the urban form. Space syntax techniques, such as axial line analysis and segment analysis, were applied to describe the integration and choice values of street networks representing the connectivity and accessibilities in the urban fabric—revealing how people move and interact within these spaces. The GIS-based digitization of the historical maps and field survey data enabled the accurate mapping of the area's spatial configurations in AlShorja and Bab AlSharqi. The use of these two methodologies together permitted the research to give detailed and accurate maps that will represent the spatial dynamics of the examined area. The research methodology used in this research gives a very comprehensive way of understanding the urban features of Downtown Baghdad.
This is a study that applies both qualitative and quantitative approaches to the understanding of street patterns, visual accessibility, and spatial accessibility in AlShorja and Bab AlSharqi. Therefore, the study is comprehensively designed to bring out an understanding of how urban configuration affects urban life for city planners and designers.

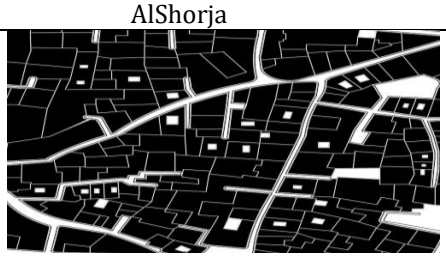
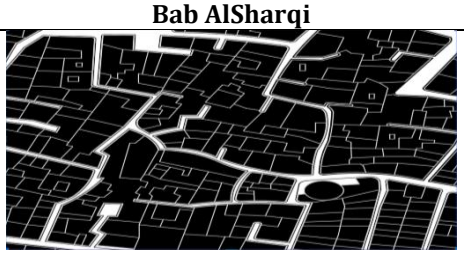
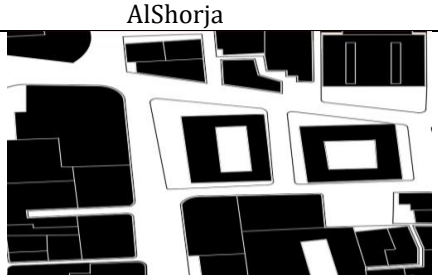
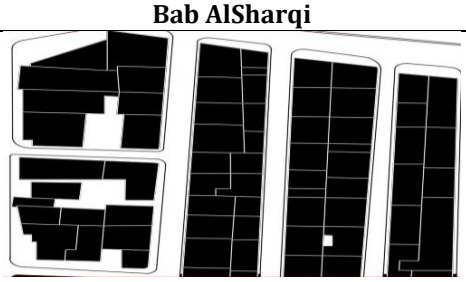
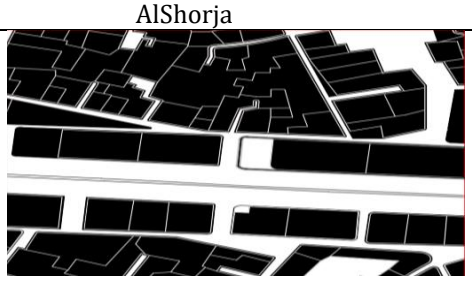
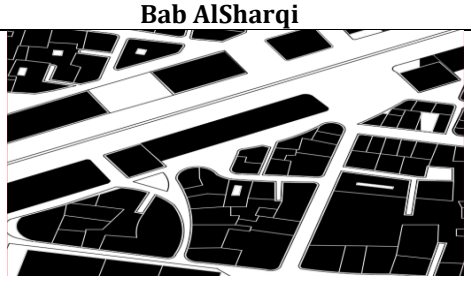
3. RESULTS AND DISCUSSION

Results obtained from the analysis of street patterns and visual permeability at the micro-scale for AlShorja and Bab AlSharqi give value since these will detail the specificity of urban features in these areas and a translation into urban life in downtown Baghdad.

3.1 Street Patterns

AlShorja has an extremely irregular street plan, characterized by narrow, winding streets; the result is a tight and complex urban fabric. This pattern is a product of an organic process of urban development over the centuries, and it reflects the deep embedding of history and culture in the region. The zigzag layout of streets allows high pedestrian mobility, prompting close interaction at a personal level with dense street life. The streets in AlShorja are usually designed with pedestrian scales, many tiny passageways and alleys. This local system of complexity provides permeability but proves difficult to navigate in cars. In contrast, Bab AlSharqi has wide streets with a more regular grid pattern in the district that can easily accommodate vehicular traffic and the associated commercial movement, among other many activities. The regular grid characteristic of modern urban planning results in efficient vehicle and pedestrian flow, as illustrated in **Table 1** below. This ordered network guarantees broad accessibilities and simple orientation, which augments an ordered way in the city. However, wider streets and a more regular layout might reduce the level of pedestrian interaction and urban vitality of an area in comparison to something more organic in feel, such as AlShorja.

Table 1. **Shows the streets' patterns of AlShorja and Bab AlSharqi .**

Examples of Case Studies		
	AlShorja	**Bab AlSharqi**
Traditional Organic Street		
	Type A: The traditional, narrow, and zigzag-curved alleys characterize Type A. This pattern has predominantly dominated the AlShorja area and is primarily found in the internal region, see **Fig 6.** In the Bab AlSharqi area, its presence is limited to parts of the north and northwest regions within the old city center of Baghdad, see **Fig. 6**.	
	AlShorja	**Bab AlSharqi**
Modern Gridded Street Pattern		
	Type B: Wide and straight streets with looping paths define Type B. This pattern is found in the AlShorja area near the Rafidain Bank and the Central Bank of Iraq, as well as the area between AlRasheed Street and AlNahir Street and other small areas, see **Fig 6**. In the Bab AlSharqi area, this pattern clearly dominates most of the urban regions in the streets of AlSaadoun, Abu Nawas, and AlNidal. Additionally, a few lanes and paths characterized by this pattern can be found in the inner parts of the urban fabric, see **Fig. 6**.	
	AlShorja	**Bab AlSharqi**
Hybrid Street Pattern		
	Type C: This type represents a hybrid that combines organic, historic, and gridded modern patterns and is found in areas that include the main straight streets surrounding the compacted organic urban forms. In the AlShorja area, the hybrid pattern is located around AlRasheed, AlJumhuriya, and AlKifah Streets, see **Fig 6.** In the Bab AlSharqi area, it can be observed in the area between AlJumhuriya and AlKhilani Streets, see **Fig. 6.**	

3.2 Visual Permeability

Clear information through a space can be referred to as visual permeability **(Beck and Turkienicz, 2009; Koch, 2012)**. It is one of the crucial elements for suitable city accessibility and the qualities of a sense of place as effects **(Dubinina et al., 2022; Long et al., 2023)**. The visible permeability in AlShorja is quite low because the streets' layouts are dense, zigzag, and complicated. The winding and narrow streets with common turns create

numerous visual blocks. While this low permeability could make the movement via such spaces extremely tough, it additionally guarantees that the distance is greater as an area of mystery and surprise. The visible cues pull the passersby into the spaces, discovering the hidden alleys and mystery urban rooms that further upload onto the layer of vibrancy and activity that rather more characterizes this part of the distance.

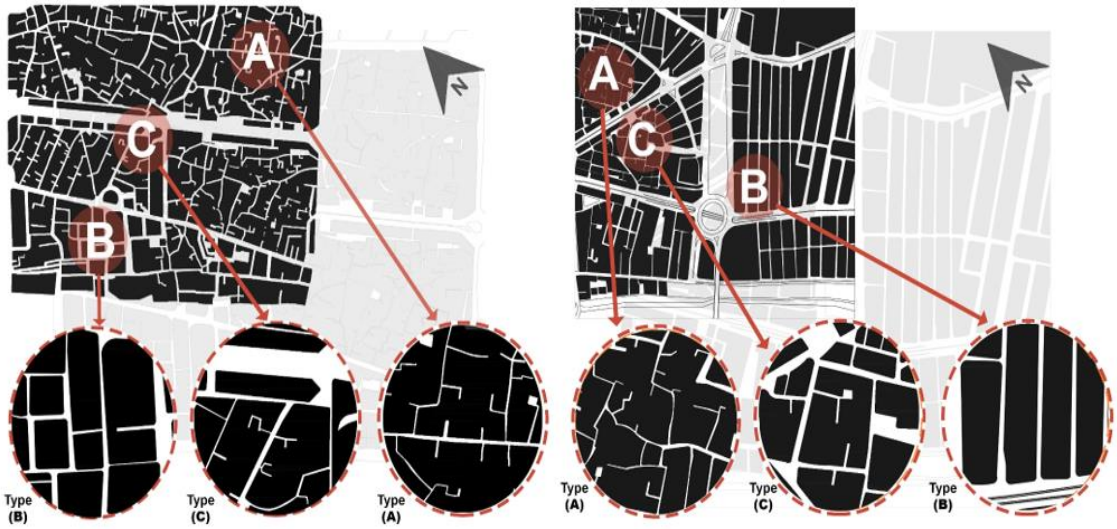


Figure 6. Streets' patterns of AlShorja (on left) and Bab AlSharqi (on right).

In assessment, Bab AlSharqi has a higher degree of visual permeability because its streets are wider and its open spaces are large. The gridiron road pattern offers a much longer line of sight and visible connectivity over longer lengths and depths of the place. This open shape of the urban structure in Bab AlSharqi creates a feeling of space and free movement, which serves to sustain this critical characteristic because of the business core, as shown in **Fig. 7**.

Figure 7. Shows physical permeability, visual permeability, and impermeable road in AlShorja (on left) and Bab AlSharqi (on right).

3.3 Spatial Accessibility

Spatial accessibility, measured with the support of area syntax, represents how smooth it is for people to move around and get right of entry to specific areas of the urban location **(Hillier, 2007; Huang et al., 2020; van Nes, 2021; Batty, 2022)**. In the case of AlShorja, the space syntax evaluation shows high local integration values, illustrating the pedestrian-oriented nature of this urban area with high levels of social interaction and communication. The dense streets and alleys make the place locally available and connected, accordingly movement-friendly for pedestrians. The high levels of local integration further show the importance of AlShorja as a rich urban space with a strong social form and cohesive spatial network, as illustrated in **Fig. 8**.

On the other hand, the global integration values for Bab AlSharqi, even though lower than those of AlShorja, place it ahead. This is indicative of its importance in the citywide community as a main commercial business district with huge vehicular traffic and connectivity. The current pattern of the urban grid encourages a greater scale of movements that support roles of industrial and administrative activities formed in the close urban areas. The value of global integration is more associated with the role of Bab AlSharqi as a significant core in Baghdad's metropolis community that connects specific parts of the city, see **Fig. 9**.

The distinction of city form between the AlShorja and Bab AlSharqi areas brings to light how both ancient and contemporary planning processes (concepts and models) have an impact on the city's existence. AlShorja is designed in a zigzag organic network pattern with low visual permeability, which creates a dense pedestrian-orientated area with essential social activity. The chaotic nature of the area's structure and its denser streets shape its unique urban form, performing as a stimulant for pedestrian navigation and local levels of connectivity. In contrast, Bab AlSharqi's grid shape and high levels of visual permeability provide a wide range of free movement and accessibility inside the limits of the urban area that fits its characteristic as a valuable business district. Wider streets and more open areas in the place bring a sense of openness and unimpeded mobility within the given area, supporting the known ideas and norms of modern city design and planning. The character of this urban area may additionally reduce pedestrian hobby to underneath the level visible inside the cozier and more dynamic placing of AlShorja.

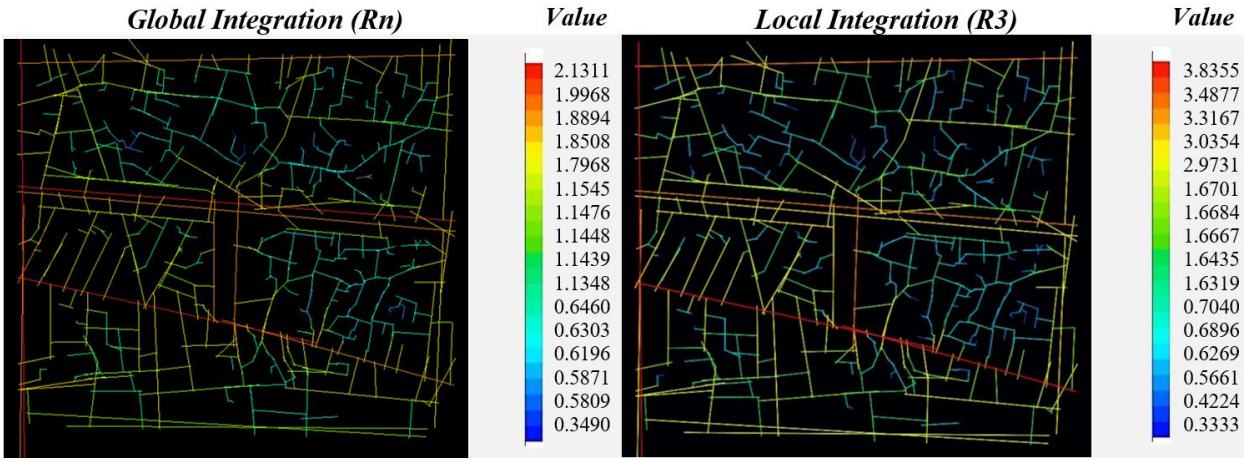


Figure 8. Shows the values of global and local integrations in the AlShorja area.

The outcomes of the current study emphasize the real need for understanding the city design that existing desires should overlap with the context of ancient areas. The insight into the spatial dynamic of AlShorja and BabAlSharqi gives the urban planner capabilities to further extend strategies that balance pedestrian hobby and energy with vehicular accessibility in creating a more livable and sustainable urban area.

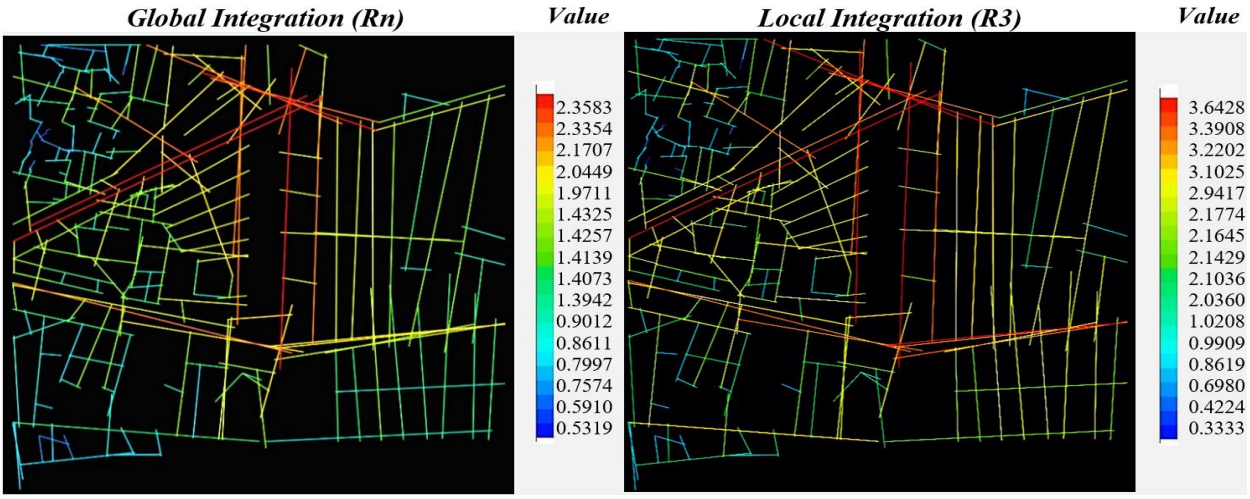


Figure 9. Shows the values of global and local integrations in the Bab AlSharqi area.

4. CONCLUSIONS

This research examines the urban dynamics, visual permeability, and spatial accessibility in downtown Baghdad, focusing on the AlShorja and Bab AlSharqi areas. It provides a comprehensive understanding of how different forms of urbanity impact the core business district. The conclusions highlight the importance of blending historical context with modern principles to create vibrant, sustainable, and functional urban spaces. The street patterns in AlShorja and Bab AlSharqi exhibit distinct characteristics. AlShorja features an intricate network of narrow streets and alleys that have developed organically over thousands of years, reflecting a pedestrian-focused environment. In contrast, Bab AlSharqi's grid structure is a more recent, planned development aimed at facilitating vehicular flow to commercial centers. This design creates wider spaces between paths, making the area easily navigable and accessible, though potentially reducing pedestrian interaction compared to the more organic and personal milieu of AlShorja. The visual permeability of the urban environment in AlShorja and Bab AlSharqi shapes unique experiences. AlShorja's narrow streets and frequent turns create low visual permeability, resulting in visual obstruction. This can be confusing to navigate but also makes the area more attractive and encourages pedestrian exploration. The dynamic and lively urban context is a result of this feature. Conversely, Bab AlSharqi's wider streets and open spaces provide higher visual permeability, improving accessibility, orientation, and free movement of people. This openness and spaciousness are compatible with the central business district function of the area. The analysis of spatial accessibility using space syntax techniques reveals distinct roles for AlShorja and Bab AlSharqi within Baghdad's urban structure. AlShorja exhibits high local integration, making it pedestrian-friendly with strong social interactions facilitated by its network of streets and alleys. Conversely, Bab AlSharqi has a higher global integration, indicating its importance in the overall urban network. The grid pattern in Bab AlSharqi enables greater movement at a larger scale, suiting its commercial and administrative

functions as a pivotal node connecting different parts of the city and accommodating significant vehicular traffic.

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Credit Authorship Contribution Statement

Noor Hadi Alsaffar: Writing – review and editing, Writing – original draft, Validation, Software, Methodology. Dhirgham Alobaydi: Writing – review and editing, Validation, Software, Methodology.

Declaration of Competing Interest

The author states that there are no known financial conflicts of interest or personal relationships that could have influenced the work presented in this paper.

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أنماط الشوارع، والنفاذية البصرية، وإمكانية الوصول المكاني لوسط المدينة: حالة الدراسة بغداد

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الخلاصة

تُعَد الأشكال والهيئات التكوينة الحضرية مؤثرة جداً في بناء الحياة المدنية، اذ انها تؤثر على تكوينات الشوارع، والنفاذية البصرية، وسهولة الوصول المكاني ، اذ لم يتم تقديم الفهم التفصلي لأهمية هذا النوع من التأثير على أداء وحيوية الفضاءات الحضرية المعاشة. لذلك تسلط هذه الدراسة الضوء على أهمية دراسة المناطق المركزية في وسط مدينة بغداد، وهي منطقتي: الشورجة وباب الشرقي، لتحليل خصائصها العمرانية. تم تطوير منهجية شاملة لهذه الدراسة اذ انها تجمع بين الأساليب النوعية والكمية معاً، بما في ذلك المسح الميداني، والتحليل الرقمي بنظام المعلومات الجغرافية، وتحليل البنية الفضائية، مما ساعد على اجراء تحقيقات عميقة في خصائص وصفات انماط الشوارع، والنفاذية البصرية، وسهولة الوصول المكاني لتلك المنطقتين المختارتين للدراسة والتحليل. تُظهر النتائج اختلافات قوية بين نمط الشوارع العضوي والمتعرج في الشورجة، والذي يحاول فيه جعل حركة المشاة والتواصل الاجتماعي أسهل. بينما اظهر نظام الشبكة المتعامد في باب الشرقي حالة من تعزيز عمليات الحركة والتدفق للمركبات والمجموعات المتوجهة لاجراء الأعمال التجارية بشكل مكثف. لذلك، فإن الشورجة تتمتع بربط محلي أعلى وحيوية شوارع أكثر في تخطيطها المكثف مقارنةً بباب الشرقي، الذي يأتي مع نفاذية بصرية وسهولة وصول مكاني أعلى ويقدم صفة جيدة لمنطقة الأعمال المركزية. خلصت الدراسة إلى أن مزج السياق التاريخي مع الاحتياجات المعاصرة يجب أن يُؤخذ في نظر الاعتبار بشكل جاد البيئات الحضرية القابلة للعيش. إن ميزات البيئة الصديقة للمشاة التي يمكن دمجها في الشورجة مع مبادئ الوصولية وسهولة التنقل في باب الشرقي ستعزز بدورها المزيد من الحيوية الحضرية وعمليات الربط. استخدام الأساليب التحليلية المماثلة والأكثر تنوعاً لدراسة المدن كبيرة مثل بغداد والمدن المشابهة لها سيثري جوانب الفهم والتحليل العلمي.

الكلمات المفتاحية: تحليل البنية الفضائية، الشوارع، النفاذية، سهولة الوصول، وسط المدينة.