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Assessing the Space Syntax Properties of Downtown: A case study of Old Baghdad

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Abstract— Downtown is considered as the primary hub responsible for determining a city's urban prosperity and success, since it extends beyond the physical center of the city and reflects its historical, cultural, economic cores, and activities. Old Baghdad, also known as AlShorja, is Baghdad's old downtown. The urban grid of Baghdad's downtown is examined in this research using a scientific, quantitative methodology. A case study was used in this work, as well as Space Syntax, which provided several measurements (integration, connectivity, and choice) to define the spatial properties of urban centers and created specific, computable data linked to concepts of integration and segregation. The chosen urban grid was measured at one kilometer square and studied at several measurements in relation to land use distribution. The findings revealed a strong relationship between integrated streets and commercial and mixed-use activities at the whole level (HH Rn), while there was clear relationship between segregated streets and residential activities, supporting the concept of privacy and isolation for residential areas. The choice values in the AlShorja area are high because the urban-blocks are constructed by a finely urban grid. Although AlShorja is represented the oldest downtown of Baghdad, the syntactic analyses show that it is the commercial core that has preserved its physical urban qualities connecting a wide range of various activities.

Keywords— Space syntax, urban grid, integration, streets, downtown, Baghdad.

1. Introduction

Cities have emerged around recognized centers, showing the original nuclei from which these cities have grown and developed. These centers spatially reflected culture, social organization, economic representation, and power. No city or town can succeed without a strong downtown that builds on the economy, opportunity, and identity of the city itself. There is an extensive literature that studies city cores and downtowns; this literature is divided into three main groups: Firstly, studies that described and analysed the basic geometric pattern of downtowns. Secondly, studies that examined the urban forms and structures of downtowns. Lastly, studies employing space syntax measures and techniques. These studies can be summarized as follows:

1.1 Downtown's Patterns

Downtown's Pattern were shaped based on navigation – relating to the flow of people, cars, and goods – some geometric patterns in these downtowns are repeated in many cities due to the configurations of the central commercial and industrial activities. The downtown can be classified as mentioned by Hartman (1950) into three patterns, namely: the circle pattern, the star-like pattern, and the diamond pattern, [27, 16].

In the absence of topographical or artificial (man-made) barriers, the geometric pattern is a circle (figure 1A). This approach is based on measuring the relative distance from the center, and with the desire of commercial activities to have a central l16ocation. Thus, the entire commercial area has taken a circular shape around the central point. The pattern seems to be more circular when there are many radial pathways in the urban area (figure 1B). As the number of radial paths decreases, the peripheral shape has become less circular, and the other sagging areas (which were fallen between these radial streets) have become larger. The small number of these pathways imposed a more star-like pattern (figure 1C). Many cities have been developed based the gridiron system, where it was superimposed to spatially facilitate the flow of traffic and offering more road options and shorter distances. A diagonal square or diamond-like was shaped the last pattern of downtowns, in particular, when the equal

distances from the center were taking into account in the formation processes, see (figure 1D). Finally, if the star or diamond patterns are reduced to their simplest, the resulting geometric pattern becomes identical to that of the square fork (figure 1E).

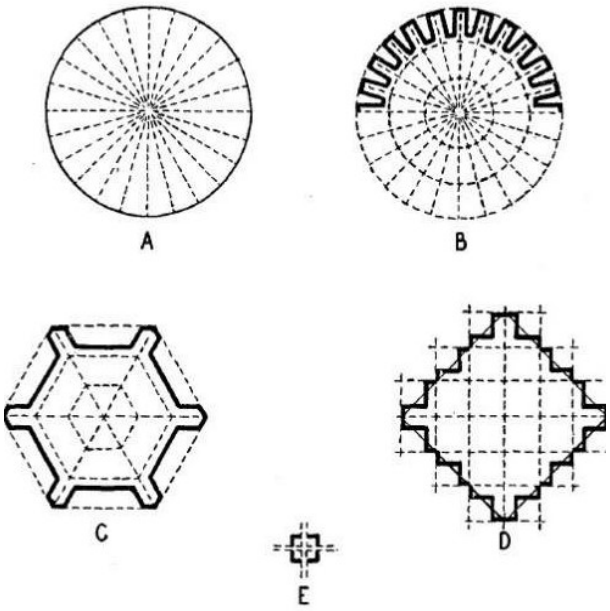


Figure 1: Downtown geometric patterns [16]

1.2 Literature Review

There is an extensive literature that addressed the topics of downtowns using different methods, measures, and techniques, in particular studying the impacts of social, environmental, commercial, and economic forms on the urban form formation. Studies that examined the urban forms and structures of downtowns based on Conzenian perspective (Morphological approach) which analyze the developments of physical forms of street, plots, and building activities; these studies were include, but not limited to, a set of well-written literature. Whitehand et al. compared the historico-geographical evolution of the ground plan of Como, Italy, and Pingyao, China. Adopting a mainly Conzenian technique formerly used in Europe. The researchers did extensive use of field surveys and a succession of large-scale plans to map changes that occur through time in streets, plots, and building ground plans. They noted that in both cities, throughout the last 2000 years, a succession of planned projects has left significant physical legacy that have served as framework for long-term morphological evolution and given rise to different intra-city patterns of modern physical forms. The research exposed cross-cultural similarities in development processes, particularly the effect of old street patterns, plots, and successive city walls. Among the notable distinctions between the two cities are those resulting from socio-cultural variations, particularly those connected to cosmological influences [20]. Xia et al. (2021) have examined the relationships between multidimensional urban form and urban vitality at the street level and explored their differences across fifteen megacities in China. Based on Conzen's town-plan analysis, the multidimensional urban form has been defined from three basic aspects: city plan, building forms, and land uses. Local vitality was measured in social and economic dimensions at different times of the day. The results revealed the changing relationships in time and place between urban form and urban vitality. In particular, some aspects have been considered as important characteristics of urban vitality which are: (compactness, connectivity, arrangement of buildings, iconic buildings, transportation facilities, and open spaces). The combination of land use and building density provided limited or unintended effects. Moreover, some indicators of the urban form can inversely contribute to the vibrancy of cities at different times or dimensions, suggesting that urban spaces bearing these qualifications may not be consistently attractive. The research suggested looking at the local spatiotemporal characteristics in urban revitalization policies [8]

At the global level, studies employing space syntax methods and measures have examined the syntactic properties of spatial networks in relation to the land use developments, human densities, social classes, and historic landmarks. However, locally, a comparative literature does not exist and there is a clear lack of studies that were related to the existing models of downtown.

In addition, studies that used morphological methods and measures were not focused on the boundaries of downtown; instead, they studied urban forms and structure in general. Studies that were locally employed space syntax measures, morphological methods, and other research techniques can be summarized as the following studies. Abbas and Al-Dujaili have explained that the historical center of Baghdad (the old Rusafa and Karkh) had grown on four morphological stages, during which the main paths were changed from perpendicular to the river to parallel to it. The ancient Rusafa integrative genotypes were tree-like in all morphological stages, but their orientation was orthogonal to the river during the first and second morphological stages and changed to become parallel to the river within the third stage, and the gridded system (parallel and perpendicular) to the river within the fourth stage. The researchers concluded that some of the new streets in the old Rusafa and Karkh, which are parallel to the river, have origins and have existed as historical paths, according to the genetic integration of this center within the four formal stages [31]. Alobaydi and Rashid have dealt with urban development processes and the evolution of the urban network in the city of Baghdad. In the first decade of the twenty-first century, the size of the metropolitan city has become huge with various patterns of urban networks, resulting in a high sense of spatial complexity. The paper analyzed six historical phases of the city - 1900, 1920, 1940, 1960, 1980, and 2000 - showing significant changes in the urban grid. Two main scales, integration and choice, were adopted for spatial composition rules to determine the compositional patterns of urban cores. The results showed that there were significant changes in the patterns and locations of the structural urban cores from one historical stage to another in the city. Some patterns undermined the concept of the inevitable relationship between commercial activities and

integration nuclei, and appeared to be more interacting with planning practices and thus affecting the intensity and direction of urban growth [12]. Abdullah and Alwan have stated a major goal that was to expose the influence of sustainable urban regeneration policies in line with successful urban sustainability methods (urban resiliency, urban symbiosis, and ecopolis), which demonstrated to boost spatial attraction and enhance the quality of life in historical cities. The study revealed common active indicators and design criteria for revitalizing ancient city cores and improving their quality of life. The results of the research, both theoretical and practical, have created a clear approach to the sustainable urban regeneration of historic city centers in accordance with urban sustainability strategies at three basic stages (urban form, urban function, and urban diffusion), as well as the relationship of accessibility to activities in determining the spatially attractive living urban form. In addition, the influence of decreasing urban areas on enhancing spatial attraction and changing the historical core into a dynamic, sustainable, and living center [28].

Several studies investigated historic nuclei and centers with the goal of addressing fundamental urban issues and forms such as environment, history, morphology, society, sustainability, heritage, territory, rituals and traditions [30, 32, 9, 11, 10]. However, studying the downtown of Baghdad relying on the values of syntactic properties and physical qualities of the spatial network in assessing the urban form has not been conducted yet.

This paper fills in the existing gap and highlights the importance of understanding the impacts of the geometric urban form on the urban life of downtown.

The syntactic properties and physical qualities can provide a better understanding of the employed measures, including integration, connectivity, and choice, of the spatial networks of the downtown. Urban designers and planners can thus rely on such measures to overcome the current urban problems (forming abandoned places, poor infrastructure, and a continuous deterioration of the heritage buildings and sites) and future complications (a lack of accessibility and connectivity) of Baghdad's downtown.

2. The Case Study

For the study purposes, Baghdad's downtown, particularly the Rusafa area formed on the east bank of the Tigris River, has been selected. AlShorja area represents the oldest downtown of Baghdad; it is considered the historical and commercial center of Baghdad. Historically, it has a long history of growth processes dating back hundreds of years. It has included many important historic buildings, heritage places, and monuments belonging to the Abbasid Empire (762-1258) and the Ottoman era (1638-1917) that have given a national heritage character to Iraq [24,12]. Baghdad's downtown (AlShorja) will be the subject of this paper's study and analysis.

AlShorja[1] area is located in the Rusafa district, east of Baghdad, on the eastern bank of the Tigris River (figure 2). AlShorja market was initially called Souq AlRayaheen and then Souq AlAttarien [34]. AlShorja has been considered the central traditional public urban space in the old city of Baghdad. The part of the historical area has included many landmarks and heritage buildings such as Al Mustansiriya School and the Caliphs Mosque on AlJumhuriya Street; these landmarks were considered the oldest Islamic features among the other oldest landmarks of Baghdad and dated back to the Abbasid period. In addition, the local heritage markets and public buildings such as Al Ghazal Souq, Souq AlSafafeer, the Central Bank of Iraq, and AlRafidain Bank and other important buildings (figure 3).

Figure 2. A: AlShorja location in Baghdad and Iraq maps; **B:** AlShorja in the past; **C:** The current form of AlShorja currently; source: The Library of Municipality of Baghdad

AlShorja area included a set of vital main streets such as AlRasheed and AlJumhoria Streets, which are considered the new street that penetrate the old historic fabric of old Baghdad. It also contains traditional arteries such as AlNahir Street (AlMustansir) and the old traditional artery of AlShorja. AlShorja area is also connected to the AlAhrar and AlShuhada main bridges founded to connect Karkh and Rusafa sides of the Tigris River (figure 4). AlShorja area characterized by the dominance of the organic compact pattern, narrow winding roads, and cul-de-sac streets due to its location within the boundaries of old Baghdad (figure 5).

[1] The word AlShorja means salty water; the area used to be originally water well that served the public and passed through this area[33].

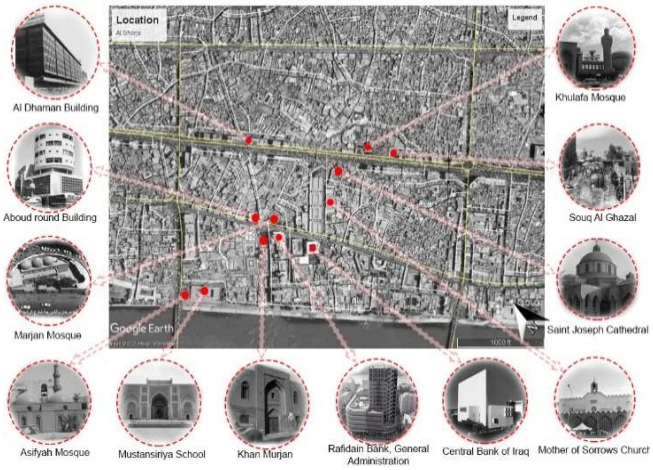


Figure 3: Landmarks located in AlShorja. Source: The Library of Municipality of Baghdad

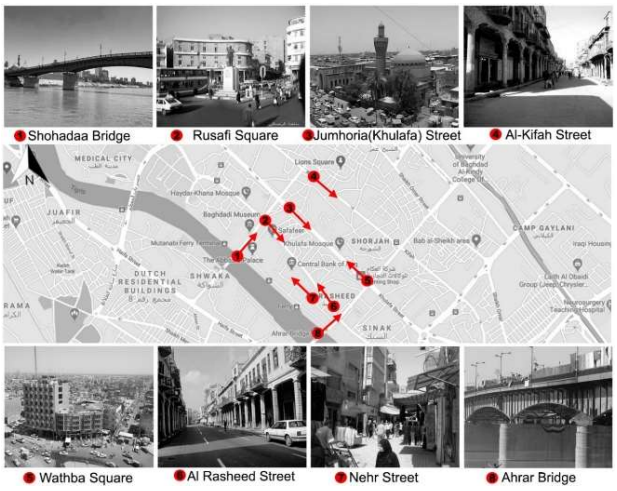


Figure 4: Important streets in AlShorja area. Source: The Library of Municipality of Baghdad

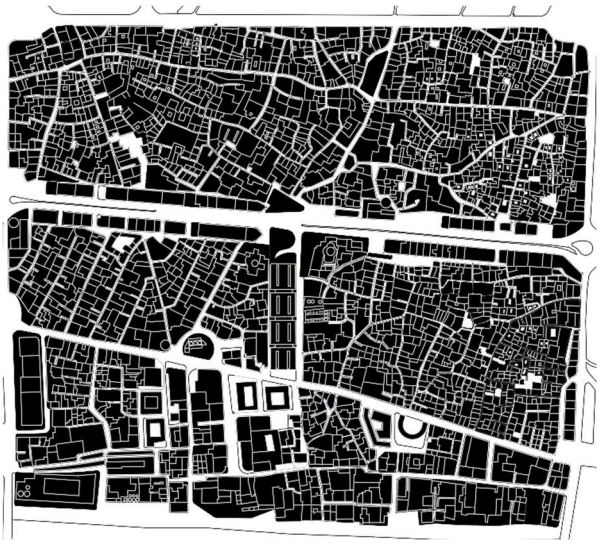


Figure 5: Urban space of AlShorja area, with mostly organic pattern. Source: Maps drawn by author

3. The Scope of Work

The scope of work of this research is limited to:

1) This paper will study the downtown of Baghdad within one square kilometre.
2) The span of the analysis will study the downtown during the last decade in terms of morphological change.
3) The analysis process will examine the syntactic properties of spatial configuration only.

4. Research Objectives

The following are the objectives of this research:

1) Studying the values of syntactic properties of spatial urban configuration, interpreting the spatial network performance of Baghdad downtown.
2) Revealing the importance of the spatial relationships founded between syntactic properties and land use distribution in relation to urban life.
3) Mapping and describing the values of integration, connectivity, and choice of most connected streets and most segregated streets.
4) Improving the quality of the daily urban life in the downtown by increasing the values of urban connectivity and accessibility.

5. Methods and Technique

The paper relied on space syntax approach to examine the downtown of Baghdad (or AlShorja). This approach includes methods, techniques, and measures to have an inclusive understanding. The analyses would study the main urban elements (streets, plots, and land uses) [33] : the spatial urban network and land uses, and would consist of three main phases: data collection, data digitization, and data analysis.

5.1 *Data Collection*

The examined data were gathered from AlShorja area (photos, maps and satellite images); since some of the historic organic urban fabrics and places dated back to the 16^{th} and 17^{th} centuries. The employed data in the analysis was based on the following criteria:

- The examined data (maps) have included main urban elements: streets, plots, and land use with a high quality of details, which were used for coordinating.
- All relevant examined data should be drawn by recognized scales needed to be rescaled to coordinate all the examined maps and information due to build a one base map for study purposes.
- Examined data and maps were certified and adopted for the academic and research purposes.

- Examined areas of Baghdad's downtown would be measured only as a one square kilometer on the map for each case study.
- Site observations would be conducted in two phases:
    - To match the data, information, and other details with each other.
    - To revisit the sites of study areas, but this time for observing the outcomes (their locations and values) based on the analyses and examinations' results.

5.2 *Data Digitization*

After preparing the basic maps, these following phases are included:

- Due to the differences of the processes of creating these maps (the projection of producing these maps), such as the photos, drawing maps, and satellite images. All the examined data, the maps, would be coordinated and digitized by using the software ArcGIS (ArchGIS 10.1) and GIS technology.
- The downtown of Baghdad (AlShorja area) with its three urban elements (streets, plots, and land uses) were drawn using AutoCAD2020 program.

5.3 *Data Analysis*

In this phase, two analytic systems were employed, namely: axial line analysis and angular segment analysis.

5.3.1 Axial Line Analysis

Axial lines are the longest visible lines used to represent individual linear space in urban contexts. An axial map is made up of the fewest number of axial lines that represent the space of an urban environment and the space between buildings [12, 2, 26, 29].

For the study purposes, examining the spatial networks and also identifying the existing spatial relations found inside the study-built environment requires converting all the examined maps into the new axial maps.

The axial maps consist of the lines that would be generated by using the Auto CAD-2020 software to draw a network of intersecting lines. This intersecting network would reflect the examined areas of spatial layouts of Baghdad's urban grids taking into account the following (figure 6):

- The axial lines should be long as much as you can when drawing processes.
- The number of the axial lines that represent the spatial networks should be fewer as much as we can generate.
- For each generated axial line, the two given points in the intersecting network must not be blocked by any physical object, since the visible connection between the two given points has to be existing.

The aforementioned axial maps were transformed into another software program called DepthmapX, a performance analyses (space syntax) program that performs a set of quantifiable analyses of the space network aimed at understanding the social logical processes within the urban environment. The program aims to produce a map of the spatial elements (streets, squares, intersections, cul-de-sacs, and open spaces) and connects them through visible structural spatial relationships.

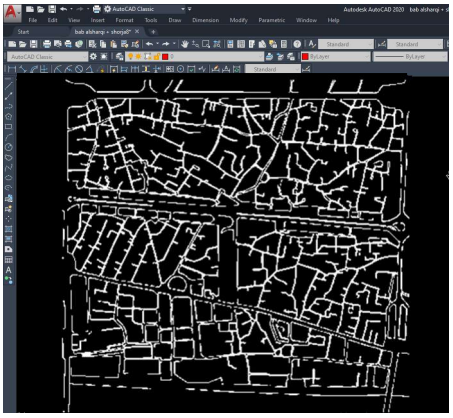
5.3.2 Angular Segment Analysis

Angular segment analysis is a fundamental space syntax analysis that aids in the understanding of movement, land utilization, and other socio-economic patterns. As an attempt to address the "segment problem", it was utilized in axial segment maps [3, 4, 14].

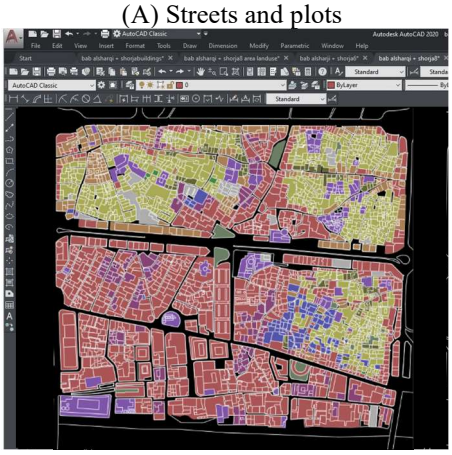
The angular segment analysis would add to the integration analyses another understanding to the generated intersecting network. Here, the intersecting network would include the axial lines that represent the streets, and each segment of the street is measured by its angle of contact with other street segments. Each axial line is broken down into several street segments, whenever the intersection exists. Every junction splits an axial line, as well as the relationship between junctions in a road networks is now taken into consideration.

In the axial analysis, the curved street is modeled with several axial lines. In angular segment analysis, the curve is modeled with several street segments derived from the axial line that are attracted to each other at the ends of the segment [5, 25, 4, 14] (figure 7).

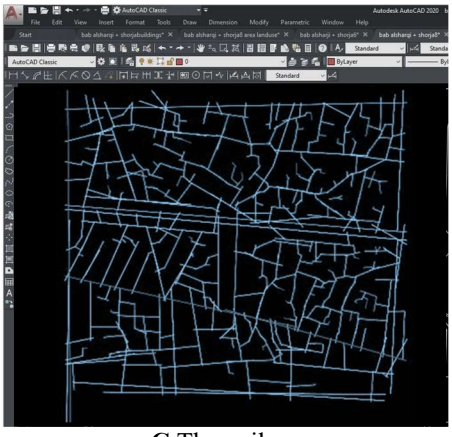
After generating the axil analysis of the downtown of Baghdad, axil maps were converted into new segment maps to study the angular segment analysis of AlShorja. (figure 8) illustrate the steps of converting the axil maps to segment maps.



(A) Streets and plots

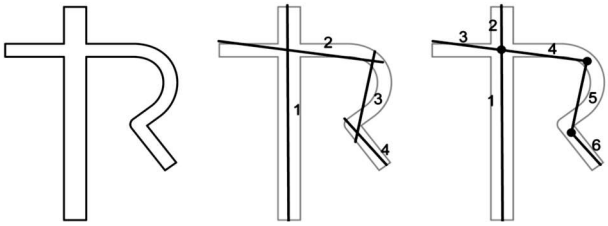


B The four morphological elements



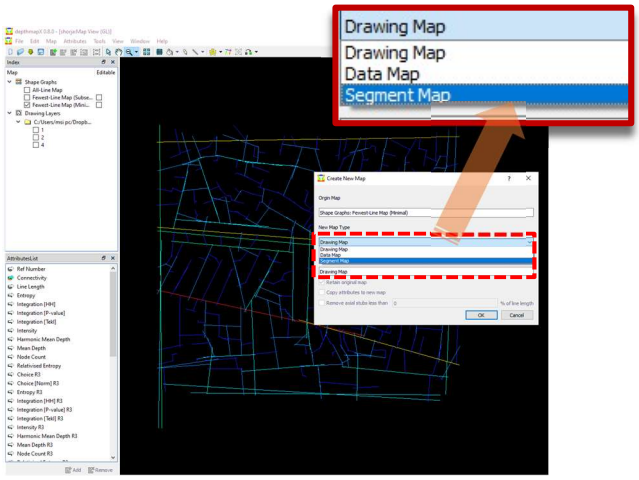
C The axil maps

Figure 6: Generating maps of streets, plots, buildings, and land uses; and then generating axil maps of AlShorja (Source: drawn by author based on maps from the Baghdad Municipality, 2015)

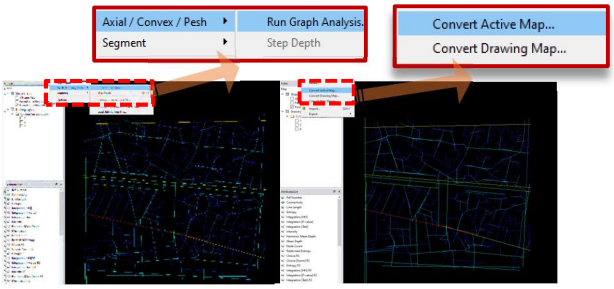


A. The street network **B.** Axil representation **C.** Segment representation

Figure 7: The difference between axial and segment analysis [19]



(C) The segment map of AlShorja



B Convert axil maps **A** Run axil analysis

Figure 8: Converting from axil line analysis to angular segment analysis (Source: generated by author)

5.4 *Measurements*

Among space syntax measures, integration and choice are the most important syntactic measures that broadly apply at different levels, locally and globally, of the given urban area in a certain context. The notion of street centrality is based on two logical concepts: 'integration', which refers to "to-centrality" and "choice" representing "in-between-centrality"[13].

All employed measures are represented in color gradation, which is represented by colors ranging from the red (which represents the highest value in the spatial network system) to the blue (which represents the lowest value in the spatial network system) marking in the axial maps. So, the two axial and segment maps of AlShorja area will be run in the DepthmapX software, and then the generated coloring maps will be overlaid on the maps of land use distribution to complete the description and interpretation. The study includes an analysis of three measures of space syntax, which are integration, connectivity, and choice [6, 5, 7, 15, 21].

5.4.1 Integration

"One of the most important measures that space syntax analyses relied on its outcomes is the integration, that informs how connected (accessible) a line is in relation to all the rest lines in the axial map. Thus, lines with high integration values refer to lines that have better connections with other lines, while lines with low

integration values identify all lines that have fewer connections with other lines" [23, 5, 6, 22, 25, 10].

The global integration analysis assesses the degree of accessibility of all other streets in the urban system, taking into account the total number of movement direction changes in relation to the whole network. The fewer direction changes (steps) from the given street to reach all the locations in the system led to a more integrated street. In contrast, streets that take many changes of direction to reach all the other locations have low inclusion values and are isolated from the other streets. In short, the greater length of the axial line in relation to its greater number of connections with the other axial lines led to a greater value of integration and vice versa. "The values of integration for each axial line in the intersecting network are calculated by the space syntax Depth-map software, relying on mathematical calculations based on equations" [13, 6].

5.4.2 Choice

The angular segment analysis is concerned with the cognitive behavior of a person travelling through space who is likely to choose the least angular path from point A to point B. The total number of overlapping trips traveling through a segment is calculated by assuming that every segment is an origin and every other segment is a destination choice. The significance of angular analysis is that it is a finer-grained analysis than axial analysis. At this point, attention is shifted from the average number of turns to the total amount of angular change in one's journey [19]

5.4.3 Connectivity

Is a local static measurement, it is defined as the number of points where space is directly connected to other spaces[31]. A street with many connections to side streets has a high connection value, while a street with few connections has a low connection value [5].

6. RESULTS AND DISCUSSION

The outcomes of the syntactic values were displayed that the range was arranged from the high values to the low ones, and these values were recording in the Table 1.

Table 1: Values of integration, Connectivity, and Choice of AlShorja

Integration	Choice	Connectivity
2.1310	438790	30
2.0663	405126	23
1.9968	401430	19
1.1451	4790	12
1.1447	4776	11
1.1443	4753	10
0.5809	2	3
0.5744	1	2
0.3490	0	1

The integration measure that used to examine the urban grids of AlShorja area has revealed several sets of colored streets that were ranged from the reds to the blues. The most integrated streets were those that they formed within the relatively large, regular, and rectangular plots, which were often associated with the commercial and mixed-use activities. These integrated spaces were used by residents, passersby, and visitors and thus they have represented all spaces being attractive for the purposes of social interactions, favorable movements, and the public commercial activities. The residential areas have recorded the least values of integration, which were characterized by the zigzag roads, cul-de-sacs, and small and irregular plots. This kind of transition from the main streets to the private roads and paths has shown a clear hierarchy of spatial network configurations. The results have shown that the presence of some commercial and mixed-use streets within the areas of low integration (figures 9, 10).

The global choice map of AlShorja area has showed that the existence of high choice values was occupied the main streets surrounding the area, which were the modern roads built based on planning practices. However, the internal area characterizing by the organic pattern showed that the lower values of choice measure, being formed within the organic pattern distinguished by cul-de-sac, leading to limited choices of using routes. When the local choice values in AlShorja area was ranged from the main street and gradually decreased when it moved to inward areas and then reached to the lowest values founded in residential isolated area. This has indicated a clear spatial hierarchy of street systems, being structured from the main streets surrounded by the commercial and mixed uses continued towards the residential areas (figure 9,11).

The results of the spatial network configuration analysis of the connectivity measure in AlShorja area has indicated that there was a strong nucleus of connectivity founded in the main streets that were surrounded by the rectangular plots, which by their edges and lengths form an easy mode for mobility and accessibility around the areas dedicated for commercial activities. While the spatial network showing the lower values of connectivity was mostly distributed in and around the boundaries of the residential small blocks, which almost have irregular urban forms and included the cul-de-sacs (figure 9, 12).

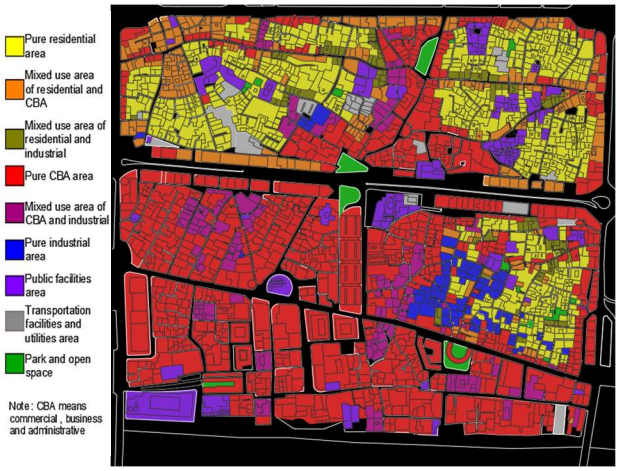
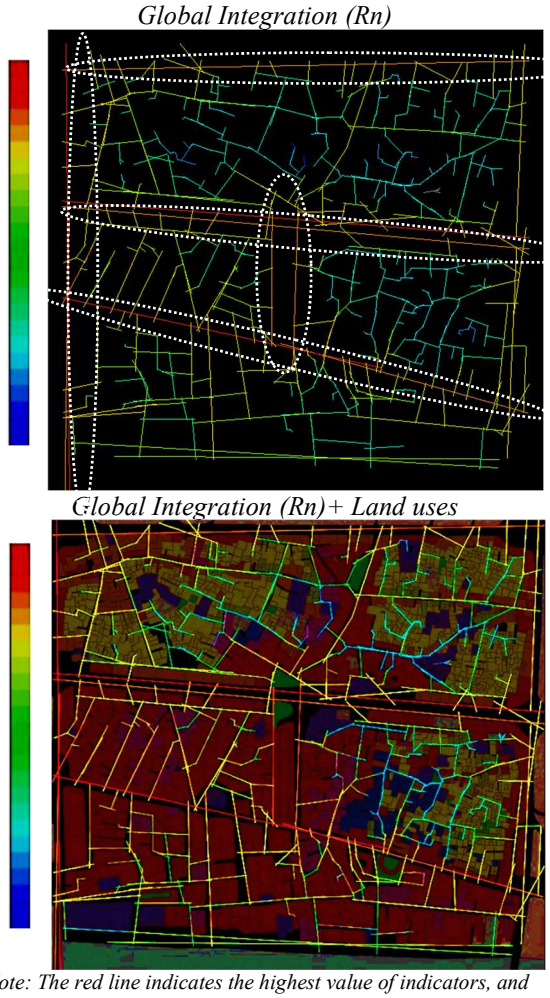


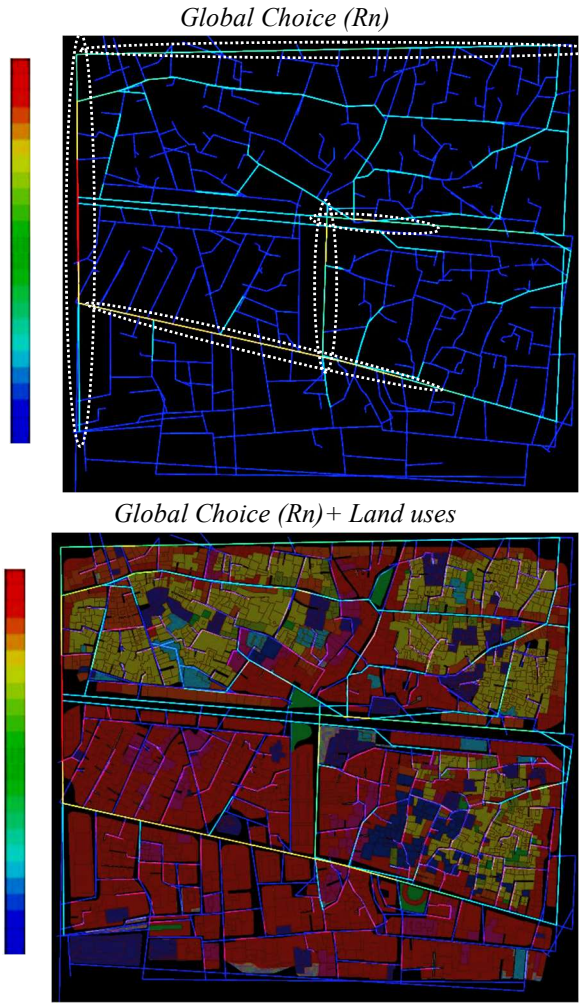
Figure 9: Land uses distributions of AlShorja (Source: Maps generated by the authors)



Note: The red line indicates the highest value of indicators, and blue indicates the minimum amount.

Figure 10: Global integration Rn of AlShorja and its relationships with land uses. Source: Maps generated by author

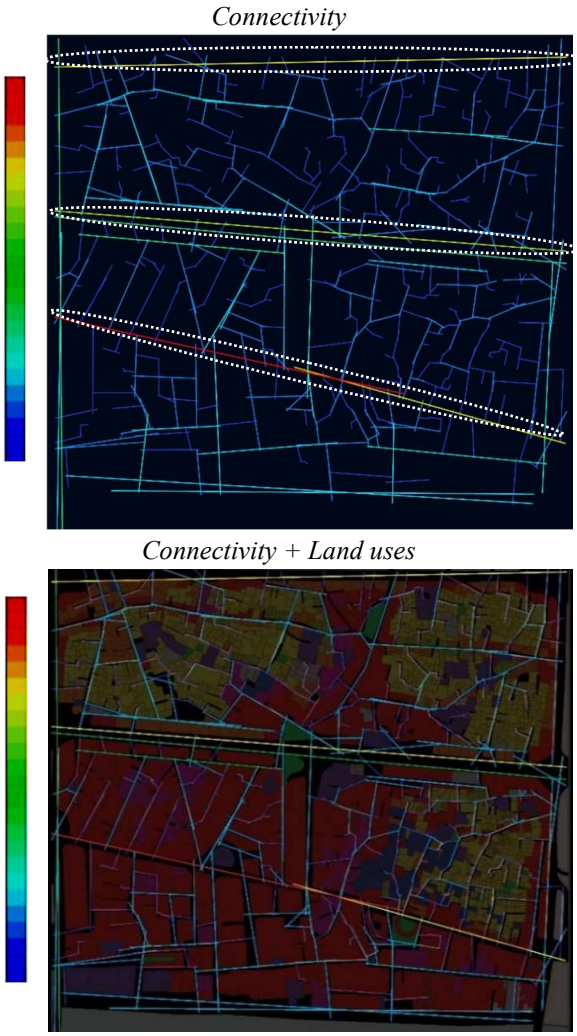
In comparison with the local studies that were analyzed and examined the urban cores of Baghdad – with and without space syntax measures – the current study has focused on analyzing and describing the syntactic characteristic and physical qualities of urban geometric properties, while Abbas and Al-Dujaili (2013), Alobaydi and Rashid (2017), Abdullah and Alwan (2019), Al-Hasani (2021), Al-Saaidy and Alobaydi (2021, 2021'), studied the syntactic characteristic in relation to morphology, street network, urban genotypes, land use distribution, geometry of urban blocks, the Multiple Centrality Assessment (MCA) and the form of downtowns. This means that the existing studies have not examined the downtown of Baghdad in the way of this methodology (including the employed methods, measures, and techniques) to study the syntactic characteristics in relation to the downtown urban forms and activities [31, 1, 12, 17, 18, 28].



Note: The red line indicates the highest value of indicators, and blue indicates the minimum amount.

Figure 11: Global choice Rn of AlShorja and its relationships with land uses around choiceable streets. Source: Maps were generated by author

Therefore, the current results of integration and choice measures founded in the downtown of Baghdad have been considered as new outcomes that have been documented and mapped for the first time.



Note: The red line indicates the highest value of indicators, and blue indicates the minimum amount.

Figure 12: Connectivity of AlShorja and its relationships with land uses around connected roads (Source: Maps generated by author)

7. Conclusion

The research has concluded a set of conclusions as follows. First, AlShorja area includes vital, active, and integrated spaces in the public and commercial urban areas. The private space in AlShorja area is characterized by the control and the privacy, a matter that comes into the harmony with the sociocultural structure of local communities, that has given the city character and identity. Second, the choice measure in AlShorja area was recorded a high value because the urban-blocks were formed finely-meshed urban grid system. In general, commercial and mixed-use activities were almost always associated with the most integrated, connected, and choiceable streets in Old Baghdad. Different values of integration, connectivity, and choice were noticed and fallen between mixed-use areas and residential zones; this was because the urban characteristics of the spatial hierarchy of streets' systems formed over time and thus led to generate those different values. Then, according to the practical results derived from the axial and segment maps as well as the site observations that conducted to match the results with the reality, Baghdad's downtown has suffered from a poor distribution of functional activities. The current generated maps of syntactic analyses showed that the commercial and mixed-use activities were associated with the low values of integrated streets in AlShorja map. Finally, syntactic analyses have shown that although AlShorja was one of the oldest urban areas in Baghdad, it is still considered as the important commercial center that has preserved its physical urban characteristics connecting a wide extent of various activities: commercial, institutional, economic, and residential. It is also considered as one of the most essential historic cores representing the valuable heritage of the traditional architecture and urbanism in Iraq and even in the Middle East region.

8. Research Limitation

- The analysis was limited to the syntactic properties of spatial networks of the urban configuration.
- The examination has focused on the spatial properties and physical qualities; thus, the other urban forms such as social, environmental, cultural, and economic aspects were not assessed in the analysis processes.

References

[1] A.-H. M. K. and P. D.-I. H. Nagler, "The Transformation of The Urban Landscape In The Old City of Baghdad between 1854 - 2009," The Brandenburg Technical University, Cottbus, 2020.

[2] A. Soltani, M. Javadpoor, F. Shams, and M. Mehdizadeh, "Street network morphology and active mobility to school: Applying space syntax methodology in Shiraz, Iran," *J. Transp. Heal.*, vol. 27, p. 101493, 2022.

[3] A. Turner, "Could a road-centre line be an axial line in disguise," in *Proceedings of the 5th International Symposium on Space Syntax*, 2005, vol. 1, no. 4, pp. 145–159.

[4] A. Turner, "From axial to road-centre lines: a new representation for space syntax and a new model of route choice for transport network analysis," *Environ. Plan. B Plan. Des.*, vol. 34, no. 3, pp. 539–555, 2007.

[5] A. van Nes and C. Yamu, "Introduction to space syntax in urban studies" *Springer Nature*, 2021.

[6] B. Hillier, "Space is the machine: a configurational theory of architecture". *Space Syntax,* 2007.

[7] B. Hillier, "The art of place and the science of space," *World Archit.*, vol. 185, pp. 96–102, 2005.

[8] C. Xia, A. Zhang, and A. G. O. Yeh, "The varying relationships between multidimensional urban form and urban vitality in Chinese megacities: Insights from a comparative analysis," *Ann. Am. Assoc. Geogr.*, vol. 112, no. 1, pp. 141–166, 2022.

[9] D. Alobaydi, H. Al-Mosawe, I. M. Lateef, and A. H. Albayati, "Impact of urban morphological changes on traffic performance of Jadriyah intersection," *Cogent Eng.*, vol. 7, no. 1, p. 1772946, 2020.

[10] D. Alobaydi, H. Mohamed, and H. Attya, "The impact of urban structure changes on the airflow speed circulation in historic Karbala, Iraq," *Procedia Eng.*, vol. 118, pp. 670–674, 2015.

[11] D. Alobaydi, M. A. Bakarman, and B. Obeidat, "The impact of urban form configuration on the urban heat island: the case study of Baghdad, Iraq," *Procedia Eng.*, vol. 145, pp. 820–827, 2016.

[12] D. Alobaydi and M. Rashid, "A Study of the Morphological Evolution of the Urban Cores of Baghdad in the 19th and 20th Century," in *Eleventh international space syntax symposium at Instituto superior Técnico, University of Lisbon, Portugal*, 2017, pp. 31–38.

[13] D. M. Alobaydi, "A study of the urban morphological processes of Baghdad: Implications and guidelines for urban design and planning in middle eastern cities," *Kansas, US Fac. Univ. Kansas*, 2017.

[14] D. Nag, J. Sen, and A. K. Goswami, "Measuring Connectivity of Pedestrian Street Networks in the Built Environment for Walking: A Space-Syntax Approach," *Transp. Dev. Econ.*, vol. 8, no. 2, pp. 1–19, 2022.

[15] F. Roozkhosh, M. Molavi, and A. Salaripour, "Accessibility, Walkability, Mixed Land Uses: Analyzing Diverse Districts Based on Space Syntax Theory," *Int. Rev. Spat. Plan. Sustain. Dev.*, vol. 10, no. 4, pp. 223–239, 2022.

[16] G. W. Hartman, "The Central Business District—A Study in Urban Geography," *Econ. Geogr.*, vol. 26, no. 4, pp. 237–244, 1950.

[17] H. J. E. Al-Saaidy and D. Alobaydi, "Measuring geometric properties of urban blocks in Baghdad: A comparative approach," *Ain Shams Eng. J.*, vol. 12, no. 3, pp. 3285–3295, 2021.

[18] H. J. E. Al-Saaidy and D. Alobaydi, "Studying street centrality and human density in different urban forms in Baghdad, Iraq," *Ain Shams Eng. J.*, vol. 12, no. 1, pp. 1111–1121, 2021.

[19] I. Kolovou, J. Gil, K. Karimi, S. Law, and L. Versluis, "Road centre line simplification principles for angular segment analysis," in *Proceedings-11th International Space Syntax Symposium, SSS 2017*, 2017, vol. 11, pp. 161–163.

[20] J. W. R. Whitehand, M. P. Conzen, and K. Gu, "Plan analysis of historical cities: a Sino-European comparison," *Urban Morphol.*, vol. 20, no. 2, pp. 139–158, 2016.

[21] L. Meng and T. Ishida, "Analysis of the Relationship between Beijing Rail Transit and Urban Planning Based on Space Syntax," *Sustainability*, vol. 14, no. 14, p. 8744, 2022.

[22] L. R. Mohammed and D. Alobaydi, "Evolution of the urban form of historic hit citadel: deriving a schematic model for iraqi fortified cities," in *IOP Conference Series: Materials Science and Engineering*, 2020, vol. 745, no. 1, p. 12180.

[23] L. R. Mohammed and D. Alobaydi, "Studying Sustainable Actions of Syntactic Structures of Historic Hit Citadel: A Morphological Approach," in *IOP Conference Series: Materials Science and Engineering*, 2020, vol. 881, no. 1, p. 12034.

[24] M. Al-Saffar, "Urban Heritage and conservation in the historic centre of Baghdad," *J. Herit. Archit.*, vol. 2, no. 1, pp. 23–36, 2018.

[25] M. Rashid and D. Alobaydi, "Territory, politics of power, and physical spatial networks: The case of Baghdad, Iraq," *Habitat Int.*, vol. 50, pp. 180–194, 2015.

[26] R. Colaço and J. de Abreu e Silva, "Exploring the role of accessibility in shaping retail location using space syntax measures: A panel-data analysis in Lisbon, 1995–2010," *Environ. Plan. B Urban Anal. City Sci.*, p. 23998083221138570, 2022.

[27] R. Rafiemanzelat, "A study on the development of livable city centres: The case of Famagusta, North Cyprus." Eastern Mediterranean University (EMU)-Doğu Akdeniz Üniversitesi (DAÜ), 2014.

[28] S. F. K. Abdullah and H. A. Al-Alwan, "Urban Resilience in the Sustainable Urban Regeneration of Historic City Centers," *Assoc. Arab Univ. J. Eng. Sci.*, vol. 26, no. 4, pp. 130–143, 2019.

[29] S. Geng, H.-W. Chau, E. Jamei, and Z. Vrcelj, "Understanding the Street Layout of Melbourne's Chinatown as an Urban Heritage Precinct in a Grid System Using Space Syntax Methods and Field Observation," *Sustainability*, vol. 14, no. 19, p. 12701, 2022.

[30] S. L. Farhan, D. Alobaydi, D. Anton, and Z. Nasar, "Analysing the master plan development and urban heritage of Najaf City in Iraq," *J. Cult. Herit. Manag. Sustain. Dev.*, no. ahead-of-print, 2022.

[31] S. S. Abbas and S. H. A. Al-Dujaili, "Historical Paths and the Growth of Baghdad Old Center," *J. Eng.*, vol. 19, no. 9, pp. 1073–1093, 2013.

[32] S. S. Aziz, D. Alobaydi, and A. B. M. Salih, "Studying flexibility and adaptability as key *sustainable measures for spaces in dwelling units:* A case study in Baghdad," in *IOP Conference Series: Materials Science and Engineering*, 2020, vol. 881, no. 1, p. 12019.

[33] T. Heath, T. Oc, and S. A. Tiesdell, "Public Places--Urban Space: The Dimensions of Urban

Design," 2003.
[34] Wassim Bassem, "Ancient market at heart of modern Baghdad," *Al-Monitor, LLC.*, 2015.

تقييم الخصائص التركيبية الفضائية لمركز المدينة: دراسة حالة مركز بغداد القديم

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الخلاصة – يعد مركز المدينة هو المركز الرئيسي الذي يحدد الازدهار والنمو الحضري للمدينة ومؤشر نجاحها ، اذ إنه يتعدى كونه المركز الجغرافي للمدينة ، بل انه يمثل المركز التاريخي والثقافي والاجتماعي والاقتصادي لها. وهنا تمثل منطقة بغداد القديمة (أو منطقة الشورجة) مركز مدينة بغداد التاريخي. اذ يتناول البحث دراسة الشبكة الحضرية لمركز المدينة القديم من خلال تطبيق نهج علمي قابل للقياس. تضمنت الأساليب المستخدمة في هذا البحث المنطقة الدراسية وقواعد التركيب الفضائي Space syntax، والتي قدمت وحدات قياس مختلفة (التكامل integration, الاتصالية connectivity, والاختيار choice) لوصف الخصائص المكانية للمناطق الحضرية ، وبالتالي إنتاج بيانات محددة قابلة للحساب تتعلق بمفاهيم التكامل المكاني والفصل (العزل) المكاني. تم قياس الشبكة الحضرية المختارة على مساحة كيلومتر واحد ، اذ اجريت عمليات التحليل على عدة قياسات والتي اعتمدت نسبة الى توزيع استخدامات الأراضي. أظهرت النتائج وجود علاقة قوية بين الشوارع المتكاملة والأنشطة التجارية والمتعددة الاستخدامات على المستوى الشمولي الكلي (HH Rn)، بينما كان هناك ارتباط واضح بين الشوارع المنفصلة (المعزولة) والمناطق ذات الاستخدامات السكنية ، والذي دعم مفهوم الخصوصية المكانية للمناطق السكنية. تم تسجيل قيم عالية لوحدة القياس الاختيار في منطقة الشورجة وذلك لكون الكتل الحضرية في المنطقة المدروسة تتكون من نظام حضري ذات شبكة دقيقة (صغيرة المسافات). بالرغم من أن الشورجة تمثل المركز الحضري الاقدم في مدينة بغداد ، إلا أن تحليلات التراكيب الفضائية اظهرت بانها النواة التجارية الاهم والتي لازالت تحافظ على الخصائص العمرانية الفيزياوية لشكلها الحضري والذي يربط مجموعة واسعة من الأنشطة المختلفة.

الكلمات الرئيسية – قواعد التركيب الفضائي ، الشبكة الحضرية ، التكامل ، الشوارع، مركز المدينة ، بغداد.