Contents available at Iraqi Academic Scientific Journals

Iraqi Journal of Architecture and Planning

المجلة العراقية لهندسة العمارة والتخطيط

Journal homepage: https://iqjap.uotechnology.edu.iq

Assessing the Influence of Urban Street Network on Land Use Distribution in Historic Urban Cores

تقييم تأثير شبكة الشوارع الحضرية على توزيع استعمالات الأرض في المراكز الحضرية التاريخية

Aya F. Alobaydi [a], Dhirgham Alobaydi [b*], Sally F. Abdullah [c]

(a, b, c) Department of Architectural Engineering, College of Engineering, University of Baghdad, Baghdad, Iraq.

Submitted: 14/03/2025 Revised: 14/03/2025 Accepted: 21/05/2025 Published: 01/07/2025

K E Y W O R D S

Urban Street Network, Land Use, Historic Urban Core, Space Syntax, Integration.

A B S T R A C T

Historic urban cores are complex spatial systems where street network configuration is key to land use distribution and urban functions. In cities like Baghdad, understanding these spatial relationships is vital to balancing heritage preservation with urban needs. This research examines the impact of street network configuration on ground floor land use in the Old Rusafa historic core. Despite its cultural and historical importance, Old Rusafa faces problems of uncontrolled urban development and the decline of traditional urban forms. The study investigates how spatial accessibility, as indicated by street network morphology, is related to ground floor land use. Using a case study approach, the research analyzed two areas in Old Rusafa—one with an organic street network and the other with a geometric layout. Spatial configuration was analyzed using Space Syntax techniques, specifically segment analysis in DepthmapX, to measure integration and connectivity at multiple scales. Ground floor land use was mapped and classified into residential, commercial, mixed-use, industrial, and public categories. Results show that higher integration and connectivity values are positively correlated with commercial land use, especially in the geometric street network, while residential uses dominate in less integrated areas.

الكلمات المفتاحية

شبكة الشوارع الحضرية، استخدامات الأرض، المراكز الحضرية التاريخية، التركيب الفضائي، التكامل.

الملخص

تُعد المراكز الحضرية التاريخية أنظمة فضائية معقدة، تلعب فيها شبكة الشوارع دوراً أساسياً في تنظيم استخدامات الأرض. تهدف هذه الدراسة إلى تحليل تأثير تكوين الشبكة على استخدامات الطابق الأرضي في نواة الرصافة التاريخية، التي تعاني من نمو عمراني غير منضبط رغم أهميتها التراثية. استخدمت الدراسة منهج دراسة الحالة، شملت منطقتين: الأولى ذات نسيج عضوي، والثانية ذات تنظيم شبكي. تم تطبيق تحليل القطاعات (Segment Analysis) عبر برنامج DepthmapX لقياس مؤشري "التكامل" و"الترابط"، وتصنيف استخدامات الأرض إلى سكني، تجاري، متعدد الاستخدام، صناعي، وعام. أظهرت النتائج علاقة إيجابية بين ارتفاع مؤشرات التكامل والترابط وانتشار الاستخدام التجاري، بينما تركزت الاستخدامات السكنية في المناطق ذات التكامل المنخفض.

* Correspondent Author contact: dalobaydi@uobaghdad.edu.iq
DOI: https://doi.org/10.36041/iqjap.2025.158242.1149

1. Introduction

Cities are complex systems made up of physical infrastructure, socio-economic activities and spatial arrangements. Among the most important components of the urban environment are urban streets and land use. These two elements not only determine the functionality and accessibility of urban spaces but also the vitality, livability and sustainability of cities (Lynch and Rodwin, 1958; Kostof, 1991; Kropf, 2009). Streets are the lifeblood of urban settlements, moving people, and facilitating economic exchanges and social interactions (Francis, 2016; Albabely and Alobaydi, 2023; Albabely and Alobaydi, 2024). The design and layout of urban streets affect how we navigate and interact in cities, determining accessibility, connectivity and spatial integration (Southworth and Ben-Joseph, 1995; Ashik et al., 2025; Brown, 2025).

Land use patterns determine the spatial distribution of urban functions– residential, commercial, industrial and recreational spaces. These patterns are shaped by historical processes, economic activities, population growth and planning interventions (Ogawa and Fujita, 1980; Zube, 1987). Mixed-use zoning and efficient land use promote walkability, reduce travel distances and sustainable urban development (Southworth and Ben-Joseph, 2013; Alobaydi et al., 2023; Alobaydi and Rashid, 2024; He et al., 2025).

Understanding the relationship between urban streets and land use distribution is especially important in historic urban cores where culture and modern urban demands coexist. Historic districts have complex spatial morphology with organic streets and layered land uses that have evolved over centuries. One such example is Old Rusafa, the historic heart of Baghdad, which has a unique spatial texture shaped by its rich cultural and historical heritage, see Figure (1).

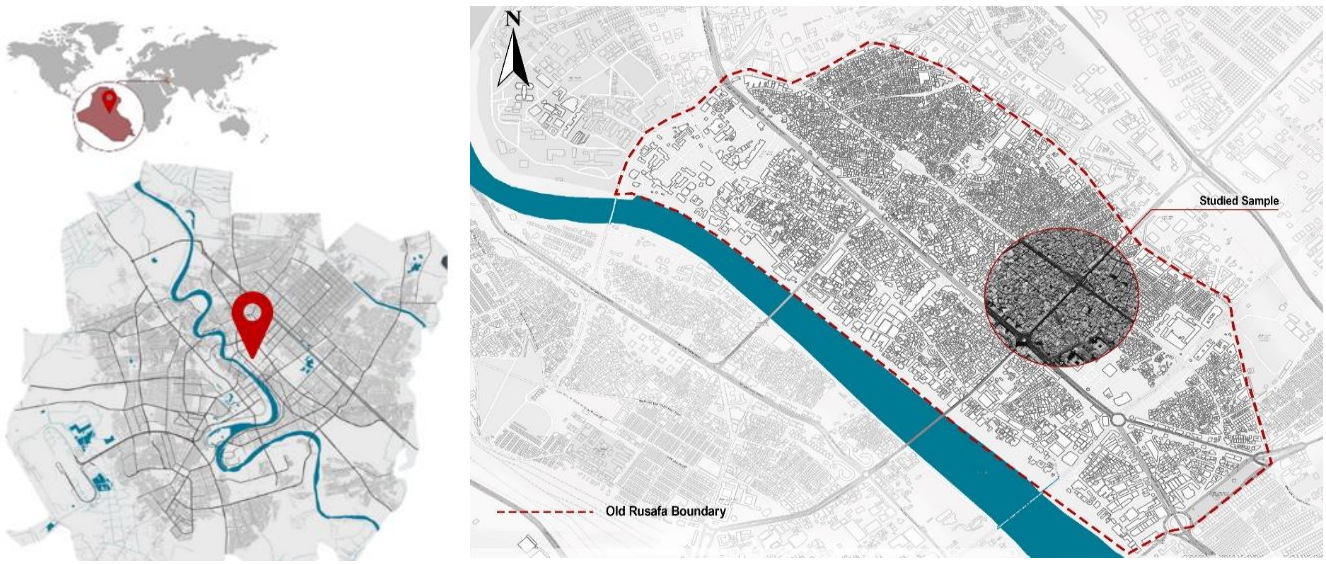

Figure 1. Presents locations of Old Rusafa, Baghdad, and Iraq, (Source: Authors' Collection).

Despite the importance of historic urban cores, there is a lack of studies that examine how street network configurations affect land use distribution, especially in heritage areas like Old Rusafa (Al Hashimi and Alobaydi, 2023; Alsaffar and Alobaydi, 2023). Previous studies on Baghdad's urban morphology have focused on broad historical narratives or general urban growth patterns, neglecting the quantitative analysis of spatial relationships at the neighbourhood scale (Alobaydi and Rashid, 2017; Al-Hinkawi, Youssef and Abd, 2021; Al-Saaidy and Alobaydi, 2021).

This research fills the gap by investigating the correlation between street network syntactics and land use distribution in Old Rusafa using the Space Syntax approach. The study aims to achieve the following objectives:

- To apply Space Syntax methods to the street networks of Old Rusafa.
- To measure the relationships between street network patterns and land use in heritage areas.
- To compare the spatial relationships in organic and geometric areas.
- To provide evidence-based recommendations for urban planners and policymakers to improve accessibility and sustainability in Baghdad's historic city centers.

The urban street network of Old Rusafa has two morphologies:

- Organic, narrow and irregular streets that emerged without formal planning (Sample A).
- Geometric, wider and structured streets were introduced through modern planning (Sample B).

These morphologies will affect the land use significantly; see Figure (2). Space Syntax, particularly through segment analysis and measures like Integration (Rn, R7, R5, R3) and Connectivity, is a robust methodology to evaluate these spatial properties (Hillier et al., 1993; van Nes and Yamu, 2021a).

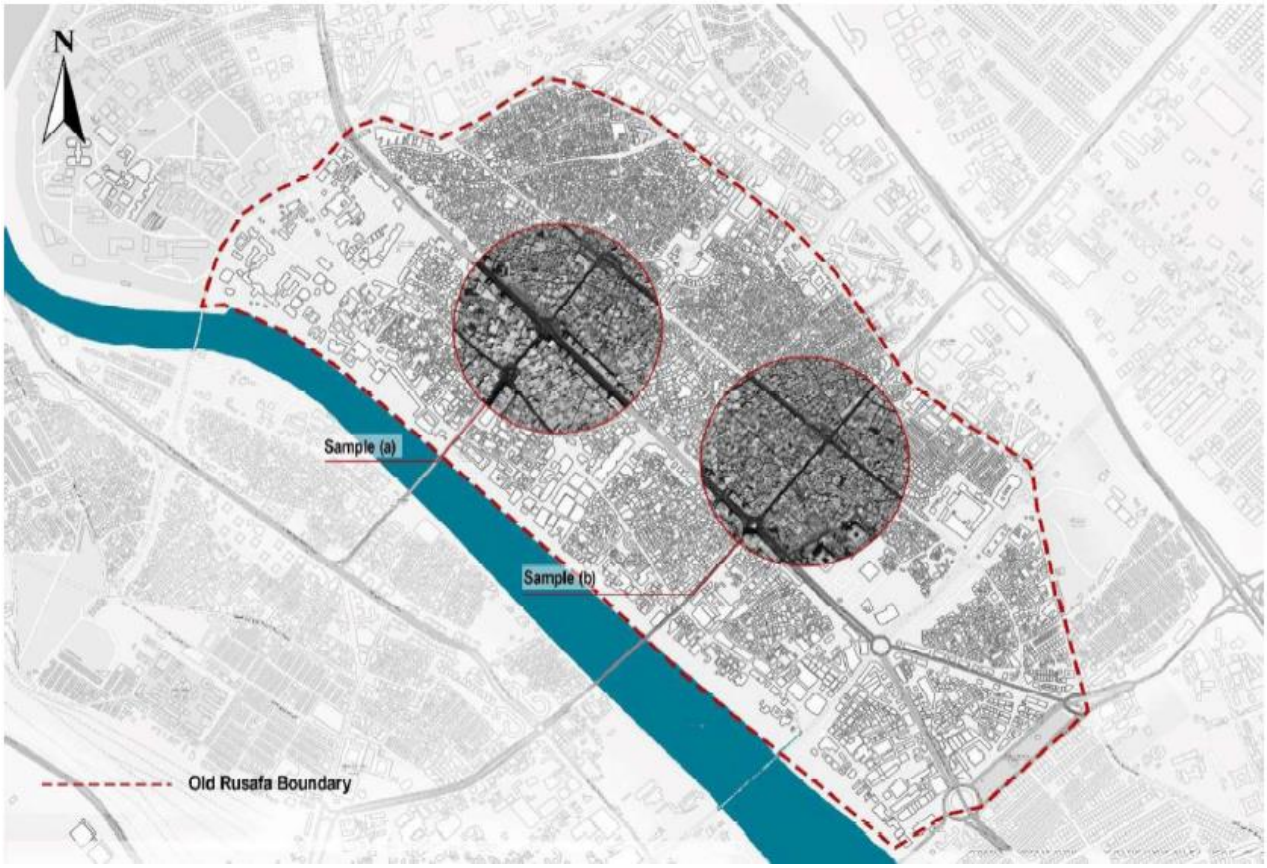

Figure 2. Defines the Study Area Boundary, a) Sample A, b) Sample B, (Source: Open Street Map base map, modified by Authors).

The research focuses on Old Rusafa, located on the eastern side of the Tigris River in Baghdad. The study area has two samples:

- Sample A: Organic Street network with narrow alleys and traditional markets.
- Sample B: Geometric Street network with wider streets and a mix of modern and traditional uses.

Spatial analysis was done using DepthmapX, QGIS and SPSS for statistical correlation. The study looks at land use patterns horizontally (ground and first floor) and vertically to get a full understanding of the spatial dynamics in the study area.

2. Methodology

This study adopts a case study approach, focusing on Old Rusafa, the historic urban core of Baghdad. The research investigates the relationship between the urban street network and ground floor land use distribution. The analysis uses a combination of space syntax methods and statistical correlation analysis, integrating quantitative spatial data analysis with urban morphological understanding to assess spatial accessibility and its impact on urban land use; see Figure (3). The methodology includes three stages:

- Case study selection and delineation of study areas
- Data collection, processing and spatial analysis
- Statistical correlation analysis between spatial configurations and land use patterns.

This allows for a multi-scalar analysis of spatial properties and their correlation with ground floor land use distribution, which is useful for urban planning and heritage conservation in historic contexts.

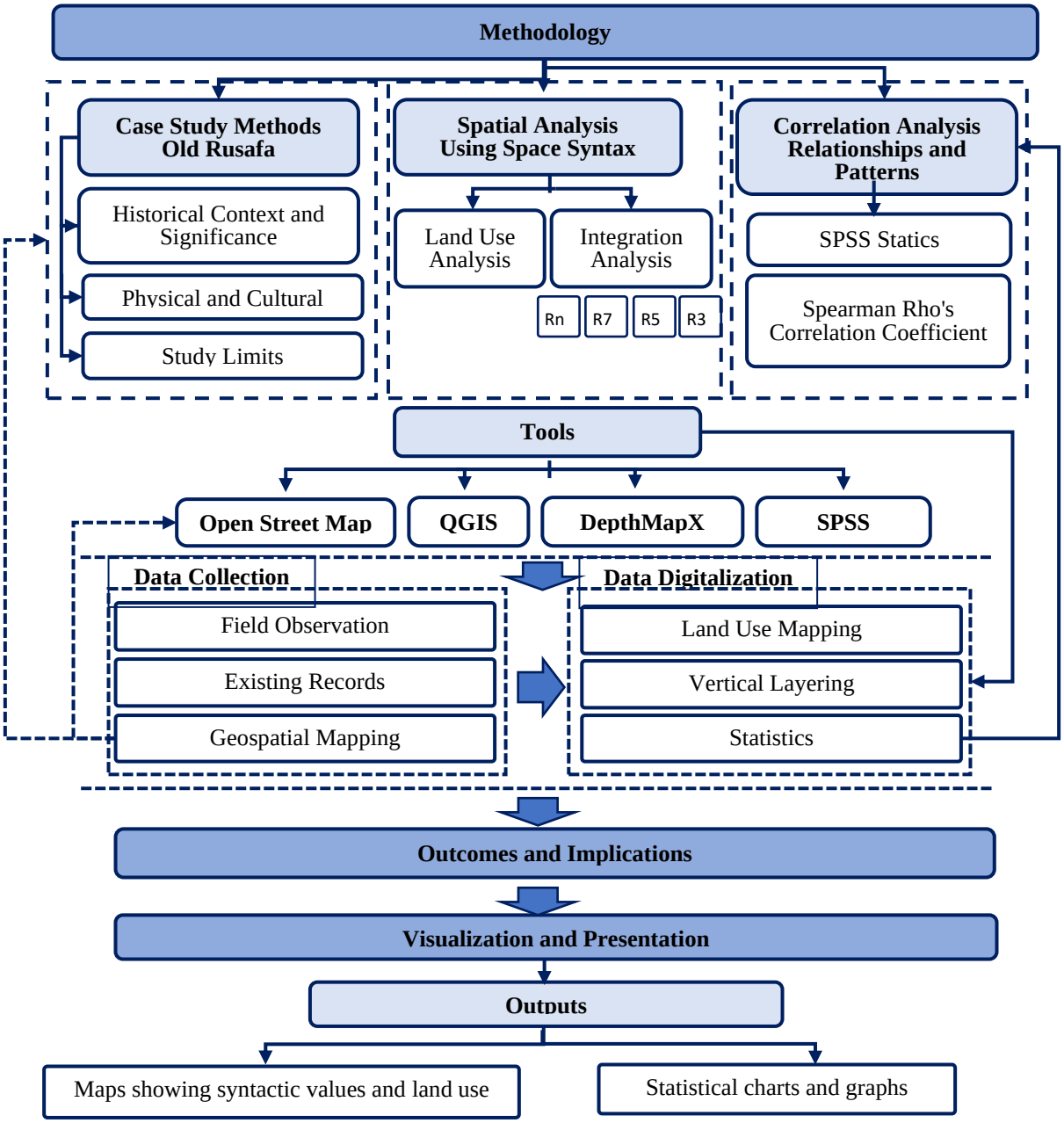

Figure 3. Shows the Research Methodology, (Source: Designed by Authors).

2.1. Case Study Selection (Old Rusafa, Baghdad)

The selection of Old Rusafa as the case study is due to its historical, cultural and spatial significance. Located on the east bank of the Tigris River, Old Rusafa is the ancient core of Baghdad. Its organic street network, high density and mixed-use developments reflect centuries of urban growth shaped by cultural, religious and economic factors (Al-Saffar, 2018, 2020, 2024; Alobaydi and Rashid, 2024; Alsaffar and Alobaydi, 2025a, 2025b).

Historically, Old Rusafa developed during the Abbasid period and was a major religious, commercial and administrative hub. The spatial pattern of the area is characterised by narrow alleys and irregular plots, typical of traditional Middle Eastern urban forms (Conzen, 1960; Hakim and Rowe, 1983; Kostof, 1991; Hakim, 1994, 2010). The compact urban fabric, diverse land uses and complex street hierarchies of the district provide a rich context to investigate the relationship between street network properties and ground floor land use patterns (Hakim, 2007, 2013).

The space analysis looks at two cases in Old Rusafa, each representing different urban morphologies. These areas were chosen to allow a comparative study of how organic vs. geometric street networks affect ground floor uses.

- Case A is in the historic heart of Old Rusafa and has an organic street network. It has narrow alleys, irregular plots, and a traditional morphology shaped by incremental growth and pedestrian-oriented movement systems (Southworth and Owens, 1993). The ground floor uses in this area are mostly commercial, small-scale retail shops, traditional markets (souks) and services along main routes. Residential uses are on secondary streets and in less accessible areas.
- Case B is in the periphery of Old Rusafa and has a geometric grid street network. This area is a planned intervention, with wider streets and more regular plot divisions. The space is designed for car traffic and modern commercial development, with better connectivity and visibility (Southworth and Ben-Joseph, 1995; Jameel and Alobaydi, 2022; Wu et al., 2022.; Alberti, 2023; Elrawy and Elian, 2024). Ground floor uses in Case B are larger commercial establishments, services and public facilities along main roads.

2.2. Data Collection and Preparation

The spatial data for this study were collected from:

- Field surveys in Old Rusafa
- Existing cadastral maps and historical documents
- Digital spatial data, OpenStreetMap layers

The street network was digitized and processed in QGIS and prepared for Space Syntax segment analysis in DepthmapX (Turner, Penn and Hillier, 2005; Alobaydi and Rashid, 2017). The ground floor land use data was collected through direct field observation and validated against existing planning records. Each building in the study areas was classified into one of five main land use categories: residential, commercial, mixed-use, industrial, and public facilities. The classification was applied only to the ground floor of each building, as we are interested in horizontal land use distribution at the street level (Hillier and Vaughan, 2007).

2.3. Analytical Framework and Tools

2.3.1. Space Syntax Analysis

The study uses Space Syntax methodology, segment analysis, to examine the spatial configuration of the street networks in the two samples. Segment analysis provides a finer grain and is more suitable for organic street networks (Hillier et al., 1993; van Nes and Yamu, 2021) see Figure (4).

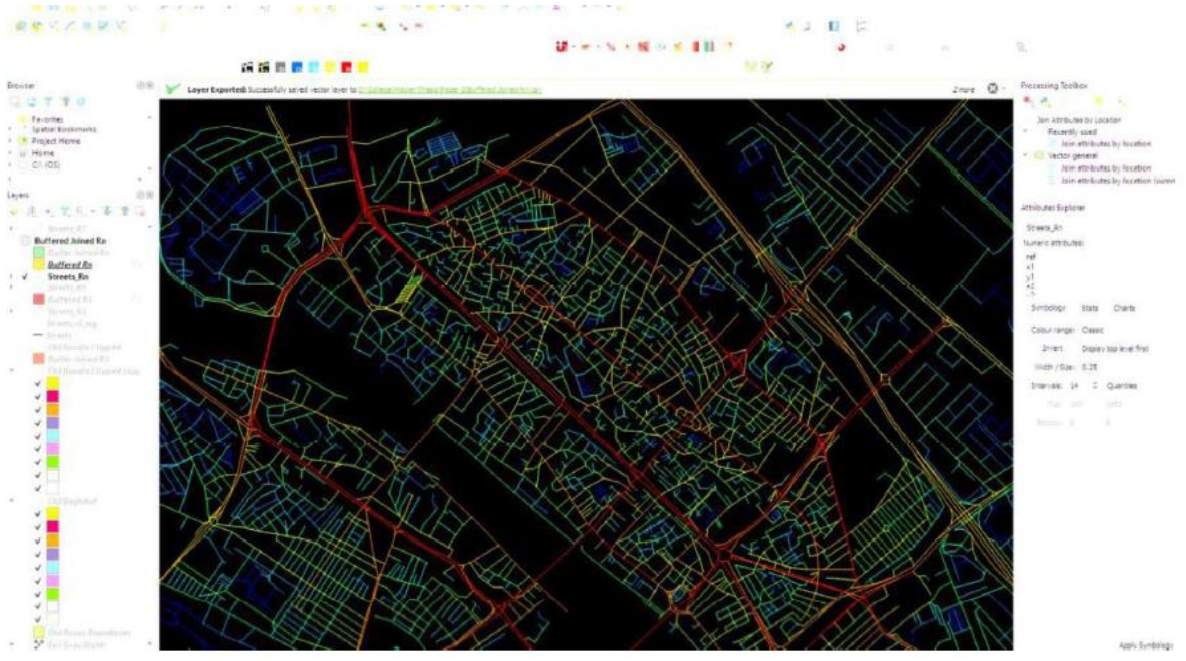

Figure 4. Allows the Space Syntax Analysis in QGIS Software, (Source: Generated by Authors using Space Syntax plugin in QGIS software).

The following syntactic measures were calculated in DepthmapX (Turner, Penn and Hillier, 2005):

- Global Integration (Rn): Measures the accessibility of a street segment within the whole network. High values indicate central locations with high movement potential.
- Local Integration (R7, R5, R3): Evaluates accessibility at neighbourhood scales, segments within 3, 5 and 7 steps of the analyzed segment.
- Connectivity: Counts the number of immediate connections a street segment has with its adjacent segments.

These measures allow us to evaluate accessibility and movement potential, and to see how the spatial structure influences land use patterns (Hillier and Hanson, 1984; Penn, 2003).

2.3.2. Land Use Mapping

Ground floor land use was mapped in QGIS; see Figure (5). Each building was assigned a single land use based on field observation and spatial records. The land use map was focused on the ground floor as it is most affected by street-level spatial accessibility and pedestrian movement (Hillier, 2007).

Commercial and mixed-use land uses were concentrated on highly integrated streets, while residential and industrial uses were often located on low-integrated and low-connected streets, which confirms general principles from previous studies (Kim and Sohn, 2002; Porta, Crucitti and Latora, 2006).

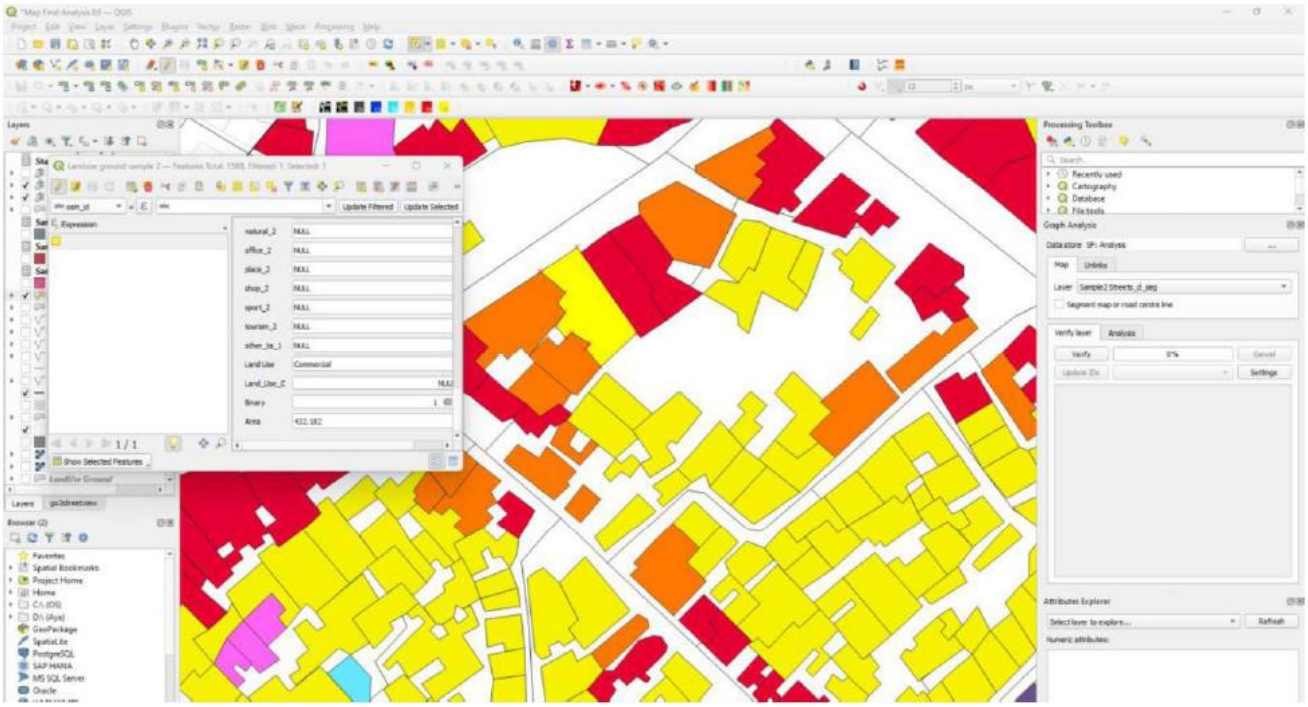

Figure 5. Assigning land uses for each building in QGIS Software, (Source: Drawn by Authors in QGIS software).

2.3.3. Correlation Analysis

The study uses Spearman's Rho correlation analysis to examine the relationship between spatial metrics and ground floor land use. This non-parametric statistical method is suitable for ordinal data and for examining monotonic relationships (Field, 2024).

The analysis process consists of three steps:

- Each building was spatially joined to its nearest street segment using QGIS spatial join tools.
- The integration and connectivity values of each street segment were linked to the corresponding land use of each building.
- Spearman's Rho was calculated in SPSS to examine the correlation between street integration values (Rn, R7, R5, R3), and ground floor land use (Residential, Commercial, Mixed-use, Industrial, Public Facilities).

The analysis tests the research hypothesis that high integration values are positively correlated with commercial and mixed-use land uses and low integration values are correlated with residential and industrial uses (Hillier and Vaughan, 2007; Alobaydi and Rashid, 2017).

3. Results and Discussion

This section presents the main findings from the spatial and statistical analysis of the Old Rusafa district in Baghdad. It includes a detailed analysis of urban street network configuration, ground floor land use and their correlation. The analysis is based on two samples—Sample A and Sample B—representing two different urban morphologies within the historic core of Baghdad. This section also discusses the implications of these findings in terms of urban form, functionality and heritage conservation.

3.1. Urban Street Network

Connectivity is a syntactic measure that reflects the number of immediate connections each street segment has with its adjacent segments (Hillier and Hanson, 1984). Old Rusafa connectivity analysis showed a differentiated spatial structure between the two samples, as shown in Figure (6).

- Sample A, which represents the organically evolved core of Old Rusafa, had lower connectivity with narrow winding alleys and irregular street junctions. The maximum connectivity was 10, and some segments had connectivity as low as 1, which means a highly segregated spatial structure.
- Sample B showed higher and more evenly distributed connectivity. The street network in this sample, with a geometric grid-like structure, has more potential for movement and accessibility. The higher connectivity values reflect the planned urban design to enhance vehicular and pedestrian circulation.

The different connectivity outcomes highlight how different urban morphologies affect the street network performance. Sample A's organic network restricts vehicular movement but creates intimate pedestrian-oriented environments characteristic of traditional Middle Eastern cities (Southworth and Owens, 1993). While Sample B's higher connectivity aligns with the modern urban planning goal to facilitate broader accessibility (Southworth and Ben-Joseph, 1995).

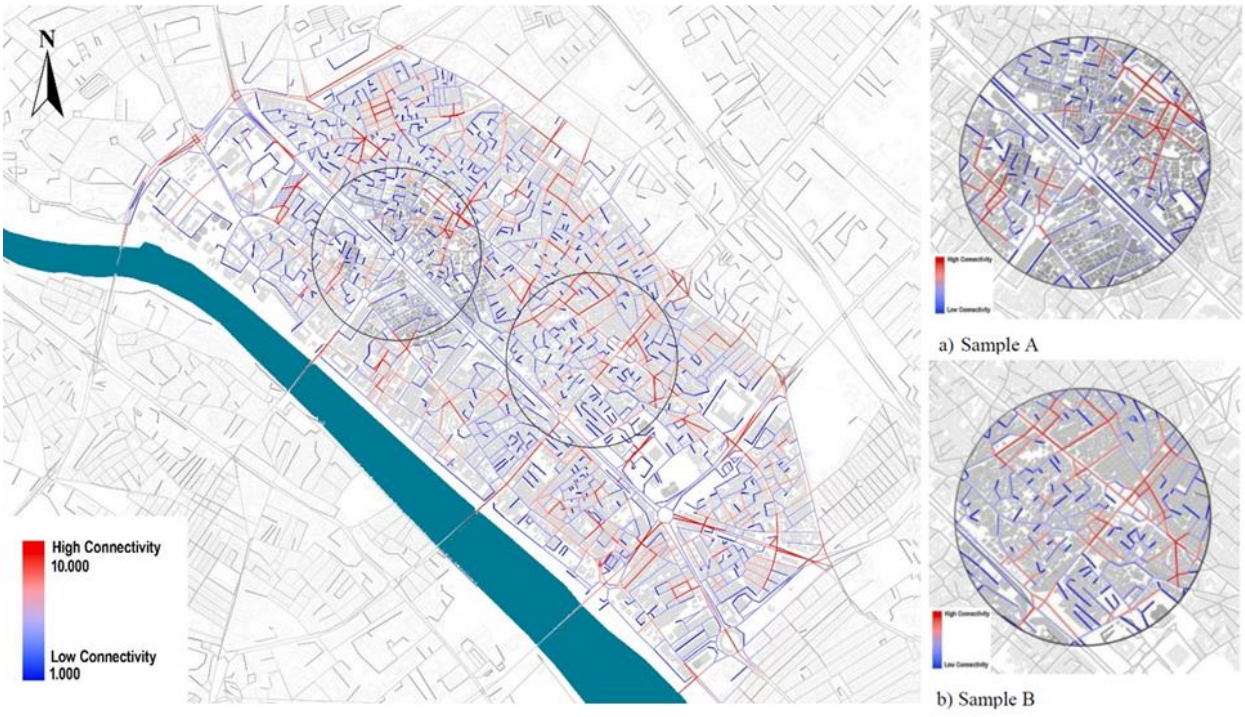

Figure 6. The Streets' Connectivity of Two Samples Within Old Rusafa District, (Source: Generated by Authors using Space Syntax plugin in QGIS software).

Integration measures how easily a street segment can be accessed from all other segments in the system. It is a key indicator of spatial accessibility and movement potential (Hillier et al., 1993). Global integration (Rn) and local integration (R7, R5, R3) analysis was conducted for both samples, see Figure (7).

Figure 7. Shows the Streets' Integration of Old Rusafa District, (Source: Generated by Authors using Space Syntax plugin in QGIS software).

- In Sample A, global integration values ranged from 34.24 to 86.40, and local integration (R7) values ranged from 4.8 to 72.6. The lower integration values imply the segregated nature of its organic street network. Streets with higher local integration aligned with commercial activities along primary pedestrian routes but remained generally disconnected from the broader urban network.
- In Sample B, global integration values ranged from 48.05 to 157.85 and R7 values from 6.05 to 83.84. The higher global and local integration values mean Sample B's Street network has more movement potential. The planned grid-like structure improves access to commercial streets and public facilities; see Figure (8).

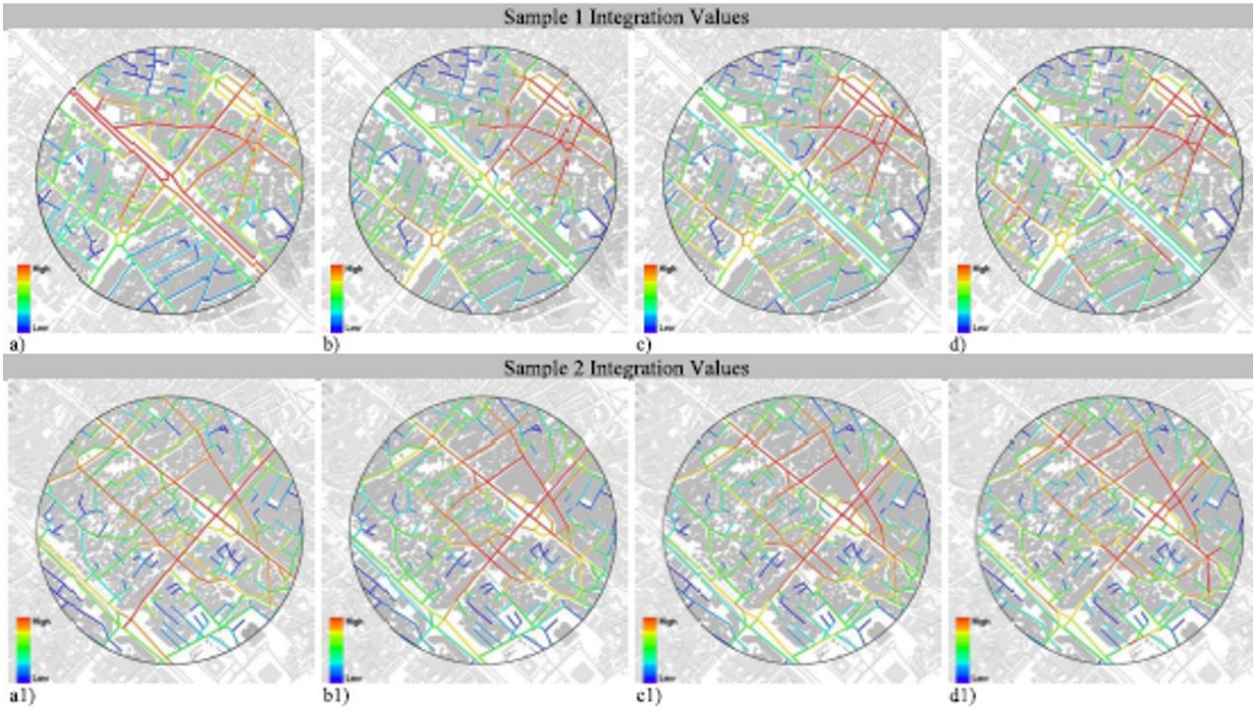

Figure 8. Shows the multi-scales of the streets' integration Values of the two Samples A and B of Old Rusafa, (Source: Generated by the Authors using Space Syntax plugin in QGIS software).

The results show the importance of street network integration in urban functionality. Streets with higher integration values support more economic and social activities, as evident in the commercial land use distribution in Sample B (Hillier and Vaughan, 2007), see Figure (9).

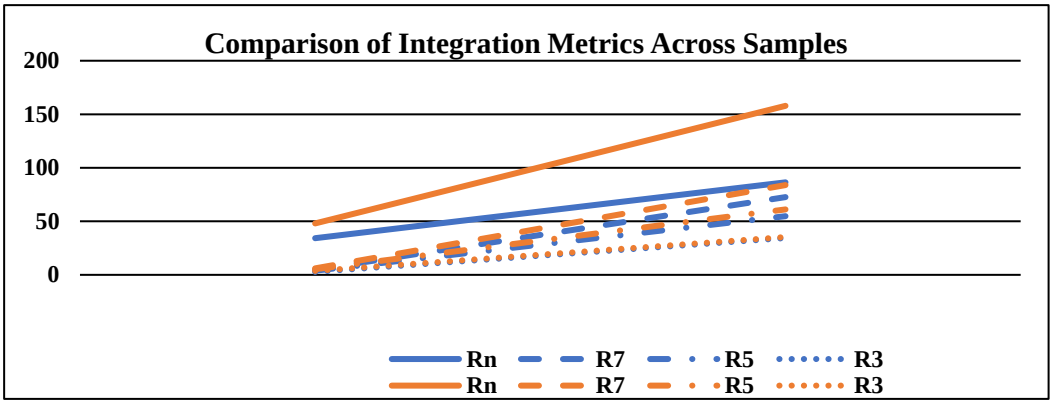

Figure 9. Compares the Outcomes of Integration Metric Across Samples A and B, (Source: Authors).

3.2. Land Use Patterns

The analysis of ground floor land use in Old Rusafa showed different spatial patterns between the two samples.

- In Sample A, ground floor land use was mostly residential, with 46% of buildings designated for housing. Commercial land use was 32%, mixed-use was 9%, industrial was 6%, and public facilities were 7%.
- In Sample B, commercial land use increased significantly by 64% of buildings. Residential was 17%, mixed-use was 8%, industrial was 2%, and public facilities were 5%.

These results show how street network morphology affects land use distribution; see Figure (7). Sample A's organic network supports traditional, residential and localised commercial uses while Sample B's grid layout fosters a higher concentration of commercial activities, especially along streets with higher integration and connectivity (Porta et al., 2006); see Figure (10).

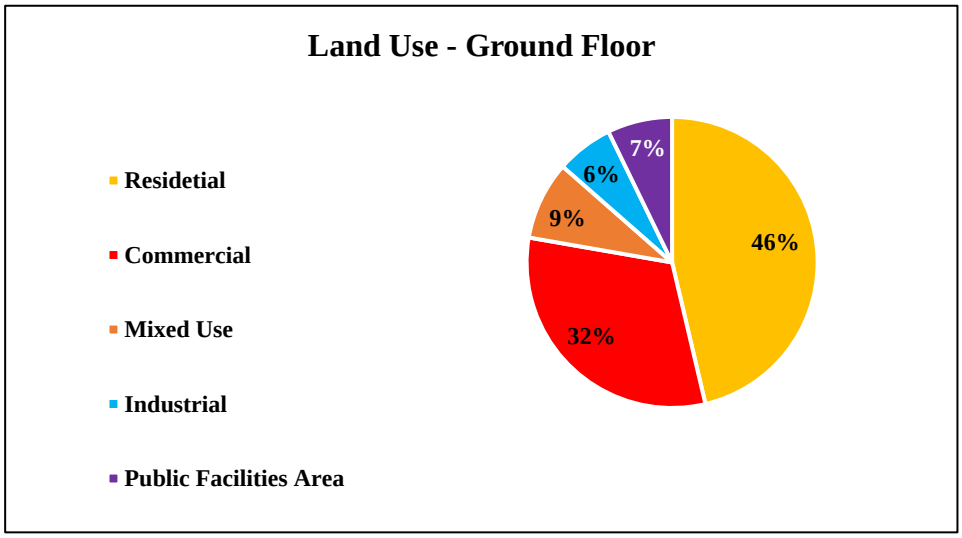

Figure 10. Shows the Ground Floor Land Use Percentage within Old Rusafa, (Source: Authors).

3.3. Correlations

Correlation between street integration values and ground floor land use in Sample A showed the functional organization of space.

- Residential land use had a negative correlation with integration at all scales, including Rn ($r = -0.158$, $p < 0.01$) and R7 ($r = -0.328$, $p < 0.01$). This means residential areas are situated on less integrated

and less accessible streets, which offer privacy and reduced traffic, as found in previous studies on the urban morphology of traditional cities (Griffiths, 2012).

- Commercial land use had low or no correlation with global integration ($r = 0.017$, $p = 0.749$). However, positive correlations emerged at local scales (R7 and R5), meaning commercial activities in Sample A are more dependent on neighbourhood-level accessibility rather than district-wide integration.
- Mixed-use areas had weak positive correlations with integration, meaning a moderate preference for locations that balance accessibility with functional diversity.

Sample B showed stronger correlations between street integration values and ground floor land use, especially for commercial activities.

- Residential land use had a negative correlation with integration at all scales, including Rn ($r = -0.200$, $p < 0.01$) and R7 ($r = -0.253$, $p < 0.01$). Just like Sample A, residential uses are situated on less integrated streets, meaning more private, less accessible locations.
- Commercial land use had strong positive correlations with integration, especially at the global scale (Rn $r = 0.179$, $p < 0.01$) and R7 ($r = 0.198$, $p < 0.01$). This reflects the strong relationship between commercial activity and high accessibility in Sample B's grid street network, as found in Hillier et al. (1993).
- Mixed-use areas also had positive correlations, but less than commercial uses. Both scales indicate that mixed-use development in Sample B gets both local and accessibility.

4. Conclusions

This research investigated the impact of urban street network configurations on ground floor land use distribution in the historic core of Old Rusafa, Baghdad. Using space syntax analysis and statistical correlation techniques, the study provides a detailed understanding of how spatial configurations affect urban functions in heritage areas. The results show the complex relationship between street network morphology, accessibility, and land use distribution and offer urban planning and heritage conservation insights.

The analysis of Old Rusafa's street network and ground floor land use patterns produced the following outcomes:

- Street Network Morphologies and Integration. Two samples were identified with different morphologies: Sample A, with an organic street network, had low connectivity and integration values. The area had narrow, winding alleys and irregular plots, typical of traditional Islamic city planning. Global integration values in Sample A were generally lower, meaning less accessibility and more spatial segregation. Sample B, with a geometric, grid-like street network, had higher connectivity and integration values. This planned intervention allowed for easier movement, higher accessibility and clearer hierarchies in the urban fabric.
- Ground Floor Land Use Patterns: Land use analysis showed that Sample A had more residential land use (46%), with commercial activities (32%) concentrated along locally integrated streets. Sample B had more commercial activities (64%), reflecting its better spatial accessibility and planned urban form. Residential uses in Sample B decreased to 17%, mostly in areas with lower street integration.

The study provides evidence-based knowledge that can guide urban planning interventions, especially in heritage areas where balancing preservation with modernization is a major challenge. By understanding the syntactic factors that influence land use patterns, planners and policymakers can make informed decisions that enhance accessibility, urban vitality and sustainability while preserving the historical and cultural identity of the urban fabric.

5. Recommendations

Based on the research findings, the following recommendations can be given for urban planning, heritage conservation, and future development in Old Rusafa and similar historic urban cores. These recommendations address the need to balance urban functionality, socio-economic vitality, and cultural heritage preservation.

- Use Space Syntax spatial analysis in urban planning to identify streets for commercial and public uses and preserve areas for residential uses.
- Align heritage conservation with the existing spatial structure, protect organic street networks and limit intensive commercial development in less accessible residential areas.
- Improve pedestrian accessibility and public spaces along highly integrated streets to foster social interaction and urban vitality.
- Encourage balanced land use by promoting small-scale commercial activities in moderately integrated areas and supporting adaptive reuse of historic buildings along main streets.
- Develop context-specific urban policies that address the different characteristics of organic and geometric areas, enforce traditional building regulations, and involve local communities in the planning process.

References

Al Hashimi, H. and Alobaydi, D. 2023 'Measuring spatial properties of historic urban networks', AIP Conference Proceedings, vol. 2651, no. 1. Available at: https://doi.org/10.1063/5.0117077

Albabely, S. and Alobaydi, D. 2023 'Impact of Urban Form on Movement Densities: The Case of Street Networks in AlKarkh, Baghdad, Iraq', ISVS e-journal, vol. 10, no. 7, pp. 147–163.

Albabely, S. and Alobaydi, D. 2024 'Analyzing movement densities in alkarkh districts: A comparative study', Journal of Engineering, vol. 30, no. 4, pp. 134–151. Available at: https://doi.org/10.31026/j.eng.2024.04.09

Alberti, F. 2023 'Regenerative Streets: Pathways towards the Post-Automobile City', Sustainability, vol. 15, no. 13, p. 10266. Available at: https://doi.org/10.3390/su151310266

Al-Hinkawi, W.S., Youssef, S.S. and Abd, H.A. 2021 'Effects of urban growth on street networks and land use in Mosul, Iraq: A case study', Civ. Eng. Archit, vol. 9, pp. 1667–1676.

Alobaydi, D. and Rashid, M. 2017 '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, pp. 31–38.

Alobaydi, D. and Rashid, M. 2024 'Morphological evolution of Baghdad: Analyzing urban growth patterns and transformation processes', Journal of Engineering, vol. 30, no. 12, pp. 16–32. Available at: https://doi.org/10.31026/j.eng.2024.12.02

Alobaydi, D. and Rashid, M. 2024 'The evolution of street structures: A morphological study', Journal of Engineering, vol. 30, no. 10, pp. 203–220. Available at: https://doi.org/10.31026/j.eng.2024.10.12

Alobaydi, D., Al-Saaidy, H.J. and Al-Askary, A.A. 2023 'Impact of Reach Centralities on Urban Accessibility and Connectivity: Insights from Iraq', ISVS e-journal, vol. 10, no. 12, pp. 714–728. Available at: https://doi.org/10.61275/ISVSej-2023-10-12-49

Al-Saaidy, H.J.E. and Alobaydi, D. 2021 'Studying street centrality and human density in different urban forms in Baghdad, Iraq', Ain Shams Engineering Journal, vol. 12, no. 1, pp. 1111–1121. Available at: https://doi.org/10.1016/j.asej.2020.06.008

Al-Saffar, M. 2018 'Urban Heritage and conservation in the historic centre of Baghdad', Journal of Heritage Architecture, vol. 2, no. 1, pp. 23–36. Available at: https://doi.org/10.2495/ha-v2-n1-23-36

Al-Saffar, M. 2020 'Baghdad: The city of cultural heritage and monumental Islamic architecture', Disegnarecon, vol. 13, no. 25, pp. 14–1. Available at:

https://doi.org/10.20365/disegnarecon.25.2020.14

Al-Saffar, M. 2024 'Sustainable Urban Heritage: Assessing Baghdad's Historic Centre of Old Rusafa', Architecture, vol. 4, no. 3, pp. 571–593. Available at: https://doi.org/10.3390/architecture4030030

Alsaffar, N.H. and Alobaydi, D. 2023 'Studying street configurations and land-uses in the downtown of Baghdad', AIP Conference Proceedings, vol. 2651, no. 1. Available at: https://doi.org/10.1063/5.0105420

Alsaffar, N.H. and Alobaydi, D. 2025a 'Street Patterns, Visual Permeability, and Spatial Accessibility of Downtown: The Case of Baghdad', Journal of Engineering, vol. 31, no. 2, pp. 140–155. Available at: https://doi.org/10.31026/j.eng.2025.02.09

Alsaffar, N.H. and Alobaydi, D. 2025b 'Urban Dynamics in Downtown Baghdad: Analyzing Syntactic Properties and Land Use Forms of AlShorja and Bab AlSharqi Areas', Journal of Engineering, vol. 31, no. 4, pp. 44–61. Available at: https://doi.org/10.31026/j.eng.2025.04.04

Ashik, F.R., Barrington-Leigh, C.P. and Manaugh, K. 2025 'Street network connectivity leads to denser urban form in Canadian cities', Cities, vol. 161, p. 105844. Available at: https://doi.org/10.1016/j.cities.2025.105844

Brown, B.B. 2025 'Residential environments and active living', Environmental Psychology and Human Well-Being, pp. 55–84.

Conzen, M.R.G. 1960 'Alnwick, Northumberland: a study in town-plan analysis', Transactions and Papers (Institute of British Geographers), no. 27, pp. iii–122.

Elrawy, S. and Elian, N. 2024 'Commercial Streets: A Framework for Creating Livable Environments in Egypt', JES. Journal of Engineering Sciences, vol. 52, no. 5, pp. 585–624. Available at: Available at: https://doi.org/10.21608/jesaun.2024.288746.1334

Field, A. 2024 Discovering statistics using IBM SPSS statistics. Sage publications limited.

Francis, M. 2016 'The making of democratic streets', Contesti. Città, territori, progetti, no. 1–2, pp. 192–213.

Griffiths, S. 2012 'The Use of Space Syntax In Historical Research : current practice and future possibilities', Eighth International Space Syntax Symposium, pp. 1–26.

Hakim, B.S. 1994 'The "Urf" and its role in diversifying the architecture of traditional Islamic cities', Journal of Architectural and Planning Research, pp. 108–127.

Hakim, B.S. 2007 'Generative processes for revitalizing historic towns or heritage districts', Urban Design International, vol. 12, no. 2, pp. 87–99. Available at: https://doi:10.1057/palgrave.udi.9000194

Hakim, B.S. 2010 'The generative nature of Islamic rules for the built environment', International Journal of Architectural Research (IJAR), vol. 4, no. 1, pp. 208–212.

Hakim, B.S. 2013 'Arabic Islamic cities rev: Building and planning principles', Routledge.

Hakim, B.S. and Rowe, P.G. 1983 'The representation of values in traditional and contemporary Islamic cities', Journal of Architectural Education, vol. 36, no. 4, pp. 22–28.

He, X., Kozlowski, M., Ujang, N. and Ma, Y. 2025 'The impact of street-based transitional edges on the urban social environment: systematic review from the last decade', Open House International, vol. 50, no. 2, pp. 415–442. Available at: https://doi.org/10.1108/OHI-03-2024-0107

Hillier, B. 2007 Space is the machine: a configurational theory of architecture. Space Syntax.

Hillier, B. and Hanson, J. 1984 'The_Social_Logic_of_Space_B_Hillier_and', Cambridge University Press [Preprint].

Hillier, B. and Vaughan, L. 2007 'The city as one thing', Progress in planning, vol. 67, no. 3, pp. 205–230.

Hillier, B. et al. 1993 'Natural movement: or, configuration and attraction in urban pedestrian movement',

Environment and Planning B: planning and design, vol. 20, no. 1, pp. 29–66.

Jameel, R. and Alobaydi, D. 2022 'Evaluating Livability of Streets: The Case Study of Alnahar Street in Baghdad', Urban Planning and Architectural Design for Sustainable Development (UPADSD), IEREK, Florence-Italy, p. 60.

Kim, H.K. and Sohn, D.W. 2002 'An analysis of the relationship between land use density of office buildings and urban street configuration: Case studies of two areas in Seoul by space syntax analysis', Cities, vol. 19, no. 6, pp. 409–418. Available at: https://doi.org/10.1016/S0264-2751(02)00071-9

Kostof, S. 1991 The city shaped. Little, Brown and Company Boston, MA.

Kropf, K. 2009 'Aspects of urban form', Urban morphology, vol. 13, no. 2, pp. 105–120.

Lynch, K. and Rodwin, L. 1958 'A Theory of Urban Form', Journal of the American Planning Association, vol. 24, no. 4, pp. 201–214. Available at: https://doi.org/10.1080/01944365808978281

Ogawa, H. and Fujita, M. 1980 'Equilibrium Land Use Patterns in a Nonmonocentric City', Journal of Regional Science, vol. 20, no. 4, pp. 455–475. Available at: https://doi.org/10.1111/j.1467-9787.1980.tb00662.x

Penn, A. 2003 'Space syntax and spatial cognition: Or why the axial line?', Environment and Behavior, vol. 35, no. 1, pp. 30–65. Available at: https://doi.org/10.1177/0013916502238864

Porta, S., Crucitti, P. and Latora, V. 2006 'The network analysis of urban streets: a primal approach', Environment and Planning B: planning and design, vol. 33, no. 5, pp. 705–725.

Southworth, M. and Ben-Joseph, E. 1995 'Street standards and the shaping of suburbia', Journal of the American Planning Association, vol. 61, no. 1, pp. 65–81. Available at: https://doi.org/10.1080/01944369508975620

Southworth, M. and Ben-Joseph, E. 2013 Streets and the Shaping of Towns and Cities. Island Press.

Southworth, M. and Owens, P.M. 1993 'The evolving metropolis studies of communit-y, neighborhood, and street form at the urban edge', Journal of the American Planning Association, vol. 59, no. 3, pp. 271–287. Available at: https://doi.org/10.1080/01944369308975880

Turner, A., Penn, A. and Hillier, B. 2005 'An algorithmic definition of the axial map', Environment and Planning B: planning and design, vol. 32, no. 3, pp. 425–444.

van Nes, A. and Yamu, C. 2021a Introduction to space syntax in urban studies, Introduction to Space Syntax in Urban Studies. Springer Nature. Available at: https://doi.org/10.1007/978-3-030-59140-3

van Nes, A. and Yamu, C. 2021b Introduction to Space Syntax in Urban Studies, Introduction to Space Syntax in Urban Studies. Available at: https://doi.org/10.1007/978-3-030-59140-3

Wu, Y., Wang, J., Lau, S.S.Y. and Miao, Y. 2022 'An improved publicness assessment tool based on a combined spatial model: Case study of Guangzhou, China', Sustainability, vol. 14, no. 22, p. 14711. Available at: https://doi.org/10.3390/su142214711

Zube, E.H. 1987 'Perceived land use patterns and landscape values', Landscape ecology, vol. 1, pp. 37–45.