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THE READING BAGHDAD'S RIVERFRONT SPACES: A SPACE SYNTAX APPROACH TO UNCOVERING THE URBAN EVENT POTENTIAL BETWEEN RUSAFA AND KARKH

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ABSTRACT

This study examines the Tigris River in Baghdad as a central urban axis that has partially lost its integrative and functional role due to contemporary urban transformations, reduced accessibility, and limited spatial activation. By employing quantitative spatial analysis using Space Syntax methodology, selected central riverfront segments were analyzed based on integration, connectivity, and intelligibility indicators to reveal spatial differentiation between the Rusafa and Karkh riverbanks. The findings indicate a clear variation in spatial potential, with highly integrated areas suitable for accommodating large-scale urban events, while less connected zones are more appropriate for localized interventions. The study also highlights the critical role of intelligibility in enhancing spatial perception and user interaction with the riverfront environment. Integrating Space Syntax analysis with a scenographic approach provides an effective analytical framework for reactivating the Tigris River as a dynamic urban stage and for supporting future riverfront design strategies in historic Baghdad.

Keywords: historic Baghdad, urban event planning, urban riverfront space, river-based events, spatial analysis (Space Syntax), scenographic potential

INTRODUCTION

Cities are like theatrical performances – they are written and rewritten upon the terrains of geography and memory. This perspective, drawn from performance studies, views urban space not as a fixed container, but as a continuously evolving stage shaped by human behavior, daily rituals, and bodily movement. As Schechner (2017) explains, the interplay of body, space, and event is central to the production of meaning within the city. In this context, the Tigris River in Baghdad is not merely a geographic boundary or a natural resource. It is better understood as a living urban stage – a spatial entity that holds the layered narratives of the city, continually reshaped through the passage of time,

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the flow of events, and the interaction between people and place (Al-Ani, 2014).

The segment of the Tigris among the Jumhuriya Bridge and Bab Al-Muadham Bridge represents a dynamic spatial core in the heart of Baghdad, where the two banks – Rusafa and Karkh – meet, each bearing architectural and cultural imprints from the Abbasid, Ottoman, and modern eras. As Salingaros (1998) notes, "urban fabric is the organizational Structure that exists more often than not in the area among buildings," where every node of human activity creates spatial meaning shaped by its relational context (Khauin & Al-Alwan, 2020).

This layered structure is particularly evident in Rusafa, which retains traces of a traditional, organic urban fabric. In contrast, Karkh is characterized by more modern, planned configurations. Cody and Siravo (2019) emphasize that urban structure must be understood not in isolation but through the lens of social and symbolic context – through its nodes, links, and spatial hierarchies. Similarly, Bianca (2000) argues that effective urban conservation is not just about physical restoration but about re-establishing the relationship between structure and performance. In this light, the river itself becomes a dynamic scenographic platform, capable of activating or generating events depending on the spatial qualities of each segment.

The study focuses on the river segment between Bab Al-Muadham and Jumhuriya bridges, selected for its historical, spatial, and cultural significance. This area is home to key landmarks such as Al-Rasheed Street, Khan Marjan, Al-Qushla, Mutanabbi Street, and Tahrir Square (see Fig. 1). Rusafa in particular hosts five documented historic pedestrian routes – originally defined in the 1984 Joint Conservation Project (JCP) and later reaffirmed (Mustafa & Ahmed, 2013) – including pathways such as Bab Al-Wastani to Al-Qala'a (2000 m), and Al-Kilani to Al-Midan (2500 m).

These walkways preserve the traditional spatial rhythm of Rusafa. On the other hand, the Karkh side lacks comparable pedestrian corridors, though it does offer open spaces and modern infrastructure (e.g., parking areas, bridge connections) that hold spatial potential. This contrast between the dense, historically embedded Rusafa and the open, modernized Karkh generates a scenographic tension – a visual, symbolic, and functional dialogue across the river. Rusafa acts as a space of symbolic production, while Karkh presents opportunities for spatial and functional investment (Ali et al., 2025).

In this light, the Tigris should not be seen merely as a physical separator, but as an interactive urban catalyst, capable of weaving together past and present, density and openness, tradition and

Table 1. Map Symbols and Land Use Classifications

Map Symbol	Land Use Classification	Map Symbol	Land Use Classification
PL	Public and semi-public facilities: leisure, cultural, religious	AO	Administrative use – other (e.g., non-governmental offices)
PLPO	Mixed public/semi-public facilities with other uses	FO	Agricultural or open field land
OP	Open spaces (parks, plazas, undeveloped public areas)	TS-01	Transportation: primary roads with standard access (≈50 m width)
CC	Central-level commercial areas	TS-02	Transportation: secondary roads with limited access (≈30 m width)
CC.PL	Mixed-use areas combining commercial and public functions	OW	Open water (rivers, canals, lakes – e.g., the Tigris River)
RH	High-density residential areas	PS	Public or semi-public service facilities (suburban/ recreational)

Source: Researcher (2025).

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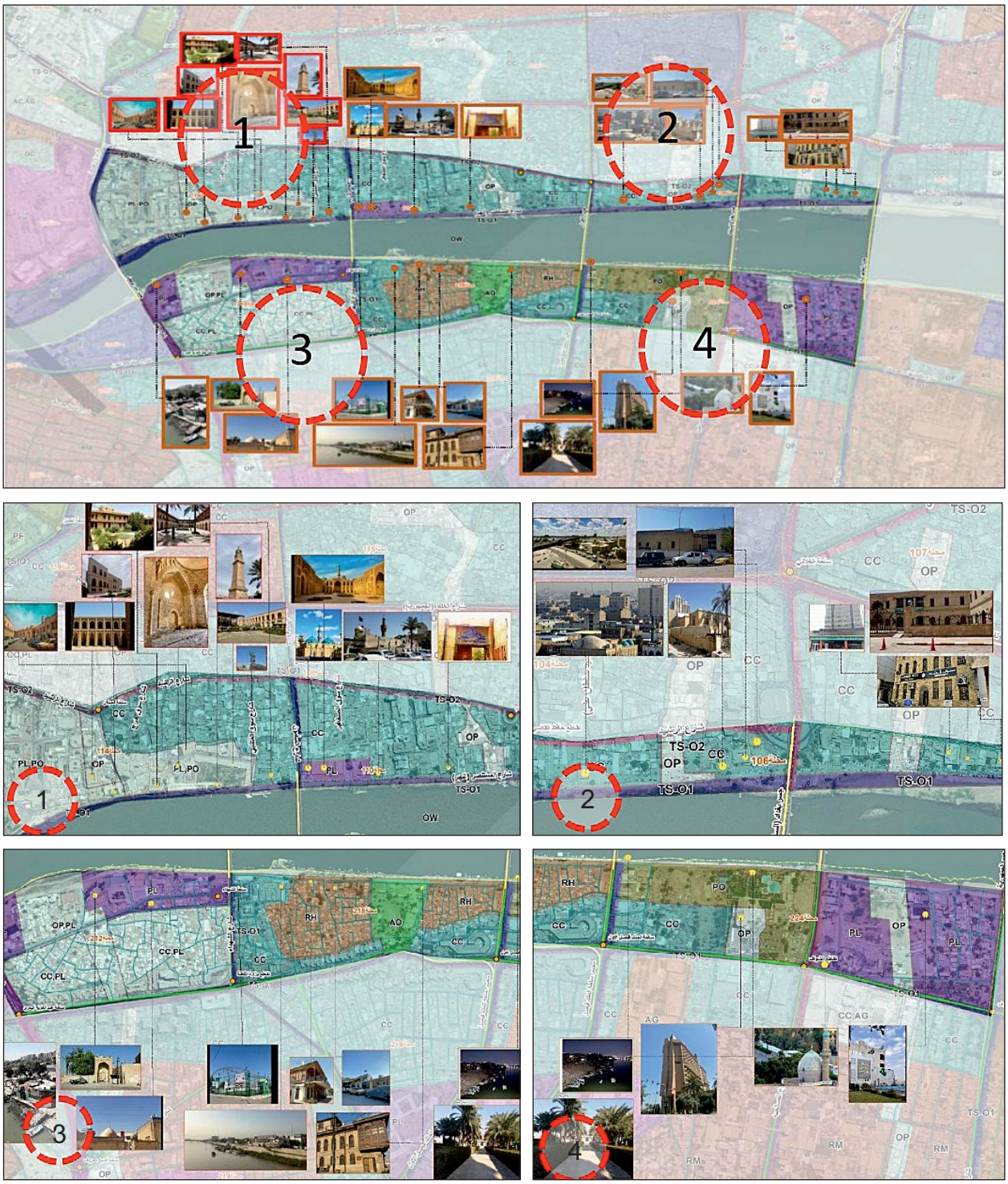

Fig. 1. Land use symbols and classifications with enlarged segments of the study area between Al-Muazzam Bridge and Al-Shuhada Bridge, based on the map legend

Source: Developed by the authors based on land use data from Baghdad Municipality and GIS spatial analysis.

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transformation. Building on this idea, the research divides the study area into mirrored segments – each analyzed as a "theatrical scene" within the river's evolving narrative. The investigation asks: Is the scene silent or expressive? Does the space present itself, or does it require reactivation? Is the river in this segment an active participant or a dormant backdrop? These scenographic questions guide not only the interpretation of the urban condition but the reimagining of river-based urban events in Baghdad.

General Description of Segment A1

Segment A1, positioned between Bab Al-Muadham Bridge and Al-Shohada Bridge, represents one of the most historically and spatially vibrant sections along the Tigris River in central Baghdad. This area features a unique blend of cultural, educational, and civic institutions on both riverbanks. The Rusafa side is notable for its dense historical fabric, hosting landmarks such as the Abbasid Palace, Al-Qushla Square, and Al-Mutanabbi Street – Baghdad's renowned literary corridor. Additional institutions like Dar Al-Wali, Al-Rashidiya School, and Al-Wazir Mosque reinforce the area's cohesive cultural identity (Bianca, 2000; JCP, 1984). In contrast, the Karkh side features more spatial openness and functional variety, including religious landmarks such as Khidr Al-Yas Shrine and Al-Qamariya Mosque, as well as public facilities like the Baghdad Rowing Federation, Pension Directorate, and Al-Karkh General Hospital. These are connected by a new corniche, enhancing accessibility and public engagement (Mustafa & Ahmed, 2013; Salingaros, 1998). Morphologically, the Rusafa side preserves key pedestrian corridors, such as the Bab Al-Wastani–Al-Qala'a and Al-Kilani–Al-Midan walkways, reflecting the city's organic spatial order (JCP, 1984). Segment A1's contrasting yet complementary urban structures provide an ideal setting for spatial analysis using *Space Syntax* tools (Hillier & Hanson, 1984; Turner, 2001).

General Description of Segment B

Segment B, placed between Al-Shohada Bridge and Al-Ahrar Bridge, represents a symbolic and functional junction along the Tigris River, marked by a clear spatial and morphological contrast between the Rusafa and Karkh sides. On the Rusafa side, the riverfront is rich in historic and cultural landmarks, including Al-Mustansiriya School – one of the earliest Islamic universities (JCP, 1984) – as well as Khan Al-Shabandar, Souq Al-Saffareen, Al-Khalidiya Lodge, and Haidar Hammam. These elements reflect a dense, layered urban texture spanning from the Abbasid era to modernity (Bianca, 2000). However, this side also faces significant spatial degradation and land use conflict, with commercial and institutional uses overshadowing residential and public functions. The riverbank suffers from poor accessibility and visual disconnection due to barriers and lack of walkability (Mustafa & Ahmed, 2013). In contrast, the Karkh side exhibits fragmented land uses with religious and service facilities like Khidr Al-Yas Shrine and the Pension Directorate (Salingaros, 1998). Despite these assets, spatial fragmentation and weak riverfront integration limit its potential. Applying *Space Syntax* tools such as Integration and Connectivity can guide strategic interventions to reconnect this segment to the broader urban system (Hillier & Hanson, 1984).

General Description of Segment C

Segment C, Positioned between Al-Ahrar Bridge and Al-Sinak Bridge, forms a key central node along Baghdad's riverfront. Geographically, it connects the Al-Midan and Al-Sinak districts on the Rusafa side, while running parallel to Haifa Street on the Karkh side. This segment hosts a dense blend of administrative, cultural, and commercial functions, contributing to its spatial complexity and usage diversity. On the Rusafa bank, the presence of major landmarks – such as the Police Headquarters, Al-Sinak Mosque, People's Hall, and the Baghdad Cultural House – creates a layered administrative-cultural character (JCP, 1984). However, the riverfront lacks pedestrian accessibility due to fenced compounds,

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visual barriers, and the absence of open promenades (Mustafa & Ahmed, 2013; Turner, 2001). On the Karkh side, Haifa Street features low-density urban blocks with scattered government buildings, parking areas, and unregulated land use. This contributes to a weak urban identity and a poor spatial relationship with the river (Salingaros, 1998). The absence of symbolic or public landmarks further limits its narrative role. Therefore, applying *Space Syntax* tools – particularly Integration, Connectivity, and Control Value – can reveal spatial inefficiencies and help direct strategic interventions (Hillier & Hanson, 1984; Turner, 2001) to activate this underutilized yet central segment.

General Description of Segment D

This segment stretching among Al-Jumhuriya Bridge and Al-Sinak Bridge – forms a critical urban threshold within central Baghdad, revealing a sharp spatial and functional disparity between the Rusafa and Karkh banks. On the Rusafa side, the Al-Sinak district acts as a southern extension of Al-Rasheed Street, historically one of Baghdad's most iconic urban corridors. Landmarks such as Dar Al-Wazir Nizam Al-Din and Al-Sinak Mosque enrich the area with cultural and architectural heritage (Al-Saffar, 2018; JCP, 1984). Despite this, the riverbank suffers from functional and visual detachment due to the presence of a concrete embankment that severs the urban edge from the Tigris, making the river nearly absent from everyday spatial experience. Conversely, the Karkh side presents a more open interface with the river but lacks cultural or civic engagement. Dominated by institutional uses and underutilized voids, it reflects a disconnected, state-centric urban character (Mustafa & Ahmed, 2013). The two bridges in this segment – Al-Jumhuriya and Al-Sinak – function primarily as vehicular links rather than civic connectors (Grosz, 2001; Lynch, 1960). Reestablishing visual and functional dialogue across the river could enable scenographic activation and re-integrate the Tigris as a civic and symbolic spine of Baghdad.

Space Syntax – Spatial Analysis of Riverfront Segments

Building on the central aim of this research – to develop interactive spatial scenarios for urban river events in Baghdad – this study adopts a top-down spatial analysis approach to examine the riverfront. This perspective treats the river not as a series of disconnected points, but as a continuous, integrated urban entity, where the interaction between both riverbanks and the overall spatial configuration directly shapes the type and nature of events that can unfold. The methodology is grounded in the hypothesis that urban events are not created in isolation, but rather emerge from the underlying spatial networks that structure movement, visibility, and interaction across the riverfront. Each river segment is analyzed as a dynamic system – a spatial scene composed of interlinked physical and social components – where the potential for public events is embedded in its syntactic logic (Al-Obaidi et al., 2025). To operationalize this analysis, the study utilizes DepthmapX, a specialized software tool for spatial analysis, applying the core techniques of Space Syntax. These tools allow for a detailed reading of the visual and movement-based structures (axial and segment maps) that define each riverfront segment. Key indicators such as integration, connectivity, and intelligibility are used to assess how spatial structure influences accessibility, centrality, and the potential for social activation. Importantly, this analysis is not purely geometric or technical (Alobaydi & Rashid, 2024). Rather, it serves as a critical interpretive tool – one that reveals how each segment of the riverfront contributes to the broader narrative of the city. By reading the river as a scenographic system, the study identifies where and how urban space can support meaningful, participatory, and context-sensitive events.

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MATERIALS AND METHODS

Data collection

In this phase, each riverfront segment is treated as a comprehensive analytical unit. The analysis is conducted using Space Syntax tools via the DepthmapX software, which enables the extraction of key spatial indicators – including Integration, Connectivity, Choice, and Mean Depth (see Table 1). These indicators help assess the structural integration, visual connectivity, and movement potential of each segment, allowing the researcher to evaluate which type of urban event (linear, centralized, or temporary) is most appropriate for each location (see Table 2).

This analytical framework is grounded in established theoretical foundations, including:

– Hillier & Hanson (1984), who emphasized the position of spatial configuration in shaping human motion and spatial conduct;
– Penn (2003), who explored the connection between spatial integration and the emergence of city events;
– Turner (2001), who advanced the dynamic understanding of spatial systems through visibility-based analysis and network logic.

Data digitalization

The examine applies Space Syntax methodology to investigate the spatial configuration of -both the Karkh and Rusafa riverbanks along the Tigris River, using specialized digital tools and the following sequential workflow:

1. Preparation of Digital Maps
   High-resolution maps were developed to cover the urban extent of the riverfront, utilizing satellite imagery and official planning documents, including streets, public spaces, and architectural elements (JCP, 1984).
2. Axial Map Generation
   Axial maps were created in AutoCAD 2020 in accordance with Space Syntax principles, by drawing the longest strains of sight with the minimal range of axial segments (Hillier & Hanson, 1984).

Table 1. Summarizing key spatial indicators, their analytical descriptions, and their relevance for spatial and scenographic analysis

Spatial Indicator	Analytical Description	Research Relevance
Integration	Indicates how well a line is embedded within the wider urban network	Identifies central areas capable of supporting scenographic activation (Hillier et al., 1993)
Connectivity	Counts the range of lines directly linked to a given line	Assesses local connectivity and supports analysis of visual and pedestrian activity (Bafna, 2003)
Choice (Betweenness)	Measures how often a line is used as a route between two points	Reveals primary movement corridors that should be visually emphasized (Karimi, 2012)
Mean Depth	Calculates the average number of directional changes required to reach different lines	Measures the simplicity or complexity of spatial structure and its effect on pedestrian navigation
Intelligibility	Correlation coefficient between RA (Relative Asymmetry) and Connectivity	Evaluates how easily users can understand and navigate the spatial layout (Hillier, 2007)

Source: Based on Hillier et al., 1993; Bafna, 2003; Karimi, 2012; Hillier, 2007.

Table 2. Presenting the relationship between spatial indicator patterns and corresponding urban event typologies, illustrating how integration, connectivity, and depth influence the scale and nature of riverfront events

Indicator Pattern	Most Suitable Type of Urban Event
High integration + strong connectivity + moderate depth	Continuous linear event (e.g., marathons, parades along the river)
Low integration + high depth + limited connectivity	Localized concentrated event (e.g., performances, fixed gatherings)
Low connectivity + short lines + dispersed integration	Small-scale temporary events (e.g., pop-up installations, workshops)

Source: own elaboration.

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3. Data Import into DepthmapX
   The CAD-based maps were exported in DXF format to DepthmapX software (version 0.30), where key spatial indicators – such as *Integration*, *Connectivity*, and *Choice* – were calculated.
4. Integrated Analysis of Both Riverbanks
   Rusafa and Karkh were analyzed as a unified spatial network, using a Radius = 5 metric to assess structural and functional relationships across the river.
5. Use of Arithmetic Averages
   The average values of each indicator were used to evaluate the overall performance of each riverbank as an urban entity and to assess their suitability for hosting events (Penn, 2003).
6. Visual Representation of Results
   Output maps were color-coded to illustrate spatial performance: highly integrated axes were shown in warm tones, while segregated lines appeared in cool tones, helping identify key zones of potential interaction with the river.
7. Simplification of the Axial Network
   The "Reduce to Fewest Line Map" command was applied to simplify the axial network without compromising its structural properties. This step aligns with Hillier and Hanson's (1984) methodology and is supported by Karimi (2012) as a critical technique in sectional spatial analysis.
8. Calculation of Intelligibility
   Intelligibility was calculated for the entire segment<– not just each bank separately – to assess the clarity of the river system as a unified spatial scene (see Table 3). This aligns with Turner (2001), who emphasized the river not as a barrier but as a spatial axis for urban performance. A highly intelligible system facilitates movement and audience orientation – an essential condition for enabling flexible and responsive urban events (Hillier et al., 1993).

Tables 3 and 4 help illustrate how intelligibility – as a core Space Syntax metric – can inform the design and activation potential of riverfront spaces by evaluating how easily people can interpret and navigate spatial environments.

Table 3. Explaining the intelligibility indicator in space syntax analysis, including its formula, components, and analytical meaning

Item	Description
Indicator Formula	Intelligibility = R^2 (Connectivity, Integration RA)
Connectivity	The number of direct connections from a given axial line, reflecting local visibility
Integration (RA)	Relative measure of spatial integration, reflecting global accessibility
R^2 (Coefficient of Determination)	Derived from linear regression between Connectivity and Integration (RA); indicates how well connectivity predicts integration

Source: own elaboration.

Table 4. Presenting interpretation ranges of intelligibility (R^2) values and their corresponding levels of spatial clarity

Intelligibility (R^2)	Spatial Clarity Level	Interpretation
0.80 – 1.00	Very High	The spatial system is highly legible and intuitive to navigate
0.60 – 0.80	Good	The system shows good clarity and is reasonably understandable
0.40 – 0.60	Moderate	The system may require visual or structural enhancements to improve legibility
Below 0.40	Low	The system is spatially unclear and difficult to read, limiting usability

Source: own elaboration.

Generating the Axial Map (Axial Map Generation)

Fig. 2 illustrates the process of generating an axial map through three interconnected stages that reflect the syntactic methodology for analyzing urban space, as proposed by Hillier and Turner.

The first stage (a) begins with the base layout of the urban area, showing the street network and building plots, which serve as the reference framework for generating axial lines.

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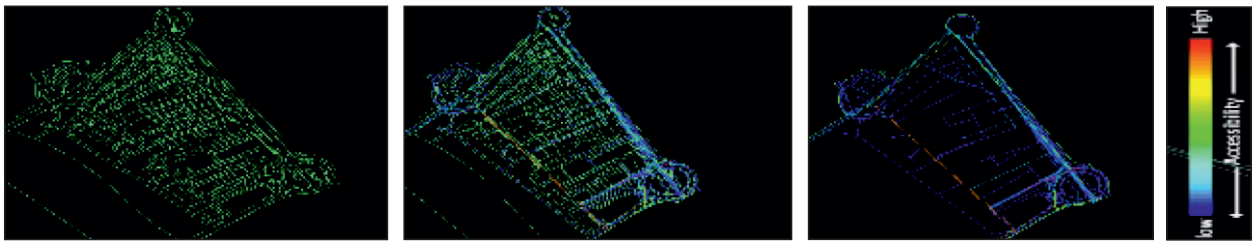

Fig. 2a illustrates the base urban layout, showing the street network and building plots that form the foundational geometry of the study area and serve as the reference framework for spatial line generation.

Fig. 2b presents the stage of generating axial lines, where the longest and fewest lines of uninterrupted movement and visibility are drawn over the urban grid, representing potential paths for pedestrian navigation and spatial interaction.

Fig. 2c shows the final axial map, where all axial lines are connected into a continuous network and analyzed using spatial indicators. The results are visually represented through a color-coded scale, in which warm colors (e.g., red and orange) indicate higher levels of spatial integration, while cool colors (e.g., blue and green) indicate lower integration within the urban system.

Fig. 2. Sequential generation of the axial map with color scale, based on Space Syntax analysis
Source: own elaboration.

In the second stage (b), axial lines are drawn over the urban grid. These lines represent the longest traces of sight and movement paths. Within the urban environment, serving as a proxy for visual and spatial accessibility.

Finally, the third stage (c) reveals the complete axial map, which interconnects all lines into a cohesive spatial network. This final map becomes the foundation for quantitative spatial analysis using tools such as DepthmapX, through which key spatial indicators like Integration, Connectivity, and Choice are extracted.

The diagram was produced by the researchers using AutoCAD, GIS, and DepthmapX software, following the methodological framework developed by Hillier and Turner for the analysis of open urban spaces.

RESULTS

This section presents a comparative spatial analysis of four selected riverfront segments within the urban fabric of Baghdad. Using DepthmapX and its suite of spatial indicators, the study examines each segment's configurational properties to assess its capacity for hosting and activating urban events. The results are summarized in Table 5 and visualized in Fig. 3.

The analysis is structured around four primary objectives:

1. Identifying the most suitable event locations based on spatial integration values, highlighting areas with the strongest potential for public engagement and centrality within the urban network.
2. Diagnosing movement flow patterns, enabling planners to direct event layouts and optimize audience circulation along the riverfront.
3. Evaluating the intelligibility of the spatial system, which reflects how easily users can comprehend and navigate the space, ensuring that event locations are legible, accessible, and intuitive.

This evidence-based approach not only supports the strategic planning of urban events but also reinforces the role of the riverfront as a dynamic and scenographically expressive urban stage.

The spatial analysis conducted using the Space Syntax methodology and implemented through DepthmapX revealed a high level of effectiveness in interpreting the structural variability across the four riverfront segments in Baghdad. Rather than serving as purely descriptive tools, key spatial indicators – Integration, Connectivity, Mean Depth, and Node Count R5 – provided a functional–kinematic map, guiding urban designers in strategically allocating public events.

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Table 5. Comparing spatial syntax indicators across four riverfront segments, including choice, connectivity, integration, depth, line length, and node count values derived from DepthmapX analysis

Indicator	Segment 1	Segment 2	Segment 3	Segment 4
Choice (Global Avg)	803.26	886.27	721.91	1720.62
Choice R5 (Local Avg)	717.71	424.09	314.72	449.43
Normalized Choice R5	0.011	0.030	0.035	0.027
Connectivity (Avg)	31.53	7.51	5.91	19.33
Integration [HH] (Global Avg)	3.00	1.49	1.34	1.40
Integration [HH] R5 (Local)	3.10	1.70	1.60	2.12
Line Length (Avg) (m)	147.61	127.20	153.63	137.93
Mean Depth (Avg)	3.16	4.82	4.84	5.59
Mean Depth R5 (Avg)	3.04	3.79	3.73	3.48
Node Count R5 (Avg)	357.37	156.81	117.53	193.80

Source: own elaboration.

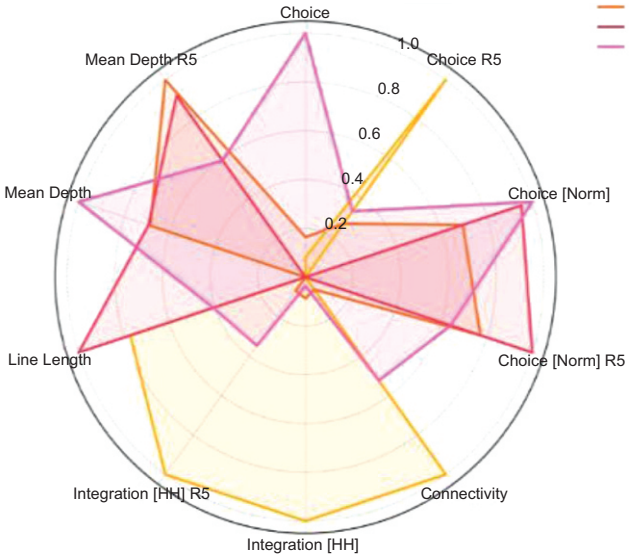

Fig. 3. Illustrating the interrelationships among key spatial indicators, showing how measures such as integration, connectivity, choice, and depth interact within the spatial system

Source: own elaboration.

For instance, Segment 1 (see Fig. 4) demonstrated high integration (3.00) and strong connectivity (31.5), making it well-suited for large-scale, open-air events such as public celebrations or mass parades. In contrast, Segments 2 and 3 (see Figs. 5 and 6) exhibited deeper spatial structures with lower connectivity, favoring localized or temporary performances that require tighter spatial control and defined pathways. Segment 4 (Fig. 7) represents a transitional condition, suggesting its suitability for medium-scale linear or sequential activities.

These findings are especially significant as they transition spatial planning from subjective intuition to evidence-based analysis, grounded in the logic of spatial structure itself. This aligns with (Fischer-Lichte, 2008) concept of "performance of space," which views spatial configuration as an active medium in meaning-making. In this context, the river is not merely a scenic backdrop, but an active stage for urban events, where its spatial form dictates both the type and distribution of urban activities.

Thus, the use of Space Syntax tools not only enriches our understanding of the riverfront's structural dynamics but also enables a scenographic match between event type and spatial capacity. The following typologies emerged:

- segments with high integration and connectivity are ideal for major, continuous events;
- segments with limited connectivity and deeper structures suit centralized or short-term performances;
- segments with moderate spatial qualities offer potential for fragmented or smaller sequential events.

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Table 6. Classifying riverfront segments according to key spatial indicators and identifying the most suitable urban event types with corresponding scenographic interpretations

Segment No.	Key Spatial Characteristics	Recommended Event Type	Scenographic Interpretation & Suitability
Segment 1	• Integration = 3.00 • Connectivity = 31.5 • Node Count (R5) = 357 • Line Length = 147 m • Mean Depth = 3.1	Large-scale linear event (e.g., river festival, marathon)	High integration and connectivity support widespread movement and dynamic activity flows – ideal for continuous, open-air scenographic events with strong visual and functional impact.
Segment 2	• Integration = 1.48 • Connectivity = 7.5 • Node Count (R5) = 156 • Mean Depth = 4.82	Centralized spot event (e.g., small performance, pop-up workshop)	Limited network and higher depth indicate a relatively enclosed spatial structure – appropriate for intimate, localized happenings requiring minimal spatial dispersion.
Segment 3	• Integration = 1.34 • Connectivity = 5.9 • Node Count (R5) = 117 • Mean Depth = 4.83	Small-scale modular event (e.g., awareness kiosk, sculptural installation)	Low connectivity and deep spatial hierarchy reduce distributive potential – favoring point-specific interventions with concentrated scenographic impact.
Segment 4	• Integration = 1.40 • Connectivity = 19.3 • Node Count (R5) = 193 • Mean Depth = 5.58	Medium-scale linear/ sequential event (e.g., processional path, mobile exhibition)	Moderate spatial integration and good connectivity allow for event unfolding across two or more visual sectors – suitable for staged, serial performances with flexible routing.

Source: own elaboration.

Table 6 presents a classification of the four riverfront segments based on the most suitable urban event typology, drawing directly from Space Syntax outputs (Integration, Connectivity, Node Count, Mean Depth, and Line Length). This spatial-event matching framework allows urban planners to tailor each segment's programming according to its scenographic potential, spatial affordances, and functional accessibility.

DISCUSSION

"Linking Spatial Analysis Indicators with the Scenographic Dimensions of the Urban Riverfront Event"

The relationship between the spatial analysis indicators and the scenographic dimensions of the urban riverfront event forms one of the key interpretive layers of this study. Each Space Syntax measure provides a distinct lens for understanding how spatial configuration supports the performative and experiential qualities of the riverfront. Integration represents the visual-social dimension of scenography, expressing how spatial continuity and openness foster collective engagement and visual unity – conditions suitable for large-scale civic or cultural events. Connectivity, by contrast, corresponds to the functional-performative dimension, as it reflects the capacity for movement, circulation, and interaction across different scenographic zones, defining how audiences and performers transition between spatial sequences. Meanwhile, Intelligibility (R^2) embodies the *perceptual-cognitive dimension* of scenography, revealing how easily users can read and navigate space intuitively without reliance on external wayfinding systems.

Together, these indicators translate into a spatial–scenographic framework that informs the design of event typologies and activation strategies along the Tigris River. Areas with high integration and intelligibility are proposed as open, collective stages for large-scale performances and river festivals, while zones with moderate or low values are better suited for smaller, localized interventions emphasizing intimacy, reflection, or micro-performance. Through this synthesis, the study bridges quantitative spatial analytics with qualitative scenographic interpretation – transforming abstract spatial data

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into applicable design strategies that enhance the experiential and performative character of Baghdad's riverfront.

Intelligibility of the Four Riverfront Segments

The Intelligibility indicator, a fundamental measure in Space Syntax analysis, evaluates how easily users can comprehend and navigate a spatial environment based solely on its visual and structural properties, without prior knowledge or external guidance. It expresses the degree to which local spatial relations predict the overall structure of the system. Methodologically, intelligibility is measured by the coefficient of determination (R^2) between connectivity (the number of directly linked spaces) and global integration (Rn), which represents how accessible a space is within the entire urban system. The closer the R^2 value is to 1.0, the higher the legibility and intuitive readability of the spatial configuration – allowing users to orient themselves and move fluidly through the environment.

In the context of Baghdad's riverfront, intelligibility serves as a key diagnostic indicator that reflects the clarity of spatial organization and the user's ability to perceive and interact with the riverine landscape. The analysis of the four selected segments revealed significant variations in spatial legibility, as summarized below:

- segment 1 ($R^2 = 0.816$) recorded the highest intelligibility, indicating a highly coherent and readable structure. This makes it ideal for large-scale, continuous events such as river festivals or public parades, where spatial clarity facilitates smooth movement and crowd management (see Fig. 4);
- segment 4 ($R^2 = 0.7191$) exhibited a strong level of intelligibility, reflecting a balanced alignment between visibility and accessibility. It is suitable for medium-scale or sequential events benefiting from clear linear connections along the riverfront (see Fig. 7);
- segment 2 ($R^2 = 0.6005$) demonstrated moderate intelligibility. While the spatial configuration is partially readable, it may require additional visual cues or design guidance. It is best suited for localized, small-scale events centered around a single node or attraction (see Fig. 5);
- segment 3 ($R^2 = 0.4781$) recorded the lowest intelligibility, suggesting a fragmented spatial logic that makes navigation less intuitive. This segment requires clear directional signage or scenographic design interventions to support user orientation, making it appropriate for compact, stationary events such as installations or micro-performances (see Fig. 6).

Table 7. Urban event design summarizing intelligibility (R^2) values across riverfront segments and outlining their implications for spatial legibility

Segment	R^2 Value	Level of Intelligibility	Interpretation	Implications for Urban Event Design
Segment 1	0.816	Very High	Strong correlation between connectivity and integration; users can easily navigate and understand the space.	Ideal for large-scale, continuous events (e.g., river festivals, public parades) with minimal intervention needed.
Segment 2	0.6005	Moderate to Good	The spatial system is partially readable but may require visual cues or layout structuring.	Suitable for localized, small-scale events where movement is concentrated and easier to manage.
Segment 3	0.4781	Moderate to Low	Low spatial clarity could cause confusion for new users; requires support through signage or design.	Recommended for focused, static events with clear spatial boundaries (e.g., installations, kiosks).
Segment 4	0.7191	Very Good	High alignment between visibility and accessibility enables fluid movement and spatial understanding.	Well-suited for medium-scale or sequential events along visually and functionally connected zones.

Source: own elaboration.

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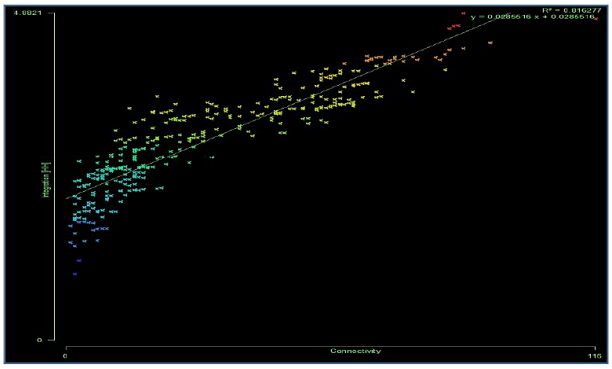

Fig. 4. Segment 1, based on Space Syntax analysis
Source: Developed by the researcher (2025).

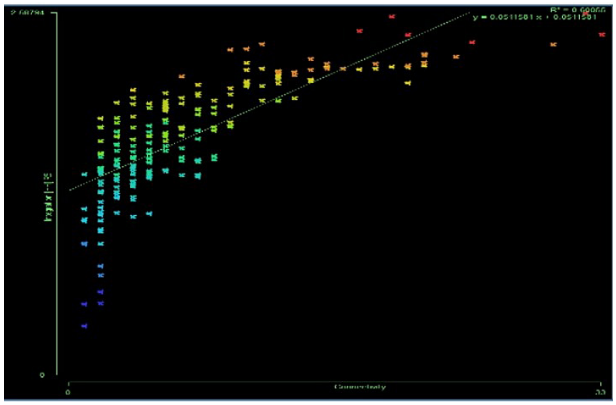

Fig. 5. Segment 2, based on Space Syntax software
Source: Developed by the researcher.

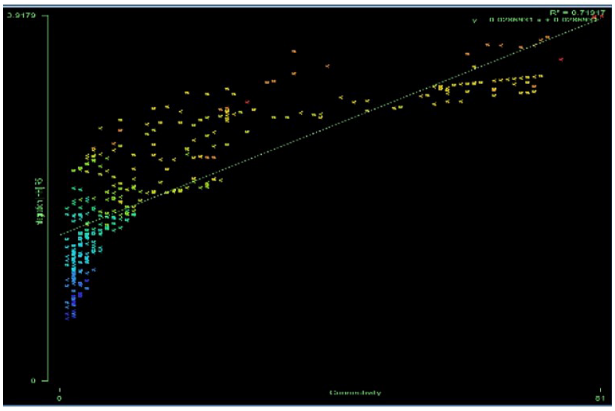

Fig. 6. Segment 3, based on Space Syntax analysis
Source: Developed by the researcher (2025).

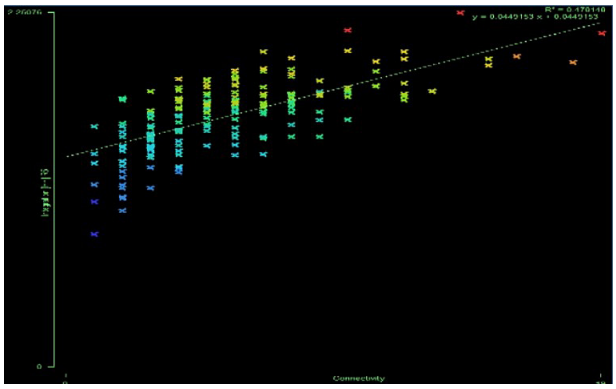

Fig. 7. Segment 4, based on Space Syntax analysis
Source: Developed by the researcher (2025).

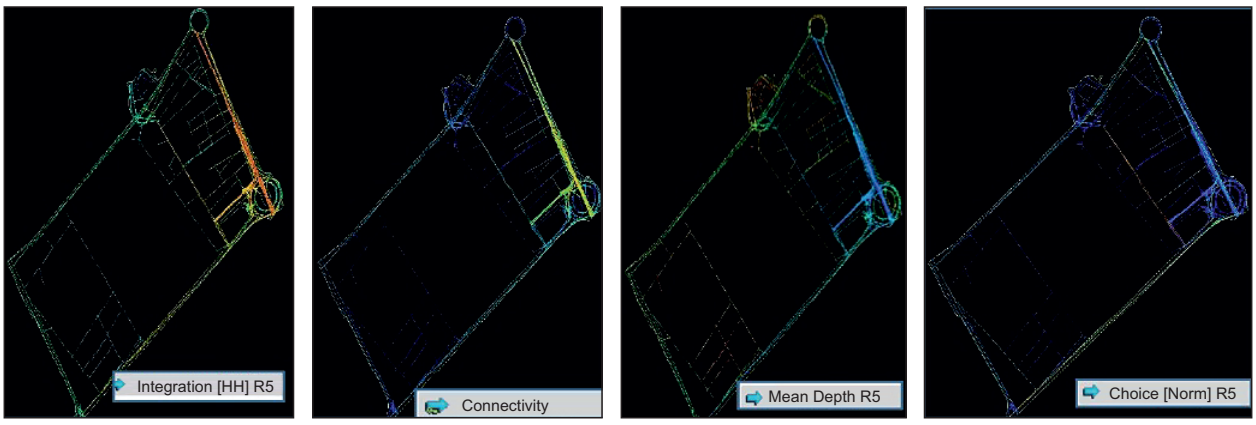

Fig. 8. The spatial configuration and axial structure of Riverfront Segment 1 between Al-Jumhuriya Bridge and Al-Sinak Bridge on the Rusafa–Karkh sides, based on Space Syntax analysis
Source: Developed by the researcher using Space Syntax methodology (2025).

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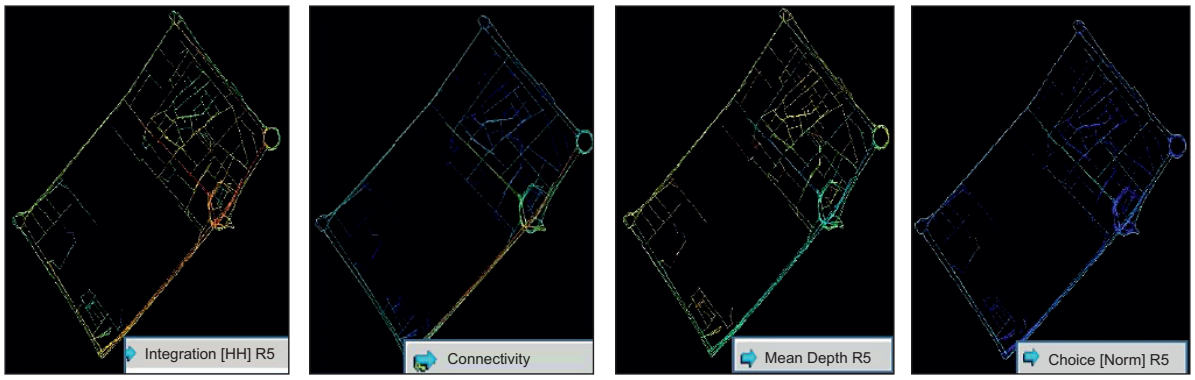

Fig. 9. The spatial configuration and axial structure of Riverfront Segment 2 between Al-Jumhuriya Bridge and Al-Sinak Bridge on the Rusafa–Karkh sides, based on Space Syntax analysis
Source: Developed by the researcher using Space Syntax methodology (2025).

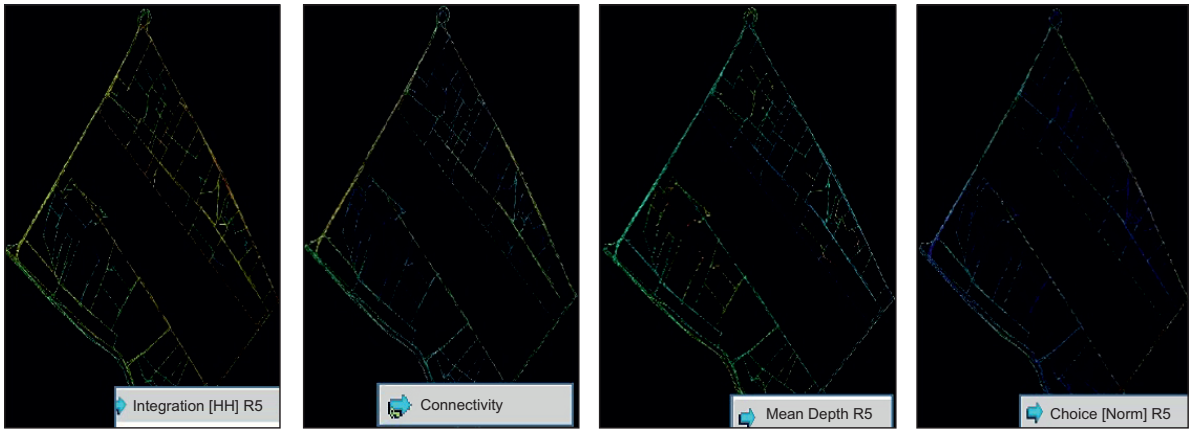

Fig. 10. The spatial configuration and axial structure of Riverfront Segment 3 between Al-Ahrar Bridge and Al-Shuhada Bridge on the Rusafa–Karkh sides, based on Space Syntax analysis
Source: Developed by the researcher using Space Syntax methodology (2025).

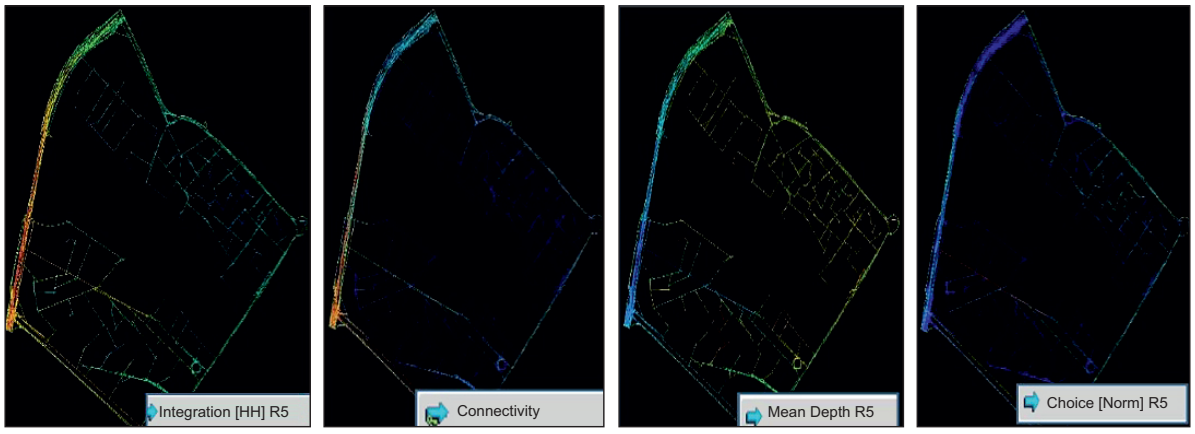

Fig. 11. The spatial configuration and axial structure of Riverfront Segment 4 between Al-Shuhada Bridge and Bab Al-Muazzam Bridge on the Rusafa–Karkh sides, based on Space Syntax analysis
Source: Developed by the researcher using Space Syntax methodology (2025).

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Overall, the Intelligibility indicator functions as an essential analytical tool for classifying riverfront segments according to their spatial clarity and event-hosting potential. By correlating local connectivity with global integration, it reveals how spatial perception and movement are interlinked. These insights help urban designers and planners to align scenographic interventions with the intrinsic logic of the urban fabric, ensuring that future riverfront events are not only visually engaging but also spatially intuitive and user-friendly.

RESEARCH LIMITATIONS

1. The analysis was limited to only four riverfront segments, which constrains the ability to generalize findings across the entire urban river stretch.
2. Environmental variables such as lighting, sound, and wind conditions were not integrated into the analytical model.
3. A lack of comprehensive data on the actual usage patterns of the space restricted the depth of the functional analysis.
4. Security restrictions in some areas impeded the execution of a full-scale field survey and user questionnaires.

CONCLUSIONS

1. Reconceptualizing the River:
   The Tigris River is redefined not as a static boundary but as a dynamic scenographic and performative spatial entity that shapes Baghdad's urban identity through the interaction of people, space, and events.
2. Scientific Contribution – Integrative Framework:
   The study integrates Space Syntax analysis with scenographic theory, offering a new methodological framework for analyzing and activating urban riverfronts with historical and spatial complexity.
3. Analytical Findings – Spatial Indicators:
   a. Integration and Connectivity are key in determining the type and scale of suitable events.
   b. High values support large-scale public gatherings; low or deep spaces are more appropriate for small, localized, or temporary interventions.
   c. Intelligibility (R^2) is essential for understanding users' spatial perception – higher values enhance intuitive movement and legibility of space.
4. Contrast Between Riverbanks:
   a. Rusafa shows a dense, coherent, and pedestrian-oriented historical fabric.
   b. Karkh suffers from fragmented, underused urban voids.
   c. This asymmetry weakens visual and functional dialogue, emphasizing the need to strengthen cross-river scenographic connectivity.
5. Segment-Based Scenographic Reading:
   Dividing the riverfront into mirrored analytical segments allows each to be read as an urban scene within a larger narrative, enabling site-specific scenographic strategies rather than generalized design solutions.
6. Methodological Contribution:
   Using DepthmapX spatial analysis provided measurable indicators that translated spatial relationships into evidence-based planning tools, bridging theory and design practice.
7. Conceptual Contribution:
   Reactivating the Tigris riverfront requires spatial-functional and scenographic integration, not mere beautification. The river should function as a performative corridor linking memory, place, and event into one cohesive urban experience.
8. Segment-Level Conclusions:
   a. Segment 1: Highly suitable for large-scale, continuous civic events.
   b. Segments 2 and 3: Appropriate for small-scale or temporary scenographic interventions.
   c. Segment 4: Ideal for linear, processional, or sequential performances connecting both banks.
9. Overall Contribution:
   The study establishes a new theoretical and analytical framework for assessing urban riverfronts, positioning Scenographic Potential as a central dimension in sustainable urban and cultural regeneration.

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and initial content structuring. All interpretations, analyses, and final decisions remain the full responsibility of the authors.

Author Contributions: Conceptualization, methodology, and study design were carried out by Noor Hussain Ali. Data collection, spatial analysis, and interpretation were conducted by Noor Hussain Ali with supervision from Sajida Kadhim Al-Kindy and Zuhair A. Nasar. Writing – original draft preparation was performed by Noor Hussain Ali. Writing – review and editing were contributed by Sajida Kadhim Al-Kindy and Zuhair A. Nasar. All authors have read and approved the final manuscript.

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