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An Approach to Investigate the Relationship between Spatial Configurational Pattern and Heritage Classification: Case study Alexandria City

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1 ABSTRACT

Heritage buildings are an important aspect of any city in terms of their capacity to provide cultural reference points. The significance of heritage buildings to a city is profound and encompasses a range of cultural, historical, economic, and social dimensions. These buildings represent the city's cultural identity, embodying architectural styles and design principles from specific historical periods. Preserving heritage buildings is essential for maintaining a connection between the past and the present, fostering a collective cultural memory that contributes to the city's overall identity. Preservation strategies entail different levels of physical intervention ranging from the most conservative strategy to the most transformative. Thus, preserving heritage buildings involves a careful approach that respects and safeguards their significant elements, ensuring the enhancement of their memory rather than compromising or losing it. The adaptive reuse strategy is an example of strategic initiatives aimed at preserving heritage buildings' significance while aligning their functions with contemporary needs. In Alexandria, heritage buildings serve as invaluable cultural assets that embody a city's heritage legacy. Defining the urban center requires a crucial examination of the interplay between urban spatial morphology and the functions of heritage buildings, posing a critical challenge to the survival of such buildings.

This paper aims to investigate the correlation between the spatial configurational patterns of the urban network and heritage buildings situated in the historical business district of Alexandria, a Mediterranean city in Egypt. This paper adopts a methodology based on examining the spatial configuration pattern using space syntax with different radii. Analytical methods within space syntax will be used to classify and arrange heritage buildings according to their spatial patterns providing a deeper understanding of their heritage attributes. The applied methodology will be employed within the heritage core of Alexandria. This study primarily concentrated on assessing key metrics of Space Syntax: integration and choice, which are considered crucial indicators of the efficiency of the urban fabric based on three radii: local 400m low intermediate800m, and high intermediate 2000. Moreover, connectivity measures and patchwork will be integral components within the framework of space syntax, serving as essential tools to analyze and understand spatial configurations in urban environments. The base map underwent on-site refinement before being imported into Depthmap for conversion into an operational spatial model.

The study's findings reveal well-defined and distinct heritage sets among the identified landmarks, determined by the integration and choice measures of space syntax, according to certain radii. This investigation can help in the understanding of conservation approaches. Heritage buildings sharing the same spatial features and within the same heritage set will be subjected to an adaptive reuse strategy, this will ensure seamless integration of their new functions. This approach ensures a cohesive and purposeful transformation that enhances the overall functionality and utility of a harmonious built environment.

Keywords: adaptive reuse, space syntax, function, heritage, spatial morphology

2 INTRODUCTION

A city's extensive urban heritage constitutes a distinctive asset. This heritage is characterized by a wealth of cultural relics and historical buildings, offering an authentic representation of traditional patterns and historical styles from various historical periods (Guo et al., 2020; Shin, 2010; Zhang and Han, 2022). Heritage districts, loaded with urban memories and exhibiting unique historical characteristics, hold considerable artistic, cultural, and economic value. They play a vital role in the sustainable development of cities (Jokilehto, 2002; Wang et al., 2018). However, the dynamic nature of cities, marked by continual

updates, expansions, and population growth, poses challenges for the preservation of urban heritage (Boussaa, 2018; Zeng et al., 2018).

Heritage buildings play a pivotal role in shaping the surrounding community and contributing to the overall quality of life. These structures serve as tangible links to the past, fostering a sense of identity, continuity, and cultural pride within the community. The physical presence of well-preserved heritage buildings often enhances the aesthetic appeal of the neighborhood, creating a unique atmosphere. Moreover, these buildings become focal points for community activities, events, and tourism, contributing to economic and social vitality. Heritage buildings foster a shared historical narrative and contribute to a heightened sense of place. As integral components of the urban fabric, heritage buildings not only enrich the cultural tapestry of a community but also have the potential to positively influence the well-being and satisfaction of its residents (Plevoets and Van Cleempoel 2012)

The field of urban heritage conservation has undergone a significant paradigm shift. In the mid-twentieth century. The prevailing focus was on the restoration of individual monuments, concentrating solely on the historical significance of individual buildings. This approach, however, failed to acknowledge the crucial role that entire historic districts play in safeguarding a city's cultural heritage. Recognizing this limitation, a more holistic approach emerged in the 21st century – the Historic Urban Landscape (HUL). This approach emphasizes safeguarding the entirety of a historic district, acknowledging the layering of historical significance and cultural values deposited over time by different communities. The HUL approach managed to preserve the heritage districts' cohesive character and functional vitality of the entire historical fabric of a district (Wang, 2012).

A critical aspect of urban heritage conservation involves carefully considering the modernization and restructuring of historic districts to achieve a harmonious integration with contemporary urban spatial configurations (Liu 2022) (Said, Aksah et al. 2013). Urban morphology prioritizes the analysis of the contextual urban fabric and the intricate interrelationships between its components, surpassing a focus on isolated monuments. This holistic approach is considered a powerful tool in the realm of urban conservation. Bill Hillier elaborates on this concept through the development of space syntax theory. Some scholars argue that integrating urban evolution with space syntax analysis elucidates the intricate transformations cities undergo over time. This theory employs spatial networks, represented by segment or axial maps, to depict the city as a socio-spatial construct. These maps enable statistical comparisons between various cities or different sections within a city. Space syntax delves into the spatial configurations and patterns within built environments, offering a unique lens through which to analyze the intricate relationships between buildings and the socio-spatial contexts they inhabit. Integration and choice values within these spatial networks reveal patterns of "natural movement," encompassing movement toward destinations, or "to-movement," as well as movement through the network, termed "through-movement." It emphasizes the importance of focusing on how spatial arrangements influence the development and ongoing vitality of the surrounding context within the context of both space and function. (Palaiologou and Griffiths 2019). This paper argues that spatial networks can provide a strong platform to effectively link urban heritage to other aspects of its city.

3 SPATIAL ANALYSIS IN THE CONTEXT OF HERITAGE STUDIES

The relationship between space and its cultural and historical dimensions extends to include assets, values, and interpretations of heritage. By analyzing spatial cultures based on unique local topological and geometric features, this approach offers numerical representations of distinct cultural aspects associated with specific locations. Moreover, the syntax of spatial descriptions and the syntax of cultural meaning are interconnected aspects that highlight the understanding of both physical spaces and their cultural values (Hillier and Hanson 1984). In research related to heritage, three distinct categories emerge: "Designed Urban Heritage," focusing on intentionally crafted monumental urban spaces; "Assigned Urban Heritage," centered on historical urban areas officially designated as heritage sites; and "Lived/Emergent Urban Heritage," exploring the cultural value of everyday urban spaces that have organically evolved.

Traditional heritage management, while meticulously defining historic area boundaries and their physical influence, often overlooks intangible elements like cultural shifts and economic impacts. Space syntax theory, conversely, offers a fresh perspective. It focuses on the interconnectedness of spaces and buildings. By considering the entire urban context as a connected system, this approach fosters a holistic understanding

of historical evolution. (Griffiths 2012). The syntax of spatial descriptions and the syntax of cultural meaning are interconnected aspects. When cities want to rejuvenate areas by focusing on their heritage, they need to find the right balance between preserving the past and making sure the development is sustainable for the future. This requires carefully examining how the heritage fits into the ongoing flow of changes in the city over time. It's about creating a harmony between preserving what's valuable from the past and shaping the urban environment for a sustainable future (Stubbs 2004)

This section explores new research directions aiming to establish a meaningful connection between spatial history and heritage. Inspired by Harvey's idea of "heritageisation as a process" (2001, p. 320), Griffiths aligns with Harvey in emphasizing collaborative connections across history, heritage, and spatial studies.

Space syntax is a spatial analysis tool, primarily concerned with examining the structural aspects of a place rather than its character. It focuses on the spatial configuration and organization of urban environments, particularly the street patterns found in historical maps. By conducting an analysis of street layouts and correlating the findings with the current distribution of significant heritage buildings, Space syntax offers valuable insights into the historical vitality of these urban centers compared to their present situation. Through this application, a deeper understanding of the factors that contributed to the prominence of these centers in the past is achieved (Van Nes 2014).

The space Syntax method offers several notable characteristics that contribute to its effectiveness as a research tool for heritage analysis. Firstly, it presents a clear, manageable, and realistic way to model spatial aspects of a heritage settlement. Secondly, it involves examining city elements as interconnected components of a larger system. Thirdly, it assigns numerical values to these elements, enabling both statistical analyses and visual comparisons within the system. Lastly, its calculations generate values that allow for meaningful comparisons across systems of different sizes (Kubat 1999).

The configuration of heritage syntactic cores influences various functional aspects like movement, interaction, and navigation across different scales of the city. Both the shape and function of these cores offer distinct possibilities for organizing and classifying heritage urban spaces. For instance, the shape and function of a syntactic core can impact how people move through and interact within a given area. Similarly, the span or coverage of these cores determines the reach of their influence, affecting not only immediate surroundings but also broader contexts within the city. This interplay between shape, span, and function highlights how spatial configuration plays a pivotal role in shaping heritage urban dynamics and functionalities (Shpuza 2009) (Karimi 2012).

Based on the literature reviewed above, the aim of this paper is to utilize a spatial network approach to analyze urban heritage within its surrounding urban context. By conceptualizing urban heritage as an interconnected system, this research seeks to integrate urban heritage considerations with other pertinent planning matters, consequently providing substantiated evidence to enhance planning processes and decision-making concerning urban conservation. The spatial network approach incorporates two distinct analytical components. Firstly, it involves a configurational analysis of the spatial networks within the city context. This analysis focuses on segment and axial models, Secondly, the approach employs an analysis of heritage networks. This analysis establishes connections between heritage data and the segment model, revealing the interrelationships between the city's spatial structure and its historical elements.

4 RESEARCH METHODS

The methodology employed in this research focuses on the preservation and management of cultural heritage, specifically targeting heritage buildings in Alexandria, Egypt. The study utilizes a structured approach encompassing three phases for the development and dissemination of heritage digitization. The First phase involves Spatial networks within the framework of space syntax theory are employed to identify the spatial attributes of the historic core and to examine heritage within its urban context. Space Syntax methodologies delve into the hierarchical structure of the street network within the heritage center. This includes the computation of integration and choice measures, such as axial lines and segment analysis, to gain insights into the spatial configuration and connectivity of the street network and to examine heritage within its urban context.

Second phase, heritage data are integrated with the spatial model to build heritage networks. This facilitates the examination of the spatial relationship between heritage assets, street integration, and choice levels. The

process involves identifying essential landmarks within the heritage center of Alexandria such as historical buildings, monuments, and cultural sites are precisely pinpointed. By analyzing how these heritage assets are distributed across the street network hierarchy and integrated streets, a heritage map is created, outlining defined heritage sets between the identified landmarks. The third phase entails the creation of "heritage sets" through the superposition of the network maps: the spatial networks and the heritage network Figure 1

1. Heritage network analysis

The process involves identifying essential landmarks within the heritage center of Alexandria such as historical buildings, monuments, and cultural sites are precisely pinpointed. Heritage data is then comprehensively integrated into a segment model, constructing heritage networks.

2. Spatial network analysis:

Spatial networks of the city, represented by segment maps indicating integration and choice, enable the visualization of the city's spatial configurations in numerical terms. Segment maps also reflect the city as a dual system with foreground and background networks and indicate movement patterns. Integration values indicate to-movement and choice values indicate through-movement. Hence, spatial networks of the city offer a framework for connecting urban heritage to its urban surroundings and for analyzing heritage within its urban context.

This research uses the Integration and Choice segment maps of Alexandria at R400m, R800m, and R2000m as spatial networks of the city, to analyze spatial characteristics of the historic core, heritage within its urban context, and the relationship between the top high Integration and choice segment lines and heritage.

3. Heritage sets established

Subsequently, after heritage networks are built, the heritage networks are analyzed to identify the most significant and high-ranked heritage segments within the network while emphasis is placed on prioritizing segments characterized by a dense concentration of heritage buildings to establish heritage sets. By comparing their spatial and movement patterns, the research establishes a link between these sets and their urban context. This provides a foundation for integrating heritage considerations into urban planning issues.

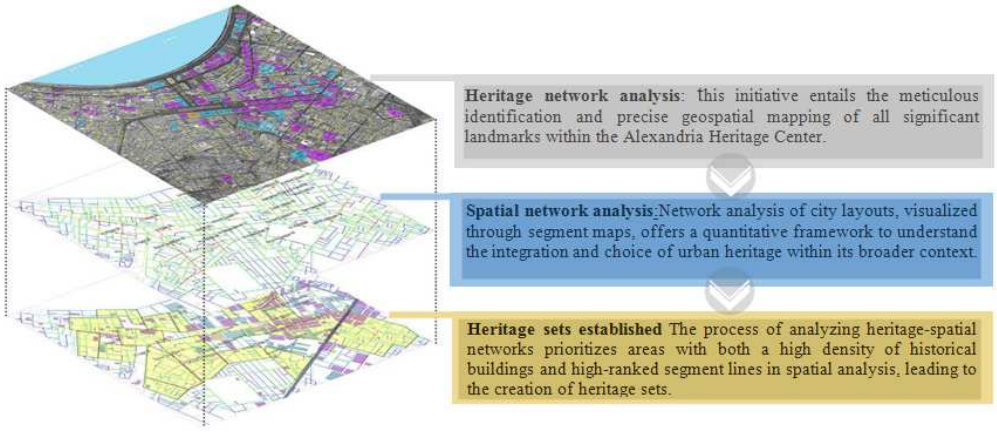


Figure 1: The adopted methodology for establishing heritage sets. Source: authors.

5 CASE STUDY: OVERVIEW OF ALEXANDRIA

The case study will employ the aforementioned methods of heritage data collection and mapping, alongside both spatial and heritage network analyses in Alexandria's historic core. The research site was purposefully selected due to the abundance of urban heritage assets within its boundaries. This particular area exemplifies the diachronic development of Alexandria, encompassing the city's origins and subsequent layers of historical accretion.

Alexandria, recognized for its rich history as one of the ancient cities globally, was established by Alexander the Great in 331 BCE and served as Egypt's capital for centuries. The city boasts a unique environmental blend, harmonizing the Mediterranean Sea with Lake Mariout, and seamlessly integrating agriculture with urban planning nearby. Alexandria features diverse historic buildings spanning various architectural styles.

Alexandria changed, transforming into a Ptolemaic city and becoming the largest in the Mediterranean basin. After the Turkish conquest in 1517, a new settlement emerged, characterized by houses, mosques, and small shops, mainly centered on the Turkish town. The declaration of Egypt as an autonomous state by Mohammed Ali and efforts to modernize attracted European migration in the late nineteenth century, introducing Western urban architecture and contributing to a renaissance under Mohammed Ali's rule (AbdelSalam 1995).

In the latter half of the 20th century, Alexandria underwent significant transformations influenced by political, economic, and social shifts, characterized by the departure of foreign nationals and an influx of rural migration, leading to a densely populated urban environment. These changes resulted in the deterioration of architectural heritage and the proliferation of concrete structures lacking aesthetic values. Political and economic shifts in the 1950s and 1960s, including the nationalization of European properties, prompted a mass departure of Europeans from Egypt, impacting the city's planned urban and architectural character. Existing buildings were repurposed for government use, leading to widespread urban fabric transformation through the demolition of older structures and the construction of new high-rises. The deterioration of built heritage escalated in the early 21st century, driven by changing demographics and a focus on short-term gains without considering the potential loss of cultural and aesthetic values. Unfortunately, the importance of preserving this architectural heritage for future generations was neglected, and preservation efforts faced minimal resistance (Heba, 2011).

5.1 Heritage Characteristics: Current heritage building listing in Alexandria

The initiative to conserve and list Alexandria's cosmopolitan heritage emerged with the 1982 comprehensive plan proposed by the government, later reviewed locally in alignment with city planning policies (Alexandria-Government, 1982; Dix, 1986). The survey conducted in 1982 resulted in the registration and listing of numerous buildings, diverse architectural styles, and entire streets and neighborhoods. This planning effort aimed to establish a significant historical connection between the contemporary city center and its rich historical background. The historical center outlined in the 1982 plan, representing the most recent transformations, is defined by the Cornish Road to the north, Safia Zaghloul Street to the east, Masjid el Attarin to the south, and Ahmed Oraby Square to the west.

In 1999, the Alexandria Preservation Trust (APT) revisited the 1980s survey, augmenting it with additional buildings of distinct styles (Alexandria Preservation Trust 1999). This survey followed the demolition of several registered buildings, either through successful lawsuits by owners in the Supreme Court or unauthorized demolitions that circumvented prevailing laws. Subsequently, conservation laws and building listings underwent progressive upgrades, culminating in the enactment of Law 144 in 2006. Building listings were consequently updated for the third time in 2007.

Under Law 144, the governor of Alexandria commissioned ALEX-MED to compile the Alexandria Heritage Catalogue, encompassing historic buildings, streets, districts, and artworks requiring protection. The resulting catalog, approved by the Egyptian prime minister in January 2008, adheres to five criteria for inclusion: possessing a unique architectural style, connections to historic figures or national history, representation of a historic period, or serving as a tourist attraction.

The listing categorized the heritage listings into three levels, regarding their significance, considering the national, city, or local classification. According to that classification 1135 buildings, across the different districts' conservation buildings were concentrated in Downtown Alexandria around the eastern harbor, represented in the Eastern and Central districts, which is a true reflection of the city's historic and urban fabric evolution. Downtown Alexandria acts as the Heritage node of the city emphasizing its urban significance (Alex-Med, 2007). The Downtown area represents around 80 percent of conservation buildings within the city as shown in the heritage building's map. The conservation buildings within this area represent the early and late expansion period influenced by the European community through the Central and Eastern districts, while the Al Gomrok district represents the Turkish-style conservation building within the city. The conservation catalog listed 38 conservation streets, where 36 of them were listed within downtown Alexandria emphasizing the heritage value of this part of the city (Reimer 1993).

Figure 2: The heritage map of Alexandria core showing the listed heritage buildings.Source: (Alex-Med, 2007)

5.2 Spatial characteristics

The historic core's spatial networks embody a distinct spatial culture. This generative structure fosters movement and co-presence, aligning perfectly with the heritage characteristics of the area.

5.2.1 Angular Segment Analysis

In the context of the case study, the angular segment analysis will be utilized to acquire measurements as segment maps will be employed instead of axial maps due to their higher accuracy and more widespread utilization. This choice is based on the recognition that segment maps offer enhanced precision and are more commonly employed in spatial analyses compared to axial maps. The analysis in this study will include both choice and integration, across multiple radii ranges. The diverse range of measurements obtained through this analysis is instrumental in revealing outcomes at various urban and spatial scales. The segment maps also make it possible to compare city areas with very different patterns of figures and ground or built

5.2.2 Angular Choice: Main Routes Through Cities and Regions

Choice represents the street segments that are highly chosen to be passed through as the shortest path The generated map is produced concerning the weight of angular connectivity for a critical angular path choice. This measure assesses the likelihood of roads being chosen for through movement. This study analysis employs different metric radii, starting with a local radius of 400m, providing insights into immediate, localized preferences. Subsequently, an intermediate radius of 800m is utilized, capturing choices that extend to a broader, intermediate scale. Finally, a higher intermediate radius of 2000m is implemented, offering a city-wide perspective on the preferred routes within the heritage areas. This multi-radius approach ensures a comprehensive examination of the choice measure, shedding light on the dynamic interplay between heritage spatial configurations and the through-movement preferences at various scales.

In the process of angular segment analysis within the case study, three specific scales are explored: the local scale at a radius of 400 meters, the low intermediate scale at a radius of 800 meters, and the high-intermediate scale at a radius of 2000 meters. While, the analysis at the local scale or neighborhood level, with a narrow local radius of 400 meters, offers a more detailed examination of immediate spatial preferences. In this context, the analysis identifies streets Al Attarin Mosque,Al Bab Al Akhdar Street, Al Dakkakin Street and France Street as the most preferred. Sets connecting these streets demonstrate the highest choice measure, indicating their significance at the local level shown in Figure 3a. The 800m radius scale highlights streets as Al Gazaar Street, Mahmoud Fahmy EL Nokrashi Street and Al Azhar Street as the most preferred. This means that these streets within their sets are consistently chosen for through-movement

reflecting their prominence and importance in the overall network at this intermediate scale as shown in Figure 3b.

While, the angular analysis of choice measure at a radius of 2000m indicates that, streets such as Ahmed Ourabi then El Nasr Street have the highest choice values for high-level intermediate through-movement on a city-wide scale. This implies that these specific roads are the most likely to be selected for movement from one point to another at a 2000m radius. In essence, on a high intermediate level, the sets associated with these streets are the most preferred ones for describing the through-movement from one location to another within the 2000m radius as displayed in Figure 3c

5.2.3 The Angular (Segment) Integration: The Location of Urban Cores

The angular segment integration shows the accessibility of a street segment in relation to all other street segments in an urban system in terms of direction changes. In this study, different metric radii are applied to unveil diverse "to-movement" potentials across various scale levels. A segment map colored using integration values generally shows the most integrated spaces in red to the most segregated spaces in blue. The most integrated set of spaces in the segment structure represents the syntactical cores of the urban area

To achieve this, Angular Segment Integration is performed at a local radius of 400m, a low intermediate radius of 800m, and a high intermediate radius of 2000 meters. Firstly, at the local scale (radius 400 meters) of angular integration segment analysis a more detailed and fine-grained understanding of the local network of streets is achieved for example streets such as Al Attarin Mosque StreetAl Bab Al Akhdar Street,Mahmoud Mostafa Assal Street,and Haret AL set AL Nayma Street and El Midan Street are highlighted. This analysis identifies clear local heritage sets, shaped by the previous streets that demonstrate high local integration. This reflects the pivotal role of these streets in shaping the overall urban spatial structure, emphasizing their significance in the local context Figure 4a. Secondly, the analysis recognizes the streets that are most integral to movement and connectivity at this intermediate scale of 800m exemplified by streets Adib Bek Ashak Street,Ahmed Ourabi Street, Salah Salem Street, Al Attarin mosque,El Nasr Street and Al Gazaar Street. Consequently, these streets are grouped into distinct heritage sets, characterized by intermediate integration values as shown in Figure 4b.

Finally, a high metric radius of 2000 meters is used for the angular segment integration analysis. The main streets with the highest values for the angular (segment) integration analysis are highlighted revealing the to-movement potentials on a high intermediate scale for example Ahmed Ourabi, El Nasr Street, El Midan Sreet, and Sidi El Metwalli Street. These main streets establish defined sets within the heritage area, referred to as the highest integrated heritage sets also they serve as primary axes as shown in Figure 4c.

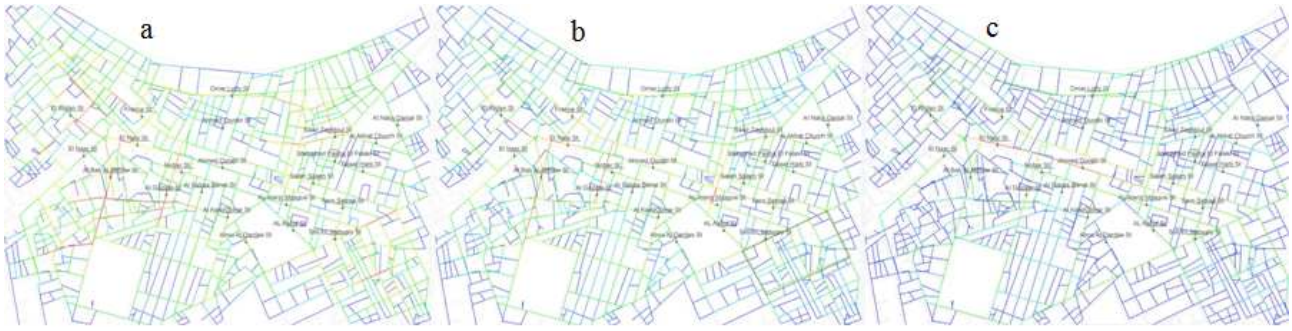


Figure 3: angular segment analysis-choice measure (a)400m raduis-(b) 800m raduis-(c) 2000m raduis. Source: authors.

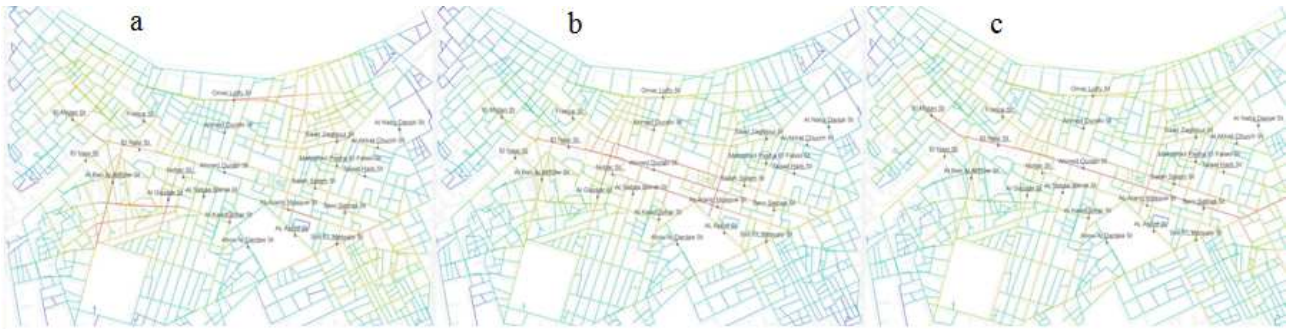


Figure 4: angular segment analysis-integration measure (a)400m radius-(b) 800m radius-(c) 2000m radius. Source: authors.

This methodology involves assessing the spatial configuration, connectivity, and layout of buildings within a given heritage context. The synthesis of Space Syntax analysis and heritage analysis results enhances the classification process by establishing a comprehensive, multidimensional framework. This framework serves as a crucial tool for categorizing and comprehending the organizational, relational, and contextual significance of heritage structures. Through the strategic integration of Space Syntax attributes and heritage analysis, the primary aim is to refine the classification of heritage buildings and systematically arrange them into cohesive sets, considering both spatial and historical dimensions. This unified methodology significantly augments the depth and precision of assessing heritage buildings

In this phase, each of the above maps was overlaid on the heritage map to find out how the heritage buildings represented in the map were correlated with the results of space syntax analysis, focusing on angular choice and angular integration maps. This entails how the cultural and historical layers represented in the heritage analysis map align or interact with their spatial configurations. It reveals areas where cultural significance and high spatial connectivity converge, providing valuable insights into how historical and cultural elements influence the city's spatial structure and generate defined heritage sets.

5.3 Heritage networks and Heritage sets construction

Urban heritage represents the cumulative layering of human cultures across space and time, serving as a historical record of a city's growth. This analysis investigates the distribution of heritage elements within the contemporary spatial network of the historic core.

5.3.1 Space syntax analysis (In the angular choice analysis)

Each set will be given a number and the initial letter of the specified radius Local-Intermediate-Global. For example, set number 1 in the Local radius will be named 1L, set 1 in the Intermediate radius will be named 1I, and set 1 in the Greater Intermediate radius will be named 1G

a. Space syntax analysis (In the angular choice analysis conducted at a scale of 400 meters local scale):

The identified sets play a crucial role in enabling seamless thorough movement across the city and contain the streets with the highest choice values and colored in dark red, for example, set 1L-6L. Next are the sets with fewer choice values and colored in light red as sets 7L-10L as shown in Figure 5a

b. The heritage Analysis:

Upon superimposing the heritage map, it becomes apparent that Set 1L comprises the most extensive assemblage of heritage buildings, then sets 4L and 10L have fewer heritage buildings leaving the rest of the sets with the least number of heritage buildings as shown in Figure 5a.

c. Space Syntax Analysis: (In the angular choice analysis conducted at a scale of 800 meters intermediate scale):

Some sets as 1I,2I, 3I, and 4I include streets of high values of angular choice colored in dark green while sets 5I-10I sets with streets of low choice values which are colored in light green as shown in Figure 5b

d.The heritage Analysis

Upon superimposing the heritage map, it becomes apparent that sets 1I, and 6I comprise the most extensive assemblage of heritage buildings, while sets 4I,7I,8I, and 9I comprise less amount of heritage buildings. The remaining sets within this radius exhibit minimal to no presence of heritage buildings as shown in Figure 5b

e. Space Syntax Analysis: (In the angular choice analysis conducted at a scale of 2000 meters greater intermediate scale):

Sets such as 1G incorporate streets characterized by high values of angular choice in a greater intermediate scale. While sets 2G-9G include streets with lower values of angular choice as shown in Figure 5c

f. The Heritage Analysis

Upon superimposing the heritage map, it becomes apparent that Set 1G,6G,7G, and 8G comprise the most extensive assemblage of heritage buildings as presented in Figure 5c

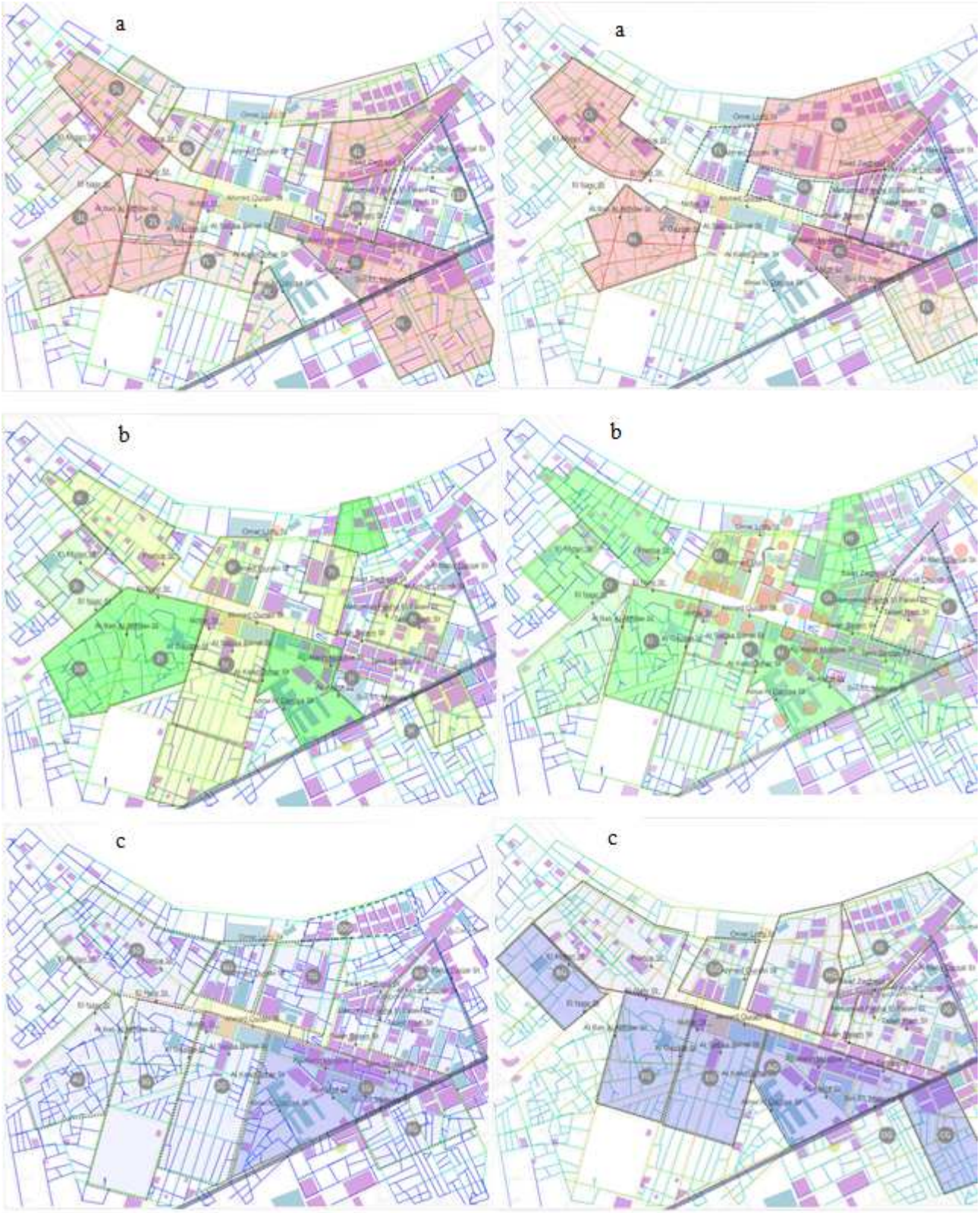


Figure 5 (left): Angular segment analysis overlaid on Heritage map-choice measure (a)400m radius-(b)800m radius-(c)2000m radius. Source: authors. Figure 6 (right): Angular segment analysis overlaid on Heritage map-integration measure (a) 400 m radius, (b)800 m radius, (c) 2000m radius. Source: authors.

5.3.2 Space syntax analysis (In the angular integration analysis)

Each set will be given an alphabetical letter and the initial letter according to the specified radius Local-Intermediate-Global. For example, set number A in the Local radius will be named AL, set B in the Intermediate radius will be named BI, and set C in the Greater intermediate radius will be named CG.

a.Space syntax analysis (In the angular integration analysis conducted at a scale of 400 meters local scale):

Sets that incorporate streets with high integration values at a local scale are characterized by a strong level of connectivity and accessibility between various locations at this level such sets are AL, BL, CL, and DL these sets are colored in dark red. Set EG demonstrates lower integration values, attributed to the streets within it having the least movement values as shown in Figure 6a.

b. The heritage Analysis

Upon superimposing the heritage map, it becomes apparent that Set AL comprises the most extensive assemblage of heritage buildings. While set DL and EL with fewer heritage buildings. Then sets BL and CG have the least number of heritage buildings as shown in Figure 6a.

c. Space syntax analysis (In the angular integration analysis conducted at a scale of 800 meters intermediate scale):

The presence of streets with high integration values at an intermediate scale is indicative of a well-connected urban environment such sets are for example AI, BI, CI DI, and EI and are colored in dark green. While sets FI, GI, and HI exhibit streets characterized by low integration values, consequently resulting in an overall low integration value for these respective sets as shown in Figure 6b.

d. The heritage Analysis

Upon superimposing the heritage map, it becomes apparent that Set AI, BI, DI, FI, and GI comprise the most extensive assemblage of heritage buildings. While set CI, EI, and HI have the least number of heritage buildings as presented in Figure 6b

e. Space syntax analysis (In the angular integration analysis conducted at a scale of 2000m greater intermediate scale):

The streets with high integration link the set to external areas and potentially to other sets, amplifying the set's accessibility to distant locations, services, and amenities exemplified by sets AG, BG, and CG and colored in dark blue. Sets DG, EG, FG, GG, HG, IG, and JG are characterized by streets with lower integration values at 2000m radius, consequently resulting in the sets having the minimum integration values at this scale as shown in Figure 6c.

f. The Heritage Analysis

Upon superimposing the heritage map, it becomes apparent that Set AG, BG, CG, GG, HG, IG, and JG comprises the most extensive assemblage of heritage buildings. While set DG, EG, and FG have the least number of heritage buildings as presented in Figure 6c.

5.4 Connectivity measure

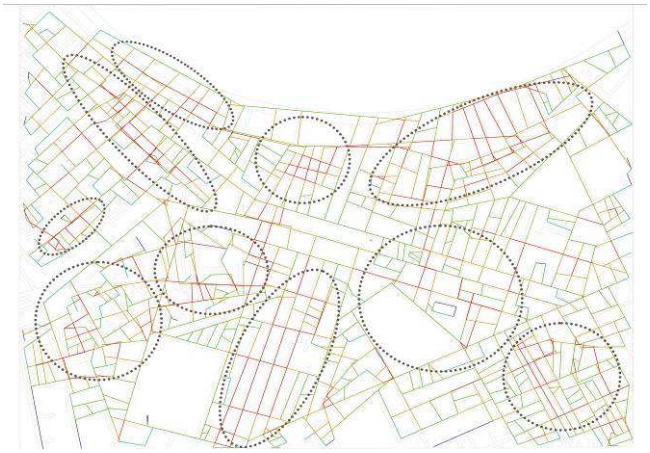
This map visually represents patches and areas with high connectivity values, depicted in red. The red coloring signifies that these specific areas or building blocks are highly connected or fall within a syntactic depth of 1. This outcome aids in delineating connected and cohesive heritage sets closely linked within the urban fabric, offering insights into spatial relationships and heritage groupings within a relatively short distance as shown in Figure 7

5.5 Patchwork

In this methodology applied in the case study, identifying patchwork involves calculating the mean depth metric within a 200-radius. This reveals local areas with unique spatial characteristics, showcasing how the interactions of streets and pathways influence block shapes and sizes. These patches signify metrically integrated areas distinguished by their distinct local connectivity as shown in Figure 8

6 RESULTS

Heritage Set AL, AI, and AG sets encompass a large number of heritage buildings and also have an increased propensity to draw movement at the local, global, and intermediate scales in the choice and integration angular analysis. The heightened value attributed to this heritage ensemble is a result of its evaluation in both the heritage, where its historical significance is assessed, and its spatial analysis while overlapping across different radii which considers its impact on the city's physical structure as illustrated in



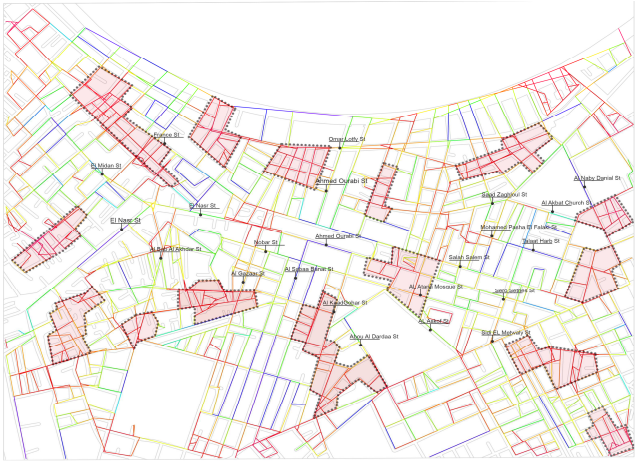


Figure 7 (left): Connectivity map showing heritage sets according to syntactic depth. Source: authors. Figure 8 (right): Patchwork map showing heritage sets according to block size. Source: authors.

The findings indicate that, despite the prominence of some sets in terms of preferred movement and spatial centrality according to space syntax analysis, they may not comprise as many formally designated heritage buildings for example sets 2L,3L,3I,4I,3G,4G in the angular choice measure and BL, FI, FG in the angular integration measure. This underscores a nuanced interplay between perceived significance in urban movement patterns and the official recognition of heritage status, emphasizing the need to consider diverse criteria when evaluating the historical and cultural fabric of an urban area Figure 9 Figure 10

The results highlight a discernible pattern where most historical buildings are positioned along streets with substantial to movement and through movement. Nevertheless, it is crucial to acknowledge that specific historical sites diverge from this trend. While the streets may not be as attractive or central within the specified radius, their abundance of listed heritage buildings underscores their crucial role in preserving and representing the city's historical and cultural identity. This suggests a nuanced dynamic where the formal recognition of heritage value may not always align with the spatial preferences within specific radii, highlighting the importance of considering diverse criteria in the evaluation of urban spaces such as sets 11L,6I,8I, 10G in the angular choice measure and FL, GL, HL, II in the angular integration measure.

Figure 9 (left): The identified heritage sets superimposed generating a choice map across different radii. Source: authors. Figure 10 (right): The identified heritage sets superimposed generating an integration map across different radii. Source: authors.

7 CONCLUSION

In conclusion, through a series of analyses, this research yields critical insights pertaining to the characterization of heritage elements, the spatial configurations, heritage networks, and the formation of heritage sets. Heritage buildings play a crucial role in linking the present to the past, offering narratives of architectural evolution, societal development, and significant historical events. Their contribution to a city's unique character and aesthetic appeal creates a sense of continuity amidst urban transformation.

The field of urban conservation has increasingly recognized the importance of integrating urban heritage into the cityscape. This research contributes to this focus by introducing a new spatial network approach. This approach not only facilitates the connection of urban heritage to its surrounding city but also enables the exploration of urban heritage as a fully interconnected system. The analysis focuses on the spatial layout and connectivity of a heritage site, aiming to understand its levels of integration and choice. The spatial network approach takes spatial networks from space syntax theory as a platform to connect urban heritage to its city. Moreover, the research identified the spatial characteristics of the historic core. The spatial network approach also links heritage data to the segment model to build heritage networks. In essence, this study aims to systematically group heritage buildings sharing the same spatial characteristics into clearly defined sets. These heritage sets hold significance in the realm of urban planning and development. This information becomes pivotal in making informed decisions about integrating heritage structures into the evolving urban landscape. Achieving a harmonious balance between heritage preservation and contemporary functionality

The assessment and measurements of the Downtown Alexandria heritage area and spatial configuration contribute to the comprehensive framework for spatial-cultural assessment in downtown Alexandria. This phase of the research is expected to enhance the understanding of the evolution of heritage sets, providing valuable insights for the preservation and sustainable development of historic urban areas.

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