Architecture and Planning Journal (APJ)

Volume 24 | Issue 1
ISSN: 2789-8547

Article 2

March 2018

HISTORICAL EDGE ASSESSMENT: SPATIAL COMPARATIVE ANALYSIS

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Abstract

This paper develops a quantitative analysis method that is capable of examining the urban edges of historic cities with reference to their spatial configuration. This aim provides the opportunity for assessing the current situation of historic urban edges. Accordingly, this assessment will help in developing appropriate regeneration plans for the site. Second, it enhances the process of comparison with other cases, in order to inherit those successful interventions that might fit according to base similarities, such as the spatial configuration, architectural characteristics, or other features, in addition, searching for any repetitive patterns. Assessing the current situation requires the evaluation of the interrelationship between both the historic and modern edge fabrics, measuring their spatial accessibility and connectivity. Four Arab cities are used as experimental comparative case studies, they are as follows: Cairo, Damascus, Alexandria and Tripoli (Lebanon).

Keywords

Spatial Analysis, Urban Edges, Historic Arab Cities, Historic edges

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ABSTRACT

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1. INTRODUCTION

Most research, in general, focuses on the urban form inside historic cities. However, the urban edge of these fabrics is commonly ignored in the literature (Conzen et al. 2012; Kai and Gu 2010; Unlu 2013) and most regeneration interventions. Although the urban edges represent the transitional interrelation between the historic core and the extending modern urban growth, as well as possessing characteristics of both historic and modern features, they are mostly classified as non-historical fabric or as less important than the historic core. Hence, their development is ignored by both sides – the historic and the modern.

There are difficulties in inheriting specific treatments from other case studies or in measuring their success, due to the huge variety of factors – such as size, culture and architectural conditions – of each case. Therefore, there is a need to introduce a base comparative datum that other layers of information can be added to, to assist in evaluating any case study. Assessing the current situation ignores the spatial interrelations of the urban historic edges. Although spatial analysis alone would not entirely reveal these interrelations (Karimi et al, 2013), it is a principal factor that can play a huge role in comparisons with other studies in the same context, or with different case studies.

This paper aims to develop an experimental method of analysis that is capable of examining the urban edges of historic cities with reference to their spatial configuration (micro and macro analysis). This aim would first provide the opportunity for assessing the current situation of historic urban edges. Consequently, this assessment will help in developing appropriate regeneration plans for the site. Second, it enhances the process of comparison with other cases, in order to inherit those successful interventions that might fit according to base similarities, such as the urban form, architectural characteristics, spatial configuration or other features. Assessing the current situation

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requires the evaluation of the interrelationship between both the historic and modern edge fabrics, measuring their spatial accessibility and connectivity.

The 'urban edge', which is the focus of the paper, represents a boundary between two kinds of areas (Lynch 1960). It comprises buffer zones as an effective conservation policy for maintaining the interrelationship between historic city and its settings, in addition to managing the development scale on both sides (Creighton 2007); (ICCROM 2008), where its size varies from one historic site to another. An urban edge is not a defined line based on walls, fences and gates – it is more where the edge of a city becomes a zone that comprises areas of social and commercial activity, and architectural character, rather than a rigid line or ring roads (Bosselmann 2008; Creighton 2007). The urban edge has distinct patterns of spatial configuration, distribution of activities and architectural features (Kostof 2010; Marcus, 2017), in which historic fabric cannot be analysed independently from their surrounding urban patterns .

Space syntax has been selected to analyse the spatial configuration of the four case studies, for a number of reasons. First, it works across different scales, starting from the micro-scale of defined space up to the largest macro-scale of the city (Hillier and Vaughan 2007). It is initially based on street-scale data, in which people experience the city, meet, intersect and carry out economic and social transactions (Hillier et al 2007). Second, it describes spatial and social phenomena as the emergent outcome of local interactions pertaining, in a variety of ways, to the global scale. Third, it represents the non-discursive relationships between spaces within the same site or as a comparative analysis between different sites, even with different scales. Finally, it measures different types of correlations (Syntax 2004) between space and people, space and space, and people and people. It provides powerful conceptual and empirical support for the phenomenological claim of a reciprocal relationship between human action related to everyday spatial movement and the qualities of the physical spatial environment (Seamon 2007).

Comparing different types of spatial variables to each other would achieve a higher level of understanding of the way a spatial system operates. The paper applies this comparison by examining the relationship between global integration and connectivity, known as 'intelligibility'. Integration represents the main accessibility measurement, and refers to how many other lines are up to 'n' (number of steps) steps away from each line (Hillier et al. 1987). It describes the average depth of a space in relation to all other spaces in the system (Klarqvist 1993), which calculates the closeness of each element to all the others, is the accessibility of 'to-movement'(Hillier 2005). Choice is another accessibility measurement in space syntax. It represents the degree of likelihood of choosing each space, or how likely it is to be passed through on all the shortest routes from each space to all other spaces in the system (Hillier et al. 1987), considering the degree to which each element lies on a path between elements, and this is its potential of 'through-movement' (Hillier 2005).

2. CRITERIA FOR SELECTION AND METHODS OF ANALYSIS

The four case studies have been selected based on a number of issues. The cities are all within Mediterranean Arab countries. Their profound cultural and linguistic unity that existed until the end of the nineteenth century, before European colonisation, gave rise to the term 'traditional Arab' cities, a term that reflects the fact that their original urban systems have sufficiently common features and original characteristics (Raymond 2008). See Figure 1 to understand their main spatial structure and preliminary land use distribution within the historic core of the four cases.

Alexandria and Tripoli have Mediterranean waterfronts and they are important port cities, while Cairo and Damascus are capitals and considered as inland cities without a seaport; however, they both overlook important rivers. A long common history combines the four cities, starting from the Pheronic era (before the construction of Alexandria city, which dates back to 331 BC) to the Mamluk Sultan Al-Mansour Qalawun in 1289, who invaded Tripoli— which was part of Syria at that time— until the Nasser era. Egypt and Syria formed the United Arab Republic in February 1958, with Gamal Abdel Nasser as president. This union lasted for only three years and was dissolved in 1961, (Alsayyad 2011). During this period, it was recorded that huge migration of many intellectuals from Lebanon and Syria to Egypt, mainly in the cinema and art and literature sectors. The three countries therefore have a common cultural background in addition to some similarities in architectural style. Their historic cores are alive and active, possessing spatial anatomical similarities, while their urban edges' conditions vary. Consequently, the four selected cities have many common features while, at the same time, they have different urban growth layers outside their historic edge with various sizes, which form a strong base for comparative analysis.

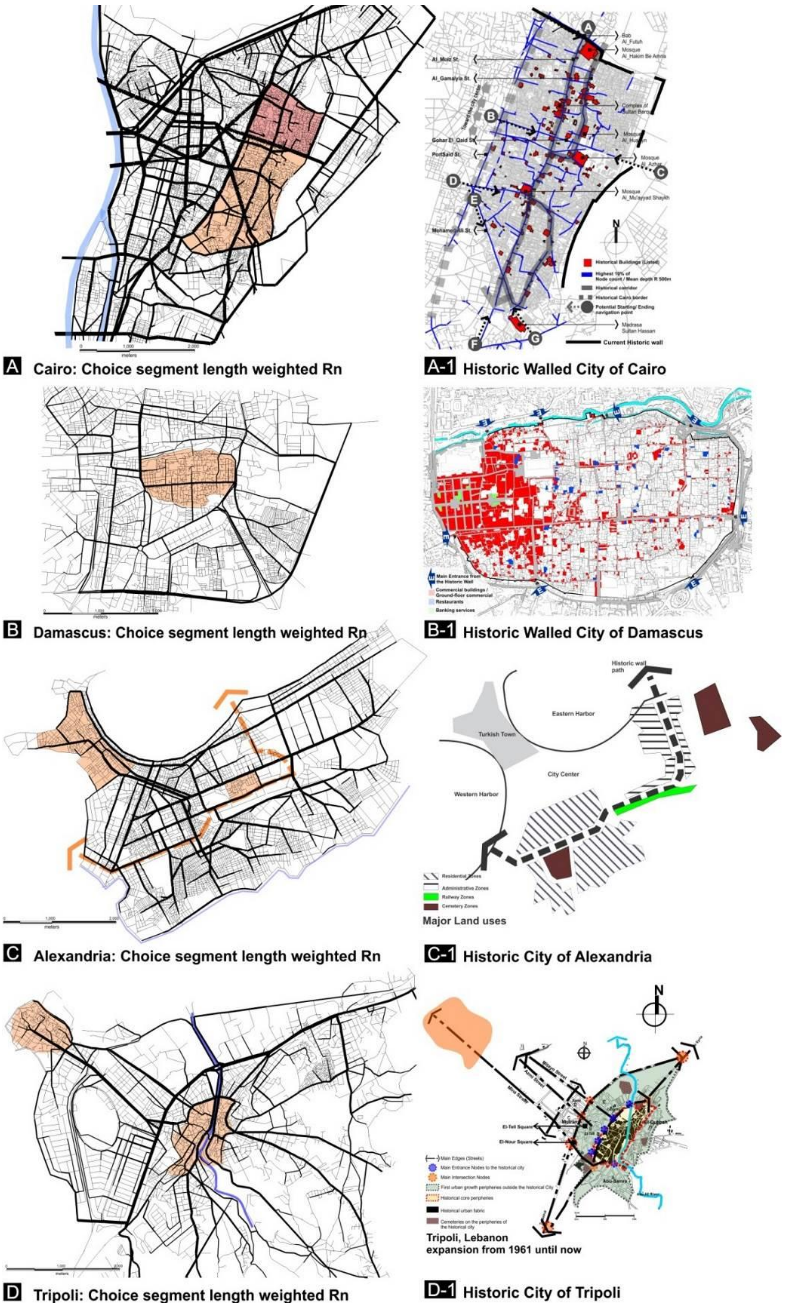
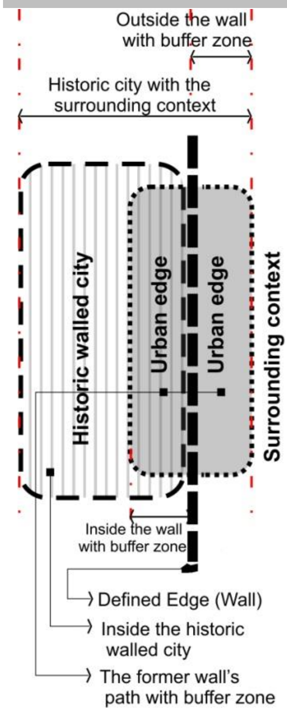


Fig. 1 ((A/A-1) Cairo) shows the highest 10% of accessible routes of Integration R500 m of Cairo, highlighting the historical buildings (in red) and the existing walls' location. Source: (Mohareb 2008). ((B/B-1) Damascus) illustrates the current situation regarding Choice R500m, which indicates the local expected movements and their relationship with the current land uses. The red blocks are historic buildings. Sources: The axial map is by the author, while the base map is from (Damascus 2005. ((C/C-1) Alexandria) shows major land use distribution along the former city wall. ((D/D-1) Tripoli) shows the location of the historic core, the modern city and the location of Al-Mina.
Reference: Author

2.1 Establishing the framework: determining the main variables and indicators

The framework examines urban edges based on their spatial configuration, land-use and architectural features (based on (Madanipour 2003) and (Conzen 2009) research; and (Conzen 1960) and (Karimi et al 2013) studies). Moreover, it is meant to be used as a comparative analytical tool that can work across cultures, scale and different spatial conditions, see Table 1 .

Table 1. Shows suggested analytical framework that is based on spatial comparative analysis. Reference: The author



Spatial configuration	Location (Where?)	Type of Analysis	Measuring methods	Tools
Urban edge of historic city (comparative analysis)	Spatial content (Macro analysis)	- Historic city and the surrounding context	- Global Integration Rn - Global Choice Rn - Choice R500m - Integration R500m - Intelligibility	SSx GIS
		- Inside the walled city (historic city)		
		- Outside the walls (with selected buffer zone as an edge)		
		- Inside the wall (with selected buffer zone as an edge)		
	- Cairo (Egypt) - Damascus (Syria) - Alexandria (Egypt) - Tripoli (Lebanon)	- The historic wall's path with buffer zone on both sides		
		- Effects of Gates (accessible points) on movements	- Accessibility	SSx
		- Land uses	- Land uses distribution and types	GIS
	Urban content (Macro and micro scale analysis)	- Proximity to the wall	- Urban form analysis	GIS SSx
		- Urban growth	- Monitoring growth transformation through different eras	SSx
FS, field survey; Sd, secondary data; SSx, space syntax; GIS, geographic information system; DR, data records				

As the foreground of the analysis, it is clear that the framework depends more on the tangible and quantitative variables, while the other issues— such as cultural and economic factors— are only represented as a by-product of the spatial, architectural and land-use analyses. Although this point of view might be considered as a limitation of the analytic framework; however, the paper considers it as an advantage. The framework is formatted as a multi-layer of analysis. Its base is designed as a quantitative experimental investigation, in order to be used either as a single analysis of an urban edge or for comparing different cases. In both situations, the variations that might occur— even in different parts of the same case— do not limit the analysis as non-quantifying variables. Nevertheless, other layers could be added to the framework, according to the needs of the research focus. Therefore, the framework is flexible, as more layers of analysis could be added according to the case study situation, without the need to alter the entire framework.

3. ANALYZING THE FOUR CASE STUDIES

The analysis is established by using the preliminary classification designed previously (Mohareb et al 2012), which highlights comparative physical conditions data between the four cities. Historic Cairo has the largest enclosed area, followed by Alexandria, while Damascus and Tripoli are relatively smaller. Damascus is the oldest walled city, dated back to 1200 BC, and it has the most well preserved wall conditions. Its deformed spatial configuration was based on an older gridiron grid (Dumper and Stanely 2007). The wall, as an urban edge, exists in different conditions in Historic Cairo and Damascus while, it is almost demolished in Alexandria and Tripoli. All the enclosed spatial patterns in the cases are organic grid except Alexandria, and they have different degrees of integration with their surrounding context. The four walled cities are connected to extended urban growth outside the walls, through either the demolished parts of the wall or the gates (if existing), as in Damascus and Cairo.

In each case, the analysis monitors the spatial transformation of the selected cases through various eras: mainly at the beginning of the twentieth century and the current situation. The selected earlier eras are Cairo in 1933 (the analysis also includes maps from 1774 and 1809); Damascus in 1910, 1929 and 1958; Alexandria in 1900 and 1927 (references are also provided from the years of 1855 and 1887); and Tripoli in 1945. The date of the selected maps are simultaneously related and represent the eras prior to the cities' independence and major spatial transformation, as it was difficult to find exact dated maps for all cases. Choice segment length weighted analysis is selected to monitor the 'through-movement' transformation resulting from the use of specified routes (urban edges) over a period of time. The choice and integration analysis include the segment length as a weighted factor to be sure that the distances are considered as an effective factors, and to obtain better results in the analysis, see Figure 2.

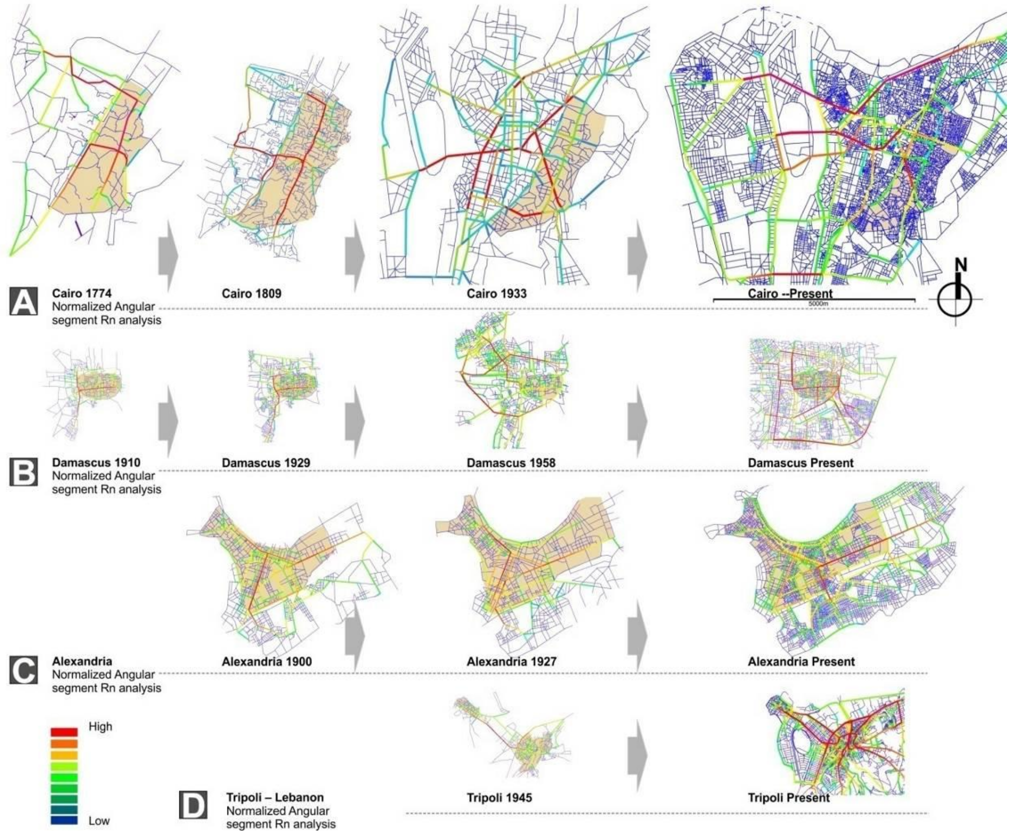
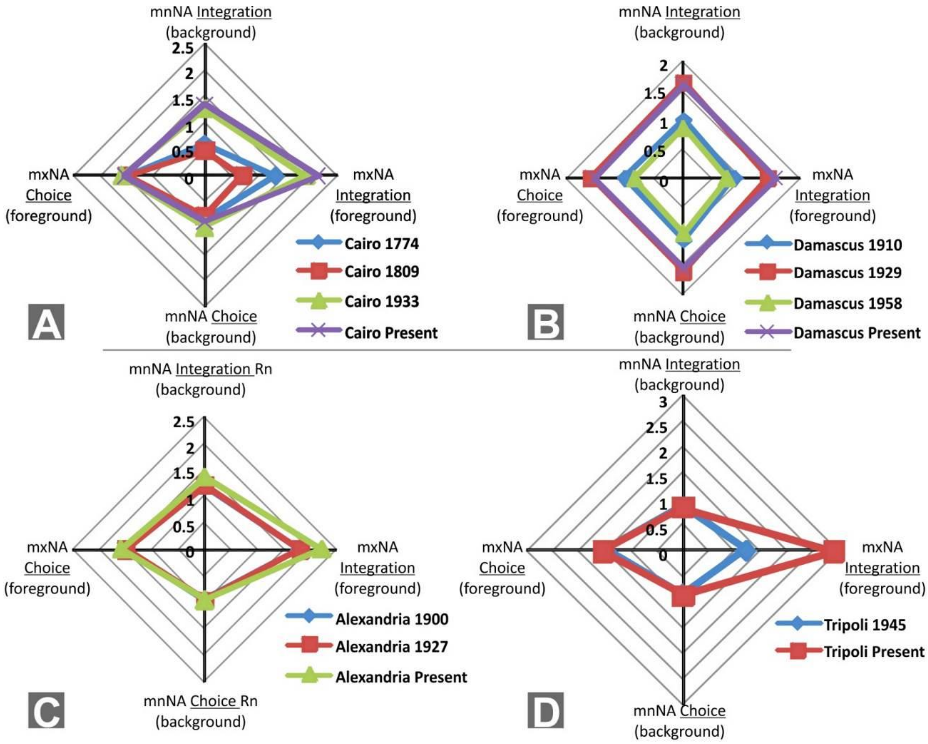


Fig. 2 Shows the spatial transformation of the four historic cities: Cairo, Damascus, Alexandria and Tripoli. The segment maps are normalised angular Choice Rn.
Reference: Author

This stage of analysis is crucial for interpreting the peripheral conditions and for monitoring the patterns of spatial configuration along the urban edges in the selected case studies. In this section, each city's network is analysed individually and compared to the other cases as a method of understanding their network system and thier transformation through time. The followed stage is a comparative spatial analysis of the urban edges of the four cities, according to the first stage of the suggested framework.

Hillier (2007 and 2012) suggests that cities have dual network (foreground and background) that reflect functional as well as spatial processes. The foreground network is more 'morphogenetic' that is generated by micro-economic activities that focus on movements to create development and changes, thus it is structured to maximize movement. Its longer lines (axial movements) form a network that links centers at all scales within the city. On the other hand, the background network is more 'conservative' space that is shaped by socio-cultural factors. Its fabric tends to have shorter lines, which includes mainly residential spaces (Hillier et al 2007, 2012)

Based on the methodology introduced by Hillier (2012) regarding the comparative analysis of cities that was applied on 50 cities, this paper examines the four cases based on normalized variables, see Figure 3. The Choice analysis variables include background analysis: Mean normalized angular Choice that highlights the degree to which the background network forms a continuous grid with direct connections. In addition, it includes a foreground Choice analysis, which is maximum normalized angular Choice that represents the degree to which the foreground grid structures the system by deformations and interruptions of the grid. On the other hand, the Integration variables, whether maximum (foreground) or mean normalized angular Integration (background network), represent the ease of accessibility in the selected cases (Hillier et al, 2012 pg. 170).



		Cairo				Damascus				Alexandria			Tripoli	
Background	mnNA Integration Rn	0.60975	0.47543	1.26279	1.350854	0.9971	0.8679	1.06792	1.00189	1.2057	1.22564	1.36812	0.858165	0.841048
	mnNA Choice Rn	0.83457	0.76264	0.96110	0.872008	0.8628	0.7547	0.9389	0.8469	0.9485	0.9636	0.9613	0.86505	0.852637
Foreground	mxNA Integration Rn	1.33322	0.70075	1.91307	2.15812	1.64667	1.44802	1.60575	1.58948	1.79958	1.79727	2.21396	1.22713	2.925135
	mxNA Choice Rn	1.46465	1.46648	1.56427	1.521112	1.60965	1.58638	1.55035	1.51879	1.50129	1.48783	1.5795	1.49006	1.54644

Fig. 3 Illustrates the four-pointed star model of the four cities. (mxNA) means maximum normalised angular Choice or Integration, while (mnNA) is for mean normalised angular measurement. (A) is Cairo, (B) is Damascus, (C) is Alexandria, (D) is Tripoli, while the lower table highlights the numerical values of the four cities
Reference: Author

Historical part of Alexandria has a very strong system of movement in both foreground and background network, which means the residential sections are not isolated and well connected with ease of accessibility with other centres within the surrounding context. On the contrary, to Damascus, as Figure 3 shows that the historic city is not connected well with other centres, and its background network is the least compared to the other three cities. Tripoli possessed very strong foreground connections, but weakly structured in the background network. Cairo has the second strongest background and the third strongest foreground network.

Reviewing their transformation through different eras, Damascus maintains the balance of its urban growth through its both networks; the foreground and the background, they both exceed proportionally. While in Cairo, the ease of accessibility improved on to-movements through time. In both port cities, the foreground to-movements have increased through time while the background remained consistent.

4. COMPARATIVE ANALYSIS: SEARCHING FOR PATTERNS

DOI: 10.54729/2789-8547.1017

The spatial configuration of specific locations on the urban edges of the historic cities is the base of the comparative analysis between the four case studies. It is intended to identify the role of urban edges towards the historic city from one side and towards the surrounding context from the other side (see Table 2). The research selected the following urban factors to compare the effects of gates or gaps (if they exist) on the edge:

- land-use distribution (mainly commercial activities),
- The residential proximity to the edge,
- The main direction of urban growth.

This paper acknowledge other factors that might affect urban edges, such as cultural and economic issues, but they are not the focus of this research. The analysis begins with the comparative spatial configuration analysis, followed by the effect of land uses on the urban edges, and ends by highlighting the extracted variables and patterns that will be used in the research framework.

Table 2 shows basic information and comparative spatial macro-scale analysis of each selected case study. The numerical values (from 1 to 17) in each case are the logarithmic normalised mean values. Reference: (Mohareb et al 2012)

Basic information		Cairo	Damascus	Alexandria	Tripoli
Date of Foundation		- 640 AD (Al Fustat City) - 750 AD (Al Askar) - 870 AD (Al Qata'i) - 969 AD (Fatimid Cairo)	- Origin prior to 1200 BC — Aramean nomads - Became one of the major cities in the Roman Empire in 64 BC.	- Origin to the Pharaonic era - 332—331 BC (Foundation) - AD 1805 – 1849–the city gained its current European gridiron pattern	- Origin to early Christian times - 1289–Mamluk Sultan Al-Mansur Qalawun abandoned the old city (El-Mina) and built a new city, which is the origin of the present town.
Size of Walled city Area per km2		Approximately 4.004 km^2	Approximately 1.28 km^2	Approximately 3.83 km^2	Approximately 0.86 km^2 (Old Tripoli) 0.45 km^2 (El-Mina)
Number of axial lines inside the walled city		**2342** (Historic Cairo) **834** (Fatimid Cairo)	**840** axial lines	**846** axial lines	**383** (Old Tripoli without wall) **300** (Al-Mina, once had a defensive wall)
Syntactic description					
Mean Global Integration (logarithmic normalised mean values)					
1	Historic city centre (inside the former wall)	**0.565**	**0.664**	**0.533**	**0.732**
2	Northern part of the wall (Buffer zone outside- 500m)	**0.690**	**0.738**	**0.530**	**0.750**
3	Southern part of the wall (Buffer zone inside- 500m)	**0.558**	**0.661**	**0.513**	**0.73**
4	Buffer zone 250m on each side of the wall's path	**0.605**	**0.680**	**0.499**	**0.731**
	Mean Global Choice (logarithmic normalised mean values)				
5	Historic city centre (inside the former wall)	**0.529**	**0.267**	**0.572**	**0.574**
6	Northern part of the wall (Buffer zone outside- 500m)	**0.576**	**0.307**	**0.569**	**0.637**
7	Southern part of the wall (Buffer zone inside- 500m)	**0.526**	**0.268**	**0.602**	**0.571**
8	Buffer zone 250m on each side of the wall's path	**0.538**	**0.281**	**0.559**	**0.588**
	Mean Choice R 500m (logarithmic normalised mean values)				
9	Historic city centre (inside the former wall)	**0.543**	**0.248**	**0.607**	**0.64**
10	Northern part of the wall (Buffer zone outside- 500m)	**0.615**	**0.074**	**0.595**	**0.667**
11	Southern part of the wall (Buffer zone inside- 500m)	**0.535**	**0.245**	**0.631**	**0.639**
12	Buffer zone 250m on each side of the wall's path	**0.551**	**0.180**	**0.582**	**0.645**
	Mean Integration R 500m (logarithmic normalised mean values)				
13	Historic city centre (inside the former wall)	**0.348**	**0.419**	**0.297**	**0.498**
14	Northern part of the wall (Buffer zone outside- 500m)	**0.380**	**0.333**	**0.249**	**0.443**
15	Southern part of the wall (Buffer zone inside- 500m)	**0.326**	**0.409**	**0.375**	**0.49**
16	Buffer zone 250m on each side of the wall's path	**0.374**	**0.406**	**0.243**	**0.484**
17	**Intelligibility – R^2 coefficient**	**0.244** (Old city with buffer zone)	**0.219** (Old city with buffer zone)	**0.018** (Old city with buffer zone)	**0.11** (Old Tripoli with buffer zone)

By examining the urban form of the case studies, the spatial configuration of Alexandria and Damascus are based on the same principle of the gridiron configuration; however, Damascus has altered that pattern to become more organic through time. Although the size of what was once enclosed by the wall of Alexandria is triple the size of walled city of Damascus, they both have almost the same number of axial lines (Table 2), which indicates that the number of movement routes almost match, although they are much longer in the case of Alexandria .On the other hand, Historic Cairo and Tripoli have organic patterns at their origin, but the size of Cairo is much larger than Tripoli.

Starting with the spatial analysis of global integration Rn (from 1 to 4 in Table 2), which means the ‘to-movement’ or the potential of being a destination attracting long-distance trips, historic Tripoli possess the highest accessibility values compared to the other three cities, followed by the walled city of Damascus, while Alexandria has the lowest values of long trips accessibility. It is clear that the buffer zone outside the four cases has more integration values than the inside one, due mainly to the existence of ring roads. When studying the wall’s path with a buffer zone of 250m on each side (number 4 in Table 2), the two capital cases show higher accessible values than for their accessibility inside their spatial fabric (number 1 in Table 2), contrary to the port cites’ lower accessibility values at the same locations. This could be explained in that longer trips are attracted to the ring roads of major cities outside their walls more than to penetrating the historic walled core, without ignoring the fact that their walls physically still exist while, in the two port cities, their walls do not exist anymore, and their core could attract more longer trips. At this stage, historic Tripoli is the most accessible city, and its inner core interacts with the outside context effectively, followed by the walled city of Damascus .

Global choice Rn (from 5 to 8 Table 2) means the ‘through-movement’ or the potential of selecting certain routes to get to a destination. It is obvious that all the mean values are lower than the global integration values. Tripoli still has the highest global choice values, followed by Alexandria and Cairo, where Damascus’ values are by far the lowest, indicating that its inner fabric does not encourage any penetrating longer trips. In contrast, Tripoli is well connected with the outside urban growth layers. Looking closely to the buffer zone values, all the four cities have higher values of global choice on their outer buffer zone of their walls except Alexandria, which has higher values at its inside buffer zone. This situation is due to the fact that the historic core of Alexandria is still the CBD (central business district) of the whole city, and attracts daily potential selected routes to access to their destination. Moving to the through-movements of radius 500m (from 9 to 12 in Table 2), this analysis shows how the case studies interact with their surrounding context in daily shorter trips as favourable selectable routes. The spatial configuration inside the walled city of Damascus does not encourage any through-movements for shorter trips, compared to the higher values of Tripoli and Alexandria in general. Alexandria has the highest mean values of shorter trip attractiveness for both inside its former walled city and on its edge. When studying the case of Damascus, it seems that the city is almost segregated at the level of the shorter selected routes of movements from the surrounding context, despite the higher number of gates compared to the other values inside its walled city (9 and 10 in Table 2). Cairo and Tripoli have higher values of choice R 500m on their outside buffer zone, while Alexandria and Damascus have their higher values on their inside buffer zone .

Attracting movements as a destination of shorter trips values (Integration R500m) (from 13 to 16 in Table 2) seems to show lower values for the four case studies compared to the choice through-movement (Choice R500m). However, the routes of the walled city of Damascus in general attract to-movement accessibility more than being used as a through-movement, compared to the other three cases. The inside buffer zone and the wall’s edge of Damascus and Tripoli have higher integration values than Alexandria and Cairo, which indicates higher movement and interactive shorter destination trips from the inside of the walled cities.

Finally, the two walled cities of the capitals— Historic Cairo and Damascus— are more intelligible than the other two port cities. Despite the fact that Damascus’ overall accessible values are much less than those of Tripoli and Alexandria, it is still more legible than the others. Although Tripoli has the lowest intelligibility values, it has the highest ranking among the other cities in terms of accessibility (through-movements and to-movements.

The wall’s path as a buffer zone attracts more global integration (to-movement) followed by global choice (through-movement), especially in Tripoli (see Table 2); however, for walking distances, they are less preferable for both choice R500m and integration R500m. Due to the ring roads or major routes that pass around the historic core outside the wall’s path, all the cities have a high attraction of accessibility (to-movements and through-movements). Even though, on the level of walking distances, they still have high accessibility (except Damascus). Damascus’ spatial configuration does not encourage through-movements compared to the other cities on both levels of choice, Rn and R500m. Moreover, outside Damascus’s wall, there are limited opportunities to walk except from the west part of the city and, partially, the southern part.

The only cases that still have gates and walls are the historic cities of Damascus and Cairo. Cairo’s main accessible gates are Bab Al-Futuh and Bab Zuwayla, and both are located on the extension of the same route. Five entrances out of eight gates in the walled city of Damascus are globally selected as through-movements, while four others are locally (Choice R500m) selected. The former path of

Alexandria wall is still limits the connectivity on both sides of the path, except in two locations surrounding the transportation hub. Through its main eight entry points, old Tripoli is well connected with its surrounding context, (see Figure 1 (D-1)) .

Urban edges are heavily affected by land-use distribution and locations, especially commercial and residential buildings. The commercial zones of Historic Cairo and, to a lesser extent, Damascus are distributed along an urban corridor, with high accessible routes connected directly to the urban edges. On the other hand, the west commercial side of Damascus is near/ on the urban edge; this part of the historic city is highly accessible to both local and global movements. In the case of Tripoli, the commercial zone is in the centre, and it is highly connected through various routes towards the surrounding context. In the four case studies, residential quarters are segregated sectors, which reflect high demands for privacy. Except Alexandria, religious buildings are located on the highest selected routes in all cases. Cemeteries are located on the urban edges of all the historic cities, with different sizes and distributions. In Damascus, they are located on the north and south side of the wall, in Alexandria on the east and south side, while Tripoli's cemeteries are distributed in all directions. Urban growth direction is affected by natural barriers or by encouraging land uses such as commercial activities, in addition to the fixed locations of the cemeteries.

The investigation found repetitive spatial patterns along the urban edges of the four case studies although they represent various conditions of walled cities. The patterns are related to the typology of the edge, with consideration of the following issues. First, the edges that comprise walls and gates attract residential sectors with low standards of living, as in the case of Cairo and Damascus. The walls' gates are accessible points between the outside fabric and the inside one; however, they do not interact with the surrounding residential quarters if those quarters are close to both sides of the wall, as in the cases of both north and east Damascus and north Cairo. Second, if the gates (physical or virtual entry points) are connected directly to a commercial route, they represent a highly accessible point, as in the case of Tripoli, Cairo (Bab Al Futuh gate and Bab Zuwayla) and Damascus (Souk Medhat Basha and Souk Al Hamdia). Third, at the earlier point of the land-use distribution, they were the periphery of the city, with heavy industrial usage (at that time) and a low standard of living conditions; currently, they are the first contact between the outside context and the historic city's core. The case of Alexandria represents a clear example; although the wall was demolished a century ago, the land-use distribution along its former path is still segregated (except at the transportation hub. They also attract a low percentage of (to-movement) accessibility in the lower radius (see Figure 2).

A numbers of causes affect the urban growth of walled historic cities towards the outside of the wall, the most important ones are as follows:

- Natural obstacles or attractors have a long-term effect on urban growth, as in the east side of Cairo (as an obstacle), the river Nile (as an attractor) and Tripoli (as an obstacle).
- The aggregation of the previously discussed points— condition of gates/ entry points, land-use types on the edge, location/size of cemeteries and the existence of the wall— affects the urban growth direction.
- Ring roads outside historic cities minimise the through-movement accessibility on various levels (local and global) of the city— for example, in Damascus (see Table 2, no. 5—12). In addition, they minimise the local to-movement accessibility for the four cases (see Table 2, no.13—16).

From the previous comparative analysis, repetitive patterns of spatial configuration can be seen to exist on the urban edges of the historic case studies (Mohareb and Krinenburg 2012). The paper examined various macro scale conditions on the historic edge, in addition to emphasising how the inside spatial fabric interacts with the outside urban growth beyond the historic edge. In the next section, a further investigation is done concerning micro scale for specific key points on the urban edges of the historic city.

5. COMPARATIVE ANALYSIS: SEARCHING FOR MICRO-SCALE PATTERNS

The microanalysis is focusing on three main positions in the four cases, they are: selectable main entry points (gate, access points); new relatively urban fabrics located on the historic urban edges; and residential quarters adjacent to the physical edge: either the wall (if exists), or ring routes that separates the historic fabric from the surrounding context.

The relationship between local and global accessibility in each case of the four cases is relatively proportional. In port cities of Alexandria and Tripoli, all accessibility values are high except the local integration R500 m, which indicates that as a destination they attract less potential pedestrian to-movement. On the other hand, inner capital cities of Cairo and Damascus attract more accessible pedestrian to-movements and through-movements and they are less accessible to vehicle potential movements.

First, the entry points are selected according to the location of the historic gates or highly accessible routes passing through the historic fabric and connecting it with the outer context. Cairo and Damascus have more resemblance values that are common in their through-movement entry points. For example, in choice R500m, point (D) in Damascus resembles the points (A) & (B) in Cairo. They are located directly on main inner and outer routes of the historic fabric. Also, point (C) in Damascus has close values with points (C) & (E) in Cairo. The three points are located on high accessible routes. On the other hand, Alexandria and Tripoli share segregated average values of to-movements for their points (B) and (E) consecutively .

Examining the global accessibility of the entry points, the four cases are interrelated. For example, points (C) in Cairo has the same value of point (C) in Alexandria, and point (C) in Damascus is similar to point (E) in Tripoli .

From Figure 4, it is obvious that the entry points that are located on the starting or ending point of main routes tend to have a resemblance in through-movement values on both scales: local and global potential movements. For example, the values of these entry points: (A) & (D) in Damascus, (A) & (E) in Alexandria, (C) in Tripoli, and the point (D) in Cairo.

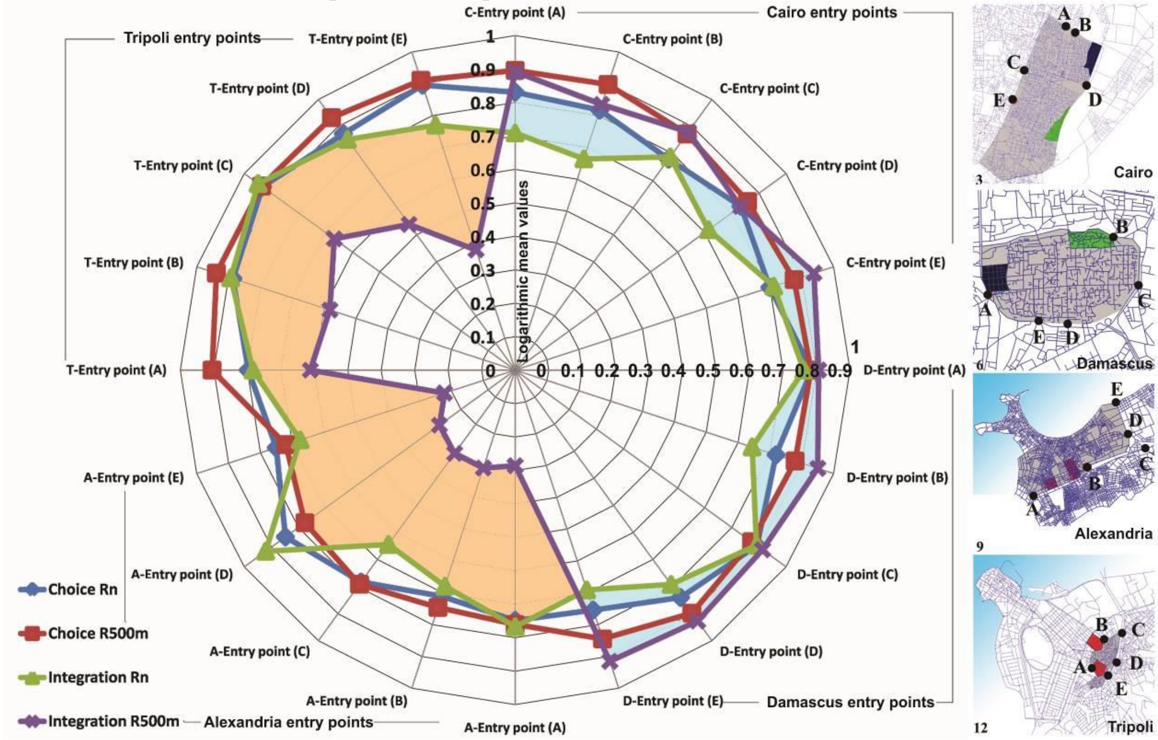


Fig. 4 Shows the multivariate average values (Choice Rn, Choice R 500m, Integration Rn and Integration R 500m) of accessible entry points in the four case studies. The first letter indicates the city: A for Alexandria, T for Tripoli, C for Cairo and D for Damascus. The right figures are the entry points highlighted in the four case studies. Their order from the top is Cairo, Damascus, Alexandria and Tripoli.
Reference: Author

Second microanalysis concerns the new fabrics on the urban edges of the four historic cities. The through-movement values for both global and local values are more correlated with particularly the integrated values of their edges. For example, in choice R500 m values, edges (A) in Damascus, (C) in Alexandria and (D) in Cairo have similar values. Also, edges (B) & (C) Cairo, (C) & (D) Damascus have similar pedestrian potential through-movements along their edges. While the to-movement accessibility in its both measurements, global and local, are less correlated values, see Figure 5.

Third microanalysis highlights the case of residential quarters adjacent to the urban edge, whether the edge in its physical form such as the wall (complete or traces) or ring roads. From Figure 6, it is clear that the values of both walled cities, Cairo and Damascus, are highly correlated with each others, on the other hand, the high correlation is between the two non-walled cities of Alexandria and Tripoli. Getting to a detailed example, average local through-movement values of edges (B) & (C) in Cairo resemble the values of (B) & (D) in Damascus. Also, the edges of (B) & (D) in Alexandria correlate with the edge of (A) in Damascus. Concerning the local to-movement accessibility, edges of (C) Cairo correlates with the edge (A) of Damascus.

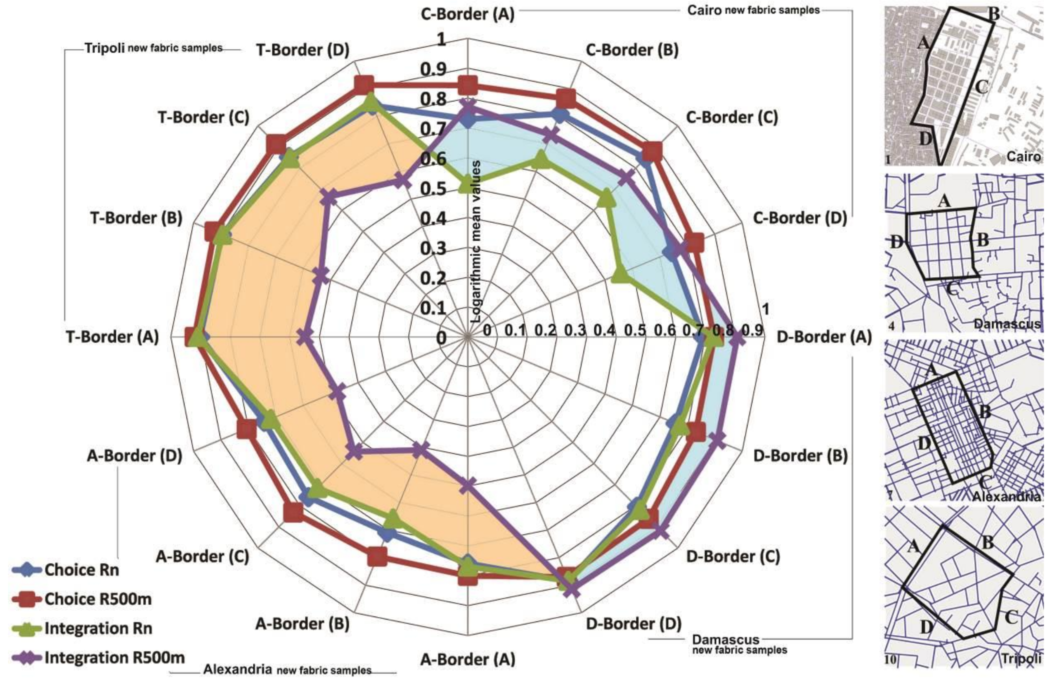


Fig. 5 Highlighting the multivariate average values (Choice Rn, Choice R 500m, Integration Rn and Integration R 500m) of new fabric samples on the edge of the four historic cities. Each case has four edges to compare. The right figures show the four samples: their order from the top is Cairo, Damascus, Alexandria and Tripoli
Reference: Author

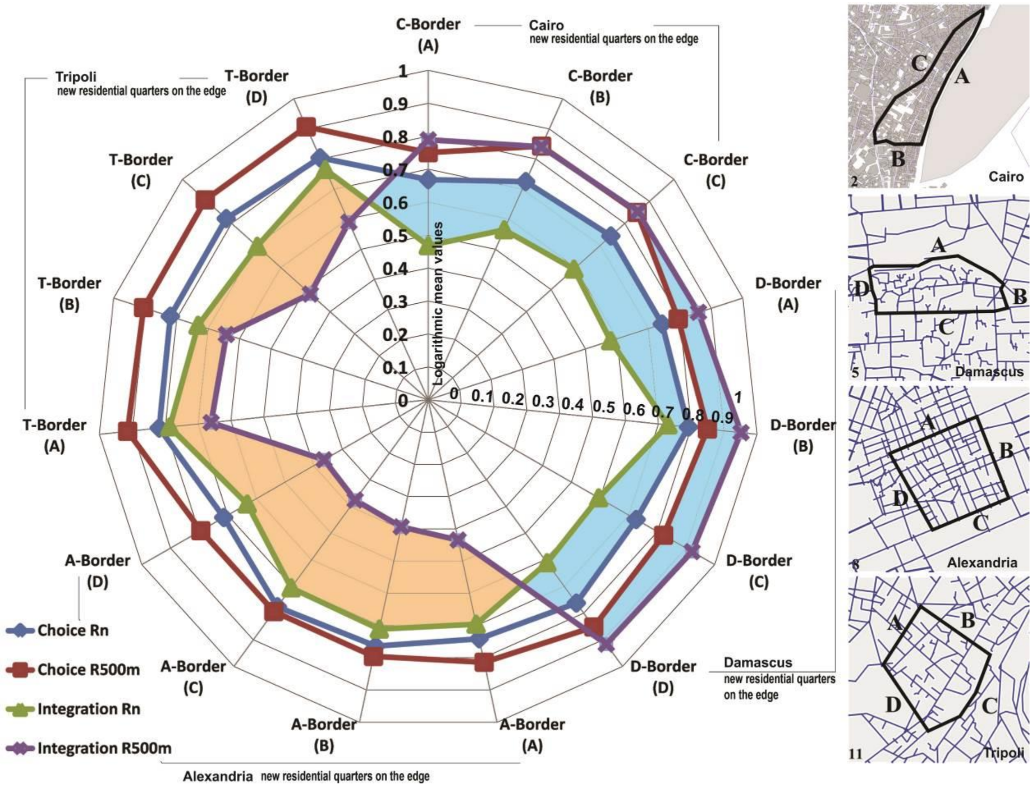


Fig. 6 Illustrating the multivariate average values (Choice Rn, Choice R 500m, Integration Rn and Integration R 500m) of residential quarters on the edge of the historic case studies. The right figures show the four samples: their order from the top is Cairo, Damascus, Alexandria and Tripoli.
Reference: Author

6. CONCLUSIONS

The paper introduced the urban edge of historic Arab cities as an analytical focus in comparison to other typical analyses, which consider the historic city as a total comprehensive case without considering its edges and managing its degree of interrelation with the surrounding context. This focus enhances the ability to effectively link intervention projects inside the historic fabric with the extended fabric outside the historic boundaries. Focusing on the edges has provided the opportunity to discover the repetitive spatial, architectural and land-use patterns that exist, through a comparative analysis of different cases. These patterns enable the possibility of learning and acquiring from other successful interventions that have been applied to similar patterns, without being limited to cultural or contextual differences.

The paper introduces an analytical assessment framework capable of measuring micro and macro levels of analysis of historic urban edges. The framework can also be used as a comparative assessment for analysing different cases. Although none of the methods used in formulating the framework – such as the space syntax theory and techniques – are by themselves unique in their usage (despite being tried and trusted systems), the way in which the methods are used, combined and organised is a new contribution. The framework was designed to have two consecutive stages. The first stage depended on understanding the historic city within its surrounding context. The second stage was designed as a comparative analysis, so that the result is not confined only to one case study, but can also be used more broadly with other cases .

Reviewing the results of the four comparative cases discloses that the two walled capitals have apparent mutual similarities in the micro-scale analysis, including entry access points (gates), new fabrics on their urban edges, and the residential quarters adjacent to their walls. In addition, on the macro-scale, they both attract low-standard residential buildings on their walled edges, and both have higher intelligibility values compared to the values of the two port cities. On the other hand, Alexandria and Tripoli, as port cities, share similar micro- and macro-scale values. This particular conclusion is the result of the comparative analysis of the four selected case studies; however, it cannot be expanded to apply to all historic cities with similar conditions, unless confirmed with further research that includes more cases.

To summarise the concluding points, the findings and the analysis of the selected case studies as follows :

- Physical and visual barriers do exist in different forms along the urban edges. They can be altered by paying attention to the type of link between both sides of the edge, considering spatial interrelation, architecture continuity and land-use typology.
- Spatial analysis would be highly beneficial as an initial preliminary investigation in urban edge analysis, particularly if the primary data is not all available .
- A ring road that might surround the former walled path does not act as one homogenous edge. This point would affect the decision-makers' policies in any regeneration intervention.
- The degree of connection to the inner or outer accessible routes is an essential factor for the success or deterioration of any intervention projects in historic sites.
- There might be related similarities (patterns) in different parts of the urban-form features, despite the location and type of edges that the traditional inner historic fabric lies behind.
- The proposed analytical assessment framework is capable of measuring micro and macro levels of analysis in walled cities. It has the potential to become a valuable tool for decision-makers in evaluating the current situation and in measuring the success of their intervention project.

This paper has been tested only by analysing the historic edges of Arab cities although, theoretically, due to its method of establishment, it could be applicable in any urban edge case that needs further or future studies.

DOI: 10.54729/2789-8547.1017

ACKNOWLEDGEMENT

I would like to thank Prof. Robert Kronenburg, University of Liverpool for his support throughout this research.

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DOI: 10.54729/2789-8547.1017