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Space syntax as a tool for tourism development of heritage areas

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Abstract

It is important to conserve Heritage areas and their cultural heritage while working to achieve economic and social gains through their tourism development. The lack of tourist facilities in these areas negatively affects the tourism industry. Achieving sustainable tourism, and improving tourism facilities, has become one of the most important strategies for protecting architectural and urban heritage and achieving economic development. Heritage areas can be re-vitalized through the restoration and reusing of heritage buildings and the rehabilitation of squares and streets with the development of policies and laws governing construction within them, considering a good understanding of how to improve the interconnection between the street network and places. By using space syntax, it is possible to analyze the structural characteristics of the street network in heritage areas, understand their nature, and how movement flows within their parts. The research used both space syntax and geographic information systems to develop a framework that guides decision-makers, urban-designers, and heritage stakeholders in developing tourism development plans for heritage areas effectively. The results can serve as a reference for future studies on the tourism development of heritage areas. The framework ap-plied to Fuwah city, Kafr-Elsheikh, which is the third Islamic Heritage City in Egypt.

Keywords

Heritage areas; Tourism development; Tourism facilities; Space syntax; Geographic Information Systems (GIS); Kernel density

1. Introduction

A lot of countries have many heritage areas within them. It may be a street with a special character that contains many heritage buildings, an entire neighborhood in the city, or within a neighborhood, or more, as a whole, forming an open museum through which history can be read. Because of the growing awareness of the value of heritage areas and the importance of preserving and protecting them, various governments seek to support and care for these areas as they represent a carrier of a historical context.

Tourism is an incentive to preserve the components and elements of cultural heritage, complementing both heritage protection and the level of tourism improvement each other. Heritage areas are attractive areas and an important resource for many activities such as entertainment, sightseeing, and hiking ... Hence, it is possible to get economic and social benefits for local communities through their tourism development.

Tourism develops an interest in cultural values in the region receiving tourists. Therefore, attention must be paid to reformulating urban plans for the development, modernization, and representation of heritage areas and preparing the center and qualifying it for the tourist function that does not contradict the historical and cultural value of the area and in accordance with the existing socio-cultural content, which differs from the rest of the city. It was found that there is a close relationship between the urban design of heritage areas and the tourism sector, as heritage buildings provide the city with distinctive attractions, while tourism depends on visiting those areas. Therefore, through the development of these areas, it is possible to give them the char-acter of continuity and sustainability.

The tourist destination system consists of four interconnected elements: attraction areas, tourist facilities, internal communication channels, and transit channels that connect these areas with the rest of the city (R. Wu et al., 2014).

Space syntax can be used as an aid in improving the quality of tourists' experience in heritage areas. It is one of the theoretical schools that explained the spatial structure of cities or urban agglomerations, through which the interaction between spaces is measured using what is called the language of space (space syntax), within which it is easy to quantify the ease of communication of urban spaces based on the movement of pedestrians in the spaces. It is also concerned with measuring the suitability of spaces for urban functions (Abdo, 2010). It provides analysis tools for the linguistic features of space, such as configuration, visibility, accessibility, and their functional relationships with the physical, social, and spiritual environment (Has, 2022; Turner et al., 2001). The theory of space syntax is an effective tool for discovering the spatial ecology of the urban environment and for giving different characteristics to urban spaces.

The target of this research is to develop a framework to guide decision-makers in devising effective strategies for the development of heritage sites for tourism, while also completing the tourism planning process properly using space syntax, as the urban street network affects not only traffic but also land use patterns, distribution of various activities and their relationship with each other. Thoughtful tourism planning can save the costs of conserving heritage areas; it is crucial to uphold respect for social traditions and cultural values to mitigate potential value conflicts.

The research followed the deductive approach to build a framework based on space syntax and GIS to guide tourism development processes in heritage areas and cities. Hence, the article is divided into three parts. The first part represents the inductive approach, which deals with the concept of tourism development and its components, space syntax theory, and its variables. The second section focuses on the development of the proposed framework, while the third deals with the case study where the city of Fuwah in Kafr el-Sheikh governorate was chosen to apply the proposed framework to it.

1.1. Tourism development of heritage areas

Tourism development is the public and private activities that contribute to the development, production, and marketing of services to serve the needs and welfare of tourists (Mohamed, 2017). It expresses the extent of the broad base of facilities and services to meet tourists' needs. It also represents a set of plans and programs that aim to achieve a continuous and balanced increase in tourism resources by finding a balance between competitive and conflicting demands on the limited resources (Mutlaf, 2016).

Sustainable tourism development is defined as development that meets the current needs of tourists and host communities while ensuring that future generations benefit. It is carried out through resource management to achieve economic, social, and aesthetic benefits while preserving the integrity of cultural heritage and the sustainability of the environment (Ahmed Shabaan Samra, 2022). Al-Bakri and Fouad (2004) and Benurfer et al. (2017) defined it as the meeting point of the needs of visitors and their host region, which leads to the protection and support of opportunities for future development, providing economic, social, and spiritual needs while preserving the urban reality and the eco-logical pattern (Al-Romeedy & Elzek, 2017).

The tourist site is characterized as a tourist attraction, because of the picturesque appearance, the natural characteristics it contains, or the buildings built with historical, artistic, or cultural values (Mutlaf, 2016). According to the Sustainable Tourism Charter, elements of cultural heritage and traditional activities must be integrated into the formulation of a sustainable tourism development strategy, as this contributes to the protection and preservation of the historical values of cultural resources and achieves sustainable economic benefits (Wang et al., 2021).

Tourist potential means the availability of reasons to motivate tourists to visit one place and not others for tourism, and it comprises two aspects, the first natural and the other human. These aspects work together in a single framework that is difficult to separate from each other (Mohamed, 2017). The natural environment and the urban environment (history, heritage, and complementary services) are the elements of sustainable tourism.

Traditional industries are also considered one pillar of tourism, as they make up the so-called tangible heritage and handicrafts because of their importance from the historical, cultural, social, or economic aspects. These industries express the identity of the citizen and are therefore one means of preserving tangible cultural heritage (Mutlaf, 2016).

Tourism development policies work to increase the number of tourists in the country and extend the average length of stay, as well as increasing the average daily expenditure of tourists, which plays an important role in maximizing the economic output from tourism. Besides the continuous increase in using the national component of tourists and services in the management operations of the tourist entity (Mutlaf, 2016). Tourism can be encouraged by promoting activities necessary for tourism activity such as trade, handicrafts, and etc., while providing a range of means that encourage cultural tourism, such as cultural centers and tourist exhibitions, intensifying entertainment elements, and establishing many facilities such as restaurants, cafes, parks and other tourist services (Mutlaf, 2016).

When allocating a piece of land or a specific area for tourism use, many factors affect the choice and determination of this role, such as the natural characteristics of the land, administrative policies, the role of the state and planning bodies, the location of the piece of land with the city in particular and the region in general, the behavior of individuals and their decisions, ease Access, transportation routes, and intersections, besides the clustering or separation factor, which is concerned with whether the different tourist uses gather with each other or not (Mohamed, 2017).

1.2. Space syntax

The initial idea of the spatial syntax technique came as an attempt to understand the development of cities and the flows of movement (Elagouri & Karakale, 2010).

Space syntax originated and developed in the 1970s at Bartlett's Architectural Studies Unit, University College, London (Hillier, 2008). It was first proposed by Bill Hillier in the late 1970s and early 1980s (Wang et al., 2021).

Space syntax can be defined as a set of theories and techniques used to describe the spatial arrangement of the built environment (Hillier & Hanson, 1984) to validate its functions and urban characteristics (Shateh et al., 2017). It is a set of techniques for analyzing spatial configurations of all kinds, especially when the configuration seems to represent an important aspect of human affairs, such as in buildings and cities (Hillier, 2008). Thus, it represents a powerful technique that can describe and analyze the patterns of each architectural space at the building or urban level (Hillier, 2008).

Hillier and Hanson 1984 defined space syntax as the relationship between the density of movement represented by the size of pedestrians in urban space and the spatial arrangement of the city as a whole (the relative importance of spaces in the city based on their visual significance) (Abdo, 2010).

The space syntax method is one of the best auxiliary ideas for architects and planners who have an interest in and awareness of the relationship between human behavior and the built environment (Bilge, 2016). It is used in quantitative studies on the relationship between urban spatial organization and human social activities (Hillier, 1996; Hillier & Hanson, 1984).

Space syntax provides concise spatial tools for measuring spatial variables in built environments independently of context-related situations where cultural aspects must be considered (Yamu et al., 2021).

Space syntax is an essential part of providing an understanding of the life of places when developing a systematic and comprehensive architectural theory in which all aspects of how humans exist in their lifeworld are considered. The space syntax can at least provide some subtle clues about how some of the spatial components of the built environment are created lively (Nes & Yamu, 2021).

However, it is not possible to analyze the character of the place, the sphere, the surroundings, or the symbolic meaning of the built form. Nor can explanations be given why a settlement was established on a particular natural site. Therefore, space syntax deals with the environment of the place and not with the character of the place, as an analysis of the character of the place requires a true understanding of the cultural background of the society and the spiritual traditions in both the present and the past (Nes & Yamu, 2021).

During the past two decades, the space syntax approach has become widely used in representing architectural and urban spaces to develop successful solutions to various problems facing the growth of cities. The most important of which is the prediction of the movement of vehicles and pedestrians, the analysis of urban expansions and their impact, and the patterns of collective behavior of residents and visitors (Elagouri & Karakale, 2010). In recent years, the space syntax model has also been used to check urban land use or preservation, renovation of old blocks, access to urban public facilities, and crime distribution in the city (Xu et al., 2020).

Space syntax is applied in a wide range of research on the relationship between urban forms and socio-economic activities such as studying the association of urban form with daily travel behaviors such as walking to enhance urban vitality and the microeconomic environment of the community (J. Wu & Yuan, 2019), modeling pedestrian traffic pat-terns in different regions (Lerman & Omer, 2013; Osmond, 2005; Özer & Kubat, 2007; Topcu & Kubat, 2012), spatial patterns of retail store (Zhai et al., 2019), Land Use Layouts in New Urban Areas (Alalouch et al., 2019), Testing the Efficiency of Urban Spaces Locally and Holistically as an Effective Tool to Discover the Spatial Structure of the Urban Environment and to Give Different Characteristics to Urban Spaces (Basil & Salim, 2016).

Some studies deal with the use of syntax in studying the impact of urban changes and expansions on traditional city centers and how to overcome urban problems in these areas, such as studying the impact of historical transformation on functional and spatial transformation (Shateh et al., 2017), studying the change in the characteristics of the spatial organization of historical urban centers caused by morphological changes (Aldauji et al., 2010), studying ways to overcome some urban problems that form the urban shape in traditional cities (Bilge, 2016).

Currently, space syntax is being used in the field of tourism, where Kádár, B. (2012), Edwards, D., & Griffin, T. (2013) analyzed the spatial systems of urban tourism and tourist behavior in public places (Edwards & Griffin, 2013; Kádár, 2012). Identify and change the route of historical places in the city center depending on the urban expansion of the city (Has, 2022). A comprehensive verification of urban forms and tourist preferences in the planning of historical heritage (Y. Li et al., 2016).

The space syntax is mainly applied in the investigation of spatial behavior and cognition in city tourism studies such as the study of movement patterns of tourists in the historical region (Mansouri & Ujang, 2017). exploring and improving the relationship between street networks and the spatial perception of tourists (Xu et al., 2020).

There are also studies for the use of syntax in the spatial planning of tourism ser-vice facilities, such as a study of Wang, M., Yang, J., Hsu, W. L., Zhang, C., & Liu, H. L. (2021) (Wang et al., 2021) to identify and plan service facilities in heritage tourism based on space structure, and some studies to explore the structural characteristics of retail stores in touristic areas (R. Wu et al., 2014).

Space syntax is based on space division. According to the spatial states of geographical entities, there are 3 basic methods: the axial method, which is used in sequential buildings and linear spaces in the urban system, the

convex polygon method, and the dividing view area method, which is used in non-linear spaces (D. Li et al., 2016).

The basic idea of the space syntax theory is to represent urban space with axial lines to analyze it and describe the relative connection of these spaces (Basil & Salim, 2016). Urban public places are mostly linear, except for squares, roads, streets, lanes, or sidewalks which are linear elements, so each spatial element of the road network can be represented as an axial line of sight that shows movement paths (Nes & Yamu, 2021). The axial map has been widely used as a syntax technique to describe urban structures (Shateh et al., 2017). The axial map, according to Hillier and Hanson, is defined as a map comprising the least number of straight lines (the longest axes) that cover the entire spatial system to be represented, which may be the spaces of a building, a region, or a city entirely (Elagouri & Karakale, 2010). The advantages of converting the spatial structure into an axial map are to provide a quantitative de-scription of the urban and social characteristics that are common to the built environment (Shateh et al., 2017).

The syntax uses 3 types of distance metrics: topological distance (least turns paths), geometric (fewest angle change paths), and metric (shortest physical paths). Then the syntax calculates the composition of the streets with different scales according to the size of the study area (Xu et al., 2020).

1.2.1. Spatial Variable of Street Network

Connectivity:

A fixed local measure representing all the direct connections that connect each street to other streets in its immediate vicinity, a street with many connections to its side streets has a high connectivity value, while a street with few connections has a low connectivity value (Nes & Yamu, 2021). The method of measuring it depends on the spatial arrangement, as it is possible through knowing the number of total spaces directly related to a space in the total spatial structure of the urban agglomeration (Abdo, 2010). The connectivity value Ci represents street connectivity (i) and the value is calculated as follows:

$$C_i = K\,(i) \quad (1)$$

Where (i) represents a specific street in the system (i = 1,2,3,..n), n is the total number of streets, and K represents the total number of streets directly adjacent to (i) (Wang et al., 2021).

The higher connectivity is considered a powerful indicator of space exposure. The higher the connectivity is, the stronger the space exposure becomes, and vice versa (Abdo, 2010).

Control:

The value of control represents the level of control exercised by the street over the neighboring streets and reflects its influence on the neighboring streets (Wang et al., 2021). It is the total number of levels in the spatial arrangement as, the greater the number of levels of control, the less the total interdependence is and vice versa, the greater the level of control is difficult to communicate (Abdo, 2010). It is expressed as the reciprocal sum of all connectivity values in the adjacent streets, the higher value shows that the street is more likely to be a traffic hub in the urban street network. The value is calculated as follows:

$$Ctrl\ i = \sum_{j=1}^{k} \frac{1}{C_i} \quad (2)$$

Where k denotes the total number of streets directly adjacent to street i, (j= 1,2,…,k) j represents the streets directly adjacent to i, and C is the connectivity value (Wang et al., 2021). This scale shows the extent to which the neighboring spaces can control the space (Elagouri & Karakale, 2010).

Depth:

It is the relationship between the total spaces of the city in terms of their connection to each other and the relative arrangement of this connection (Abdo, 2010), meaning the number of overlapping lines that must be crossed to move from one space to another (Hillier, 2008). The total depth TDi refers to the location depth of a particular street and is expressed as the average of the minimum number of steps from the street to all adjacent streets (assuming the minimum number of steps between two adjacent streets is 1). Low average spatial depth indicates greater accessibility. Its calculation is as follows:

$$TD_i = \sum_{j=1}^{n} d_{ij} \quad (3)$$

Where n is the total number of streets, dij is the minimum number of steps between streets i, j (Wang et al., 2021). The ease of communication of the spaces in the city was reflected in their functions, as the commercial spaces must be easy to be connected to them highly, and therefore measuring the depth of the spaces in existing cities enables the evaluation of their uses (Abdo, 2010).

Mean depth is the sum of the average numbers of convex spaces for a space void in the urban agglomeration (Abdo, 2010). It can be calculated as follows:

$$D_i = \sum_{j=1}^{n} \frac{d_{ij}}{n-1} \quad (4)$$

The lower mean depth indicates that the area is more suitable (Xu et al., 2020). The mean depth is inversely proportional to the number of spaces, and directly proportional to the ease of connection (Abdo, 2010).

Integration:

Integration is the most important concept in spatial syntax analysis. It defines the numerical relationship of organization between spaces at the city or building level (Has, 2022). It shows how each space relates to the other spaces within the overall system depending on the largest possible amount of motion change (Basil & Salim, 2016).

The value of global integration (Ii) refers to the degree of spatial aggregation or dispersion between space (i) and other spaces as follows:

$$\mathrm{I}_i = \frac{n\left(\log_2\left({}^{(n+2)}/_{3}\right)-1\right)+1}{(n-1)(D_i-1)} \quad (5)$$

where Di is the mean depth (Xu et al., 2020).

Global integration describes how a street relates to all other streets in a predetermined spatial system. Global integration analysis determines the accessibility of all other streets of the urban system considering the total number of direction changes of the urban entity (Nes & Yamu, 2021). A higher integration value shows higher accessibility and commonality of space (Xu et al., 2020). The areas where the high-value lines are concentrated are expressed as the core of the integration, the center of the system, and these areas are suitable for hosting central uses because of their integrated structure (Has, 2022). The integrated spaces are called the "integrated nucleus", which expresses the highest degrees of accessibility as guiding points for movement (Aldauji et al., 2010). In contrast, streets of less integration value, from which many changes of direction must be taken to reach all locations in the urban system, lead to spatial separation (Nes & Yamu, 2021). The nucleus of isolation, which ex-presses the most isolated and least accessible spaces, appears as points of orientation for movement from all the spaces of the system (Aldauji et al., 2010).

It is clear from the foregoing that urban centers have the highest global integration, where the flow of human movement and the location of functions, and the different activities of the spaces can be recorded along the axial lines (Nes & Yamu, 2021). It shows the active uses of land such as shops, whether it is a car-based shopping center or a pedestrian-friendly main street with neighboring streets (Nes & Yamu, 2021).

Besides global integration, the value of local integration (k) is used and indicates the relationship between space (i) and other distances within (k). Usually, k=3 and this term is called radius integral 3 (Xu et al., 2020).

Local integration (R3) refers to the isolation or integration of space and here, three steps are calculated to move from one space to another (Basil & Salim, 2016). R3 is used to verify pedestrian traffic, as pedestrian traffic on most predictable pedestrian journeys is on average limited to three levels (Hillier, 2008). The average depth value of all streets within a radius (3) is calculated (Nes & Yamu, 2021).

Pedestrian flow rates correlate with local integration values, while motorized traffic corresponds to global integration values. Local integration analysis indicates local shopping areas in the city. The locally integrated streets are the most vibrant shopping streets, with different land uses. Local urban shopping areas often have low global integration values, but high local integration values. This helps explain the differences between local-scale centers and urban centers (Nes & Yamu, 2021).

Intelligibility:

Space Intelligibility is a measure of the relationship between public urban space and local features, it can be

defined as "the degree to which what can be seen and experienced locally can be seen in a system that allows large-scale system learning without conscious efforts" (Hillier, 2008). This indicator shows whether it is possible to understand spaces by wandering through a limited number of them. This is based on a comprehensive picture of the city (Elagouri & Karakale, 2010). Intelligibility represents the correlation between the integration and control values of system spaces and Pearson's correlation coefficient (r) is adopted as a measure of Intelligibility, ranging from 0 to 1(Aldauji et al., 2010; Elagouri & Karakale, 2010). More integrated areas are more knowledgeable, and a clear system is one whose areas are also well connected, and vice versa. If the link is weak, the product becomes an incomprehensible environment (Hillier, 2008).

1.3. Spatial cognition and tourism service facilities

Historic urban centers could attract cultural activities such as museums, crafts, tourism, workshops, etc. (Nes & Yamu, 2021). The street network structure of urban forms influences the distribution of land use and tourism service facilities. Studies indicate that there is a considerable correlation between the spatial features of street networks in historic areas and the agglomeration of tourist service facilities in those areas (Wang et al., 2021).

The distribution of stores is influenced by the high spatial configuration of the urban street network on a micro and macro scale. In the built environment, successful shopping areas benefit from a strategic location both locally and globally. In addition to determining where shops will be located, integration plays a crucial role in determining how connected a shopping street is to its immediate side streets (Nes & Yamu, 2021).

The global spatial integration of the street network is a suitable place for economic centralization. That is, the spatial configuration affects the flow of traffic and the optimal location for economic activities. According to the theory of natural movement economic process, the spatial configuration of streets and road networks influences both the flow of movement and the location of shops in built environments. The spatial integration of the street network is directly proportional to the flow of pedestrian traffic and the area of land extending along the street network to become attractive for economic uses. It is clear that as the number of people on the street increases, the number of shops along the street, will be more and that attracts more people to the area (Nes & Yamu, 2021; Penn et al., 1998).

According to studies, the degree of integration of the street network into the built environments during the urban transformation process affects both land use development and building density. If the road and street network in an urban area is not spatially integrated or is not well connected to its surroundings, the area tends to be monofunctional and lacks a variety of economic activities and street life. Conversely, the metropolitan area tends to be multifunctional, with a high density of built-up mass and lively streets (Van NES et al., 2012).

The theory of natural urban transformation states that the spatial configuration of the road and street network affects the degree of building density and the degree of land use versatility. The greater the total spatial integration of the mobility network at different levels, the greater the diversity of land uses and the greater the building density for both GFI and FSI (Nes & Yamu, 2021; Van NES et al., 2012).

Research has shown that high spatial integration of the road network means large numbers of people on the streets, high levels of various economic activities, higher real estate prices, high building density, and a high degree of versatility (Nes & Yamu, 2021; Ye & Nes, 2014).

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Li, D., Yan, X., & Yu, Y. (2016) (D. Li et al., 2016) clarify that the areas with high values of connectivity and integration would attract a large number of people. So, they are appropriate for developing commercial and tourist

activities. The study of Wang, M., Yang, J., Hsu, W. L., Zhang, C., & Liu, H. L. (2021) (Wang et al., 2021) agrees with this as it shows that the development of tourist service facilities can be prioritized in areas with a high level of global integration and low total depth. Global integration is the most strongly variable that correlated tourist service facilities. Also, it proves that there is a relationship between tourist service facilities and global integration, connectivity, and control. As connectivity increases, so does the density of restaurants and entertainment venues.

Xiong, Q., Zheng, Y., & Zhang, B. (2022) (Xiong et al., 2022) denote that the higher integration becomes, the stronger the accessibility of the region gets. Xu, Y., Rollo, J., Jones, D. S., Esteban, Y., Tong, H., & Mu, Q. (2020) (Xu et al., 2020) indicate that the main tourist street must have the strongest accessibility, convenience, and public exposure. According to the study of Dong, Y., Jiang, Y., Quan, D., & Zhu, H. (2022) (Dong et al., 2022), establishing the heritage corridor is dependent essentially on the street network as the accessibility of the corridor determines the tourists' willingness to travel, the comfort, and the cultural experience. Li, J., & Duan, J. (2004) (LI & DUAN, 2004) suggested that the high value of global integration makes it easier to collect pedestrians. So, they are the most appropriate streets to gather tourists.

2. Methods and Materials

2.1. Methods

Space syntax and Geographic Information Systems (GIS) were used to develop strategies to guide tourism planning in heritage areas (Figure 1).

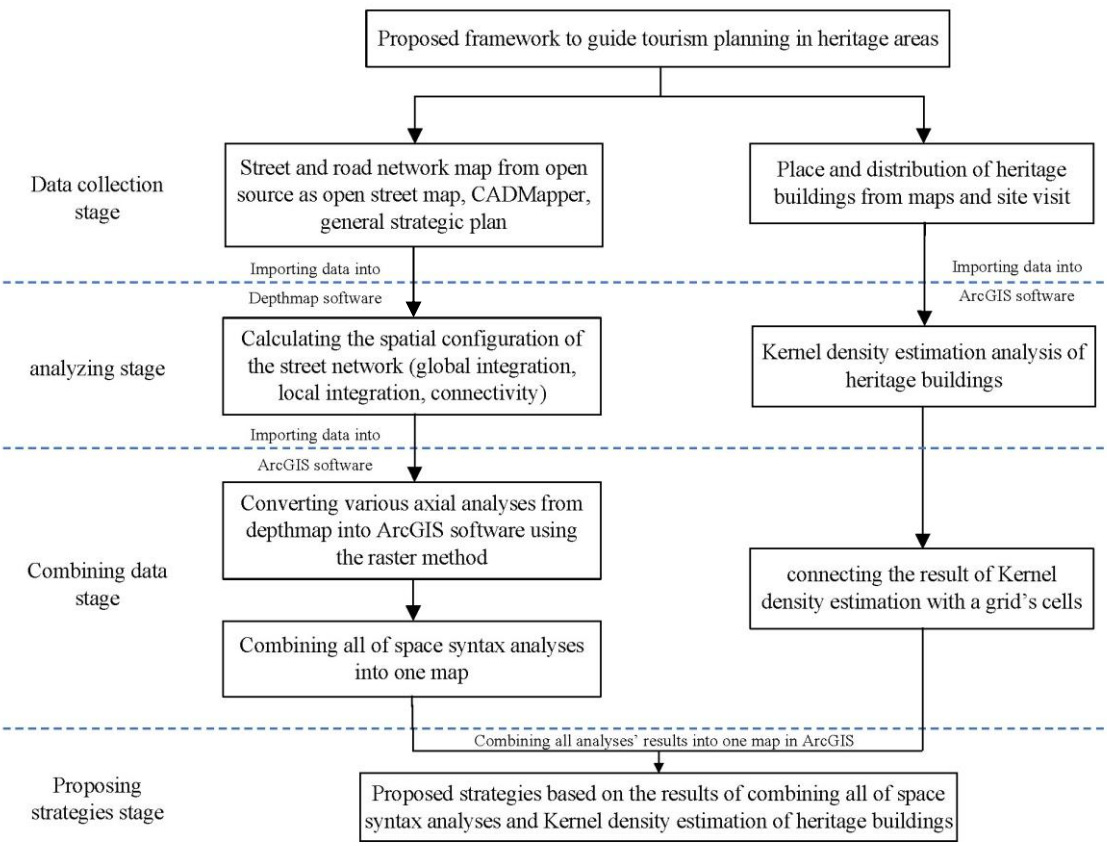


Figure 1 Conceptual framework for developing strategies to guide tourism planning in heritage areas (Authors).

First, the space syntax method is used to analyze the spatial configuration of the street and road network of the heritage city. Depthmapx (an open-source software) can process the axial map of the study area. Axial analyses are carried out and integration, connectivity, and control values are calculated for each line on the axial map, according to topological distance. The integration degree can be divided into global and local degrees. The research used the topological radius distance R= 3 for the local degree. As R= 3 is the closest scale value similar to a pedestrian walking in space (Xiong et al., 2022).

Second, the space syntax results for the street and road network calculated in Depthmap were imported into ArcGIS software. Then, through using the raster method, the values from the axial map (global integration, local integration, and connectivity) were connected to grid cells (10 ×10 m) by spatial join tool. The values for each cell are decided by the highest values of the line inside it (Nes & Yamu, 2021). Through using the natural break method which minimizes the differences between data values in the same class and maximizes the differences between classes (*Data Classification Methods—ArcGIS Pro | Documentation*, 2023), All values were grouped into high, medium, and low values in ArcGIS. To aggregate all the results from space syntax into one framework, the overall space syntax results are calculated according to table 1.

Table 1. Proposed aggregation technique for space syntax analysis results. (Authors)

Space syntax analysis	Aggregation technique
High value	H_g-H_l-H_c H_g-H_l-M_c, M_g-H_l-H_c, H_g-M_l-H_c H_g-M_l-M_c, M_g-M_l-H_c, M_g-H_l-M_c
Medium value	M_g-M_l-M_c H_g-H_l-L_c, L_g-H_l-H_c, H_g-L_l-H_c H_g-L_l-L_c, L_g-L_l-H_c, L_g-H_l-L_c H_g-M_l-L_c, M_g-H_l-L_c, L_g-H_l-M_c, L_g-M_l-H_c, H_g-L_l-M_c, M_g-L_l-H_c
Low value	L_g-L_l-L_c L_g-L_l-M_c, M_g-L_l-L_c, L_g-M_l-L_c L_g-M_l-M_c, M_g-M_l-L_c, M_g-L_l-M_c
Where	H_g= high global integration, M_g= medium global integration, L_g= low global integration H_l= high local integration, M_l= medium local integration, L_l= low local integration H_c= high connectivity, M_c= medium connectivity, L_c= low connectivity

Third, using ArcGIS to calculate the kernel density of the heritage buildings located in the study area. As kernel density estimation (KDE) is a non-parametric technique for density estimation (Budde, 2019) that can identify the distribution model for heritage buildings and their density in urban spaces. A higher density value indicates a higher heritage building density as well as greater agglomeration. Also, the results were divided into three levels: high, medium, and low by the natural break method. The results of (KDE) were assigned to points using raster to point tool, before connecting the data of the assigned points with the grid cells through summarize within tool. Finally, by combining all the quantities data from space syntax and kernel density analyses, a set of strategies are proposed to guide tourism planning in heritage areas.

Based on analyzing the relationship between the streets network and the tourist service facilities in the aforementioned literature, there are five different types of urban areas. For each of them, different strategies can be made for the heritage area. They are all depending on the degree of global integration, local integration, and connectivity of the street and road network, besides the kernel density of heritage buildings (Figure 2).

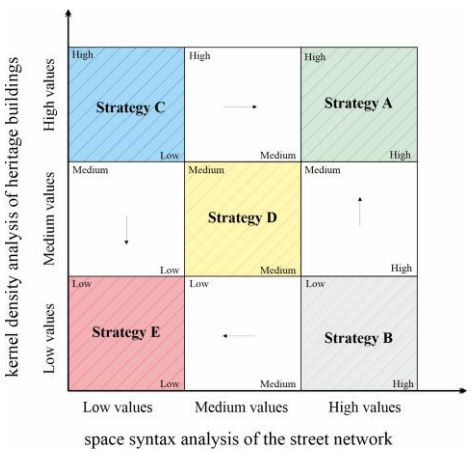


Figure 2 Various strategies to guide tourism planning in heritage areas based on aggregate the results from the Space syntax analysis with the results from kernel density analysis (Authors)

Strategy A: areas have high values for space syntax analyses of the street and road network, as well as a high kernel density of heritage buildings. These areas are often in the historical city center. Because of their wide range of

permitted uses, these places have the potential to constitute a historic corridor. The heritage corridor has an innate advantage for the development of the cultural tourism industry, bringing new vitality to the area (Dong et al., 2022). The main goal of heritage corridor construction is to create a positive interaction between conservation and utilization, which can be seen as a crucial part of planning for heritage conservation (Dong et al., 2022). If space becomes available, it can be used as a tourism service facility (Museums, cultural centers, ...). Also, the ground floor level of the existing buildings can offer an opportunity for traditional craft shops and … Besides, conserving heritage buildings and reusing them. They can be reused in their usage or other uses that are compatible with their heritage values. All interventions in these areas must respect the heritage values and traditions of local communities.

Strategy B: areas that have high values for space syntax analyses of the street and road network, but a low kernel density of heritage buildings. These areas are frequently found outside the historic city center. If these areas were located nearest to the old city, they could be tourist corridors. They are qualified to build accommodations, restaurants, and other commercial and tourism service facilities. As they have high values of connectivity and integration, they attract a big number of people. If there is available space, it can be used as a tourism service facility. The ground floor of their buildings can be used for shops, small businesses, and tourist services. If these areas are far from the old city center, they are suitable for local markets. Local shops and services on the ground floor of their buildings can be facilitated.

Strategy C: areas have low values for space syntax analyses of the street and road network, but in contrast, have a high kernel density of heritage buildings. These areas are typically in the historical city center. The street network in these areas needs to be developed to make it more intelligible and to facilitate moving from one area to another through the historical center. The development of the street network can trans-form it into secondary heritage corridors that connect different districts of the historical city center. Heritage buildings in these areas can be conserved by using compatible policies according to their values and status. The tourism development process should consider the aesthetic, social, and cultural dimensions, natural and cultural landscape, and the broader visual context of heritage areas (Martínez Yáñez et al., 2022; Pedersen, 2002). Changing the street network should be in appropriate limit to ensure that the old city's urban form is conserved.

Strategy D: areas that have medium values for space syntax analyses of the street and road network and a medium kernel density of heritage buildings. Usually, these areas are located in the historical city center. These areas have the potential to trans-form into a secondary tourism corridor by improving and developing their street network and using the ground floor level of buildings as tourism facilities (Shops). If there is available space to develop, these areas can be developed for commercial use. Where possibilities exist to provide appropriate facilities for the visitors without adversely impacting on the significant features or old city characteristics.

Strategy E: areas of low value for space syntax analyses of the street and road network, as well as a low kernel density of heritage buildings. These areas are mostly located in quiet resident areas. High densities of only dwellings are preferred when there is space to develop. The road network in these areas is characterized by calmness and separation, and thus it is of a single function.

2.2. Materials (Case study: Fuwah City)

Fuwah was known as the “City of Mosques” (Abdallah, 2017). because it has the fourth-largest number of Islamic antiquities in the world (Ghanam & Abdo, 2021). It is also the third Egyptian city, after Cairo and Rashid, that has the largest group of religious and civil buildings representing different Islamic eras, most of which date back to the Ottoman era (Planning, n.d.). It is represented by many mosques, corner mosques, shrines, and Takiyya of archaeological value. Almost no street or lane hasn't an archaeological mosque, as the number of archaeological mosques is approximately 365 (Abdallah, 2017; El Ibiary, 2006). There are approximately 25 historic buildings registered (Planning, n.d.). It was selected as a nature reserve by UNESCO’s Museums without Borders organization

(Alkurdy, 2021). However, the insufficient focus on preservation has led to a considerable loss of its cultural heritage, as it has not been adequately protected.

The city of Fuwah is administratively affiliated with the governorate of Kafr El-Sheikh, as it is at the northwestern end of the governorate. Fuwah City is the capital of Fuwah Center. It is on the eastern shore of the Rosetta branch near the Rosetta Estuary, and it extends on the Nile coast at a length of 3 km and is approximately 27 km from the Mediterranean coast. Fuwah is about 191 km from Cairo and about 98 km from Alexandria. It is in the middle of the cities of Mutobas and Desouk, 6 km away from the city of Mutobas and 12 km from the city of Desouk (El Ibiary, 2006; Ghanam & Abdo, 2021; Planning, n.d.) (Figure3).

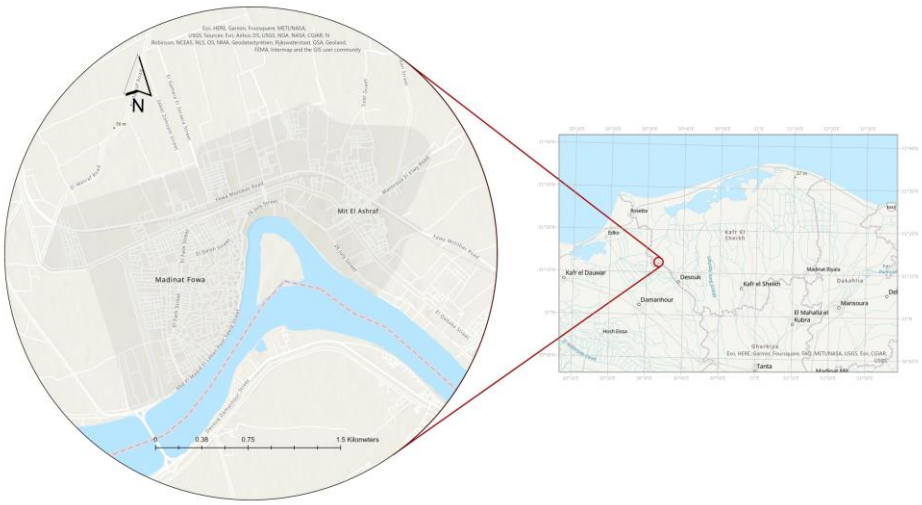


Figure 3 Location of Fuwah city, Kafr El-Sheikh, Egypt.(Authors)

Fuwah is one of the oldest cities in the Delta region, dating back to Pharaonic Egypt, where it was the capital of the seventh region in Lower Egypt [45] (the north-western region of the North Kingdom) and was named (Barhant Amanti). After the union of the northern and southern kingdoms, the city became an important port for Pharaonic Egypt, then the Greeks called it Metalis, and it was called in the era of the Romans the city of Poei and became the second port of Egypt. After the Islamic conquest, its name changed to Fuwah (El Ibiary, 2006; Ghanam & Abdo, 2021).

Through the ages, Fuwah was known for being a commercial and industrial city. Where in the Mamluk era oils' presses and mills of yields spread. Furthermore, it was famous for its paper industry, and it had a house for minting copper coins (1978 ,زهير). During Muhammad Ali's reign, the city was renowned for its industrial facilities, such as rice mills, cotton mills, and a tarboosh factory. Additionally, the city was recognized for fishing and manufacturing boats (El Ibiary, 2006). Fuwah city absorbs about 70% of all spinning and weaving in the center (Planning, n.d.).

One of Fuwah's most important industrial activities is handicraft, which are shown in the manufacture of carpets, kilims, and Goblan, which are still inherited by the city's population, so the number of handlooms in 2021 is about 3500 looms (El Ibiary, 2006; Ghanam & Abdo, 2021). In addition to the production of copper crafts and wooden crafts like pulpits and mashrabiyat

The second half of the 20th century saw a clear expansion of the city, which resulted in the emergence of new urban features that are distinct from those of the older areas of the city in terms of their nature and characteristics. This led to a different urban formation in the city (El Ibiary, 2006; Ghanam & Abdo, 2021). However, the compact urban fabric, including the agglomeration, adjacent buildings, and circular streets, still exists in the old area (the city's core). The most important streets in the area are Abdel Moneim Street and El Geish Street (Planning, n.d.). Whereas the compact cumulative fabric is found close to the city's center and the mesh fabric predominates in the

contemporary areas on the city's out-skirts (Ghanam & Abdo, 2021). Some of the city's streets still keep their old names.

The state of the buildings is closely related to how the city has grown, as most of the structures in the center of the city exhibit signs of deterioration (Planning, n.d.), and the hap-hazard pairing of ancient structures with more modern ones has led to damage to their aesthetic aspects (Ghanam & Abdo, 2021).

Fuwah is a heritage reserve because of its Islamic monuments and mosques. It offers a variety of tourist possibilities, including religious and historical tourism. The most well-known mosques in the region are the Abu Al-Makarem, Prince Hassan Nasrallah, Al-Qana'i, Sidi Ra'i Al-Dar, Sidi Abdullah, Al-Numeiri, and Sidi Abu Al-Naga mosques. In addition, there are many historical sites, including the gates of the Tarabish factory and the linen factory from the era of Muhammad Ali Pasha, Al-Takiyya Al-Khalwatiya, Raba Al-Khattabiya, the Hussein Majir Agency, and the archaeological Tell Qabrit. Ecotourism, where Dahab Island faces the city of Fuwah in the Nile River, whose banks are rich in aquatic plants and fish breeding grounds, attracting wild birds, particularly migratory ones. Besides the manufacture of ropes made of staple and linen, and decoration of wood and furniture by assembling, inter-locking, stuffing, digging, and making geometric decorations, with experience and skill in the manufacture of carpets and kilims. Finally, recreational tourism is represented in the Families Park and the Nile Ferry (Planning, n.d.) (Figure 4).


4. Sidi Mosa Mosque


5. Sedi Mosa Mausoleum


6. Al-Numeiri Mosque


7. Abu sha'ira Mosque


8. Alshekh Saaban Mosque

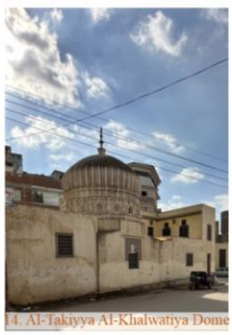

9. Al-Qana'i Mosque


10. Al-Gharabawy Mausoleum


11. Hassan Nasrallah Mosque


12. Al-Foqaai Mosque

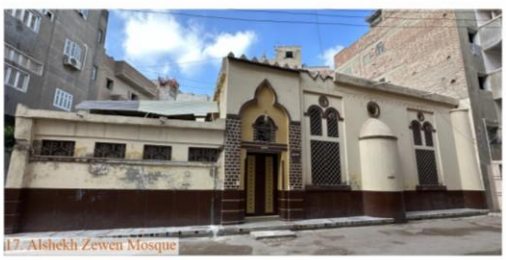

13. Sidi Ra'r Al-Dar Mosque


14. Al-Takiyya Al-Khalwatiya Dome


14. Al-Takiyya Al-Khalwatiya


15. Sidi Abdullah Mosque


16. Ahmed Alstohy Mausoleum


17. Alshekh Zewen Mosque


18. Raba Al-Khattabiya


19. Abu Al-Makarim Mosque


20. Linen Factory Gate


21. Mohamed Ali Linen Factory

Figure 4 Fuwah's heritage buildings: (a) location of listed heritage buildings; (b) samples of buildings' style in the city; (c) photos for some listed heritage buildings.(Authors)

However, there is insufficient utilization of the city's tourist resources and potential, and the city lacks, in particular, the elements of tourist accommodation, as there are no hotels, hostels, or even youth hostels, or establishments that provide services to tourists such as restaurants, so the city is not qualified to receive tourists. Besides, the absence of markets for the distribution, marketing, and export of carpets and kilims [45].

3. Results and Discussion

The axial map of Fuwah city depended on the maps from the general strategic plan for Fuwah and Google Maps.

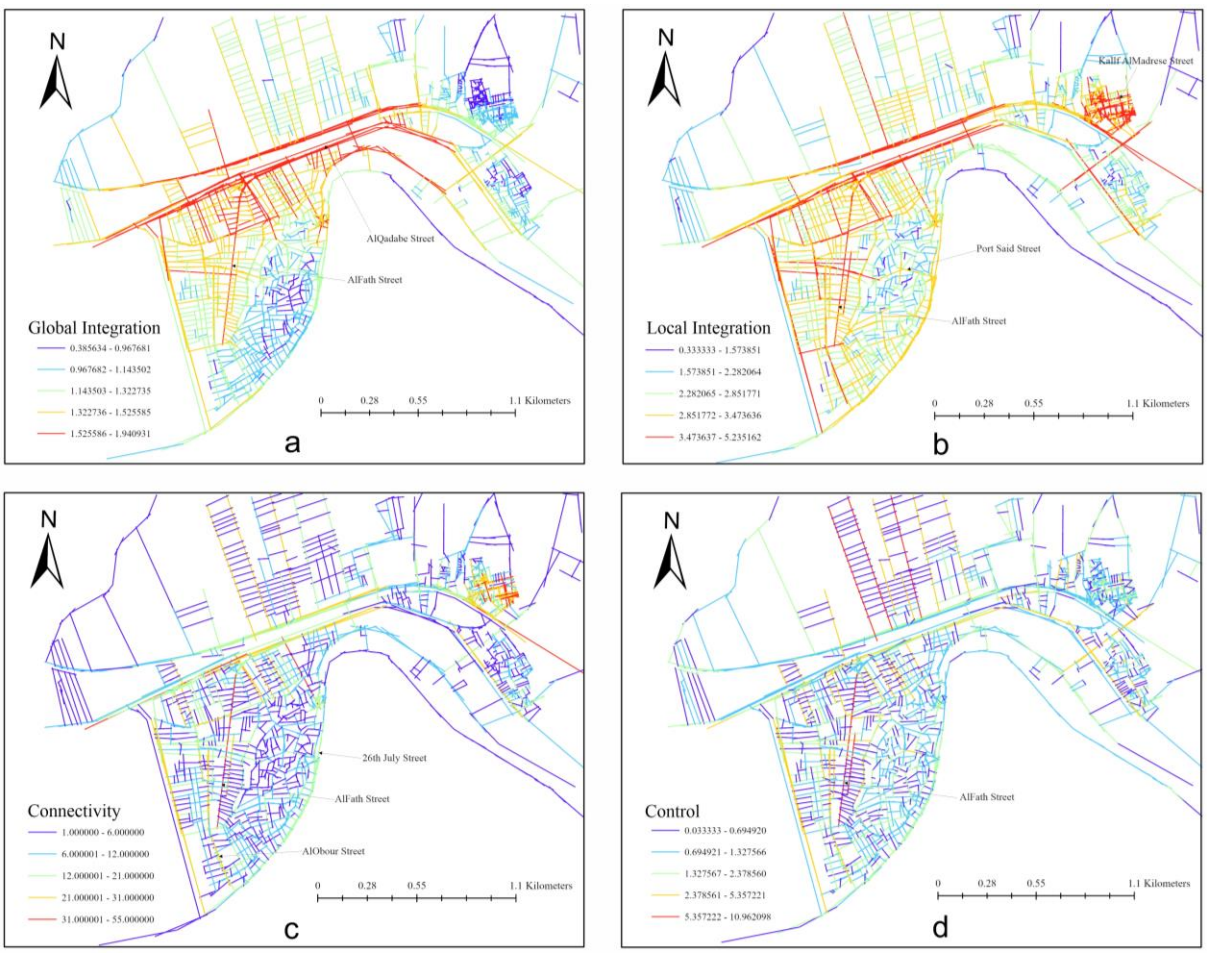


Figure 5 Space syntax analysis in Fuwah city (a) Globel Integration; (b) Local Integration; (c) Connectivity; (d) Control. (Authors)

1375 axial lines that have replaced the streets of the whole city. Figure 5 a, b, c, and d shows the results of the space syntax analyses. The analysis's findings are displayed based on five values, which are local and global integration, connectivity, control value, and intelligibility value. The maps' colors denote high and low values. While blue indicates low values, red indicates high values.

In the city, the average values of local and global integration are 2.63 and 1.2, respectively. The connectivity value on average was around 9.07. While the average control value was 1. At the global level, the average mean depth value was 7.81, whereas locally, it was 2.52. As for the average total depth, it was 10,743.4 at the global level and 285,456 at the local level.

Figure 5a clarifies that the local streets are less in value of global integration than the main streets of the city. The value of global integration ranges from 1.9 to 0.39. AlQadabe Street has the highest global integration value of 1.9. It is the street on which the train station is located. This value is higher than the city's average global integration by 58%. The global integration value of AlFath Street was 1.6, while it reached 1.4 in 3 streets.

For local integration, Figure 5b shows that Kallf AlMadrese Street, which is at the urban expansion of the city, has the highest value of 5.2, which is higher than the average local integration value of the city 98%. As for the street network inside the city, the highest value was 4.3 for AlFath Street. While Port Said Street, which is in the old city (historic district) has 3.6.

According to Figure 5c, AlFath Street has the highest connectivity value (55). The connectivity value of AlObour Street, which connects AlFath Street and 26th July Street, was 17. In the historic district, Port Said Street has the highest value of connectivity as the value reached 15. The connectivity value for 26th of July Street (Corniche) was 18. These are distinguished as the most connected streets have greater accessibility and vision, and these spaces represent the axis between the most important landmarks in the city.

As for the value of control, AlFath Street showed the highest value of control, which is 10.96, which explains the control it exercises over the neighboring streets and reflects the strength of its influence, so that this street is likely to be a traffic center in the urban street network (Figure 5d).

The value of intelligibility at the global level was 0.05, which is considered a low value. While it was at the local level of 0.6, which is a good value indicating that it is easy to form an impression from the local part to the entire old city (Figure 6).

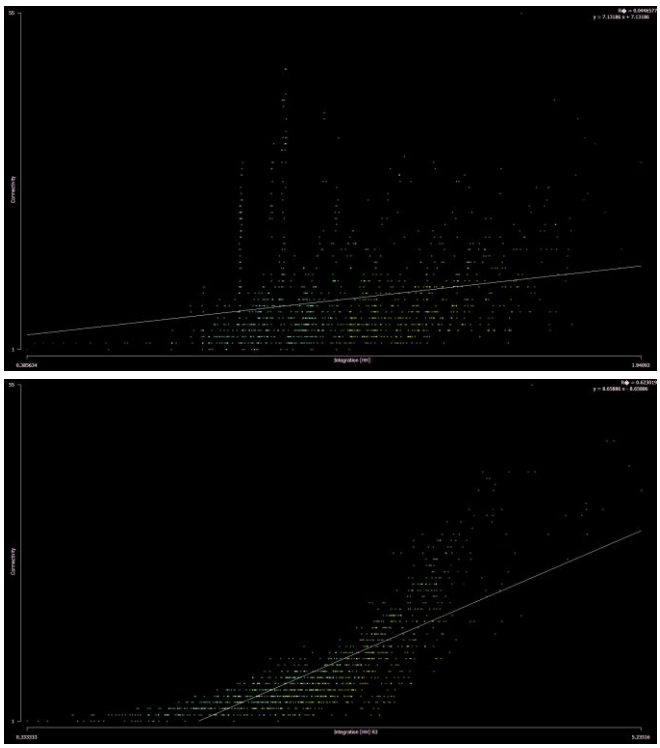


Figure 6 Intelligibility at the global and local level in Fuwah city. (Authors)

It is noted that AlFath Street has the highest value of integration, connectivity, and control. Therefore, it has a significant impact on the neighboring streets. It represents the street separating the historical area (the old city) from the rest of the city, as the historical area is on one side of it. Also, it links the 26th of July axis and AlQadabe street, which are both main streets. Because it is the most integrated street, it has high accessibility.

ArcGIS was used to conduct KDE for the registered heritage buildings in Fuwah city, and the results were classified as natural break (Figure 7).

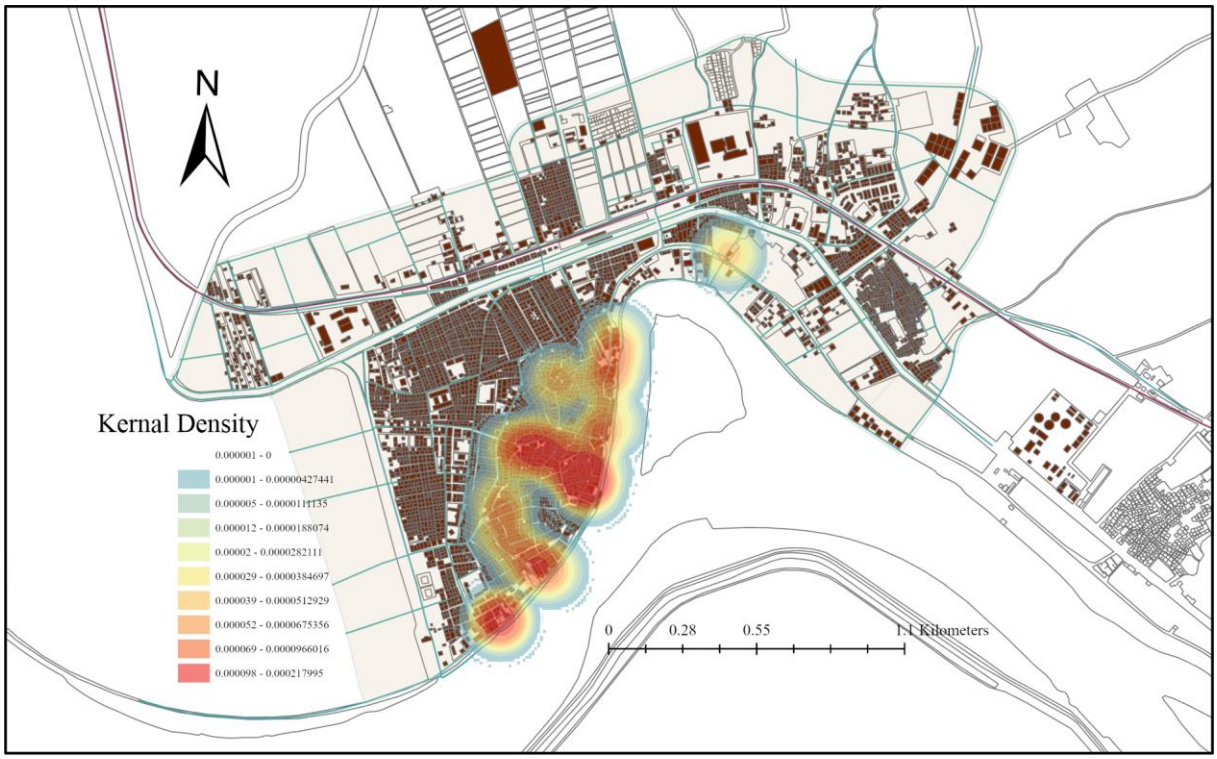


Figure 7 KDE for the registered heritage buildings in Fuwah city. (Authors)

From KDE analyses, Heritage buildings spread throughout the entire area of the old city. 26th July Street (corniche) connects heritage areas. The highest agglomeration of heritage buildings is located nearest to Port Said Street. Other agglomerations appear near both Daert Al-Sabawi Street and the south part of ELGaish Street. There is no agglomeration outside the old city.

According to the proposed framework through using ArcGIS, it is possible to aggregate data from space syntax, KED analyses as shown in Figure 8.

The space syntax, KDE can be combined into one matrix to visualize the various types of strategies that guide tourism planning in heritage areas. The results indicate that (as shown in Figure 9) Port Said Street, 26 July Street (corniche), Daert AlSabawi Street and the south part of EL-Gaish Street are all within the scope of Strategy A, as these areas are characterized by high values for both space syntax analyses and kernel density (KDE) of heritage buildings. Therefore, they are suitable as heritage corridors (pedestrian paths) passing through religious and secular heritage buildings, and they are also essential routes for sightseeing in the inner city. It is also suitable for supplying tourism service facilities.

26 July Street (corniche) the city's waterfront plays an important role in external connectivity that allows access to its historic districts. The city's historical fabric is along the street supports its integral value and thus commercial, social, and cultural spaces can be intensified therein, as it represents an important tourist destination. Port Said Street has several heritage buildings in a linear form, with Al-Qanai Mosque at its beginning, followed by Da'i Al-Dar Mosque, Al-Takiyya Al-Khalwatiyah, and Al-Omari Mosque at its ending. All these streets can be transformed into heritage corridors. However, 26 July Street has a greater chance of having shops and tourist services as restaurants and accommodation services than the inner streets. Accommodation services are highly connected with global integration, connectivity, and accessibility besides view. The 26th of July is suitable for accommodation facilities as it is next to the Nile River and is easily accessible through which the city's heritage and tourist areas can be accessed.

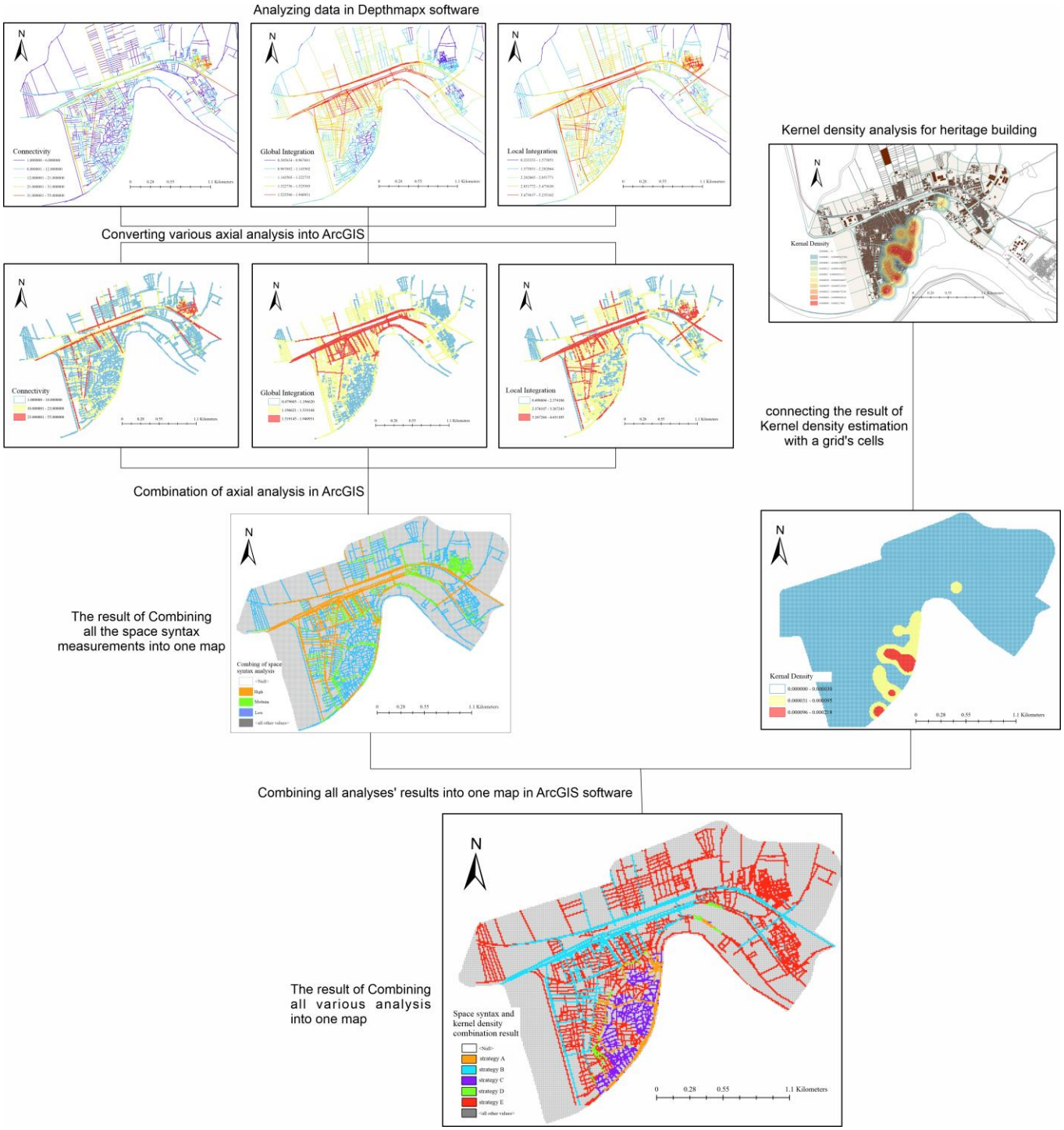


Figure 8 Process of combining analysis from Depthmapx and ArcGIS. (Authors)

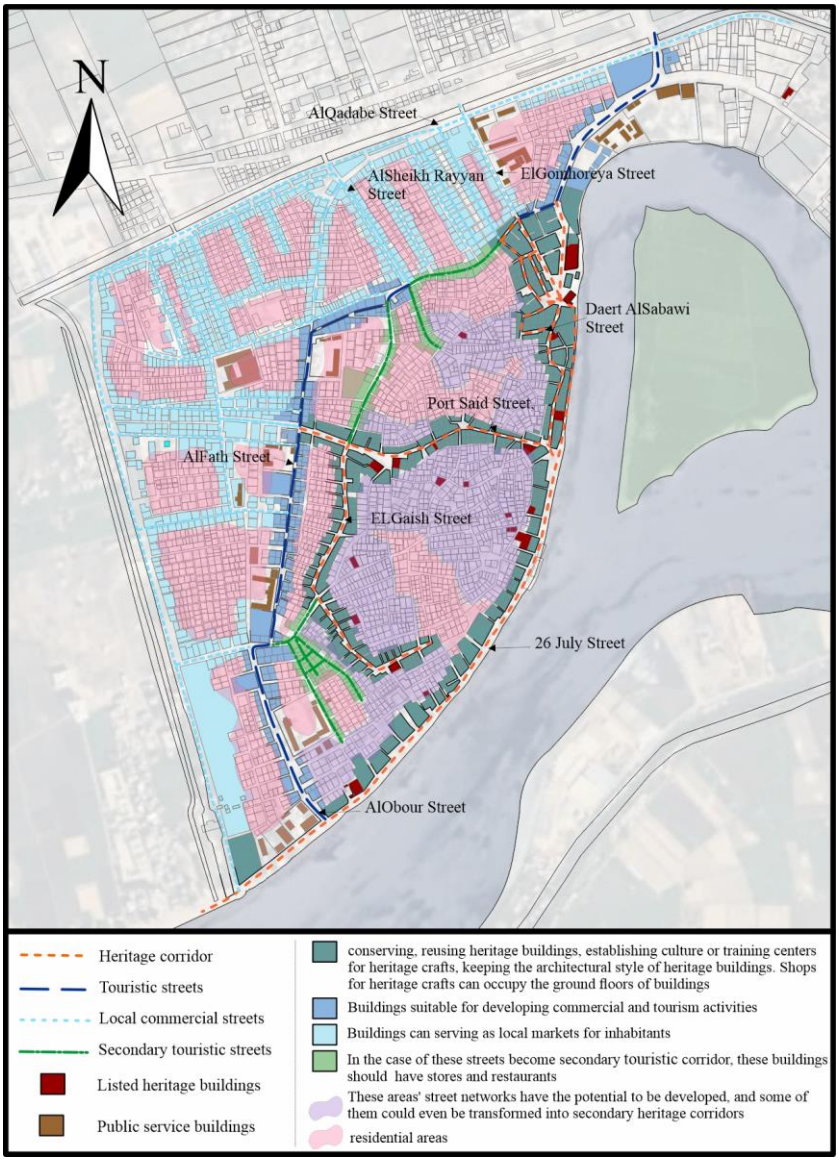


Figure 9 The proposed plan for developing heritage tourism in Fuwah city. (Authors)

Generally, the Street network of these areas needs to be developed and enhanced and occupancy removed to accommodate tourists' movement. Besides, conserving, restoring, rehabilitating, and reusing heritage buildings. Also, establishing culture or training centers for heritage crafts such as kilims and carpets in the available lands, while keeping the architectural style of heritage buildings. Shops for heritage crafts can also occupy the ground floors of buildings in these areas.

It is worth noting that each of Al-Takiyya Al-Khalwatiyah was reused to promote heritage awareness, but it is currently closed and not in use, and the Khatahtbe raba' also underwent reuse, but it was unsuccessful.

The focus of B strategy is on the streets with blue degrees colored areas. Where there are low values for the kernel density (KDE) of historic buildings and high values for space syntax analysis. They can be divided into streets that are outside of the city's historic core or the heritage area, which is suitable for serving as local markets for inhabitants. Streets that are close to the historic center serve as auxiliary routes that connect the city's urban areas to the heritage or historic areas that surround them.

AlFath Street represents the border that separates the historic area and the rest of the city. It additionally connects between the north and the south of the city. Because of its high value for space syntax analysis, it can attract many people and is therefore suitable for developing commercial and tourism activities. It has the potential to be a major tourist corridor and can be provided with many tourist services such as shops, restaurants, etc. considering improving the condition of the street and developing it to suit the movement of tourists. This is also possible in the first section of AlQadabe Street (from the city's entrance and railway station to AlFath Street), ElGomhoreya Street, and AlSheikh Rayyan Street, which both connect AlQadabe Street with the historic area.

As for the streets in the area in purple. Because of their high kernel density (KDE) of historic structures and low space syntax analysis values, these streets area are classified as belonging to strategy C. These areas' street networks have the potential to be developed, and some of them could even be transformed into secondary heritage corridors that connect areas of different heritage value within the city's historic center, With the need to essentially keep the current network and without affecting heritage conservation. The social, cultural, and historical values, customs, and traditions of the region should be respected as well. Street connectivity can be increased by increasing the connection between the street and its neighboring streets or by creating corridors through demolished buildings to connect with the surrounding streets. Enhancing the connection between street areas through increased spatial permeability improves the tour path index. Secondary alleys should enrich tourists' senses in different ways.

The streets of the areas shown in green are in the strategy range D, where the average value is for both space syntax analysis and kernel density (KDE) of historic buildings. Improving and developing the street network in these areas can increase integration and connectivity value. The street can become a secondary tourist corridor while conserving its cultural, historical, and social values by improving the connection between it and other sites. To attract tourists, it should also have stores and restaurants. ELGaish Street is the most important of these streets.

In terms of the areas included in strategy E (color red), both space syntax analysis and kernel density (KDE) of heritage buildings show low values. They are streets and alleys for indoor living where residential areas, schools, and other non-tourist areas are located. They serve life and work. This type is hard for tourists to reach. As for the residents, it is the main place for daily activities, at the same time the low integration corridors also guarantee privacy for the residents' lives.

4. Conclusions

Heritage buildings in historic areas are considered the main cultural resource for tourist attractions. Its spatial distribution has a significant effect on tourists' movement and pedestrians' paths. They are the most important attraction element in the spatial system for historic areas. While tourist services and facilities represent complementary elements that support tourist attraction. But they must be available appropriately for the comfort and safety of tourists, with an emphasis on conserving the identity, personality, and culture of these areas and not affecting their visual vision. To achieve sustainable development of tourism in cultural heritage areas, it is necessary to maintain a balance between tourism and conserving cultural heritage areas.

By combining spatial data, it is possible to create different classifications of urban areas based on the spatial, functional, and physical characteristics of the built environment. This will help develop strategies and plans for tourism development in cities rich in architectural and urban heritage.

The research proposed a new framework for dealing with heritage areas and their tourism development based on combining the spatial data produced by depthmap and GIS. The quantitative analysis of both space syntax and kernel density estimation (KDE) for heritage buildings was aggregated to create a set of strategies that encourage sustainable heritage tourism in historical areas and cities and improve tourists' spatial perception. It also enhances the vitality of the city's old historical center. The proposed

framework was conducted on Fuwah city, Kafr El-Sheikh Governorate in Egypt, which is the third city in Egypt that contains Islamic cultural heritage after Cairo and Roset-ta. The research results and the proposed framework are not limited to a specific region but can be applied to numerous historical cities around the world. Urban designers and heritage stakeholders can use it in studies of urban formation and submit proposals for the renewal of historical city centers in general and those that have lost their tourist importance in particular. It is easy to implement to improve policies for protecting and renovating heritage areas and meeting the realistic needs of both residents and tourists.

It is worth noting that analysis of both the syntax and kernel density of heritage buildings was used to provide key guidelines that decision-makers can follow to develop and revitalize tourism in historic city centers. However, in developing detailed plans and accurately determining project locations, a group of other factors must be included, such as land uses, building conditions, locations of available lands, street widths, and infrastructure. Therefore, the research recommends adding these factors to future studies.

References

Abdallah, A. (2017). فوه "مدينة المساجد".. تضم 365 جامعًا بعدد أيام العام وتشتهر بصناعة السجاد اليدوي والكليم ومقصد السياح. *Al-Ahram daily newspaper*.

Abdo, M. (2010). *space syntax as a tool for studying the spatial structure of the city*. Cairo University.

Ahmed Shabaan Samra, M. (2022). Using Heritage Sites at Bahariya Oasis on the Tourism Urban Development. *MEJ. Mansoura Engineering Journal*, *47*(3), 60–68. https://doi.org/10.21608/bfemu.2022.254424

Alalouch, C., Al-Hajri, S., Naser, A., & Al Hinai, A. (2019). The impact of space syntax spatial attributes on urban land use in Muscat: Implications for urban sustainability. *Sustainable Cities and Society*, *46*, 101417. https://doi.org/10.1016/j.scs.2019.01.002

Aldauji, M. H., Abdallah, H. S., & Galal, E. W. (2010). The Effect of Morphological Changes in Urban Fabric on its Syntactical properties - A Case Study in Mosul Old Suq. *Iraqi Journal of Architecture and Planning*, *9*(19), 348–362.

Alkurdy, S. (2021). خبير يطالب بإعداد ملف لتسجيل «آثار فوة» كتراث عالمي باليونسكو| صور. *Akhbar El-Yom Newspaper*.

Al-Romeedy, B., & Elzek, Y. (2017). Sustainable tourism planning as an entry point for achieving sustainable tourism development in Egypt. *Journal of Economics and Law*, *1*, 41–59.

Basil, A., & Salim, H. (2016). The Syntactical Analysis of Urban Structure Using Space Syntax Theory. *Journal of Planner and Development*, *21*(1), 18.

Bilge, I. (2016). Space Syntax Strategies: A Lesson from Iranian Traditional City, Case Study is Kashan. *A+ Arch Design International Journal of Architecture and Design*, *2*(2).

Budde, R. (Ed.). (2019). Kernel density analysis – A tool for the visualization of spatial patterns in regional studies. In *Robust-Workshop in Essen; 2019*.

Data classification methods—ArcGIS Pro | Documentation. (2023).

Dong, Y., Jiang, Y., Quan, D., & Zhu, H. (2022). Study on the Heritage Corridor Construction of the Western Han Dynasty Mausoleums Region. *Current Urban Studies*, *10*(01), 55–72. https://doi.org/10.4236/cus.2022.101004

Edwards, D., & Griffin, T. (2013). Understanding tourists' spatial behaviour: GPS tracking as an aid to sustainable destination management. *Journal of Sustainable Tourism*, *21*(4), 580–595. https://doi.org/10.1080/09669582.2013.776063

El Ibiary, N. (2006). *Urban Growth of the Egyptian cities and its influence on the Monumental sites*. Tanta University.

Elagouri, F., & Karakale, W. (2010). Structural analysis of some desert cities using space syntax technique Case studies: Tripoli, Benghazi, Sebha, Agdames, Ghat. *The 8th International Architectural Conferences*.

Ghanam, R., & Abdo, H. (2021). Introduction to sustainable preservation of antique buildings ... A case study of civil heritage buildings in the city of Fouh - Kafr Al sheikh governorate. *Journal of Architecture, Arts and Humanities*, *6*(27), 756–778. https://doi.org/10.21608/mjaf.2020.26852.1559

Has, A. C. (2022). Determining Density in the Historical Region with Space Syntax Analysis, Erzurum City Center Example. *Forestist*, *72*(3), 299–312. https://doi.org/10.5152/forestist.2022.21045

Hillier, B. (1996). *Space is the machine: a configurational theory of architecture* (1. publ). Cambridge Univ. Press.

Hillier, B. (2008). *Bill hillier mapping method: Basis of space syntax technique*. Space Syntax Laboratory.

Hillier, B., & Hanson, J. (1984). *The Social Logic of Space* (1st ed.). Cambridge University Press.

Kádár, B. (2012). Spatial patterns of urban tourism in Vienna, Prague and Budapest. In *Metropolitan Regions in Europe* (pp. 277–312). Austrian-Hungarian Action Found.

Lerman, Y., & Omer, I. (2013). The Effects of Configurational and Functional Factors on the Spatial Distribution of Pedestrians. In D. Vandenbroucke, B. Bucher, &

J. Crompvoets (Eds.), *Geographic Information Science at the Heart of Europe* (pp. 383–398). Springer International Publishing.

Li, D., Yan, X., & Yu, Y. (2016). The Analysis of Pingyao Ancient Town Street Spaces and View Spots Reachability by Space Syntax. *Journal of Data Analysis and Information Processing*, *04*(04), 177–186. https://doi.org/10.4236/jdaip.2016.44015

LI, J., & DUAN, J. (2004). Multi-scale representation of urban spatial morphology based on GIS and spatial syntax. *Journal of Central China Normal University (Natural Sciences)*, *38*(3), 383–387.

Li, Y., Xiao, L., Ye, Y., Xu, W., & Law, A. (2016). Understanding tourist space at a historic site through space syntax analysis: The case of Gulangyu, China. *Tourism Management*, *52*, 30–43. https://doi.org/10.1016/j.tourman.2015.06.008

Mansouri, M., & Ujang, N. (2017). Space syntax analysis of tourists' movement patterns in the historical district of Kuala Lumpur, Malaysia. *Journal of Urbanism: International Research on Placemaking and Urban Sustainability*, *10*(2), 163–180. https://doi.org/10.1080/17549175.2016.1213309

Martínez Yáñez, C., Maclaren, F., Smith-Christensen, C., Gowen, M., Donovan, J., Kelly, I., Millar, S., Fonseca, S., Deyá, T., Bhattacharya, A., & Hiriart Pardo, C. A. (2022). *ICOMOS International Charter for Cultural Heritage Tourism (2022): Reinforcing cultural heritage protection and community resilience through responsible and sustainable tourism management.* ICOMOS Annual General Assembly (Bangkok, Thailand) in November 2022 = ICOMOS International Charter for Cultural Heritage Tourism (2022): styrkelse af kulturarvsbeskyttelse og samfundsresiliens gennem ansvarlig og bæredygtig turismeforvaltning Vedtaget af .

Mohamed, R. (2017). *The strategy of tourism development in land use Case study – North-Western region of Syria*. Aleppo University.

Mutlaf, H. (2016). Tourist Expansion Areas and Tourist Sites Between the Application Requirements and The Investigation Difficulties, Timgad (Mauri) Model. *Journal of Social Sciences and Humanities*, *35*, 13–44.

Nes, A. van, & Yamu, C. (2021). *Introduction to space syntax in urban studies*. Springer.

Osmond, P. (2005). Evaluating urban ambience-an investigation into quantifying the qualities of the walkable city. *The 6th International Conference on Walking in the 21st Century*.

Özer, Ö., & Kubat, A. S. (2007). Walking initiatives: a quantitative movement analysis. *6th International Space Syntax Symposium*, 1–13.

Pedersen, A. (2002). *Managing tourism at world heritage sites: A practical manual for world heritage site managers.* UNESCO World Heritage Centre.

Penn, A., Hillier, B., Banister, D., & Xu, J. (1998). Configurational modelling of urban movement networks. *Environment and Planning B: Planning and Design*, *25*(1), 59–84. https://doi.org/10.1068/b250059

Planning, G. A. for U. (n.d.). *A project to prepare the general strategic plan for the city of Fuwah, Kafr El-Sheikh Governorate*. Ministry of Housing, Utilities and Urban Communities.

Shateh, H., bin-Dou, S., & Alzawi, N. (2017). The impact of historical transformation on the spatial and functional transformation of the urban environment. *Journal Of Alasmarya University*, *2*(1).

Topcu, M., & Kubat, A. S. (2012). Old and new city: morphological analysis of Antakya. *8th International Space Syntax Symposium*, 1–16.

Turner, A., Doxa, M., O'Sullivan, D., & Penn, A. (2001). From Isovists to Visibility Graphs: A Methodology for the Analysis of Architectural Space. *Environment and Planning B: Planning and Design*, *28*(1), 103–121. https://doi.org/10.1068/b2684

Van NES, A., BERGHAUSER PONT, M., & MASHHOODI, B. (2012). Combination of Space syntax with spacematrix and the mixed use index: The Rotterdam South test case. *8th International Space Syntax Symposium*.

Wang, M., Yang, J., Hsu, W.-L., Zhang, C., & Liu, H.-L. (2021). Service Facilities in Heritage Tourism: Identification and Planning Based on Space Syntax. *Information*, *12*(12), 504. https://doi.org/10.3390/info12120504

Wu, J., & Yuan, Q. (2019). Space Syntax and Walking in a Historic Waterfront Neighborhood-Case Study of Shang Hai Hong Kou Port. *Cities as Assemblages*, 271–279.

Wu, R., Zhang, H. L., Zhang, J., Chen, X., Zhang, S., & Yan, B. (2014). Micro-scale spatial structure and spatial associations of urban historical and cultural tourism destinations: A case study of Confucius Temple, Nanjing. *Geographical Research*, *33*(12), 2427–2436.

Xiong, Q., Zheng, Y., & Zhang, B. (2022). Optimization Strategy of Commercial Space in Xianyukou Hutong Based on Kernel Density and Space Syntax. *Journal of World Architecture*, *6*(6), 40–48. https://doi.org/10.26689/jwa.v6i6.4510

Xu, Y., Rollo, J., Jones, D. S., Esteban, Y., Tong, H., & Mu, Q. (2020). Towards Sustainable Heritage Tourism: A Space Syntax-Based Analysis Method to Improve Tourists' Spatial Cognition in Chinese Historic Districts. *Buildings*, *10*(2), 29. https://doi.org/10.3390/buildings10020029

Yamu, C., Van Nes, A., & Garau, C. (2021). Bill Hillier's Legacy: Space Syntax—A Synopsis of Basic Concepts,

Measures, and Empirical Application. *Sustainability*, *13*(6), 3394. https://doi.org/10.3390/su13063394

Ye, Y., & Nes, A. V. N. (2014). Quantitative tools in urban morphology: combining space syntax, spacematrix and mixed-use index in a GIS framework. *Urban Morphology*, *18*(2), 97–118. https://doi.org/10.51347/jum.v18i2.3997

Zhai, W., Bai, X., Shi, Y., Han, Y., Peng, Z.-R., & Gu, C. (2019). Beyond Word2vec: An approach for urban functional region extraction and identification by combining Place2vec and POIs. *Computers, Environment and Urban Systems*, *74*, 1–12. https://doi.org/10.1016/j.compenvurbsys.2018.11.008

زهير, ا. (1978). *وصف مصر - المدن والأقاليم المصرية*. مكتبة الخانجي،.