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Regeneration of Routes in Cities to Meet Pedestrian and Two-Wheeler Demands by Utilizing Space Syntax Theory

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1 ABSTRACT

The rapid growth in cities has led to new city patterns specially in third world countries. With the development and progress in technology, new demands have appeared. The future of technology and the digital transformation have led to the request for faster and cheaper means of transport that need to fulfill new demands. One of these challenges is the usage of two wheelers to quickly support delivery demands in crowded cities. In addition no pedestrian routes are considered. Modification in the infrastructure needed to be done to meet these demands. In this study the coastal city of Alexandria in Egypt is studied as an example of a quick expanding city. First, investigation of the direct impact of currect routes on the built environment whether main or secondary routes two-wheelers movement is done. Followed an analysis of integration and choice of current routes in order to help in suggesting safe pedestrian and two-wheeler paths and roads. The research aims at providing regeneration of roads in cities and for guiding the design of new ones in existing projects based on simulation results. Green and energy saving is what is needed to collaborate with the digital era. The significance, magnitude, and consistency of integration and choice measures justify their relevance in built infrastructure interventions to promote pedestrian and two wheelers. The main aim of this study is to optimize decision making by using the space syntax theory. The research aims at providing a pilot sample of responsive routes in existing cities and for guiding the design of new ones in the future.

Keywords: space syntax, Pedestrian, bicycle, regeneration, city planning

2 INTRODUCTION

2.1 Routes in Cities for Pedestrian and Two-Wheelers

Currently, vehicular; two-wheelers; and pedestrian flow are inevitably overlapped in old cities. To solve the problem of their overlap, interface and match a study must be made to study optimal location of their interaction in order to suggest parking areas for vehicles and two-wheelers. Considering in mind that two-wheelers can be bicycles whch is a green mode of transport or motor cycles which are treated as vehicles. Followed is to provide a suggested suitable walkable pedestrian flow, considering other transport modes as well as. This will also lead to preserving some urban old historic cities from traffic; thus, increasing and diversifying transport modes, so as to offer suitable alternatives to easier transport modes such as two-wheelers and suggest safe pedestrian routes. In urban areas pedestrian routes are typically provided by a combination of sidewalks, carriageways and crossing points. “One specific example is the designation of pedestrian routes to schools” (Institute for Transport Studies, 2005). However, it is relatively uncommon for pedestrian routes to be planned and signed as a network. Pedestrian routes can also be shared with other users, most commonly with cyclists (Institute for Transport Studies, 2005). Cycling is considered “an extremely flexible transport mode, which makes it easy to combine with other transport modes” (Institute for Transport Studies, 2005). Therefore, it is fundamental to include cycling “infrastructure in mobility planning” considering that choice of transport depends on several factors (Institute for Transport Studies, 2005). These factors include time; reliability; flexibility; comfort; security; finances; and the environment which fall into the choice of bicycles and the two-wheelers ((Institute for Transport Studies, 2005).

2.2 Strategies for Pedestrian and Two-Wheelers

A city’s parking strategy can help support pedestrian and two-wheeler traffic. If there is a distance between the parking space and the destination more people will consider pedestrianization and two-wheelers an attractive transport mode. Pedestrianisation is known as a traffic policy that is intended to reduce the opposing environmental and safety effects of vehicles, to reclaim space for both pedestrians and non-traffic activities, and, to improve the urban environment (Institute for Transport Studies, 2022). In urban areas pedestrians are provided by a combination of sidewalks, carriageways and crossing points. An example is the designation of pedestrian routes to schools and educational facilities. Yet, it is relatively uncommon for

these routes to be planned and signed as a network. Nevertheless, the majority of pedestrian routes comprise road corridors which are footpaths along major highways; routes over land available for public use such as parks and river banks; and other public places. Pedestrian routes can also be shared with cyclists as has been previously mentioned. An image of a bike route and footpath with symbols along a bridge at a park in Poznan, Poland can be shown in Figure 1.

Fig. 1: An Image of a Bike Route and Footpath with Symbols Along a Bridge at a Park in Poznan, Poland (Source: Dreamstime, 2019)

On the other hnd two-wheelers presented by bicycles have taken a faster turning point. Several countries have already invested in improving its bicycle infrastructure. The expanding bicycle network and parking areas has been found to be a green sustainable economic mean of transportation. “In larger cities where rush hour congestion is an issue the bicycle will be perceived as a good alternative to the car in relation to travel time (Cycling Embassy of Denmark, 2018). To promote two-wheelers local authorities are to work with structure plans, as well as master plans. Here the focus is on the local area and how different local planning fields should work together to provide good land use and organize infrastructure, including the cycle track network. The mobility plan should help ensure good two-wheeler parking facilities at traffic hubs when transferring to another transport mode. There should be a focus on destinations such as schools, commercial areas, and all central areas. A focus area is the link to the primary cycle track and pedestrian network, in order to reach more outlying destinations such as traffic hubs and commercial areas with many workplaces.

The local authority’s various plans for the physical design of cities and local areas are crucial for the function of cities and local communities, including how to get from one place to another. Successful land use planning makes it easy and natural to move by two-wheelers or on foot. “However, there is a fine balance here since many functions in a small area may also mean traffic chaos if the area isn’t geared to traffic or if the design isn’t optimal” (Cycling Embassy of Denmark, 2018). This could have a negative impact on people who wish to use two-wheelers or walk in the area. As a result, there will be a need for many parking spaces since people will drive into the center shop, or to pick up children from schools. Architecture and mainly planning can play an important role in encouraging the use of two-wheelers. Cities equipped with safe two-wheeler lanes, parking lots, and pedestrian routes and facilties. This can encourage citizens ˝to refrain from using their cars and opt for a much more sustainable means of transportation” (Tommorrow City, 2021).

3 SPACE SYNTAX APPROACH

Space syntax, originated in the seventies of the last century by Bill Hillier and his colleagues at the Bartlett School of Architecture, University of London. Space syntax is ˝a theory and method for analysing spatial relationships“ (Akkelies van Nes et al., 2021). Hillier‘s contribution to understanding the built environment ˝through an operational method to analyze spatial relationships between built objects allowed for a new refined knowledge about the relationship between space and society“ (Yamu C. et als., 2021). It combines tangible factors with intangible factors.

For urban planning and design, space syntax can test the spatial effects of various urban design proposals and potentials. If the land use is affected by the volume and density of people in the streets, then space syntax ˝assesses the effects on the future potentials of street life that are connected to land use“ (Yamu C. et als., 2021). Thus, urban design proposals can be tested to give an indication of the potentials of vital urban street life. Space syntax can support decision-making for urban designs, allowing the creation of sustainable cities and communities.

In this study the axial analysis which reduces the grid into a system of lines is used (Hillier B. et Hanson J., 2009). In the space syntax theory, "spaces and routes could be ranked from most integrated to most segregated based on the integration analysis" (El-Darwish I., 2022). The more "integrated space or a route is the more likely it is to be a destination location for it is easier to reach" (Hillier B., 1996). It is important to distinguish between local and global integration first. Axial integration estimates the degree of accessibility that a street has to all other streets in the urban system, taking into consideration the total number of directions (Yamu C. et als., 2021). Axial integration is strongly related to connectivity. The fewer the direction changes of a certain street to all other streets in the system, the higher its integration, hence its inter-accessibility (Yamu C. et als., 2021). Figure 2 illustrates an axial map (b) and a global axial integration analysis (c) of the settlement (a) and the justification graph (d), with the root node A representing the main street.

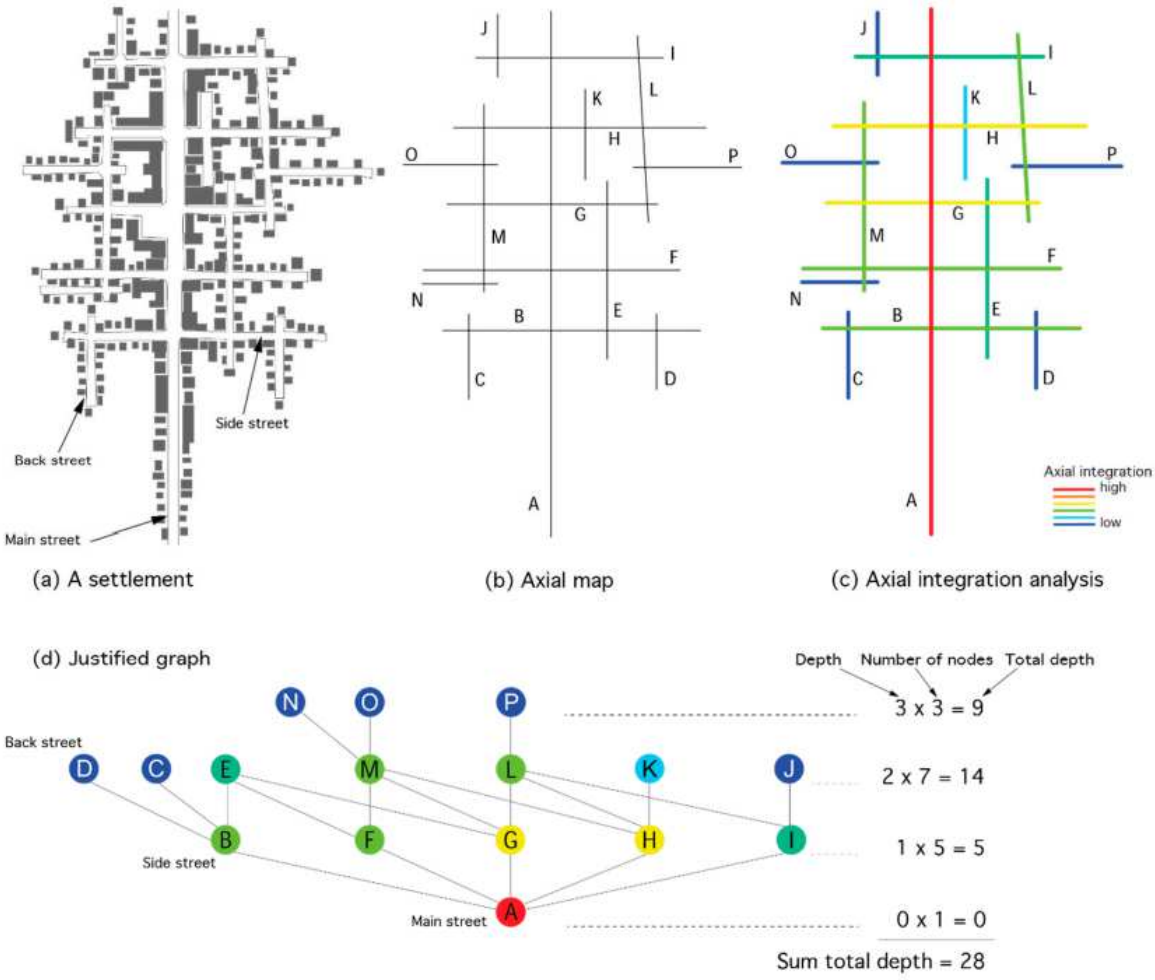

Fig. 2: An axial map (b) and a global axial integration analysis (c) of the settlement (a) and the justification graph (d), with the root node A representing the main street. (Source: Yamu C. et als., 2021)

Another analysis is the Choice analysis that shows how much a route could be used as being the shortest path from and to all other routes (Al-Sayed K., 2018). Choice is the potential of through movement, a route is chosen for movement from all routes to all others. Choice measures how likely ˝an axial line or a street segment is to be passed through on all shortest routes from all spaces to all other spaces in the entire system or within a predetermined distance (radius) from each segment" (Hillier B. et als., 1987). Figure 3 demonstrates the depth analysis in two differrent roots, which is the base idea of integration analysis and shows how choice is calculated (Source: Mohareb N., 2019).

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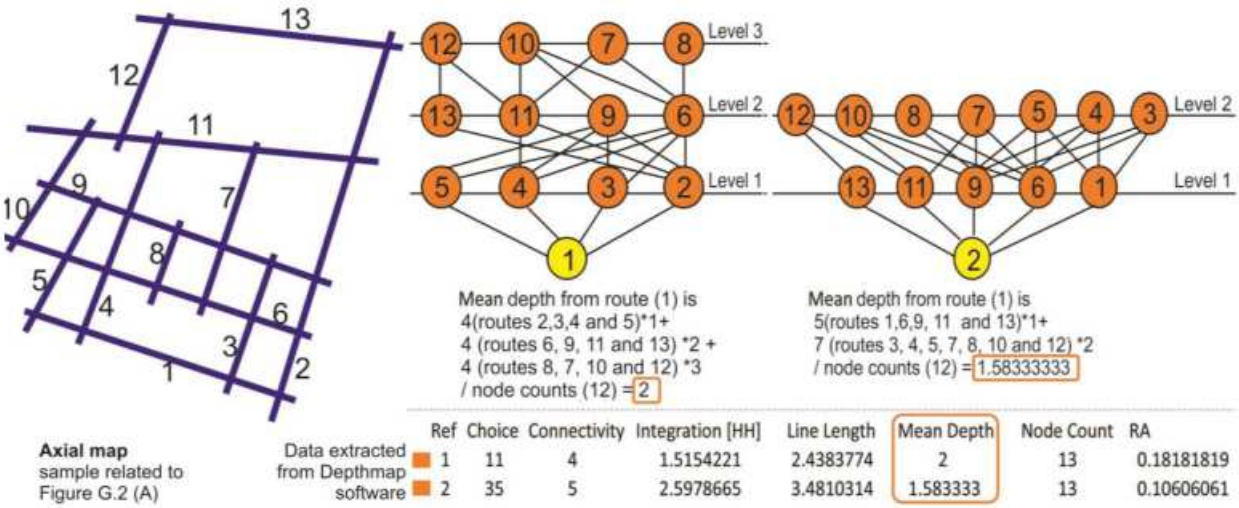

Fig. 3: The Depth Analysis in Two Differrent Roots (Source: Mohareb N., 2019)

4 CASE STUDY

This study focuses on the historical city of Alexandria, Egypt. By using Depthmap for applying the space syntax theory routes are suggested based on intersections and many other analysis for both pedestrians and two-wheelers due to their importance. Mixed pedestrian, two-wheelers and vehicles are shown in the eight different views of various routes located in the sample area of the study showing mixed modes (Figure 4).

Fig. 4: Views of Eight Different Streets Showing Mixed Modes (Source: Author)

This experimental research using an inductive approach starts by studying a sample of a residential area in Alexandria, Egypt. An ariel view of Stanely bridge a main feature of the study area in Alexandria, Egypt can be seen in (Figure 5). By testing the study area's routes utilizing the space syntax theory parking areas are suggested in order to be able to choose and provide two-wheelers and pedestrian routes. Followed the Space Syntax theory is again applied to check differences to help in decision making in the choice of pedestrian and two-wheelers routes.

Fig. 5: View of Stanley Bridge, Alexandria, Egypt (Source: (The Arab Contractors, 2019)).

5 METHODOLOGY

A configurational approach is faced with suggesting parking locations, taking space into action. First, the urban grid provides the required information about its uses, and therefore could help in proposing the location of parking areas, considering the movement behavior along its paths for the transfer from vehicle to the pedestrian/two-wheeler tracks. The first step of the work is to create two different plans of three neighborhoods in the East district of Alexandria, Egypt. A terrain view of Alexandria, Egypt showing the study area is shown in (Figure 6). (Figure 7) shows the study area consisting of three neighborhoods in the East district of Alexandria, Egypt. The plan is then reduced into sets of straight paths, named axial maps. Such axial maps are further transformed into segment maps, "suitable for allowing the adoption of a metric length for the radius and a more intuitive understanding of the results" (Turner A., 2007). (Figure 8) shows the defined cores in the grid of the study area: vehicular (a) Choice core, (b) Integration core. The normalization step is then acted, in order to be able to graphically overlap the results coming out of the analysis, in view of the fact that the analysis for the pedestrians (R= 1000 m) and for the vehicles (R= 8000 m).

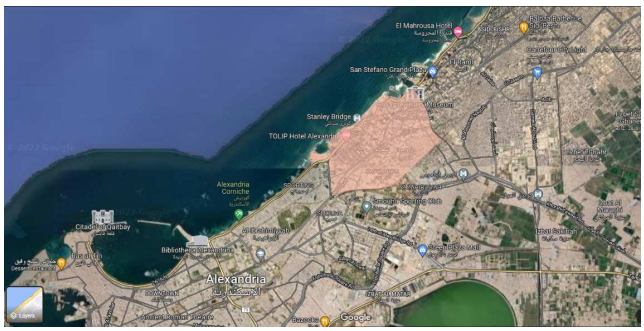

Fig. 6: A Terrain View of Alexandria, Egypt Showing the Study Area (Source: Adapted from Google Earth).

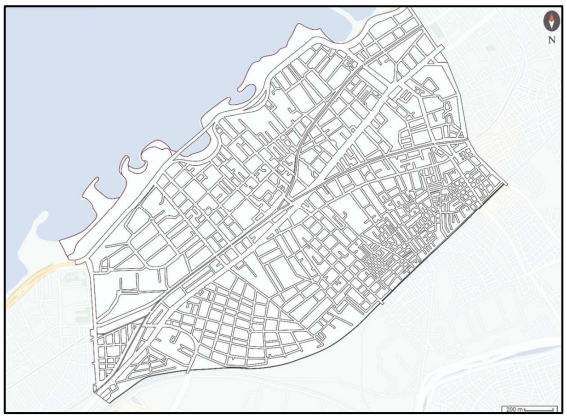

Fig. 7: The Study Area Consisting of Three Neighborhoods in the East District of Alexandria, Egypt (Source: Author).

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Fig. 8: The Defined Cores in the Grid of the Study Area East Alexandria, Egypt: Vehicular (a) Choice Core, (b) Integration Core (Source: Author).

Areas, highly affected by different traffic modes, are hence suggested to be suitable for the location of parking. In order to verify the level of proximity of those locations to schools, commercial areas and main public facilities of the selected residential study area located in the East district of Alexandria, Egypt, the pedestrian and vehicles Choice cores are overlapped to the Integration core, computed according to a local (R= 3) radius of Integration. (Figure 9) shows the different landuse of the study area.

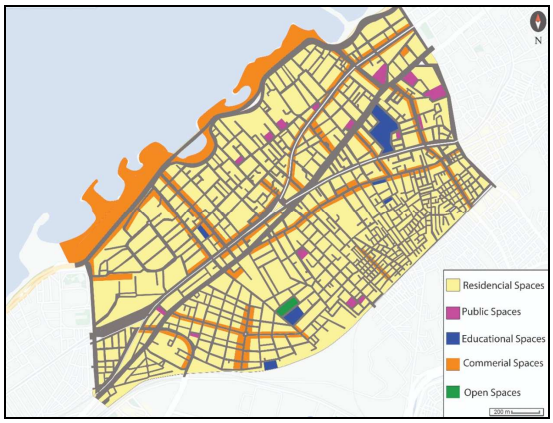

Fig. 9: The Different Landuse of the Study Area (Source: Author)

6 RESULTS

The main results are summarized in (Figure 10) where most of the suitable location for parking sites appear based on the map in (Figure 8) (a) and (b) which represent the actual result of the interception between the pedestrian Choice core (R= 1000 m), the vehicular Choice core (R=8000 m) and the Integration core. The most suitable location for parking sites appears according to the pivoting areas around different movement flows, as a point of conjunction of several important streets and the land use. And from subjective observation of mixed uses found everywhere as shown in (Figure 9). In this study only significant uses are considered and merged with the Choice and Integration core results. Based on the suggested pedestrian/two-wheelers routes and parking locations of the study area another analysis is done for vehicular (a) Choice Core, (b) Integration Core as shown in Figure 11. From Figure 11 it can be seen that choice results did not differ a lot but some routes became more integrated. If highly integrated could cause traffic congestion in peak hours which was not considered in the study. More designs could be tested in further studies to reach ultimate proposals based on configuration analysis applyin space syntax theory which is considered a powerful tool. One of the drawbacks is that traffic can differ at different hours and different seasons which cannot be measured by the space syntax theory but surely it could comapre between different design proposals.It is also important to highlight on the waterfront sidewalks, where people stroll along the seaside overlooking the sea and where various points of interest like restaurants, entertainment centres, sports facilities, and beach properties are located and adjacent to it. For this cause sidewalks and traffic lights are enough for two-wheelers and pedestrians considering that the waterfront of linear Alexandria is one of its main features.

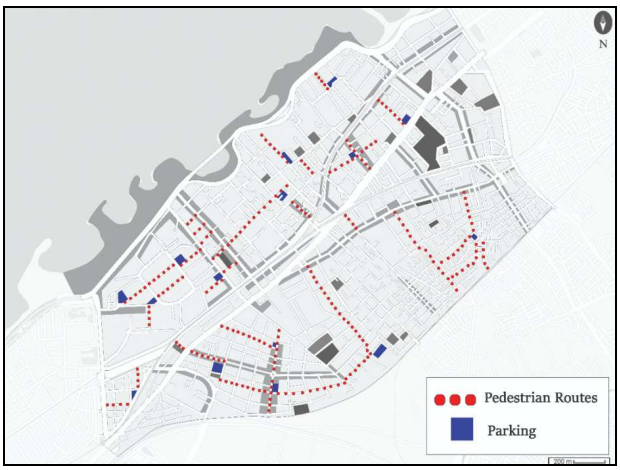

Fig. 10: Suggested Location for Parking and Pedestrian/Two-wheeler Routes (Source: Author)

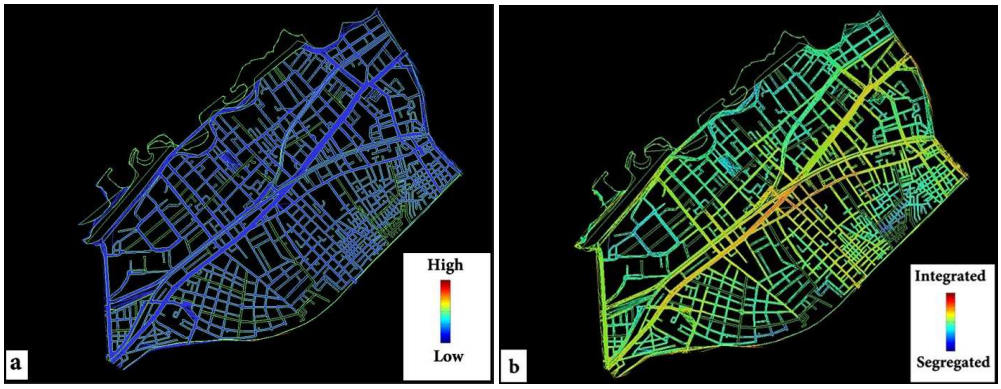

Fig. 11: Based on the suggested parking and pedestrian/two-wheelers routes of the Study Area East Alexandria, Egypt: Vehicular (a) Choice Core, (b) Integration Core (Source: Author).

7 CONCLUSION

This research shows how space syntax can powerfully be used to help select the location for pedestrian/two wheeler routes and parking sites, providing results that appear to narrowly correspond to the actual situation. It is worth underlining that this research is merely a theoretical study that aims at testing a method for identifying possible for pedestrian/two wheeler locations, which could sometimes not be applicable for actual old cities design but some uses can be modified,and because of the presence of buildings that could not be removed or demolished. However, this study can help in suggesting pedestrian and two-wheelers routes based on the results, when accompanied and sustained by the outputs of traffic models and their details. The suggested location for pedestrian/two wheelers and the parking zones, using Space Syntax theory in the case of part of East Alexandria is a reliable tool for concretely supporting planning and decision-making. Furthermore, a similar approach can be easily extended to suggesting routes and the location of other urban activities, differently related to the distribution and influence of other vehicles and transportation movement.

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