Reading of Yas Island 2020 Master Plan in Terms of Accessibility and Walkability by Using Space Syntax

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Abstract. The concept of walkability in cities has been spreading wider with time and even more rapidly during the past decade. Due to several factors, including climate change and human well-being, expanding the walkability within cities as a substitute for vehicular means of transportation has become a very noticeable change in cities around the world, and in Abu Dhabi city in specific. When it comes to entertainment and tourist destinations, walkability plays as a main factor in enhancing the experience of the users in that area of the city. Yas Island has become one of the main focal points in Abu Dhabi city, and the various and important landmarks, mostly recreational, are placed on the island adjacently and very close to each other, with the hospitality facilities, in a way that encourages the factor of walkability to be added, and therefore enhancing the overall experience of the visitors within the island. The most common Axial Map analysis methods of a street network that were used are Integration, Choice, Mean Depth, and Connectivity, and space syntax is based on four those basic conceptions of space. Using a program named 'DepthmapX,' that was built on mathematical methods and geographical computer technology, we ran different simulations on Yas Island 2020 street network map to get the four main axial maps. In the context of the island being an urban and dynamic system, the study focuses on simulations of street networks as well as spatial integration for urban walkable regions of different areas of the island. The analysis, at the beginning, aimed to read the simulations to translate the findings, then went in depth on highlighted areas on the street network maps that had critical information that identifies zones for improvement related walkability and spatial integration. The outcome of the analysis, the streets that circulate and revolve around Yas Island's major tourist attractions become extremely segregated and less interconnected. To reach the surrounding closeted tourist attraction it is easy to reach by foot, yet difficult across the island with such hot weather in Abu Dhabi. It also calls for the revision of currently vacant property and the reconsideration of high-connectivity regions, which were originally intended to be solely residential neighborhoods, into more public and communal spaces. This paper demonstrates the usability of space syntax in defining/assessing the accessibility of spaces, its role and importance in mobility and urban planning for the case of Abu Dhabi.
1. Introduction
Abu Dhabi has developed a 2030 vision that aims towards three main goals: sustainability, diversity, and high value-added economy. With the Abu Dhabi 2030 vision, the government has made a significant effort in making that vision into reality by 2030, and this included a plan for redevelopment of the urban lifestyle into a more sustainable one, which has led to the need of a redevelopment of the urban design of the city.

The public demand and the need for more sustainable urban development played a great role in leading the concept of walking and walkability to become a prominent element in urban design. The need to minimize air pollution and carbon emissions per capita, as well as the exhausting traffic stress that urban centers experience, have boosted popular support for better urban design that focuses on enhancing and infusing walkability and active transportation. Moreover, Walking and riding have been identified in health studies as methods that aid physical rehabilitation and minimize modern chronic diseases such as obesity, diabetes, and hypertension, as well as mental health and depression. Furthermore, the concepts of liveability of local communities, as well as sustainability and its three pillars: economic, social, and environmental, are all intertwined with walkability and walking [1].

In an urban setting, Space Syntax is developed to measure relationships. The two main criteria for those relationships are ‘to movement potential’ between street segments and ‘through movement potential’ of street segments in relation to one another. Because of how computer models can be made fast and with a great degree of accuracy, computer technology has permitted the use of space syntax in larger urban contexts [2].

The spatial analysis results can be compared to a large variety of socioeconomic data, such as pedestrian flow rates, property values, crime distribution, placement pattern of urban functions (shops, homes, etc.), degree of building densities, and so on. There are links between degrees of geographical integration and various socio-economic indicators, according to global study. As a result, space syntax is increasingly being used in urban design and redevelopment, as well as in enhancing wayfinding in complicated buildings (such as museums, art galleries, hospitals etc) [3].

The study focuses on simulations of roadway networks as well as spatial integration for urban walkable sections of different areas of Yas island map 2020, in the context of the island being an urban and dynamic system. The analysis began by reading the simulations, using space syntax, in order to translate the findings, and then focused on highlighted locations on the street network maps that contained crucial information then identified zones for improvement in terms of walkability, sustainability, and spatial integration.
2. Methodology
Yas Island was chosen as the study area because it is one of Abu Dhabi’s most prominent places, with world-class multi-purpose leisure, shopping, and entertainment activities. Benoy created the master plan for the 2,500-acre leisure island. It features a 32-kilometer beachfront frontage. The island is conveniently placed between Dubai and Abu Dhabi. The 1.1-kilometer Yas Tunnel Road and motorways connect it to the mainland. Several tourism sites, business centers, and entertainment venues are included in the master plan [4].

Figure 1. Land use of Yas Island 2020 map.

Figure 2. Aerial-Satellite View of Yas Island 2020 map.

The current Yas Island plan is being developed in alignment with Abu Dhabi 2030 Vision which aims to improve the standard of living for all residents and visitors to the Emirate by establishing lively, mixed-use communities and providing a varied range of housing options. The Estidama sustainability program is at the heart of Vision 2030, ensuring that developments are environmentally, economically, socially, and culturally sound [5].

Yas Island was chosen based on the Space Syntax analysis and simulations performed with the software DepthmapX. Connectivity, Integration, Choice, and Depth Distance are the most often utilized space syntactic analysis methods for a street network.

- **Connectivity** measures number of spaces that are immediately connected to a point of origin [6].
- **Integration** measures the numbers of turns one needs to make from a street segment in order to arrive at all other street segments in the network while taking the shortest paths. Inspection of integration can also take place at the local scale as opposed to the scale of the entire network. In theory, the integration measure displays the cognitive complexity of reaching a street and is frequently argued to anticipate the pedestrian use of a street.
- **Choice** measure is most easily described as a ‘water-flow’ in the street network. Streets containing the highest total values of accumulated flow are said to possess the highest choice values. While Choice analysis may be constrained to limited local radii along the lines of Integration, understanding it is much more challenging. These values are often argued to determine the car traffic flow of streets.
- **Depth Distance**, the most intuitive of the three analysis methods, describes the linear distance from the center point of each street segment to the center points of all the other segments. Streets carrying the lowest Depth Distance values are considered to be nearest to all the other streets. Like Integration and Choice, the search radius can be restricted to any distance [7].

The 'Axial Map' type was used to study and analyse the Yas Island 2020 map. We chose Axial Map as our analytical method because it is simple to read and comprehend the results. The analytical method in this case refers to the process of calculating the shortest path between the sources and destinations. Through most circumstances, distance has typically been used to determine the shortest journey in a city.
Axial lines are the longest lines of visibility in a street. Axial maps are made up of a collection of axial lines that form street connections. DepthmapX axial analysis generates maps based on its determined global integration measures. There are four layers in this map, each of which is described and labelled by its radius, or 'Radii.' R=2 and R=3, which determine local depth, are dispersed as 2 or 3 steps away from each element and are primarily suggested for walkable urban areas. In terms of the Radii, R=5 and R=7 is more commonly utilized to observe global vehicular movement.

The maps are illustrated in figures of two maps R=2 and R=3 in one figure, and R=5 and R=7 in one figure. In the figures also we highlighted the most significant data (colour) shown on map and labelled from ‘A’ to ‘D’. The results, as readable data, were distributed in tables below then the result description followed by them.

The maps are illustrated in separate figures. We also emphasized the most important data (colour) on the map, which is labelled from ‘A’ to ‘D’ in the figures. The results were illustrated in highlighted zoomed maps, with the result description following them.

The simulations generated Connectivity, Integration, Mean Depth, and Choice maps; however, due to page number constraints in this publication, we only presented Connectivity and Integration analysis for the 2020 Yas Island map, primarily due to the important readings and results in comparison to the other two types of maps.

3. Maps Analysis

3.1 Connectivity Map, R= 2

Figure 3. Yas Island 2020 Land Map – Connectivity for Radii = 2.

Most of the roads on the island have low connectivity values except in one area, which is the center of the island where the retail, Yas mall, is located. Due to the presence of tourist attractions and well-known landmarks, this area has a high population density. The roads, or shortest path is leading to the entrance to Yas Mall. All the other routes are different entrances and exits to the mall.

3.2 Connectivity Map, R= 2

Figure 4. Yas Island 2020 Land Map – Connectivity for Radii = 3.
The highest value in this radius is also located in Yas Mall’s entrance, which can be labeled as the easiest access and shortest path for visitors to reach the other accesses or sides of the mall. As for the surrounding roads that show medium values indicate difficulty in reaching the adjacent facilities in the same area by feet, especially with the heat weather in the UAE.

3.3 Connectivity Map, \( R = 5 \)

![Figure 5. Yas Island 2020 Land Map – Connectivity for Radii = 5.](image)

By vehicular movement radius 5. The most connected and shortest path is the intersection inside the parking area of Yas Mall. It expands to show medium to high values that connects to the main highway of the island which shows higher values by car rather than by foot.

3.4 Connectivity Map, \( R = 7 \)

![Figure 6. Yas Island 2020 Land Map – Connectivity for Radii = 7.](image)

For radius 7, with the higher perimeters for vehicular movement, shows higher values towards Al Maha Street, on the west side, where bus stops are available and easy to reach by foot from Yas Mall and Ferrari World, since both are the most famous tourist attracting landmarks on the island. The medium values expand around the same area, while on the contrary, the rest of the islands show longer roads indicating lower connectivity values.

3.5 Integration Map, \( R = 2 \)

![Figure 7. Yas Island 2020 Land Map – Integration for Radii = 2.](image)
The integration map with 2 steps away from each element by foot shows medium to low values all across the island. However, the highest medium integration values are centered in Yas Mall, as a retail place, and in the surrounding areas. This can indicate the safety of the areas and how easy it is to reach by foot because of how integrated they are with the surrounding street network.

3.6 Integration Map, \( R = 3 \)

![Figure 8. Yas Island 2020 Land Map – Integration for Radii = 3.](image)

As for radii 3, the values drop, showing significant change in the values, except in the access road of Yas Mall and some small roads surrounding the mall. In this radius, this may indicate that visitors or users may have difficulty to navigate, walking from one place or area to another due to the low integration of the surrounding street network. Due to the configuration of the roadways, it is impossible to reach across the areas on foot unless you enter retail establishments or go through open spaces or parking lots, indicating that just one part has very high integration.

3.7 Integration Map, \( R = 5 \)

![Figure 9. Yas Island 2020 Land Map – Integration for Radii = 5.](image)

As the radius increases to 5, for vehicular movement, most values of integration around the island indicate medium assimilation, therefore, medium integration of the street network by car. Nevertheless, the highly integrated areas are accessible by west of Al Maha Street to the main highway of Yas Island and connected to the surrounding roads, that shows it is easier to reach by car.
3.8 Integration Map, $R=7$

![Figure 10. Yas Island 2020 Land Map – Integration for Radii = 7.](image)

The final radius of 7, starts expanding the island’s integration values from medium to high, focusing towards the center and a bit of the highlighted part of Al Maha Street. The roads are highly integrated and connected show easy visibility and safer to reach by both, car, and foot. However, due to the planning of the street network, the importance is drawn towards the center, entertainment, and retail mainly, which explains the higher digits. Due to the proximity of the retail and recreational areas around the center, Yas mall, this area is quite active. The most segregated sections, indicated in dark blue, are residential and certain hotel sectors, as well as worker housing that is designed to be isolated, close to their workplace but away from the public and its traffic.

4. Overview

Based on the review analysis, the emphasis has shifted away from densely packed retail and entertainment districts and toward less densely inhabited residential regions. This is a problem since the streets that circulate and revolve around Yas Island’s major tourist attractions become extremely segregated and less interconnected. To reach the surrounding closeted tourist attraction it is easy to reach by foot, however very difficult across the island with such hot weather in Abu Dhabi and lacking shading pedestrian roads. More emphasis is being placed on streets that can accommodate significantly less traffic. In terms of the socio-economic impact, the challenge in access may deter some people from visiting Yas Island tourist attractions as frequently, unless by car or public transportation from outside the island, given that Yas Mall currently serves as the island’s bustling economic center, stimulating social interactions and retail activity.

5. Conclusion

To summarize what has been stated, it has been shown that Space Syntax and DepthmapX are incredibly useful tools in urban planning, allowing for the identification of areas that can be improved. According to the findings of the analysis, the 2020 Yas Island plan discovered a lack of walkable spaces in the island's busiest sections, necessitating alternative solutions to boost walkability in newer constructions in the remainder of the island's areas.

It also calls for the revision of currently vacant property and the reconsideration of high-connectivity regions, which were originally intended to be solely residential neighbourhoods, into more public and communal spaces. The retail and entertainment centers, as well as other focal areas on Yas Island, are centered around the central integration core, which is accessible by automobile but not by foot, showing poor connection for walkability.

Finally, the island’s street network focuses on the accessibility and transportation either by car or public transportation to reach in and out of the island, and from major areas around the island. Nevertheless, the walkable areas that are placed in the same type of land use are close enough to reach by foot yet lack shading areas from the harsh sun and high temperature, and only focuses on certain sides of the tourist’s attraction redeemed by car accessibility the most.
6. References

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