DEVELOPING AN AGENT-BASED MODEL OF PEDESTRIAN WAYFINDING TO CONDUCT THE BEST TOURISTIC PATH IN HISTORIC DISTRICTS

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DEVELOPING AN AGENT-BASED MODEL OF PEDESTRIAN WAYFINDING TO CONDUCT THE BEST TOURISTIC PATH IN HISTORIC DISTRICTS

Abstract
A historic district is a historic and cultural conservation area that reflects traditional aspects from the past. A sense of memorable pathway allows pedestrian to experience the city happily and attract touristic activity in urban historic districts. The characteristics of touristic districts which facilitate pedestrian movement help in determining the optimum track. The aim of the research is to create an agent-based model (ABM) to simulate the activity of pedestrians in historic districts in order to way find the best touristic paths. Using Space-Syntax, a simulation of the interaction of tourists with the attraction points in old districts pathway will be made in two different case studies located on North Lebanon. A comparison will be made between the simulation model results and field observation. Findings show that the results of the simulation are different than the real environment. The importance of the research is based on developing a framework that helps urban designers and individuals that are concerned with tourism to find the best factors that can affect tourist way-finding and thus being able to develop these districts.

Keywords
Agent-based Model, Wayfinding, Attraction Points, Tourists Movement, Pedestrian Flow
1. INTRODUCTION

A historic district is a historic and cultural conservation area that reflects traditional aspects from the past, such as social, economic, cultural, and lifestyle characteristics, as well as context (Lu Lu, 2015).

Historic urban areas are essential for establishing a sense of place as a memorable location with historic and social elements that attract economic and creative activity. As a result, the concepts of meaning, behaviors, and consequences influence the variety of patterns and forms of activities. Planning activities, opportunities for entertainment and social meetings, groups of physical experimentation, access, visual clarity, experienced freedom, sense of belonging, personalization domains, and even historical aspects are all factors to consider (Ragheb, 2021). Tourist activity can occur in the social, cultural, physical, and aesthetic elements of the city. Because attractions may be engaged with, this urban design alters visitor experiences (N. Giriwati, 2013). These old regions are associated with "intimacy of interactions and authenticity of experience," according to visitors. Heritage tourism is also viewed as a strategy since it promotes local culture while also expanding the seasonal and geographic area of general tourism. Tourism was first introduced to historic districts in western countries at a young age, and it has since played an important part in district preservation and economic rehabilitation (Lu Lu, 2015).

Every town, city, or urban region has intrinsic natural site, terrain, and man-made setting features that have potential stemming from its own natural shape, feeling of place, sense of history, spirit, and philosophy (N. Giriwati, 2013). Tourists can directly experience cultural landscapes, performances, local cuisine, handicrafts, and cultural activities from the past and present through heritage tourism. As a result, these regions are classified as a specific type of tourist destination (Lu Lu, 2015). The component that attracts tourists to a given city is known as the destination (N. Giriwati, 2013).

The spatial concept of a touristic destination is the existence of many factors, such as resources considered as the initial attraction in tourists’ experience, services that are able to enhance the visit and make it worth, the infrastructure component that will make tourists accessibility and mobility feasible (N. Giriwati, 2013).

So, in the following part the focus will be only on the urban factors of touristic destinations such as: Iconic and landmark buildings Entrances, Public Gardens and places to meet and talk, shaded areas and shaded pathways, etc…

2. ATTRACTION POINTS FOR URBAN WAYFINDING

In this part, a literature review on attraction points especially in urban historic districts, and the attraction features that make a district walkable, adding to how to way find using these features is done.

2.1 Attraction Features in Urban Historic Districts

Cultural needs, according to the UNWTO (United Nations World Tourism Organization), connect individuals with tourism locations, but they disregard the attractive impacts of cultural resources. Tourist demand and tourism destination resources, on the other hand, were also factors in tourism appeal (Haifeng Luo, 2021). The image that a tourism site projects is inextricably tied to its appeal; it shapes its competitive positioning and considerations. It's vital to realize that "attractiveness" isn't an objective concept, but rather the result of a broad market attribution with distinct subjectivity characteristics (Arturo Calvo Mora, 2011).

Due to the lack of more objective methodologies, one key issue with evaluating streetscape urban qualities aspects for pedestrian walks is the sometimes variable and unreliable estimates of streetscape features among different field surveyors, even with pricey training. Various interventions on the change of the built environment to promote walkable and livable streetscapes and neighborhoods are a possible strategy to solving this problem. Planners and urban designers can help shape the built environment to encourage walking. Many researchers created a field manual that included precise measuring techniques for categorizing street physical elements as well as detailed guidelines for field work and surveys that focused on the walking experience (Li Yin, Zhenxin Wang, 2016).
Researches that have studied the link between walking and the built environment focused only on specific points in macroscale (land-use pattern, street network qualities). Pedestrian-oriented design features such as crosswalks (e.g., crosswalk coverage rate, signal system, and crossing facility design benchmark), walkways (pavement rate, sidewalk dimensions), and roads (such as number of traffic lanes) width are all street-level streetscape markers that affect walking experience. Moreover, the existence and convenience of street crossings, aesthetic aspects (environmental beauty, availability of tree-lined roads), and existence of signals, as well as the presence of safety factors such as cleaning, intriguing views, and architectural design, motivate walkers (Ozbil, 2019).

Furthermore, physical characteristics have an impact on the quality of the walking environment, both directly and indirectly, through individual perceptions and sensitivities. Individual reactions to a place—how individuals perceive the conditions there, given their own attitudes and preferences—are different from urban design features such as sense of comfort, perception of safety, and degree of curiosity. All of these factors—physical characteristics, urban design aspects, and individual reactions—could have an impact on how people perceive the setting as a walking environment (Figure 1). Researchers can better define the relationship between physical elements of the street environment and walking behavior by evaluating these intervening variables (Reid Ewing S. H., 2009).

Ewing (2015) declared that more than 200 unique studies of the built environment and travel were reported in a recent meta-analysis. As a result, both the travel and physical activity literatures usually disregard the streetscape aspects that urban designers consider so crucial. At least six audit methods for monitoring the built environment that can be related to travel and physical activity are known to exist. In their measurement technique, all six contain—at least some—streetscape aspects. The Columbia University team, for example, examined 20 streetscape features, including the proportion of historic buildings, courtyards, piazzas, and parks, buildings with non-rectangular silhouettes, prominent landscape features, and so on.... (Annex 1). In their measurement technique, all six contain—at least some—streetscape aspects. The Columbia University team, for example, examined 20 streetscape features, including the proportion of historic buildings, courtyards, piazzas, and parks, buildings with non-rectangular silhouettes, prominent landscape features, and so on.... (Reid Ewing e. a., 2015).

![Physical Features](image1)

![Urban Design Qualities](image2)

![Individual Reactions](image3)

![Walking Behavior](image4)

Fig.1: Chart showing the factors that affect walking behavior (Author, n.d.)

Some studies measure other added features to improve pedestrian activity such as: disabled facilities, proximity between places of attraction, shaded spaces to sit and relax, air quality and thermal comfort (Juriah Zakaria, 2015).

### 2.2 Wayfinding Using Attraction Points

How people navigate from one place to another, including their information collecting and decision-making processes for orientation and movement through space, is referred to as wayfinding. According to Lynch (1960), wayfinding should be planned for first-time visitors because recurrent visitors can navigate using their previous experiences. Wayfinding designs that are well-designed alter over time when users change, buildings expand or are restored, outside improvements are made, or greater cultural shifts occur (Hunter, 2014).

The study of human navigation focuses on the mechanisms that occur when people orient themselves and navigate across space. Theories attempt to explain how humans navigate the physical world, what they need to navigate, how they convey directions, and how their verbal and visual talents affect wayfinding. Travel with the objective of reaching a
familiar destination, exploratory travel with the goal of returning to a familiar point of origin, and travel with the purpose of reaching a novel destination are the three types of wayfinding tasks identified by researchers. This paper focuses on landmark-based piloting, where success hinges on the ability to recognize attractions and follow the accompanying navigation directions correctly. The use of landmarks in human spatial thinking and communication depends on the visual, semantic, and structural appeal of characteristics in historic space.

- **Visual Attraction** consists of: percentage of void in the elevation, shape of the buildings, color palette of the materials, and visibility of the built environment
- **Semantic measures** include cultural and historical significance, as well as explicit markers.
- **Structural attraction:** consists of some very visited elements of the built environment. Ex: nodes, boundaries and regions according to Lynch (Raubal, 2017).

The landmark-based piloting will be realized by what Gordon Cullen called “Serial Vision” in 1961 classic Townscape. Serial Vision is about the following images observed by the pedestrian rather than from the birds’ eye view (Black, 2020). Serial Vision first shown after the emergence of computer aided design rather than CAD technologies. Serial Vision may be the animation done with computer systems in urban design (Peng, 2011). Landmarks have the power to attract tourists or pedestrians’ attention and guide them to their destination. To make this feasible, many principles come together. Serial Vision is based on working on a series of disclosures while maintaining interest and contrast in order to maintain stimulation and create a lively environment (Raphy, 2021).

To sum up, the research will focus on using different types of physical features and urban design qualities as input to way find the optimum touristic pathway in historic districts, taking into consideration one type of wayfinding which is attraction points-based traveling, these attraction points are defined by their visual attraction, semantic measurements and structural attraction too.

3. **METHODOLOGY**

The research is conducted through a **mixed method**: a quantitative approach at the beginning by a **simulation** of the optimum navigation track for tourists in old cities, then using a qualitative approach, the results will be tested by a **field survey** in different case studies to check if they are correspondent with the reality. The methodology of the research was divided in many phases.

- **Phase 1:** Establishing a framework of the urban qualities of a streetscape in order to identify the factors of the best touristic path through the literature review and identifying the factors which this research will be focusing on.
- **Phase 2:** Using the previous factors as input for the simulation done using ‘SpaceSyntax’ in order to have the best pedestrian track applied in different case studies, El Batroun historic city (touristic zone) and Mina old city (non-touristic zone).
- **Phase 3:** Checking tourists experience in the reality through an observation in the studied zones.
- **Phase 4:** Comparison between the simulation and the field observation and results analysis.

3.1 **Space Syntax and Agent Based-Model**

Space syntax is a set of techniques for analyzing spatial layouts and human activity patterns in buildings and urban areas. It is also a set of theories linking space and society. Space syntax addresses where people are, how they move, how they adapt, how they develop and how they talk about it (SpaceSyntax, 2021). DepthmapX is a part of Space Syntax and it is a complicated software program that specializes in running a number of spatial network analysis in order to help you understand the social processes taking place in the planned area. This application is based on the ‘Embodied Space’ idea, which explains the natural visual connection between a person and their surroundings. To put this hypothesis to the test, DepthmapX was created to allow you to design a model architecture that mimics the natural flow of patterns in buildings and cities. (SoftPedia, 2021)

ABM (agent-based modeling) is a new modeling approach, it is the relationship between an agent and its environment in general (Chen, 2012). (Figure 1) Because the concept of ‘agent’ is the most important aspect of ABM, it should be defined first (Russell, 1995).
Agents are computational systems that live in a complex dynamic environment, detect and act autonomously in it, and thereby achieve the goals or tasks for which they were created (Maes, 1995).

![Fig.2: An agent in its environment. (Chen, 2012)](image)

ABM provides a number of advantages over traditional modeling paradigms, making it particularly well suited to sociological research, notably urban studies and project management. The following are the most important benefits: ABM is a flexible model that captures emergent events, provides a natural description of a system, and captures emergent phenomena (Bonabeau, 2002). Understanding not just how people behave, but also how the interactions of many individuals lead to large-scale consequences in the urban system, is one of the most important responsibilities of urban analysts. This is referred to as "social science.” The scope of social science is fairly broad, encompassing practically all aspects of urban life, from segregation to land cover change. ABM is particularly well suited to social science modeling. ABM applies concepts and methods from social science and computer science to social processes. (Axelrod, 2010)

The main drivers of pedestrian activity, according to the evidence, are urban morphology and land use distribution, which are strongly correlated. Pedestrian wayfinding should start with a configurational analysis of the urban form and street network. Pedestrian flow volumes and distribution are significantly correlated with the topological hierarchy of natural streets, among other characteristics. Due to visual links and the topological hierarchy of the underlying living structures, these variables synthesize relevant topological and geometric patterns and produce the idea of natural movement and navigation. Using ABM as a methodology, we were able to determine the "desire lines" of travel for pedestrians, map the areas with the highest pedestrian demand, and map the most common pedestrian itineraries. Knowing the factors that influence the distribution of livable spaces, when applied to the formal process of city-making, would mean that pedestrian flow could be "intentionally" designed, for example, by strategically allocating amenities or aligning the design of the street network to the location of amenities. (Asriana, 2017)

After identifying the agents as the pedestrian walking in the historic cities, in the following, a description of the case studies environment will be made.

### 3.2 Environment - Case One: Batroun Historic City Attraction Points

Batroun is a city on Lebanon's southern coast. It runs along a rocky promontory and covers an area of 4.68km2 around 54 kilometers north of Beirut. From the early Bronze Age until the current day, this city has been continually populated. Indeed, recent archaeological excavations in the heart of Batroun's historic city revealed evidence of removing and civilizational continuity dating back to the Bronze Age (third millennium). Batroun was included to the Lebanese Official List of Historical Monuments on March 15, 1957, under Law 15282. The monuments in Batroun's historic center, a considerable number of which are also featured in the list described above, provide an outstanding example of traditional architecture. Batroun has significant archaeological importance, owing to the existence of relics from diverse eras, including the following:

- Roman Theater, carved into the rock in a semi-circular shape
- Crusades Citadel
- The Phoenician wall
- Churches (The Basilica of Saint Stephan, The Church of Saint George, The Church of the Lady of the Square, The Church of the Lady of the Sea)
- Taiga (a very known night club and resto-café in Batroun)

Batroun look likes the old city of Byblos (Jbeil), Lebanon which is inscribed on the World Heritage List (UNESCO, 2019).

Fig. 3: Location of Batroun Old City, North Lebanon

Fig. 4: Map of Batroun's Attraction Points (Source: Google Maps)

3.2.1 Visibility graphs in old city of Batroun

First, and in order to conduct the optimum pedestrian path, an agent-based model was developed, this is done using Space Syntax DepthmapX 0.80. All attraction points that are located out of the pedestrian zone are excluded from the study. To develop the model, and following the steps of the software manual, the process begins by simulating the visibility graph of the whole zone and zooming in in each zone that contains an attraction point.

Visibility Graph is the set of lines of two indivisible points where no obstacle is set between these points in the Euclidean plan. Those lines are called edges and the points which are the location points are called nodes. Visibility graph are very important when studying pedestrian motion in the urban environment. (F Othman, Z Mohd Yusoff and A R Abdul Rasam, 2019)

Using DepthmapX 0.80 tools, a simulation for visibility graphs in each zone have run. In the overall map of Old Mina, the attribute summary shows that the connectivity had a minimum of 0 (dark blue in the map) and a maximum of 277 (red in the map), with an average of 75,3115. (figure 5&6)
3.2.2 Agent analysis in old city of Batroun

For the pedestrian experience analysis where the agent is the tourist and the environment is Mina Old City. The visibility graph was important to be done before running agent simulation so the software read the voids spaces such as roads, walkways, public spaces etc… Starting with the agent analysis, first the attributes need to be set up.

- The analysis length is the number that represents the analysis period per timesteps (as unit of measurement), in this following this value is set to 200.
- In a new column, the number of agents going through predetermined gates is recorded. These gate count values are recorded in a data map layer and can be compared to observed gate counts in the real built environment that represent pedestrian flow per time unit. In this case, this value is set for “none”.
- Release Rate indicates how many agents will be introduced to the simulation in each timestep. (Here it is set for 0.1)
- Then, agents’ starting point must be released either randomly (using the software) or by indicating them from selected locations counted as entry gates. In this case, selected gates were chosen in each area.
- Field of view is set for 15 bins which is equal to 170°.
- Steps before turn decision: These are the steps or grid points that the agent must pass through before deciding to shift direction at random. (Set as default: 3 steps)
- Time Step in systems: timesteps each agent applies before disappearing from the simulation.
- The Record trails for 50 agents is checked.
- Movement rules: There are different rules within this drop-down list. It is advised that you use the standard rule which is the default. (Kinda Al_Sayed, Alasdair Turner, 2010)

In Batroun Old City, four main gates for agents were selected based on field observation and pedestrian experience. The gates are the red points on the map (figure 7). Gate (1) represents pedestrian who are coming from the fishing Port. Gate (2) represents people who are coming from outside Batroun as a whole and Gate (3) and (4) represents people who are coming from the outside of the old city, (4) is internal and (3) is on the waterfront.

In figure 7 and 8, we can see the results of the simulation recording the traces of the pedestrian who were moving through this area starting with the selected gates. We can notice that the streets connecting the gates are the most walkable streets, two main axes had the most visibility which are the waterfront and the restaurant axis (very know in Batroun).

Some traces were detected in zones were no gate is available, this is because the software had some limitations concerning the resolution and the scale of the map,
which had affected the filling step of the voids area and thus conducting to some non-readable roads and paths.

3.3 Environment Case two: Mina Old City Attraction Points

Mina City is a seaside autonomous town in northern Lebanon, near Tripoli. El-Mina is built on the site of the ancient Phoenician city of Tripoli. It serves as a port for modern-day Tripoli, Lebanon’s second-largest city, which is located 5 kilometers to the east. El-Mina, along with Byblos, Tyre, and Sidon, is the location of the ancient city of Tripolis, which goes back to the Phoenician era and is one of Lebanon’s oldest towns. Following the Islamic reconquest of greater Tripoli from the Crusaders, the site of Tripolis was relocated inland, and today’s El-Mina became the harbour district of greater Tripoli, eventually having its own municipal board in the early twentieth century, separate from that of Tripoli but within the context of greater Tripoli. Tripoli Marina was another name for it (Wikipedia, 2021).

Some of the greatest landmarks situated in El-Mina are: The islands, the old towers, the sea side Corniche and the scaffolds. Focusing only on the landmarks that can be reached by walking, the following can be listed:
- Sheikh Affan Scaffold
- Hammams (traditional bathhouses)
- St. Georges (Jorjios) Cathedral
- Deguise Mosque (Omar Ben Al-Khattab Mosque)
- Mino-Labban street (Contains Bars and restaurants for Night Life, art centers and museums)
- Mina Old Town (including mosques and churches, a Caravan Serail, a Mamluk Fortress, and souk (traditional marketplaces))
- Beit Al-Fann (House of arts)
- Corniche (Wikitravel, 2021)

The map will show these various attraction points distributed in the old districts of El Mina City, connected within streets, pedestrian walkways, and other components.

3.3.1 Visibility graphs in old Mina

First, and in order to conduct the optimum pedestrian path, an agent-based model was developed, this is done using Space Syntax DepthmapX 0.80. All attraction points that are located out of the pedestrian zone are excluded from the study. To develop the model, and following the steps of the software manual, the process begins by simulating the visibility graph of the whole zone and zooming in in each zone that contains an attraction point. Visibility Graph is the set of lines of two indivisible points where no obstacle is set between these points in the Euclidean plan. Those lines are called edges and the points which are the location points are called nodes. Visibility graph are very important when studying pedestrian motion in the urban environment. (F Othman, Z Mohd Yusoff and A R Abdul Rasam, 2019) Using DepthmapX 0.80 tools, a simulation for visibility graphs in each zone have run. In the overall map of Old Mina, the attribute summary shows that the connectivity had a minimum of 0 (dark blue in the map) and a maximum of 2491 (red in the map), with an average of 1066.36. (figure12)
In Mino Street, the attribute summary shows that the connectivity had a minimum of 0 (dark blue in the map) and a maximum of 250 (red in the map), with an average of 66,464. (figure 13)

Near Saint Georgious Church (Attraction Point), the attribute summary shows that the connectivity had a minimum of 2 (dark blue in the map) and a maximum of 1885 (red in the map), with an average of 631,143. (figure 14)
Near Tamathili Cadastral (Attraction Point), the attribute summary shows that the connectivity had a minimum of 8 (dark blue in the map) and a maximum of 3586 (red in the map), with an average of 1305.54. (figure 15)

Near Omar Bun El Khattab Mosque (Attraction Point), the attribute summary shows that the connectivity had a minimum of 2 (dark blue in the map) and a maximum of 2184 (red in the map), with an average of 996.858. (figure 16)
3.3.2 Axial roads

Focusing on the pedestrian and car-free zone, where pedestrian is more comfortable concerning walkability. The connectivity of these roads is simulated in order to check the path which is the most connected to the studied urban environment. As we can notice, that the most connected axis is the one that links Port-Said Road to Mina New Municipality which is located front of the sea (red to yellow). Second, Mino Street has medium to high connectivity (yellow to green) and finally the road behind the Mina New Municipality has medium connectivity (Light blue).

The attribute summary of this zone shows that the connectivity had a minimum of 2 (dark blue in the map) and a maximum of 559 (red in the map), with an average of 136,847. (figure 17)

3.3.3 Agent analysis in old Mina

For the pedestrian experience analysis where the agent is the tourist and the environment is Mina Old City. The visibility graph was important to be done before running agent simulation so the software read the voids spaces such as roads, walkways, public spaces etc… Starting with the agent analysis, first the attributes need to be set up.
- The analysis length is the number that represents the analysis period per timesteps (as unit of measurement), in this following this value is set to 200.
- In a new column, the number of agents going through predetermined gates is recorded. These gate count values are recorded in a data map layer and can be compared to observed gate counts in the real built environment that represent pedestrian flow per time unit. In this case, this value is set for “none”.
- Release Rate indicates how many agents will be introduced to the simulation in each timestep. (Here it is set for 0.1)
- Then, agents’ starting point must be released either randomly (using the software) or by indicating them from selected locations counted as entry gates. In this case, selected gates were chosen in each area.
- Field of view is set for 15 bins which is equal to 170°.
- Steps before turn decision: These are the steps or grid points that the agent must pass through before deciding to shift direction at random. (Set as default: 3 steps)
- Time Step in systems: timesteps each agent applies before disappearing from the simulation.
- The Record trails for 50 agents is checked.
- Movement rules: There are different rules within this drop-down list. It is advised that you use the standard rule which is the default. (Kinda Al_Sayed, Alasdair Turner, 2010)

![Fig. 18: Window of Agent Analysis Setup in Space Syntax](Source: DepthmapX 0.80)

In Mino Street and surrounding areas, four main gates for agents were selected based on field observation and pedestrian experience. The gates are the red points on the map (figure 19). Gate (1) represents pedestrian who are coming from Port Said Street to Cornice, Gate (2) represents people who are coming from cornice or old souks to Port Said Street, Gate (3) represents people who where near the waterfront and Gate (4) is for people who where are coming from Mina but not the old city.

In figure 19, we can see the results of the simulation recording the traces of the pedestrian who where moving through this area starting with the selected gates. We can notice that the streets connecting the gates are the most walkable streets, some streets like Mino which has no gates linked directly to it recorded some pedestrian trails.
Some traces were detected in zones were no gate is available, this is because the software had some limitations concerning the resolution and the scale of the map, which had affected the filling step of the voids area and thus conducting to some non-readable roads and paths.

Fig. 19: Agent Analysis in Mino Street (Source: DepthmapX 0.80)

Fig. 20: Agent Analysis near Saint Georgious Church
(Source: DepthmapX 0.80)

Fig. 21: Agent Analysis near Tamathili Cadastral (Left) and Omar Bun El Khattab Mosque (right)
(Source: DepthmapX 0.80)
4. RESULTS AND DISCUSSION

In this part, the research will focus on the optimum path found using Space Syntax DepthmapX 0.80 Simulation and then comparing these results with the reality in order to track any pedestrian or tourist’s activity.

4.1 Optimum Tourist Path Based on The Agent-Based Model

The optimum path is the one that have the most connectivity in the visibility graphs and the greatest number of trails recorded in it.

4.1.1 Optimum path in Batroun old city

In Batroun Old City two districts were recorded as the best pedestrian tracks, first the waterfront axis (1) is recorded as a best path and it includes three main attraction points which are the Phoenician Wall, Fisherman Port and the church of our Lady. The highest connection in this path is 265 (red zone on the map). The second path (2) is the main axis that lead the tourist to any district in the old city even to the first optimum path. The highest connection in this zone and in all the area is 277 (red dots on the map).

Fig. 22: Visibility graph showing the greatest number of connections in each path:
path (1) on the left & path (2) on the right
(Source: DepthmapX 0.80)

Adding to the that, the same paths have recorded the greatest number of agents trails which is 4 in agent analysis of 50 agents (red dots on the map).

Fig. 23: Agent Analysis showing the highest number of agents in path (1) on the left and path (2) on the right
(Source: DepthmapX 0.80)

4.1.2 Optimum path in Mina old city

In Mina old city, the simulation couldn’t show its best result in the overall map and the highest connectivity was found in the sea (figure 12). In order to be more accurate, attraction points map and old pedestrian districts were simulated (offshore path is neglected because it’s not only a pedestrian axis and not connected with pedestrian paths to the old city). In this case, four paths were recorded as the best tracks in Mina Old City: Path (1) parallel to the waterfront and connected to all the old city, it includes many attraction points which we can cite Omar Bun El Khattab.
Mosque with a highest connectivity of 250 (red zone), Path (2) that links Port Said Road and the waterfront axis with a highest connectivity of 239 (red zone) and includes Saint Georgious Church, Path (3) which leads to Tamathili Cadastral and Mina Old Souks and had a highest connectivity of 179 (yellow zone) and finally Path (4) a derived path from track (2), this path is known for its bar and restaurants called Mino Street and had a highest connectivity of 160 (yellow zone).

![Fig.24: Visibility Graphs of Path (1) on the left and Path (2) on the right (Source: DepthmapX 0.80)](image1)

Fig.24: Visibility Graphs of Path (1) on the left and Path (2) on the right
(Source: DepthmapX 0.80)

![Fig.25: Visibility Graphs of Path (1) on the left and Path (2) on the right (Source: DepthmapX 0.80)](image2)

Fig.25: Visibility Graphs of Path (1) on the left and Path (2) on the right
(Source: DepthmapX 0.80)

Adding to that, the agent analysis shows the same importance of paths (1), (2) and (3) and (4). (See figure 19) but these paths did not record the highest number of agents, instead some open spaces did.
4.2 Comparing the Results with the Real Urban Environment

The real urban environment results were detected through an observation method of research. The level of researcher participation was from distance to observe people behavior and pedestrian movement. The purpose is to detect how people moves through these districts. The observation is done in the last month of 2021 during festive preparations and in weekends (4 & 5 December 2021) since it’s the most time were people moves and visits touristic spaces and in weekdays (8 December 2021) to observe pedestrian inhabitants. The observation was structured and have a target of motion detection.

4.2.1 A comparison through Batroun old districts

The results have shown that during weekdays and weekends, inside the old city (souks and residential zones) and near touristic areas few people were detected in path (1), more is detected in path (2) but not in a considerable manner.

Moreover, and comparing with the simulation, few and rare pedestrian were found in old souks and in residential districts. The simulation is confirmed.
Besides the results mentioned above, path (2) showed more dynamism because it is a connection to all the old city but this dynamism is shown via cars more than pedestrian.

4.2.2 A comparison through Mina old districts

The results have shown that during weekdays and weekends, inside the old city (souks and residential zones) and near attraction points few people were detected in path (1), (2) and (4), more is detected in path (3). Moreover, and comparing with the simulation, few and rare pedestrian were found in old souks and in residential districts. The simulation is confirmed in this case.
5. CONCLUSION

Historic districts are conserved places that reflect the cultural and the history of its inhabitants. Some of these places are considered nowadays as touristic landmarks and attraction points. Tourist aim to experience traditional buildings and old districts in each city they have visited in will visit. Focusing on the landmark-pilot type of travel, this paper studied pedestrian wayfinding in historic spaces using one factor which is the serial vision through attraction points. In order to simulate this factor, an agent-based model was developed with Space Syntax DepthmapX 0.80 software. Visibility graphs and Agent Analysis maps were produced through a simulation and this is to achieve the aim of the paper which is finding the best route in touristic districts.

This model has been applied on two different case studies, Batroun Old City and Mina Old City, these are two historic cities located on the waterfront of North Lebanon, with same climate zone but different urban typology. Results of the simulation have led to find best districts in each historic city but when comparing with the real situation, we can find that these zones were not as walkable as the simulation has shown. This maybe because of the bad weather in the festive month (December 2021), and there is any kind of wind protection, few shading devices in both zones. Other factors may be studied in further researches.

REFERENCES


<table>
<thead>
<tr>
<th>Variable Long Name</th>
<th>Definitions</th>
<th>Directions</th>
</tr>
</thead>
</table>
| Proportion of historic buildings | Historic: clearly determined to be pre-World War II high detailing, domed roof shape, iron fire escape, and so forth; post-World War II buildings are usually geometrical and architecturally simple (though they may be impressive), have lots of glass surface area, and little detailing | - Estimate the proportion of historic buildings visible at street level (out of total block length excluding cross streets).  
- Record the estimate as a decimal using increment of tenths (.10).  
- As you walk count instances of (not elements or sections of) courtyards, plazas, and parks on both sides.  
- Record the number of courtyards, plazas, or parks you encountered within the study area. |
| Courtyards/plazas/parks—both sides | Courtyard: a permanent space in which people are intended and able to enter  
Plaza: large,enterable open space (bigger than fifteen square feet), often with art, plants, or associated with building(s)  
Park: place intended for human use/ recreation, often with greenery, a playground, and so forth  
Garden: enterable and larger than ten square feet | - Note the presence (1) or absence (0) of commercial or public outdoor dining on your side.  
- Record a 1 if outdoor dining is present and a 0 if it is not.  
- Count buildings with nonrectangular shape on both sides.  
- Record the number of buildings with nonrectangular shape you counted within the study area. If the building is ambiguous, take a picture. |
| Outdoor dining | Outdoor dining: dining tables and seating located mostly or completely outside. Even if there are no patrons, there is outdoor dining as long as the tables and chairs are present. | |
| Buildings with nonrectangular silhouettes | Buildings with nonrectangular shapes: those that do not have simple rectangular profiles from at least one angle, as seen by the passing pedestrian. Visible pitched roofs, bay windows in the roof or foundation lines, dormers, and so forth qualify buildings as nonrectangular. Signs, awnings, entrances, and porches are not considered in the shape of the building. | - Looking at both sides of the street and in the distance (only visible and prominent features ahead), count instances of individual/distinct natural landscape elements.  
- Record the number of distinct landscape elements you encountered on either side of the street or in the distance (prominent distinct features only). |
| Major landscape features | Major landscape features: prominent natural landscape views like bodies of water, mountain ranges, or man-made features that incorporate the natural environment; serve as natural landmarks for orientation or reference. Parks do not count as major landscape features. | - Looking at both sides of the street and in the distance (only visible and prominent features ahead), count instances of individual/distinct natural landscape elements.  
- Record the number of distinct landscape elements you encountered on either side of the street or in the distance (prominent distinct features only). |
| Major landscape features | Major landscape features: prominent natural landscape views like bodies of water, mountain ranges, or man-made features that incorporate the natural environment; serve as natural landmarks for orientation or reference. Parks do not count as major landscape features. | |
| Buildings with identifiers | Identifiers: clear signs or universal symbols that reveal a building's street-level use. A stoop can identify a church, gas pump a gas station, tables and chairs a restaurant, mannequins a clothing store, and so forth. Words can also identify a key building: high school, "restaurant," "pharmacy," "shoe store," "cafe," and brand or franchise names. A name such as "Joe's" would not work, while "Joe's Pub" would identify the building. | - Looking at both sides of the street and in the distance (only visible and prominent features ahead), count instances of individual/distinct natural landscape elements.  
- Record the number of distinct landscape elements you encountered on either side of the street or in the distance (prominent distinct features only). |
| Proportion of street wall—same side | Street wall: the effect achieved when structures on a block continuously front the sidewalk/path providing a defined street edge and feeling like a wall. A façade or wall greater than five feet contributes to the street wall if it is set back no more than ten feet from the sidewalk/path edge. Gates/ fences, greenery, or both greater than five feet tall that obstruct more than 60 percent of your view of the space beyond also count. | - Note the proportion of your side of the block that consists of a street wall (of the total block length) (excluding the cross streets from the denominator).  
- Record the proportion estimates (use decimal increments of .10) for your side.  
- As you walk count the number of directions (front, right, and left) in which you see at least one long sight line at any point along the block.  
- Record a 1 if you had a long sight line in one direction, a 2 for two directions, and a 3 if you had a long sight line in all three directions at least once during your walk through. |
| Proportion of street wall—opposite side | Same as above | Same as above for the opposite side |
| Long sight lines | Long sight line: the ability to see at least 1,000 feet or about three city blocks into the distance at any point during your walk through the block. | - As you walk count the number of directions (front, right, and left) in which you see at least one long sight line at any point along the block.  
- Record a 1 if you had a long sight line in one direction, a 2 for two directions, and a 3 if you had a long sight line in all three directions at least once during your walk through. |
| Proportion of sky ahead | Frame of vision: your frame of vision is the "box" that is visible when you look ahead with your line of sight parallel to the ground. To better define the area, make a box with your fingers (thumbs and pointer fingers) and hold it up to your face. Slowly move it away until you can see all four sides—this is your "box." | - Look directly ahead.  
- Without moving your head, assess the percentage of sky visible in your frame of vision.  
- Record the estimated proportion (use decimal increments of .05). |
<table>
<thead>
<tr>
<th>Variable Long Name</th>
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<tbody>
<tr>
<td>All street furniture and other street</td>
<td>Street furniture and other street items: only the following: tables (without associated chairs), chairs (without associated tables), vendor displays (count one per vendor), ATMs, hanging plants, benches, flower pots, parking meters, umbrellas, trash cans (public only), newspaper boxes, mail boxes, bike racks, bollards (count one per set), hydrants, flags, banners, merchandise stands, street vendors, pedestrian-scale street lights (not for cars), phone booths (one per structure), but stops (count one per stop), and train stations (count one per entrance).</td>
<td>- Count visible street furniture and other items on your side and within the block. Do not count furniture in enclosed parks, gardens, plazas, and courtyards.</td>
</tr>
<tr>
<td>items</td>
<td></td>
<td>- Note the proportion of street-level façade on your side that is covered by windows of any size.</td>
</tr>
<tr>
<td>Proportion of first floor with windows</td>
<td>Windows: average proportion of first-floor façade made up of windows.</td>
<td>- Record the proportion out of the whole block length (use decimal increments of .10) that is covered by street-level windows.</td>
</tr>
<tr>
<td>Building height—same side</td>
<td>Building height: 12 ft per floor times the number of floors, including the roof floor of buildings with slanted roofs and dormers and any visible sunken floors</td>
<td>- Note the height of the buildings on your side, whether they are set back, and the percentage of the block that the buildings of the same height occupy.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Record the heights of the buildings (record buildings of the same height together) considering their width, the total length of the block, and thus the percentage of the block (adding to 100 percent) each building height spans on the reverse side of the form.</td>
</tr>
<tr>
<td>Small planters</td>
<td>Small planters: any potted arrangement of trees, shrubs, or flowers that are smaller than ten square feet at their base. The planter should be within ten feet of the sidewalk edge and appear to be permanent (not small enough to be able to be brought inside at the end of the day) but not in ground.</td>
<td>- Count all the visible street-level planters on your side of the block and within ten feet of the sidewalk edge. This includes planters on private and public property but not those inside enclosed parks or gardens.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Record the total number of small planters on your side, within the study area.</td>
</tr>
<tr>
<td>Proportion of active uses</td>
<td>Active use buildings: one in which there is frequent pedestrian traffic (more than five people enter/exit while you are observing the block) Always active: parks, stores, restaurants, attached/apartment-style residential buildings, hospitals, and schools Always inactive: construction sites, parking lots, churches, detached/single residence units, and vacant or abandoned lots.</td>
<td>- Note the amount of active-use buildings that are on your side within the study area. If a building is active, assume all sides are active (even blank walls).</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Record the proportion of the total block (use decimal increments of .10).</td>
</tr>
<tr>
<td>Number of buildings</td>
<td>Visible building: buildings that can be distinguished by separate doors/entrances (especially for residential, architecture, colors, and so forth)</td>
<td>- Count the visible buildings on both sides of the street within the study area.</td>
</tr>
<tr>
<td>Dominant building colors</td>
<td>Basic colors: the colors used for the majority of the building’s façade.</td>
<td>- Record the number of buildings within the study area.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Count the number of basic building/structure/surface colors on both sides of the street within the study area. Do not distinguish between different shades of the same color.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Record number of distinct building colors.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Count the number of distinct accent colors.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Count individual pieces of public art that are within the study area or intended for viewing from the sidewalks/path.</td>
</tr>
<tr>
<td>Accent colors</td>
<td>Accent colors: the colors used for building trim and roofs, street objects, awnings, signs, and so forth</td>
<td>- Record the number of pieces of public art.</td>
</tr>
<tr>
<td>Public art</td>
<td>Public art: monuments, sculptures, murals, and any artistic display that has free access. Art must be the size of a small person or have clear identification indicating its status as art (creator, dedication, year, materials, etc.).</td>
<td>- Record the number of pieces of public art.</td>
</tr>
</tbody>
</table>