



An-Najah National University
Faculty of Graduate Studies

**WALKABILITY IN URBAN AREAS AND
INFLUENCING FACTORS; RAFIDIA STREET -
NABLUS, AS A CASE STUDY**

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This Thesis is Submitted in Partial Fulfillment of the Requirements for the Degree of Master of Roads and Transports Engineering, Faculty of Graduate Studies, An-Najah National University, Nablus - Palestine.

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By

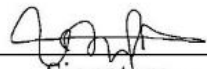
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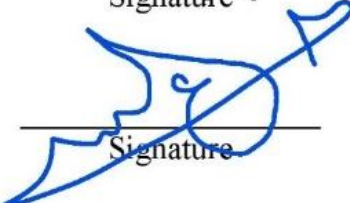
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Dedication

To my cherished homeland

" Palestine "

My heart will forever pulse with hope for you

Acknowledgements

Thanks, and praise be to God, Lord of the Worlds, by whose grace I have reached this point. To the homeland for the soil that shaped my identity. To my university instructors for your dedication and the care that made all this possible.

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To my friends, for the laughter, strength, and cherished memories we've shared. To my childhood friend, for being a constant in my life's journey. And to everyone who supported me, for believing in me when I needed it most. To the experts who responded to my questionnaire.

Declaration

I, the undersigned, declare that I submitted the thesis entitled:

**WALKABILITY IN URBAN AREAS AND INFLUENCING FACTORS;
RAFIDIA STREET - NABLUS, AS A CASE STUDY**

I declare that the work provided in this thesis, unless otherwise referenced, is the researcher's own work, and has not been submitted elsewhere for any other degree or qualification.

Student's Name: Zaki Rakan Zaki Alawneh

Signature:

A handwritten signature in blue ink, appearing to read 'Zaki Rakan Zaki Alawneh', with a stylized flourish at the end.

Date:

29/10/2024

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Abstract

Walkability is a crucial component of sustainable urban development, directly influencing the quality of life by promoting pedestrian mobility, reducing traffic congestion, and enhancing environmental health. This study explores walkability by examining the essential elements and indicators that influence pedestrian movement and accessibility in urban areas. It introduces a comprehensive walkability index designed to assess and quantify these factors, offering a standardized framework for evaluating walkability across various settings.

In developing countries, the walking environment is ignored due to a variety of factors, including financial constraints, lack of policies and studies on influencing factors on, and negligence of society and decision-makers regarding this mode of urban mobility. Walking in different land uses, like city center, commercial area, or residential area, is not always safe due to different factors, including lack of pedestrian facilities.

The methodology was developed by integrating 10 elements, 29 indicators, and 80 sub-indicators to evaluate walkability. The elements and indicators were weighted by experts. Furthermore, data was gathered using various methods, including questionnaires, field observations, and aerial photographs. Both qualitative and quantitative data were converted into measurable quantitative scores, ranging from 0 to 1.

Analysis showed that the walking environment in Rafidia street has several weaknesses. These issues stem from factors such as poor organization, linear layout, lack of attention to pedestrian facilities, and inadequate distribution of services. Additional contributing factors include the inconsistency of road right-of-way throughout the area, the absence of barriers separating pedestrians from vehicles, and the lack of a key element streetscape design.

This study not only presents a detailed analysis of walkability in Rafidia Street, but also offers practical solutions to improve pedestrian experiences in urban areas. By developing a clear framework for assessing and enhancing walkability, the study contributes to the broader efforts of creating sustainable, livable cities that prioritize pedestrian mobility.

Keyword: Walking, Walkability, Walkability Elements, Walkability Indicators and Sub-indicators, Walkability Measuring.

Chapter One

Introduction

1.1 Background

Multimodal streets provide individuals with safe, attractive, and convenient travel options, including walking, cycling, public transit, and motorized vehicles. They also contribute to making cities more efficient by being designed to accommodate various modes of transportation and offering diverse mobility options for users (1). Contemporary urban design trends emphasize creating cities that prioritize greener, pedestrian-friendly spaces. This growing focus on walkability is increasingly evident in the principles of mobility and urbanism (2).

According to the World Bank, urban mobility is defined as moving between locations within urban areas. Additionally, it functions to enable people to reach housing, jobs, and urban services. Personal mobility is defined as personal transport from one location to another, by car or motorcycle, or other non-motorized means (3). The concept of accessibility emphasizes interactions with urban spaces to ensure access to goods, services, activities, and public life. Accessibility is a crucial factor in achieving sustainability (4).

1.1.1 Walking and User

Walking is one mode of transportation, and is the first transportation mode humanity used (5). It is basic to mobility and the most frequently used mode after private cars. Walking also is the most active and widely used mode of transportation in urban communities (6). It links with public transportation when starting or finishing any trip (7).

Walking is the origin of the beginning or end of any trip. Walking distance is generally defined by time, size, and shape (8). It is also defined as moving a short distance from one point to another (9). In addition, all human activities depend on walking. For example, moving from a public transport station to a commercial area needs walking. These points show the need to study the importance of walking for different types of land uses.

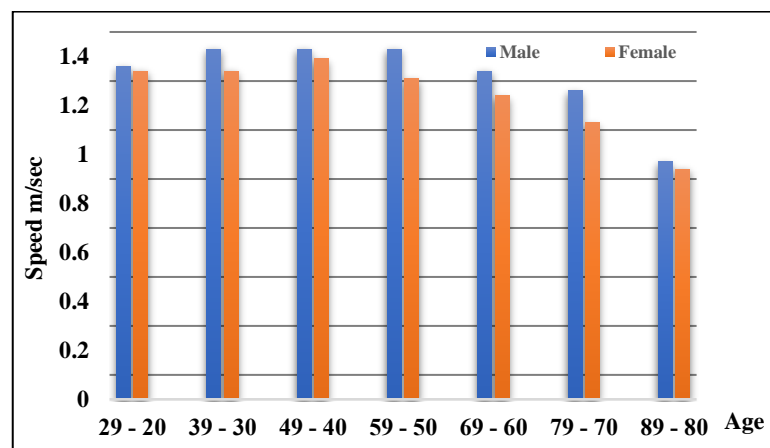
Walking has a strong relationship with all types of land uses. The center of an urban area and its services can provide a variety of facilities that meet daily needs (8). For this, there

is a strong relationship between the transportation sector and land uses. Walking is the process of moving from one place to another by foot, usually reaching locations within at least a 400m - 800m radius. This distance can be translated from 5 min. to 10 min. of walking (5).

Pedestrian speed varies due to several factors and reasons, like gender and age. Females walk slower than males, and youngers walk faster than the elderly. Pedestrians' speed ranges from 0.94 m/sec to 1.36 m/sec. Figure 1.1 shows the difference in walking speed by sex and age (10).

Figure 1.1

Speed by Sex and Age



(Cronkleton, 2019)

Beside their trips goal, pedestrians seek pleasure when walking, requiring amenities such as seating, lighting, favorable weather, and good surface conditions. These features enhance their sense of security and comfort (11). For this, a special environment is required, with comfort and safety being the major elements (12). Achieving the environment for walking will reduce motorized usage, improve air quality, etc.

1.1.2 Walkability

Walkability is a crucial element in achieving sustainability. Walkability is the ability to comfortably and safely meet personal needs within a reasonable walking distance, typically 30 minutes or less (13). It is also known as a concept for assessing the walkable environment in urban areas (9).

A walkable city means that people can walk easily because there are sufficient and well-maintained sidewalks. This encourages people to accomplish their daily activities without relying on automobiles. Additionally, the opportunities for visitors and tourists increase, making the urban areas more enjoyable to explore on foot (14).

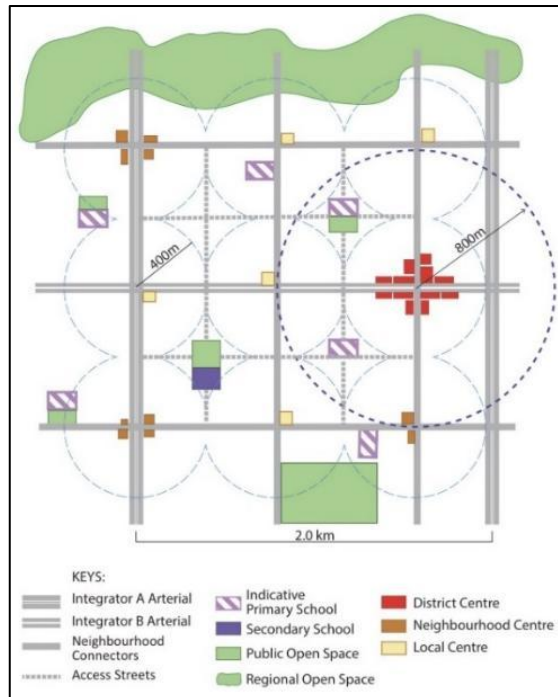
1.1.3 Walkable Area

A walkable urban area has high connectivity and accessibility, offering easy access to both the street and pedestrian networks. This enables pedestrians to reach their destinations more easily and in the shortest distance possible. This plays an important role in providing a comfortable walkable environment (14).

Walkable neighborhoods are typically characterized by a radius of 400 to 800 meters (5 to 10 min.) from community center services, which can be reached on foot. The walkable distances range from 250 to 800 meters, depending on the service centers as shown in Figure 1.2. Specifically, they extend up to 800 meters from the city center, 400 meters from the village or neighborhood center, and 250 meters from the main bus routes, with density of 22 dwellings per site hectare (8).

Figure 1.2

Walkable Access Area



(WAPC, 2007)

1.1.4 Benefits of Walking

Walking facilities offer a multitude of advantages that contribute to progress across diverse development objectives, nurturing healthier, more sustainable, and inclusive communities. These benefits of walking encompass a broad spectrum, including:

- **Social Development:** Walking facilities create opportunities for social interaction and community engagement.
- **Public Health:** Encouraging walking as a mode of transportation promotes physical activity, reducing the risk of obesity, heart disease, and other health issues. The WHO attributes at least 4.2 million premature deaths each year to ambient air pollution (15).
- **Mobility and Accessibility:** Walking facilities make communities more accessible to all individuals, including those with disabilities or limited access to other modes of transportation.
- **Environmental Sustainability:** Walking is a zero-emission mode of transportation that reduces air pollution and greenhouse gas emissions associated with motor vehicles.
- **Economic Vitality:** Well-designed walking facilities can attract more pedestrians to urban areas, such as commercial zones. These facilities are a crucial factor in attracting more pedestrians.
- **Safety:** Properly designed sidewalks and pedestrian pathways enhance safety for pedestrians, reducing the risk of crashes and injuries. According to the WHO, there are 1.19 million annual deaths due to traffic crashes (15).
- **Security:** Security is a concern for pedestrians, especially women, as they move more than men. Good infrastructure can enhance pedestrian security (16).
- **Reduced Traffic Congestion:** Encouraging walking as a viable transportation option can help alleviate traffic congestion and reduce the demand for parking infrastructure in urban areas.
- **Tourism and Recreation:** Well-designed walking trails and pedestrian-friendly areas attract tourists and residents alike, promoting recreational activities such as hiking, jogging, and sightseeing.

1.1.5 Summary

This study will focus on pedestrian walkability, as well as the methodology to measure and evaluate walkability. The pedestrian environment surely affects pedestrian mobility as various elements within this environment will affect the quality of pedestrian mobility. These elements would include street design and network, land use, etc.

In general, in developing countries, such as Palestine, this mode is marginalized. This might be due to reasons, such as the need to develop other modes within the limited available resources. For this, a study area must be selected to apply and measure these characteristics and evaluate their walkability.

Rafidia Street will be the study area since it has many services and diverse environmental areas, such as green areas, commercial areas, and institutions. On Rafidia Street, you will find government and NGO institutions, universities, schools, shopping centers, etc. The major challenge and danger for pedestrian mobility is when crossing the road to the other side; this might lead to increasing pedestrian crashes. We can improve this in many ways such as speed reduction, refuge medians, traffic lights, keep vehicles away from pedestrian activity as possible, etc.

Researchers measure and evaluate walkability in various ways, with some focusing on people's socio-economic characteristics, while others use built environment characteristics. Therefore, it is necessary to find a methodology to determine walkability factors and a method for measuring walkability in urban areas. Transportation engineers and urban planners consider walkability an essential principle and a step towards transit-oriented development and sustainability, aiming to reduce vehicle-miles traveled.

Walkability measurements based on built environment characteristics depend on people's preferences characteristics; these characteristics should be taken into consideration. Therefore, it is necessary to explore the following questions. What are these characteristics? What are the indicators of these characteristics? How will it be determined? What is the methodology for evaluating them? What is the appropriate study area? All these questions, as well as others, should be taken into consideration in any walkability study.

1.2 Problem Statement

In many places, including Palestine, private cars are the main mode of transportation in the neighborhood, city center, and commercial area due to various reasons including existing policies and infrastructure, as well as poor walking facilities. Therefore, it is usual to use vehicles instead of walking. On the other hand, walking is a widespread behavior in many countries; it is one of the most common modes of transportation. Also, all human activities depend on walking; however, this requires providing the appropriate environments, which is the “*walkability*” in this study.

In developing countries, the walking environment is ignored due to a variety of factors, such as financial constraints, lack of policies and related studies on influencing factors on walkability, and the negligence of society and decision-makers about the importance of this mode of urban mobility. In developed countries, there are more than one factor and associated indicators related to pedestrian walkability, and some of these indicators may not apply to developing countries. Therefore, it is necessary to develop a methodology to measure walkability and develop a scenario to improve its environment.

Walking in different land use types, like the city center, commercial area, or residential area, is not always safe due to more than one factor. This might include lack of pedestrian facilities such as sidewalks, traffic signs, and crossroad regulations. The presence of trees and green spaces, noise levels, and building characteristics also affect the walkability of a given area. In addition, the dearth of green spaces and public parks in cities enhances the role of walking as a form of recreation. Lack of proper infrastructure for pedestrians hinders their ability to safely navigate the streets. These issues exist in Palestinian cities; a neglect of the walking environment.

When traveling from the city center to An-Najah National University, for example, the route typically involves traversing Rafidia Street. In these areas, pedestrians encounter various challenges that manifest in several issues. Pedestrians often navigate traffic lanes, returning to sidewalks and potentially causing obstructions, particularly with strollers that may impede car lanes. Crossing roads in this manner heightens the risk of accidents. The situation is further compounded by sidewalks being occupied by shop owners, vendors, kiosks, and occasional car parking, thus reducing available space. Additionally, insufficient sidewalk widths, inadequate tree planting, poorly placed barriers, and lack of

proper lighting poles, often in disrepair or entirely absent, contribute to an environment that is not only inconvenient but also unsafe for pedestrians.

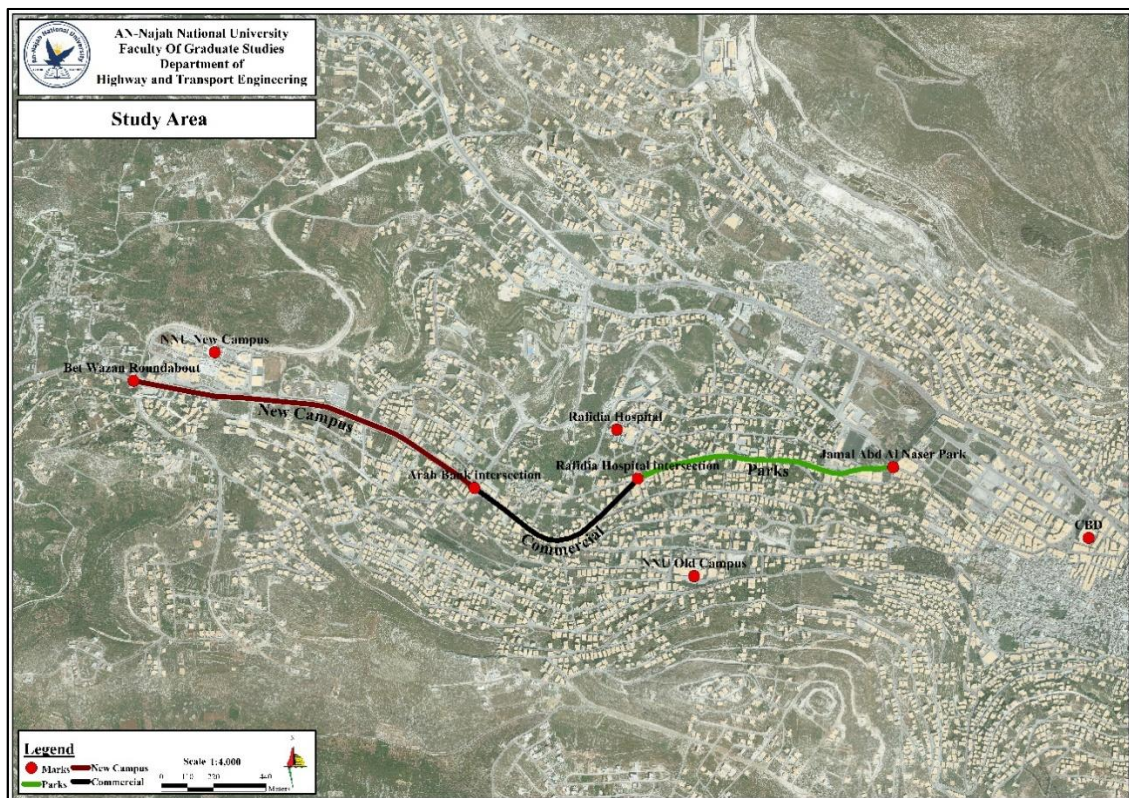
This study seeks to establish a methodology for measuring walkability and to develop strategies for enhancing the walking environment within the study area to ensure its sustainability. It aims to explore methods for improving walkability in diverse urban contexts, considering different land use types to create more pedestrian-friendly spaces.

1.3 Study Area

This research will concentrate on a neighborhood in the southwestern part of Nablus City. The study area extends along Rafidia Main Street for 3.5 kilometers, starting from Jamal Abd Al Nasser Park up to Beti Wazan Roundabout, as shown in Figure 1.3.

Figure 1.3

Study Area



This study area was chosen due to several factors, notably the abundance of services available nearby. Additionally, its diverse land uses including commercial and residential zones, restaurants, healthcare facilities, educational institutions, and recreational spaces, making it a multifaceted locale. The area's population is characterized by its diversity, encompassing individuals from various age groups and backgrounds, thus presenting an intriguing subject for examination. Moreover, the presence of varying terrain adds another dimension to the study. Additionally, it is considered one of the liveliest areas in the city, second only to the city center for the reasons mentioned above. Furthermore, it is evident that the facilities within the study area exhibit varying characteristics.

1.4 Importance of the Study

The study's significance lies in determining the most influential factors in pedestrian movement in urban areas, and making it a methodology that can be applied to other urban areas of various types. Walkability should be seen as more than just a means of transportation but also as an opportunity for recreation and physical activity. Therefore, it is important to study it from more than one side. If ignored, this would lead to an increase in private vehicles' usage.

Walking is one of the most common transportation modes used when beginning or finishing any trip. Therefore, it is significant to prioritize walking as a mode of transportation. If we ignore it, this will lead to an increase in the number of moving vehicles in the country and cause congestion almost all the time.

This study aims to develop a policy for planning pedestrian mobility across different land use types in various areas of the city. Knowing the needs of pedestrians will lead to reducing the use of cars by developing infrastructure for pedestrian facilities and improving its environment. In addition, to find a solution for current and future mobility related problems, one should answer to the question; what is the best walkability environment for different land use types?

Therefore, the walkability assessment method will help urban planners, analysts, and decision-makers enhance walkability in urban areas. In addition to making this mode of transportation more sustainable.

1.5 Study Objectives

The objectives for this thesis are to:

- Identify elements and indicators that affect the walkability, and develop a walkability measure index.
- Assess the walkability for a selected street in Nablus; Rafidia Street based on the selected indicators and the developed walkability index.
- Develop scenarios to improve pedestrian walkability; towards a sustainable walking environment, reducing the use of vehicles.
- Provide a guide-line policy for pedestrian walkability.

1.6 Thesis Structure

The thesis contains six chapters, there are: Introduction, Literature Review, Methodology, Data Collection, Analysis, and Conclusions & Recommendations.

The initial chapter encompasses the theoretical framework, encompassing key terms and definitions, the study's problem statement, objectives, important, and the study area. The focus shifts to a comprehensive literature review concerning pedestrian movement, delving into aspects such as the walking environment, encompassing considerations of security, safety, climate, terrain suitability for pedestrian activity, and related nuances.

Chapter two delves into the methodology utilized in this study, detailing the establishment of evaluation criteria and the associated calculation methods. Additionally, it identifies the necessary data to be collected.

In the three chapter, the methods for collecting various types of data mentioned in the preceding section are elucidated, alongside techniques for presentation and preparation for analysis in the subsequent stage.

Chapter four of this study entails the analysis of data collected in the preceding stage, culminating in the derivation of results.

The concluding chapter of this study will encapsulate the primary findings, discussing the results and presenting recommendations based on the study's outcomes.

1.7 Literature Review

1.7.1 Introduction

As discussed in the preceding chapter, walkability refers to the extent to which the built environment encourages and supports walking, making it accessible for pedestrians. Various characteristics and elements contribute to enhancing walkability, safety, and comfort for users. This chapter focuses on these elements to identify which aspects are significant for study and which are not. Additionally, it will pinpoint the indicators used for evaluating these elements.

There are many studies, reports, and individual or institutional research in different countries addressing walkability. Some of them are for developed countries and others for developing countries. This section discusses the evolution of walkability studies, from the initial “3Ds” to the development of the Global Walkability Index, etc.

The concept of walkability gained significant attention with the seminal study introducing the "3Ds Layout" Design, Diversity, and Density. These features are related to pedestrian characteristics, behavior, and the functioning of urban form. The 3Ds layout impacts travel demand in neighborhoods, as the diversity of land use and higher density enhance walkability and reduce the reliance on vehicle travel (17).

London introduced the "5Cs" as the foundational principles for organizing the walking environment: comfortable, conspicuous, connected, convivial, and convenient. These elements form the framework that enhances the walkability of an areas (18).

Following this, Pikora (19) categorized walkability variables into four groups: safety, destination, functional, and aesthetic. Krambeck (20), in The Global Walkability Index, categorized walkability into three main components: safety and security, convenience and attractiveness, and policy support. This index comprises 25 indicators and 45 variables. Teran (21) expanded this categorization into nine elements: density, surveillance, land use, parking, connectivity, traffic safety, experience, community, and green space.

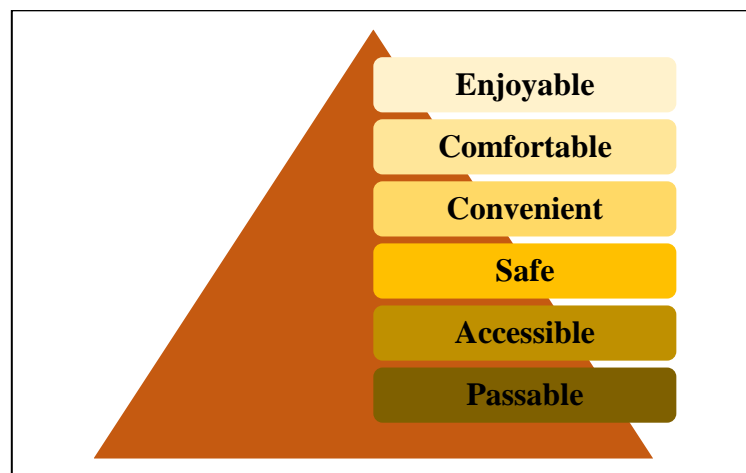
This chapter of the thesis is divided into two parts. The first part provides a general overview of the elements, while the following section delves into further details.

1.7.2. General Elements

The general elements of walkability include land use, building design, and street network and design. Others discuss detailed elements and sub-elements (indicators and factors) such as comfort, efficiency, convenience, attractiveness, safety, security, etc. Three key elements, in particular, influence pedestrian transport networks and infrastructure. Babinard (22) indicated that when designing, it is essential to achieve the pedestrian environment elements depicted in Figure 1.4.

Figure 1.4

Pedestrian Environment Elements.



(Babinard, 2018)

As noted by Babinard (22), three key elements for the pedestrian network and infrastructure include street network, street design, and land use & building design.

Street design: Street design plays a crucial role in protecting pedestrians from motor vehicles in two ways: by reducing vehicle speed and providing sidewalks. The focus here is on sidewalk characteristics and the surrounding environment. Sidewalks must be clear and unobstructed, among other requirements. Additionally, there are several other considerations related to sidewalks, such as adequate width, as well as elements related to the environment surrounding the sidewalk, such as lighting and street furniture, etc. The physical environment affects pedestrian mobility:

- Safe Sidewalks & Crosswalks.
- Adequate shade & lighting.
- Traffic sign, Open space & parking.

Building design and land-use mix: The built environment surrounding pedestrian routes greatly influences pedestrian comfort and convenience. Various elements, such as kiosks, vendors, shops, and the ratio between street width and building height, are crucial factors. A balanced mix of land use and building design further enhances walkability. Moreover, higher density contributes to a more inviting environment for pedestrians. When land-use policies promote a physical environment:

- Building with visual frontage.
- Complementary activity
- Land-use balances mix

Street network: The street network is a crucial factor for pedestrian movement in urban areas. A high number of intersection nodes and cross ratios indicate greater connectivity. Pedestrians prefer short, direct routes to their destinations, so the street network should be designed with small block sizes, ideally with a maximum distance of 100 meters. This shortens pedestrian trips. Additionally, connectivity with public transit is a crucial element for the success of the trip chain. This can be achieved in several ways when designing a street network:

- Short distances between intersections for enhanced connectivity
- Integration and connectivity with public transit
- Simplify navigation by designing small block sizes and layout.

According to the World Bank (23), the comprehensive design of transportation facilities for pedestrians must include high-quality infrastructure. This design should meet the three key elements required for pedestrian environments, thereby enhancing pedestrian mobility. These three key elements achieve the six pedestrian environmental elements depicted in Figure 2.1: enjoyable, comfortable, convenient, safe, accessible, and passable for all users regardless of age, gender, or ability. These elements work together to create a pedestrian-friendly environment.

Complete Street: Burlacu (24), the Complete Streets concept involves designing and operating streets to ensure safe, appealing, and comfortable access for all users, including pedestrians, cyclists, motorists, and public transport users of all ages and abilities. This approach aims to reduce transportation costs, promote alternatives to private cars, encourage healthy lifestyles through walking and biking, foster a sense of place, enhance

social interactions, and boost the value of adjacent properties. The specific design features of a Complete Street can vary by location but may include:

- Pedestrian infrastructure: Sidewalks, crosswalks, median crossing islands, and raised crossings.
- Traffic calming measures: Features that reduce driving speeds and define the edges of vehicle travel lanes.
- Bicycle accommodations: Dedicated bike lanes or wide shoulders for cyclists.
- Mass transit accommodations: Facilities like bus pullouts or dedicated bus lanes.

1.7.3 Detailed Elements

Factors/indicators of walkability are classified under a family of efficiency, comfort, and convenience. Krambeck (20) highlighted that walkability components include convenience, safety and security, and policy support. These were further divided into 22 elements and 45 indicators/variables. When the pathway is comfortable, walkability will have more positive aspects and become more attractive. In each of the following subsections, aspects that affect pedestrian comfort are presented.

1.7.3.1 Comfort

It encompasses emotional reactions to the external environment, including social, physical, and physiological responses. Measures include comfortable weather for walking and the comfort level depending on the surrounding situation and the individual. There are numerous and varied factors that can influence pedestrian comfort, which can be divided into several aspects such as visual, pollution, thermal, and odors (11).

The city offers numerous activities, and pedestrian pathway requirements vary from one city to another, aiming to be accessible and enjoyable for all age groups. The sense of comfort experienced by pedestrians depends on the surrounding environment. As the positive attributes of the pathway increase, so does the level of comfort (25).

These indicators include sidewalk width, grade, condition, and shade, as well as quality of service factors such as lighting, transit availability and frequency, and parking service availability. Also, accessibility and continuity of path (4).

1.7.3.2 Efficiency

Efficiency in sociology measures the difference between the intended direction and speed and the actual movement of pedestrians (26). It also indicates how well pedestrians conform to the crowd (27).

In this measure, Ovstedal (11) included choosing speed and the absence of obstacles or plant, while Blecic (4) described it in terms of route continuity, time, and distance.

1.7.3.3 Convenience

This means walking freely and easily without any constraints or hardships, as physical obstacles or features can affect the actual use of this mode. Indicators include street lighting, trees, shade, and parking (4).

This component also includes attractiveness. It considers whether pedestrians must walk long distances to cross road, if the sidewalk has shade, and whether the sidewalk is obstructed. There are many indicators for convenience such as obstructions, coverage, availability of crossings, disability infrastructure, quality and maintenance of walking path surface, cleanliness, trees, and connectivity (20).

1.7.3.4 Safety and Security

The two concepts, safety and security, can be distinguished as follows: safety concerns physical well-being and protection from accidents, while security refers to protection from threats such as crime and harassment. Both are essential aspects of a pedestrian-friendly environment (28).

Road safety is one of the most important concerns and challenges globally (25). The safety aspect is physiological. The World Bank's "walkability index" includes safety as a key criterion for ranking the pedestrian environments of cities. Many indicators like crossing safety, safety rules, laws and regulations, pedestrian safety education are included in this aspect (20). This aspect impacts socioeconomic mobility.

Good infrastructure design for pedestrian reduces injuries and death from accidents. Improved infrastructure for pedestrian can increased safety. Pedestrian safety can be improved by better walking infrastructure, traffic calming interventions, and design of the street network (22).

The security aspect is physical; thus, it's crucial for pedestrians to feel secure while walking. This ensures comfortable walking for everyone. Gender plays an important role here, as women tend to be more sensitive to security concerns and require greater protection than men. Women's daily routines aren't like the man's. Women go to more than one place during the day, such as the supermarket, take the children to school, do domestic duties, child care, and care for the elderly. For this they need to be safe at any time of the day (29; 11).

Street watchers encourage humans to use walking paths. Street watchers refer to people who work or sit near a pedestrian path. This aspect can be measured using various indicators such as street vending, pedestrian activity, street surveillance, vandalism, and crime rates.

1.7.3.5 Attractiveness

This aspect relates to the frequency of human activity and is determined by its appeal, making pedestrian pathways enjoyable and inviting. There are multiple indicators/factors involved, including patterns of land-use diversity, path gradient, tree obstruction, and shade (4).

As Meeder (30) demonstrated, the gradient has a significant influence on pedestrian attractiveness, whether the path slopes upward or downward. The study observed pedestrians navigating various slope conditions. In cases of uphill slopes, pedestrians tend to use transit services to navigate the gradient. Additionally, an increase of 1% in gradient can decrease walkability attractiveness by approximately 10%.

1.7.3.6 Weather and Temperature

Weather significantly impacts pedestrians, as it affects walkability differently based on age groups. Younger individuals may not be as concerned with weather conditions, whereas adults often seek protection from adverse weather. Pedestrians with walking difficulties need more protection from weather conditions, while those without such problems require less protection. Walking is generally acceptable in cloudy or sunny weather, but uncomfortable in snow or rain (11). Additionally, Tanzil (25) highlighted that comfort levels vary with weather conditions; sunny weather is more comfortable than rain or snow.

A gentle breeze is most enjoyable for walking. Wind speeds less than 7 mph are acceptable for all pedestrian activities, including amphitheaters and outdoor seating areas, while wind speeds 7 - 11 mph is acceptable for mild walking. Wind speeds of 12 - 15 mph is acceptable for brisk walking activities (31).

Pedestrians feel comfortable at temperatures between 16 - 22 °C. Shade from buildings and trees reduces sunlight, while tree shade also helps circulate air (25). Ovstedal (11) described preferred temperatures for walking, noting that temperatures between 0 - 15°C are comfortable, while those between 23 - 33°C are less so. However, temperatures between 16 - 22°C are the most comfortable.

1.7.3.7 Environmental Conditions

The environmental conditions vary across different aspects and must be considered simultaneously, catering to the diverse needs of pedestrians in urban areas. This challenge and concern differ significantly between urban centers, which require more amenities, compared to residential or suburban areas.

The surrounding environment and conditions play an important role in enhancing walkability, as urban area design often prioritizes motorized vehicles over pedestrian facilities. The width of the sidewalk should align with the pattern of the surrounding area; otherwise, it may generate discomfort. Also, if the path is wide enough, it will invite other users (25).

Positive emotional responses from pedestrians depend on their surrounding environment. This means the environment must be clear, unpolluted, and with well-maintained sidewalks, all contributing to a valuable interaction among pedestrians. (11).

1.7.3.8 Accessibility

This concept centers on the relationship between pedestrians, urban activities, and transit services, with the goal of improving accessibility and walkability. It helps planners recognize future planning requirements (4). Accessibility is an important factor for walkability; disrupting the walking of normal people is possible, but on the other hand, it is not possible to disrupt the movement of people with special needs or the elderly (14).

Pedestrians generally choose the shortest walking paths. A well-maintained path provides comfort. The comfortable travel distance ranges from 0 to 400 meters, with less comfort extending from 400 to 1000 meters, and discomfort typically occurring beyond 1000 meters (25).

According to Kaszczyszyn (32), accessibility is determined by the ease of reaching activities and services, as well as factors such as cost. Public transport spot accessibility is classified based on divided distances and time. Table 1.1 illustrates the classification of public transport spot accessibility. Blecic (4) also described accessibility as the ability to reach transit spots and the frequency of their service.

Table 1.1

Public Transport Spot Accessibility Classification

Distance (m)	Time (min)	Level
0 – 400	0 – 5	High
400 - 800	5 – 10	Moderate
800 - 1200	10 – 15	Poor
1200 - 1600	15 - 20	Inaccessible

(Kaszczyszyn, 2019)

Walking comfort hinges on the accessibility between pedestrian networks and public transit. A pedestrian-friendly environment is characterized by efficient design, adequate maintenance, and high accessibility and linkages. Easy access enhances walkability in urban areas, making them more pedestrian-friendly and ensuring physical comfort for visitors (14).

1.7.3.9 Facilities

Facilities improve pedestrian safety and mobility, and facilities must provide access for all pedestrians. Without providing access for all, people with disabilities have fewer opportunities to engage in their activities (33).

Street furniture such as toilets and seats enhance pedestrian comfort. Other street facilities such as crossings, road signs, and lighting are also essential, particularly at night. Different facilities or aspects change from country to another dependent on climate; for this it's important to find fundamental facilities pedestrian needed them (25).

Facilities should not be undersigned or they will not work. There are a large number of facilities that pedestrians need, including sidewalks, crosswalks, ramps, transit

treatments, sign, barriers, telephone, and trash. Minimum sidewalk widths, which vary depending on the type of road, should be provided, as specified Table 1.2 (33).

Table 1.2

The Minimum Sidewalk Widths

Type	Width
Local or collector	1.5 m
Arterial or major	1.8 to 2.4 m
CBD, parks, schools, and other	2.4 to 3.7 m
Major pedestrian generators	2.4 to 3.0 m

(Zegeer, 2002)

1.7.3.10 Pleasantness

Tanzil (25) defined pleasantness as the ability for pedestrians to walk enjoyably and comfortably. In contrast, Blečić (4) described it as a sense of space with a "vibrant atmosphere" that encourages pedestrians to spend more time walking. A key factor in this regard is the presence of tree canopies covering sidewalks, as they help reduce air temperature and sunlight.

It can be measured in various ways, including activity, aesthetics, cleanliness, urban texture, noise, landscape, tree canopies, architecture, shade, and scenery. Among these, tree shadows are particularly important as they can reduce temperatures by up to 12°C. All these elements contribute to improving walkability in urban areas and enhancing walking as a mode of transportation (34).

1.7.3.11 Streetscape

This concept, of interest to both public health and transportation sectors, focuses on street facilities. Streetscape primarily encompasses visual elements such as sidewalks, building, landmark, green and open spaces, and street furniture. Also, it examines relation between walking behavior and physical environment urban areas. Streetscape focuses on physical walking facilities such as footpaths, level of service (LOS), and pedestrian protection from traffic (9).

According to Walk Friendly Community, design elements play a significant role in making walking enjoyable and comfortable. Streetscape elements enhance walkability (35).

1.7.3.12 Walk Score

It measures the score of community walkability based on the typical daily needs of individuals. These measures are based on the distances one must walk from one location to another, encompassing various service categories such as restaurants, parks, groceries, retail, errands, schools, cultural, and entertainment (36).

According to Walk Score (37), walkability is measured based on routes and essential services needed by humans, such as finance, public health, and government. This data analysis generates a score out of 100 for each community, with different levels assigned based on accessibility metrics. Communities with services reachable within 5 minutes receive the highest scores. Table 1.3 illustrates the walk score percentages and their corresponding descriptions.

Table 1.3

Walk Score Description

Score	Level	Description
90	Paradise	Daily errands do not require a car.
70	Very	Most errands can be accomplished on foot.
50	Somewhat	Some errands can be accomplished on foot.
25	Car-Dependent	Most errands require a car.
0	Car	Almost all errands require a car.

(Walk Score, 2023)

1.7.3.13. Sustainability

According to Azmi (38), this concept is widely adopted globally across various aspects such as socioeconomic and environmental considerations. It addresses urbanization challenges in urban areas. The United Nations defines sustainability as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (39).

To enhance walkability and create a sustainable neighborhood, it is essential to establish specific requirements. Identifying these points is crucial for achieving this goal:

- Diversity: safe and convenient walk.
- Autonomy: strategic placement and clustering of community facilities.
- Response: The place must adapt to the environmental climate and landscape.

This principle of sustainability is applied in planning neighborhoods or urban areas. It can be used when establishing new neighborhoods or developing existing urban areas (38).

Zakaria (40) defined sustainable development as balancing environmental protection with human needs, meeting these needs both now and in the future. Sustainable transportation is one of the aspects of sustainable development, alongside environmental, social, and economic factors.

Malaysia Institute of Transport (MITRANS) (41), the Organization for Economic Co-operation and Development (OECD) and Centre for Sustainable Transportation (CST) identified a sustainable transport system as one that:

- Addresses the needs for mobility and accessibility for both society and individuals, respecting the environment and human considerations, while balancing present and future requirements.
- Is efficient and adequate, seeking alternative modes of transport to support a competitive and balanced economy.
- Decreases emissions, utilizes alternative energy sources, and reduces space usage.

Sustainable development involves the integration of social, environmental, and economic factors. The environmental aspect must be considered when planning and designing construction projects (40).

Baobeid (42) indicated that there is an intersection between livability and sustainability. Sustainability involves balancing environmental, economic, and social factors, aiming for resource regeneration and preservation for both present and future needs. Livability, on the other hand, reflects the community's satisfaction with their surrounding environment.

This classification of sustainability includes:

- Environmental: reduce emission and carbon footprint, encourages use of public transportation, and sustainable land use.
- Social: safer environment, stronger social interaction, freedom of movement, healthier population.
- Economic: customer savings, public savings, accessibility to goods and services, savings from healthcare sector. These are the three fundamental features' aspects of sustainability (42).

1.7.4 Literature Review Summary

The literature review indicates that a typical walkable environment comprises multiple elements, contrary to the expectation that the pedestrian environment consists solely of sidewalks. The elements of walkability are not always integrated together; researchers often focus on one or a few elements. On the other hand, many elements that are studied for walkability are applicable in developed countries, but not necessarily in developing ones. Additionally, some studies do not describe the methodology used to measure walkability.

The below summary provides a concise description of all elements of walkability, along with the probable factors/indicators for each element. This will improve the comprehensive understanding of walkability elements, guiding focus towards the most critical elements based on their frequency in the literature. It also addresses the methodologies used to study and measure walkability elements. The elements studied in the literature review are:

- **Street design:** should prioritize pedestrian safety and comfort within the pedestrian environment. This includes considerations such as sidewalks, landscaping, street lighting, street furniture, public facilities, and sidewalk width.
- **Building & Land Use:** The surrounding environment along pedestrian paths, plays a crucial role. Factors such as kiosks, shops, vendors, visual aesthetics, architectural design setbacks, and the ratio of building height all contribute to shaping pedestrian experiences.
- **Street network:** Achieving optimal pedestrian mobility hinges on several factors, including a high ratio of intersection nodes to road links. Additionally, factors such as having short, direct routes to destinations, small block sizes, connectivity, and seamless integration with public transport are paramount.
- **Complete Streets concept** involves designing and operating streets to ensure safe, appealing, and comfortable access for all users, including pedestrians, cyclists, motorists, and public transport users
- **Comfort:** Greater availability of elements and additional factors contributes to increased comfort, as it is associated with a wider array of amenities and considerations.

- **Efficiency:** Can be influenced by various factors such as pedestrian infrastructure, including well-maintained sidewalks, clear signage, and pedestrian-friendly crossings. Additionally, factors like proper urban planning, which promotes short walking distances, direct routes, and integration with public transportation, can enhance efficiency.
- **Convenience:** Walking without constraints or hardships freely and easily. Indicators include street lighting, trees, transit frequency, parking, cleanliness, sidewalk condition.
- **Security & Safety:** Feeling safe and secure while walking on-site, both during daylight hours and in darkness, is influenced by factors such as separation between pedestrian and vehicle paths, as well as concerns regarding crashes, vandalism and crime. It also includes crossings, refuge islands, street watchers, gender diversity.
- **Attractiveness:** This pertains to the patterns of land use and the quantity, type, and positioning of urban attractions, including the number, density, size, diversity, and frequency of human activities.
- **Weather and Temperature:** Study of weather & temperatures affecting pedestrian movement; wind, sunshine, snow and rain.
- **Environmental Conditions:** It reflects the surrounding environment concerning pedestrian movement, encompassing factors such as sidewalk width and obstacles along the sidewalk.
- **Accessibility:** The accessibility of stops and the ability of individuals to access services and activities are crucial. Depending on the distance and time required to reach them, this includes services, transit points, and community participation.
- **Facilities:** The necessary amenities required to cater to pedestrians of diverse needs should be provided, including sidewalks, crosswalks, ramps, transit treatments, sign, barriers, telephone, and trash to enhance the pedestrian environment.
- **Pleasantness:** Examine the factors influencing the smoothness of pedestrian movement, which include tree canopies along pedestrian paths, cleanliness, pedestrian activity, and noise levels.
- **Streetscape:** The initial interpretation pertains to the visual components of the street, encompassing buildings, roads, sidewalks, open spaces, green areas, and street furniture.

- Sustainability: Involves harmonizing the satisfaction of human necessities with safeguarding the environment. It entails incorporating the environmental, social, and economic aspects essential for sustainable development.

The street design, building and land use, and street network elements will be excluded from the study, as their detailed aspects are addressed in other components. Similarly, comfort and sustainability will be excluded as they contribute to future recommendations. Also, will evaluate whether the walkability facilities ensure comfort and sustainability.

The complete street includes multiple elements and requires additional time and researchers to analyze user behaviors. Therefore, the focus will be on walkability based on facilities. Based on this, the 10 elements to be studied in this thesis are: efficiency, convenience, security and safety, attractiveness, weather, environmental conditions, accessibility, facilities, pleasantness, and streetscape. The indicators and sub-indicators for each element will be described in a later chapter.

Chapter Two

Methodology

2.1 Introduction

The use of walking as a mode of transportation extends beyond a single type of land use, encompassing the diverse environments where people engage in their daily activities and fulfill their needs. Given its association with human mobility across varied settings, it transcends specific locations or land use categories.

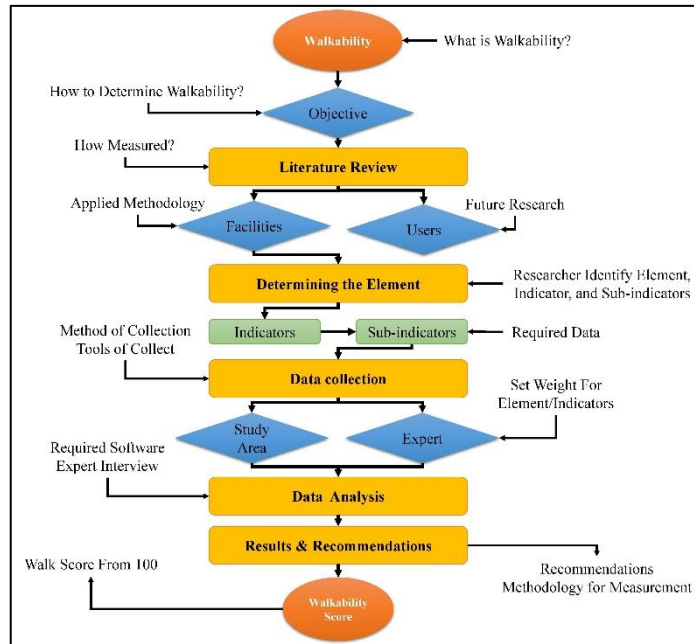
This chapter describes the most crucial aspect of this study: the methodology used to accomplish its goals. The process involves several sequential steps, beginning with the fundamental inquiry: how to measure walkability? After reviewing the literature, we can answer this question by identifying the key elements that affect walkability. Several elements will be selected from the literature.

From the literature review, it is evident that there are multiple methodologies available. This section of the thesis outlines the comprehensive approach employed for its completion. Generally, there isn't a singular methodology due to the various approaches available for examining walkability. Some methodologies focus on analyzing public pedestrian facilities, while others investigate user-related factors. Therefore, the methodology used will include both approaches to cover a broader range of aspects related to walkability. Generally, the study focuses on the pedestrian environment.

Figure 2.1 illustrates the methodology and process steps in a flow chart. The methodology consists of five sequential steps, starting with the preparation stage, which includes setting objectives and conducting a literature review. The second step involves identifying the elements, indicators, and sub-indicators to determine the specific data needed. The third step outlines the methods of data collection, the tools to be used, and how the data will be displayed. The fourth step involves data analysis, including the software required. The fifth and final step presents the results, which include the measurement methodology, recommendations, and scenarios.

Figure 2.1

Methodology and Process Steps Flow Chart



2.2 Preparation Stage

Figure 2.1 shows a graphical depiction of the different phases integral to conducting the study. It highlights the sequential order of the steps, aiding in understanding the overall methodology employed. In this stage, the methodology will identify the main elements of walkability and how each one of them affects walkability, preparing it to identify the main indicators and sub-indicators that will be used to evaluate and measure walkability in the study.

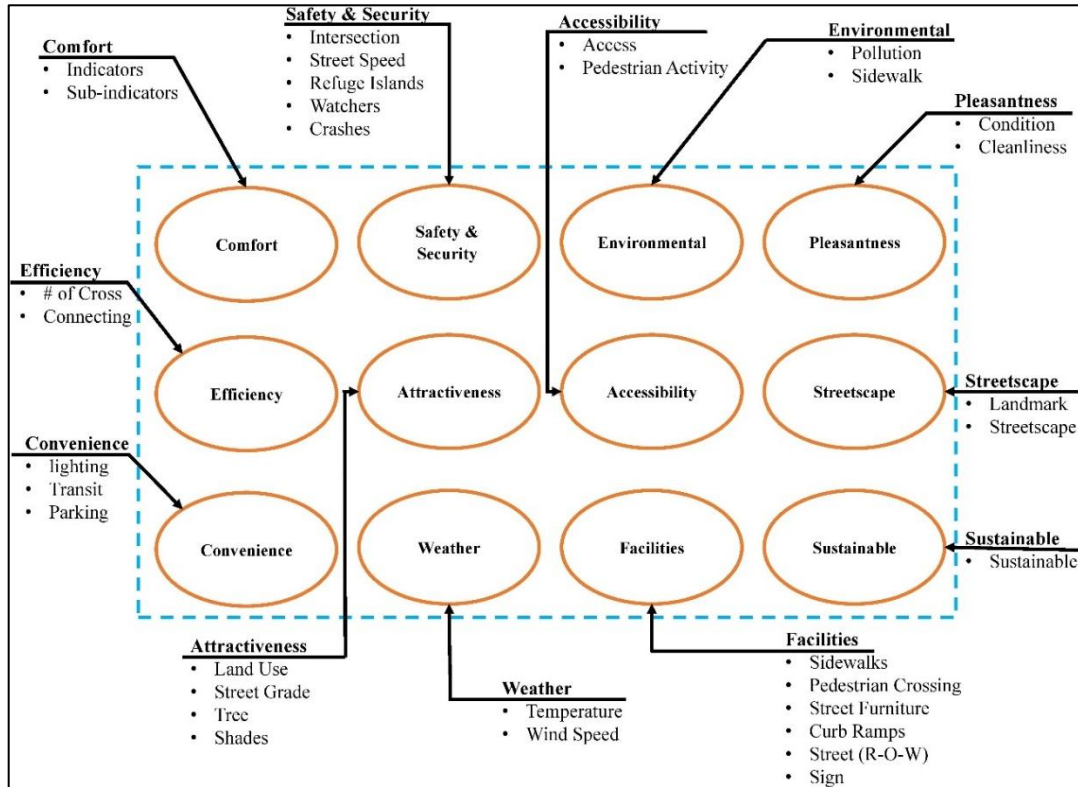
The indicators and sub-indicators will be crucial in determining the overall walkability of the area being studied. From the literature review, it was noted that there are overlapping indicators and sub-indicators among the elements. To ensure clarity and precision in the assessment process, any overlapping indicators will be excluded, but each remaining indicator will be weighted according to its importance. All indicators and sub-indicators will be established based on the researcher's opinion. Twelve elements have been identified and discussed in the following sub-section.

Figure 2.2 illustrates the twelve elements and indicators of walkability. To evaluate walkability, ten of these elements were chosen and are briefly described in Table A.11 in Appendix A. The other two elements, comfort and sustainability, are highlighted for their

critical role in walkability. Their significance will be further described in the analysis and recommendations later in this study.

Figure 2.2

Walkability Elements and Indicators



2.3 Identify Elements, Indicators & Sub-indicators

In these stages, the methodology involves identifying both primary indicators and sub-indicators. The 12 elements are divided into 29 primary indicators, which are further broken down into sub-indicators. By establishing a clear framework for evaluation and measurement, these indicators will aid in assessing the walkability of different urban areas. The primary task in this step is to identify the sub-indicators. By evaluating these specific components, a score for walkability can be determined. These sub-indicators may include factors such as sidewalk availability, connectivity, and crash, etc.

2.3.1 Comfort

Comfort lacks specific indicators or sub-indicators because it is closely linked to other elements. As other indicators improve, comfort levels also rise. In summary, the degree of comfort is similar to the overall walkability score.

2.3.2 Efficiency

This element is associated with the efficiency of the road network. To check and evaluate efficiency, two primary indicators will be used: connecting and the number of intersections. This element encompasses a total of seven sub-indicators:

Connection indicators are divided into five sub-indicators:

- Number: How many roads connect to the street?
- Type: What type of roads connect? Are they minor, major, or staircases?
- Staircase: Do you need to ascend or descend stairs to access the road?
- Lengths: What are the lengths of these connecting roads (250, 400, 800+ meters)?
- State: Are the connecting roads continuous or non-continuous?

Intersection indicators are divided into two sub-indicators:

- Number: How many intersections are there per 100 meters?
- Distance: What is the distance between intersections?

2.3.3 Convenience

It assesses the convenience of the surrounding environment for pedestrians, evaluated through three indicators: street lighting, transit, and parking. This element consists of seven sub-indicators, which are:

Street lighting focuses on a single sub-indicator:

- Availability: Is there adequate lighting available throughout the study area, and is it sufficient?

Transit is evaluated based on transit services, divided into four sub-indicators:

- Stations: How many stations are there per 100 meters?
- Distance: What is the distance between stations (400, 800+ meters)?
- Frequency: How many taxi vehicles are there per 100 meters?
- Furniture: Is there any furniture at the taxi station, and what is its condition?

Parking is evaluated based on two sub-indicators:

- Availability and Type: Are there parking lots on this road? What type of parking is available?
- Cost: Is it free or paid?

2.3.4 Safety & Security

The safety and security of the pedestrian environment are evaluated using five indicators: conflict points, speed, refuge islands, street watchers, and crashes. This element will be assessed through 14 sub-indicators, which are:

Conflict points indicators between pedestrian and vehicles divided into two sub-indicators:

- Intersection conflict points: the number of conflict points at intersections.
- Private entrances: the number of private entrances per 100 meters.

Speed indicators include one sub-indicator:

- Speed: what is the likely driving speed? / What is the probable speed on this road?

Refuge islands indicators are divided into six sub-indicators:

- Availability & Width: Are there refuge islands, and what are their widths?
- Length: How long are these islands? Do they cover the road completely or partially?
- Usability: Are these refuge islands usable?
- Condition: What is the condition of the refuge islands? Are they in good or poor condition?
- Clean: What is the degree of cleanliness of the refuge islands?
- Length of first side barrier: What is the length of the barriers on the first side? Do they fully or partially cover the road?
- Length of the other side barrier: What is the length of the barriers on the other side? Do they fully or partially cover the road?

Street Watchers indicators are divided into two sub-indicators:

- Kind: What type of street watchers are present? Are they drivers, shop owners, police, pedestrians, or a combination of these?
- Number: What is the number of pedestrians per 100 meters?

Crashes indicators are divided into two sub-indicators:

- Injuries: What is the number of injuries per 100 meters?
- Degree: What is the degree of injuries: fatal, difficult, moderate, or low?

2.3.5 Attractiveness

This aspect is considered complementary, yet its significance lies in providing appealing elements that encourage pedestrian activity. To measure this factor, we will use four indicators: land use, street gradients, trees, and shade. This element will be assessed through seven sub-indicators, which are:

For land use, there is a single sub-indicator:

- Pattern: To what extent is walking required? What type of land use is present? Is it industrial, residential, mixed, or commercial?

Street is dealt with in one sub-indicator

- Grade: What is the street slope? Is it steep, moderate, or level? This measures the degree of comfort.

Trees element is assessed through two sub-indicators:

- Obstruction: What is the vertical clearance between the sidewalk and the lower branches?
- Shadows: What percentage of the sidewalk is covered by tree shadows?

Shade is divided to three sub-indicators:

- Available & Coverage: Are there umbrellas available and covering the sidewalk? What is the coverage area?
- Owns: What is the ownership of these umbrellas? Is it private or public owned?
- Usability: Can pedestrians use it? Is it partially or fully usable?

2.3.6 Weather

Weather can impact walkability in various ways and fluctuates throughout the year. The weather element considers suitability for walking based on two indicators: temperature and wind speed. This element will be assessed through two sub-indicators, which are:

Temperature has a single sub-indicator:

- Degree: How many days are suitable for walking with temperatures between 15°C and 20°C?

Wind is assessed using a single sub-indicator:

- Speed: How many days are suitable for walking with wind speeds less than 19 km/h?

2.3.7 Environment

It involves a range of factors associated with the nearby natural and built environment. Therefore, prioritizing and improving the environmental aspects of walkability is crucial. This element comprises two indicators related to facilities and the surrounding area: pollution and sidewalks. This element will be assessed through nine sub-indicators, which are:

Pollution is divided to four sub-indicators; these are:

- Type: Is there pollution present? What type is it: solid, water, air, noise, or visual?
- Cause: What is the source of this pollution? Is it from construction, sewage, or commercial/retail activities?
- Level: What is the degree of pollution? Is it high, moderate, or low? Is it acceptable or not?
- Duration: What is the duration of this pollution? Is it permanent, temporary, or instantaneous?

The sidewalk environment indicator focuses on five sub-indicators related to obstacles:

- Length: Are there any obstacles on the sidewalk? If so, what is the length of these obstacles per 100 meters?
- Width: How much sidewalk width is left after this obstacle?
- Degree: What is the size or extent of these obstacles? Are they fully obstructed, partially obstructed, or empty?
- Duration: How long do these obstacles last? Are they permanent, temporary, or instantaneous?
- Cause: What are the causes of these obstacles? Construction, street furniture, kiosks, or maintenance?

2.3.8 Accessibility

Access to public life pertains to individuals' ability to engage in various activities. In this study, accessibility is defined by two indicators: pedestrian access and pedestrian activity within different walkable distances of 250, 400, 800, and over 1000 meters. This element will be assessed through three sub-indicators, which are:

Access is divided to two sub-indicators:

- ATM: Are ATMs accessible within the study area, and how far is the walking distance to reach them? Is it within an acceptable distance, or not?
- Taxi: Are taxis accessible within the study area, and what is the walking distance required to reach them? Is it within an acceptable distance, or not?

Pedestrian activity evaluated through a single sub-indicator:

- Variety: What variety of activities are available in the study area? What types of activities can be conducted on the street, such as government institutions, shopping, restaurants & cafes, recreation, or a combination thereof?

2.3.9 Facilities

The facility of walkability encompasses the quality and availability of pedestrian infrastructure, focusing on the environment of the facilities. This element comprises six crucial indicators, each addressing multiple aspects: sidewalks, pedestrian crossings, street furniture, curb ramps, streets, and signage. This element will be assessed through 23 sub-indicators, which are:

The sidewalk indicator is divided into ten sub-indicators:

- Length: What is the length of the first sidewalk?
- Length: What is the length of the other sidewalk?
- Width: What is the width of the first sidewalk?
- Width: What is the width of the other sidewalk?
- Barriers: What is the length of the barriers on the first side?
- Barriers: What is the length of the barriers on the other side?
- Length: What is the length of the first frontage offset (parking)?
- Length: What is the length of the other frontage offset (parking)?
- Width: What is the width of the first frontage offset (parking)?
- Width: What is the width of the other frontage offset (parking)?

Pedestrian crossing indicators include two sub-indicators:

- Availability: Are there pedestrian crossings? What type of crossing; is it overpass, underpass, on-street?
- Distance: What is the spacing between pedestrian crossings? Is it more or less than 300 meters?

Street furniture availability is divided into five sub-indicators:

- Benches: Are there benches?
- Toilets: Are there public toilets?
- Trash: Are there trash bins?
- Telephone: Is there a public telephone?
- Bollards: Are there bollards? What is their length?

Curb ramps have a single sub-indicator:

- Availability: How many curb ramps are available per 100 meters?

The street has a single sub-indicator:

- R-O-W: What is the (R-O-W) width? Is the width sufficient to design a good sidewalk?

Sign availability has four sub-indicators:

- Speed reduction: Are there speed reduction signs?
- Stop line: Are there stop line markers?
- Crosswalk: Are there crosswalk signs?
- Clarity: Are the signs clear for users?

2.3.10 Pleasantness

Pleasantness describes the overall sense of enjoyment and comfort pedestrians feel while walking in a specific location. It refers to the quality or state of being agreeable or enjoyable. Increased pleasantness in walkability encourages more frequent and longer walks. The assessment of sidewalk pleasantness focuses on single indicator: sidewalk. This element will be assessed through four sub-indicators, which are:

Pleasantness has four sub-indicators:

- Condition: What is the state of the first sidewalk? Is it in poor, or good condition?
- Cleanliness: Is the first sidewalk clean? How comfortable is it for pedestrians?
- Condition: What is the state of another sidewalk? Is it in poor, or good condition?
- Cleanliness: Is the other sidewalk clean? How comfortable is it for pedestrians?

2.3.11 Streetscape

Streetscape refers to the visual and physical elements that contribute to the character and appearance of a street. It encompasses a wide range of features, and a well-designed streetscape enhances walkability. This element is evaluated using two indicators: landmarks and streetscape. This element will be assessed through four sub-indicators, which are:

The landmark assessment includes four sub-indicators:

- Attraction points: Are there any attraction points? Are there any historical sites?
- Buildings: Are there any distinctive buildings?
- Open spaces: What types of open spaces exist?

Street landscape has a single sub-indicator:

- Landscape: Does the street have landscaping? This includes the availability of plants, decorations, furniture, and sidewalks.

2.3.12 Sustainable

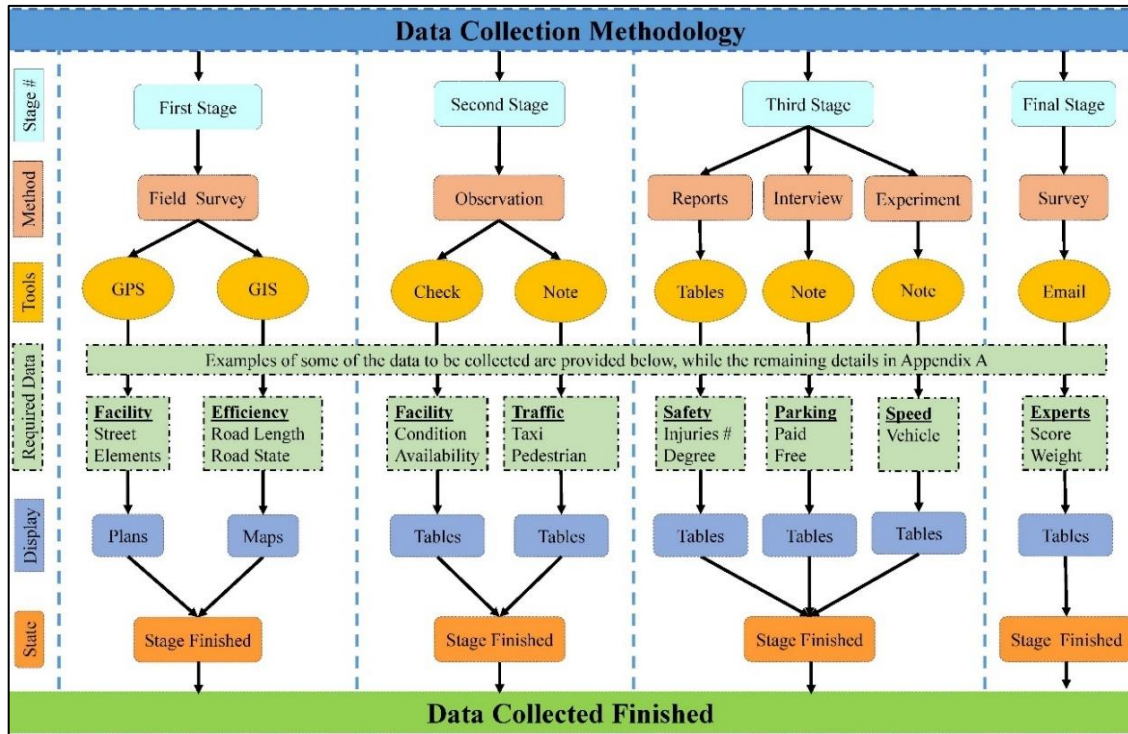
Evaluating the sustainability of walkability entails assessing various elements to ensure that walking as a mode of transportation remains environmentally, socially, and economically sustainable. By considering these factors and engaging in comprehensive evaluation processes, we can effectively measure sustainability. In essence, it guides us to the level of sustainability we have achieved. This categorization is founded on the 11 elements previously mentioned.

2.4 Data Collection

Various methods were employed to collect data based on the specific information needed. Data were gathered from multiple sources, utilizing four types of data: primary, secondary, quantitative, and qualitative. The methods of data collection can be comprehensive, including aerial images, reports, experiments, Global Positioning System; GPS, interviews, observations, and questionnaires. Additionally, it may sometimes be necessary to combine methods. The data collection process was divided into four stages to simplify the process and ensure data accuracy. Figure 2.3 illustrates the data collection methods.

Figure 2.3

Methodology of Data Collection



The question at hand is what is the method of data collection that will be used and how the data will be collected? Dividing the study area into smaller sections will facilitate data collection and analysis. As previously described, the study area is Rafidia Street, which spans over 3.5 km. To streamline the data collection process, the street is divided into 35 sections of 100-meter each. This segmentation will not only simplify data collection but also enable more detailed observations and comparisons within the Rafidia Street area. Appendix A, Tables A.2 through A.11 provides detailed descriptions of the data collection methods.

The first stage of data collection is divided into two types based on the data being gathered. It involves using GPS and GIS to identify the locations of street facility components, laying the foundation for a detailed description of each component in the next phase of data collection. This data is further displayed using GIS and AutoCAD maps.

The first type of spatial data includes the locations of transit stations, Automated Teller Machine ATM, the length and width of refuge islands, the length of barriers, street gradients, and the dimensions of obstacles such as electric, lighting, and telephone poles

and boxing, trees, traffic signs, advertisements, kiosks, and landmarks. It also covers the length and width of sidewalks, the length and width of parking areas, the distance of barriers and bollards, and the distances between pedestrian crossings.

The second type of spatial data is derived specifically from aerial images using GIS. This includes characteristics of street and staircases connectivity, road length and state, staircases length and state, intersection location and the distances between intersections, intersection conflict points count, tree shadows, access to taxi, and shaded coverage areas.

The second stage of data collection involves observation to identify the characteristics of the collected elements. Additionally, further data were gathered during this stage. The most extensive data collection is conducted through observation, which involves recording various aspects. Many indicators and sub-indicators were collected, including land use patterns, road types, street watcher kind, tree vertical obstructions, sidewalk obstacles degree, duration, and reasons, pollution types, causes, levels, and duration, and the variety of pedestrian activities.

The availability of street lighting, parking, shade, curb ramps, pedestrian crossings, benches, toilets, trash cans, telephones, landmarks, attraction points, buildings, open spaces, and streetscape were also recorded. Additionally, the presence and clarity of signage, including speed reduction signs, stop lines, and crosswalks were assessed.

Also, the condition of transit stations, refuge islands, and sidewalks, as well as the cleanliness of sidewalks and refuge islands were assessed. Counts were taken for streets and staircases connections, intersections, taxi, transit stations, watchers, and conflict points with private entrance spaces. The usability of shade and refuge islands was also observed.

The third stage of data collection involves gathering information through reports, experiments, and interviews. Report data were used to collect previously gathered information from sources such as the traffic police, including the number of crashes and the degree of injuries. Additional data on weather, including temperature and wind speed over the years. Also, R-O-W.

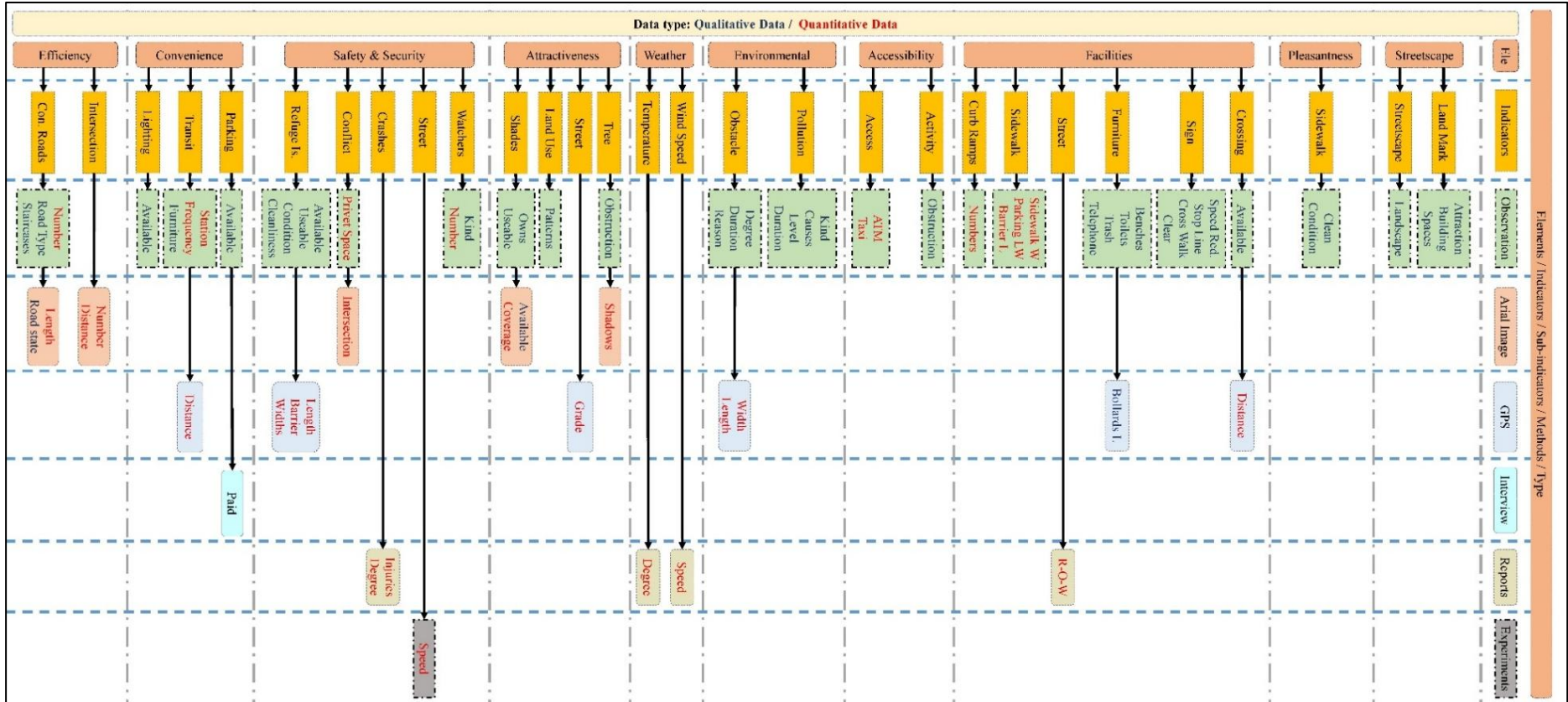
Experimental data involves measuring the speed at which vehicles can move through streets, while interviews with parking employees gathered information about the paid of

parking lots. Additionally, a combination of methods, such as observation and GPS, were used to identify type and measure obstacles.

The final stage is a questionnaire, which was distributed to experts. They assigned weights to the previously identified elements, indicators, and sub-indicators to measure the walkability score out of 100%. This questionnaire, detailed in Table A.11 in Appendix A, involves experts assigning a total weight of 100% to the walkability elements. Additionally, Tables A.12 through A.21 show the weights assigned by experts to the walkability sub-indicators, also totaling 100%. The methods of data collection and types of data collected for all sub-indicators are illustrated in Figure 2.4.

Figure 2.4

Data Collection Tools and Types



2.5 Data Analysis

Data analysis includes examining, cleaning, transforming, and modeling data to uncover valuable information, draw conclusions, and support decision-making. In this research, descriptive analysis will be used. The data as presented in Figure 2.2 shows the 10 elements, 29 indicators, and 80 sub-indicators that will be integrated to assess walkability. To ensure consistency and accuracy in the analysis, it needs quantifying all the data; converting it into numerical values.

The detailed analysis of the data will be covered in the data analysis chapter. In general, the data is divided into spatial and non-spatial categories. The spatial data will be evaluated against established design standards/criteria to assess its conformity. The non-spatial data will be compared and analyzed based on criteria established by the researcher. Since the data includes both qualitative and quantitative aspects, various software programs will be used, which will be explained in the next section.

When handling data, it's essential to consider their types carefully. Quantitative data is relatively easy to rearrange, but qualitative data has specific characteristics that make it more challenging to work with and require a process to reorganize. Therefore, both qualitative and quantitative data will be converted into scores to simplify the subsequent analysis steps and create a uniform dataset.

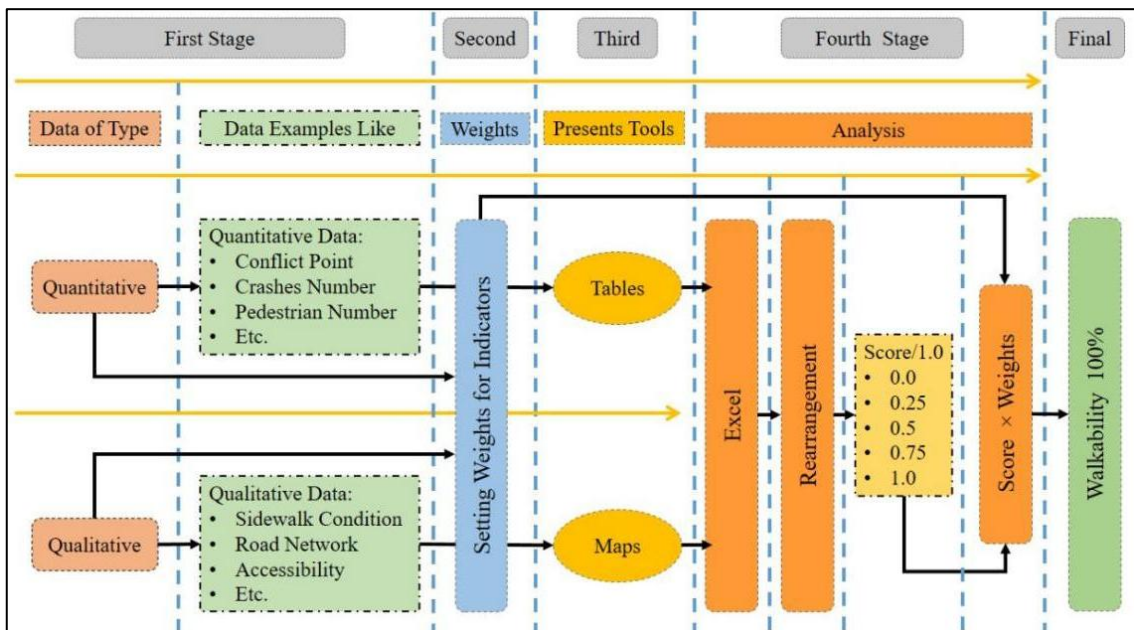
The uniformity of the data will be achieved by applying a scoring methodology to the collected data. This scoring system uses values ranging from 0 to 1, where a score closer to 1 indicates a better value, with 1 representing the optimal value. A score near 0 suggests a poorer outcome, with 0 being the worst possible score. The scores for the other data points will also range from 0 to 1, although this can vary among sub-indicators. Table A.2 through A.11 in the Appendix A illustrates all these values, explaining how they are selected and applied in the study area.

The final stage of the analysis involves developing an equation to quantify the overall walkability score, considering the relative importance of each element, indicator, and sub-indicator. Experts will assign appropriate weights to these components. This equation will provide a comprehensive measure of walkability and can be applied to different neighborhoods or cities to identify areas for improvement. A comprehensive explanation of these equations, from Equation 3.1 and A.1 to A.15, is provided in Appendix A. The

result of this study will be the development of a method for evaluating walkability, with Rafidia Street serving as a case study. The evaluation score will be expressed as a percentage, based on the elements, indicators, and sub-indicators.

The methodology of analysis is illustrated in Figure 2.5, which outlines the steps for analyzing the data, consisting of four stages. The first stage involves preparing the collected data, including both qualitative and quantitative data, and the element and sub-indicators as shown and described in Figure 2.4 with a description of each one to assign a weight to them. In the second stage, weights are assigned to the elements, indicators, and sub-indicators in preparation for measuring walkability. The third stage involves analyzing the data by assigning scores from 1, which will be described later. The final stage involves multiplying the scores by the assigned weights.

Figure 2.5
Methodology of Data Analysis



The analysis will be carried out for each section individually, based on the previously identified elements and sub-indicators. Given that the road exhibits varying characteristics along its length, it will be divided into three sections, as shown in Figure 1.1 The Overall Study Area and Three Parts. Each section differs in length and characteristics, reflecting the facilities present in the study area. The first part extends from Bet Wazan Roundabout to the Arab Bank intersection; the second part runs from the

Arab Bank intersection to the Rafidia Hospital intersection; and the final part stretches from the Rafidia Hospital intersection to Jamal Abd Al Naser Park.

2.6 Data Analysis Software

There will be three types of software used in the analysis of the data collected, which are GIS, AutoCAD, and Excel:

- GIS: This tool is used for spatial data analysis and visualization. It enables to capture, store, manipulate, analyze, and present geographic information. It is used to analyze spatial data; median and sidewalk availability and width, and to assess the network.
- AutoCAD: It facilitates the creation of detailed plans, sections, and elevations, which are essential for various design and engineering applications. It will be used to draw the data collected by GPS and prepare it for use in GIS. Additionally, it will analyze the grade of the road and identify the locations of road elements such as signs and barriers.
- Excel: This versatile spreadsheet application is used for data analysis, visualization, and management. It will be used to analyze all the data collected during the research study, and to converting all data quantitatively, then calculate the overall score for walkability.

2.7 Results and Recommendations

The results and recommendations from this study can be utilized and presented in several ways. Firstly, they can serve as valuable tools for urban decision-making and design support. Secondly, the study will provide a walkability score for the study area. Thirdly, it will propose potential improvements to enhance walkability within the area. Additionally, recommendations will include using this methodology to measure walkability and exploring further scenarios for developing the study area.

Chapter Three

Data Collection

3.1 Introduction

This chapter outlines the detailed data collection, sources, and methods used. Data as gathered using various methods based on the specific information required relevant to the specific research or analysis.

Ethical considerations, such as informed consent, the purpose of the study, and protecting personal information through confidentiality and anonymity, was also considered. Finally, the chapter addresses data documentation and reporting.

3.2 Defining Objectives and Scope

When collecting data, it is essential to define the purpose and ensure it aligns with the research objectives. In this study, the data gathered must address how walkability will be assessed using the 12 elements of walkability: comfort, efficiency, convenience, safety & security, attractiveness, weather, environmental factors, accessibility, facilities, pleasantness, streetscape, and sustainability. The indicators and sub-indicators for these elements were detailed in the previous chapter and are illustrated in Figure 2.4.

The scope of the study area can be determined by identifying its boundaries, which can be categorized into two types: population and geographical study area. The population boundary is not applicable to this study, while the geographical boundary of the study area is relevant. The study area is located in the Rafidia district, specifically along the main Rafidia Street, spanning approximately 3.5 km. The boundaries of the study area extend from Bet Wazan Roundabout to Jamal Abd Al Naser Park, including other connected roads, which will be identified by their type and length.

3.2 Data Sources

Data collection sources are divided into primary and secondary. Both types are used in the study, but the primary data, which the researcher collects directly, will be the main focus. Secondary data is used to a lesser extent. The sources of data are described in the next section, including information collected directly and existing data gathered for other purposes.

3.2.1 Primary Data Source

The primary data collected by the researcher includes experts' questionnaire to assign weights to the elements, indicators, and sub-indicators, weather element is considered secondary data as well as data on 9 other elements and 25 indicators, detailed as follows:

- Efficiency: Road connections characteristics and intersection locations.
- Convenience: Street lighting, transit options, and parking availability.
- Safety & Security: Pedestrian conflict points, speed, refuge islands, and the presence of street watchers.
- Attractiveness: Street gradients, trees, and shade indicators.
- Environmental: Pollution levels and sidewalk obstacles.
- Accessibility: Access and the diversity of pedestrian activities.
- Facilities: Sidewalk characteristics, pedestrian crossings, street furniture, curb ramps, and signage.
- Pleasantness: Sidewalk condition and cleanliness.
- Streetscape: Landmarks and street design.

3.2.2 Secondary Data Resource

The secondary data, gathered from various sources, includes 4 elements and 4 indicators. The sources of this data are defined as follows:

- Attractiveness: Includes land use, with data sourced from Geomolg.
- Weather: Includes temperature and wind speed, with data sourced from the Meteoblue weather website.
- Safety & Security: Includes crash data, sourced from Police Traffic records.
- Facilities: Includes street right-of-way (R-O-W), with data sourced from Geomolg.

3.3 Data Collection Methods

The data collection methods encompass qualitative, quantitative, or a combination of both types of data.

3.3.1 Qualitative Methods

The qualitative data is crucial for evaluating walkability as it provides in-depth insights into the subjective aspects of pedestrian environments. It captures the nuances of how individuals perceive and engage with their surroundings.

3.3.2 Quantitative Methods

Quantitative data is essential for assessing walkability, as it provides measurable and objective metrics for evaluating different aspects of pedestrian environments. This data generally includes numerical measures that allow researchers to assess the efficiency, safety, and overall quality of walking spaces. By quantifying these factors, researchers can gain insights into how well pedestrian environments function.

3.3.3 Mixed Methods

Another source of quantitative and qualitative data is the expert questionnaire, which involves assigning weights to the 10 elements and 80 sub-indicators. This process is carried out by 12 experts. The quantitative data includes the weights assigned to the elements and sub-indicators, years of experience, and the average daily walking time in minutes. The qualitative data encompasses gender, work sectors, educational degrees, and whether walkability is used as a mode of transportation. This data is also crucial for measuring walkability.

3.4. Data Collection Tools

The data collection process must be conducted in sequential steps, beginning with observations using GPS devices and preparing sketch paper, followed by the use of checklists, aerial images, field notes, cameras and videos, experiments, reports, interviews, and finally, expert questionnaires.

Data Collection Tools:

1. Observation

In the context of assessing walkability, these tools include:

- GPS Devices

GPS devices are used to track and record the exact locations of observed features.

- Checklists

Pre-defined lists of specific elements or features to observe and record.

- Aerial Image

High-resolution images from drones or satellites are used to observe larger-scale features and patterns that may not be visible from the ground.

- Field Notes

Detailed notes taken during observations of the study area document conditions, behaviors, and other relevant factors.

- Cameras and Video

Devices used to capture visual data enable later analysis.

2. Experiments

Systematically conducting tests under controlled conditions to gather data.

3. Reports

Involves gathering and analyzing information from existing reports to support research objectives.

4. Interview

Gathering information directly from individuals through structured or semi-structured conversations.

5. Questionnaire

Information from respondents using structured questionnaires designed to address specific research questions.

3.5 Sampling Techniques

Sampling techniques in a walkability study refer to the methods used to select a subset of the population or study area for data collection and analysis. The chosen sampling technique depends on the research objectives and the specific characteristics of the study area. A well-designed sampling strategy ensures that the collected data accurately reflects the overall walking environment in the study area.

There are two main categories of sampling techniques: probability sampling and non-probability sampling. Non-probability sampling used in this study, providing methods such as convenience sampling and purposive sampling. This approach is suitable because the study focuses on the walking environment rather than the walkers, making a representative sample unnecessary.

3.6 Data Collection Process

The data collection process outlines how data is gathered and highlights any issues encountered. Typically, unexpected factors may arise during data collection, requiring additional considerations. To address these potential issues and fill any gaps, pilot testing will be carried out. This involves conducting a preliminary test of the data collection tools and methods to identify problems and make necessary adjustments.

During the pilot testing conducted on the 15 sections of the study area, it was noted that several sub-indicators might require modification, either by adding new ones or removing existing ones. This process facilitates necessary adjustments before the full-scale data collection, thereby improving the reliability and validity of the study.

From the pilot testing, it was observed that some indicators were overlooked, including: the number of roads connected to the road under study, private space and parking entrances, refuge island barriers on both sides, kind of street watchers, dimensions of obstacles, sidewalk dimensions and barrier lengths on both sides, dimensions of frontage offset (parking), cleanliness and condition of both sidewalks and refuge islands, etc. Also, there was a need to integrate safety and security elements.

Data collection execution is conducted after making the necessary adjustments to ensure consistency, adherence, effectiveness, and efficiency. This process involves setting up the data collection plan, which begins with numbering the study area sections, establishing

checklists for sub-indicators, and conducting surveys by the researcher. Data collection was carried out separately for each section.

3.7 Data Management

Data collection management entails overseeing and coordinating the complete process of gathering, storing, and handling data to guarantee its accuracy, integrity, and usability. Ensuring effective management is essential for making sure that the collected data is reliable, precise, and valuable for meeting the research or project objectives.

The collected data was stored in two formats: first as physical documents, including checklists and sketches, and later converted into digital formats, such as Excel spreadsheets and maps, to facilitate analysis. To ensure data quality, accuracy, completeness, and consistency checks were conducted, including random spot checks on the gathered data.

3.8 Data Collection Considerations

3.8.1 Ethical Considerations

Ethical considerations in data collection are essential to ensure that the research is conducted responsibly and with respect for participants' rights. In this study, the focus is on the experts' questionnaire. By informing the experts that the research is used for educational purposes only. Additionally, their identities and personal information, including their evaluations of elements and sub-indicators, years of experience, education degree, gender, work sector, and opinions about the elements and sub-indicators, will be protected.

3.8.2 Special Considerations

The data collection process, as outlined in Appendix A, provides clear guidelines and options for collecting data. However, special considerations are necessary when gathering specific information, such as the length of refuge islands, sidewalks, barriers, bollards, obstacles, types of street watchers, shadows from trees and umbrellas, variety of pedestrian activity, and landscape elements. These considerations will be detailed in the following section.

The evaluation score for sub-indicators such as the length of refuge islands, sidewalks, barriers, bollards, and obstacles is based on their measured lengths. For instance, a length of 10 meters would receive a score of 0.1, while a length of 35 meters would receive a score of 0.35, and so forth.

Each kind of street watcher is assigned a score of 0.25, with a score of 0 for the absence all kinds. A section will receive a full score of 1 if all kinds are present. If only two kinds are present, the score will be 0.5, and so on. This sub-indicator cumulatively scores and includes the following options: None, Driver, Shop Owners, Police, and Pedestrians.

Shadows from trees and umbrellas are evaluated based on the percentage of the shaded sidewalk area in each section compared to the total sidewalk area. For instance, if 10% of the area is shaded, it scores 0.1; if 50% is shaded, it scores 0.5; and if 100% is shaded, it scores 1, and so on.

Variety of Pedestrian Activity assigns a score of 0.25 to each activity. If all activities are present in a section, it will receive a full score of 1. If only two activities are present, the section will score 0.5, and so on. This sub-indicator accumulates scores and includes the following options: government institutions, shopping, restaurants and cafes, and entertainment.

For the landscape elements, each carries a score of 0.25. If all elements are present in the section, it will receive a full score of 1. If only two elements are present, the score will be 0.5, and so forth. These elements are evaluated cumulatively and include Plants, Decorations, Furniture, and Sidewalks.

3.9 Data Collection Documentation

The documentation of data collection involves systematically recording and presenting the data gathered for this study. Data was documented using two methods: spatial data is presented in figures, while numerical data is displayed in tables. For technical writing clarity, data collection is presented only for one section out of the 35 sections of the study area in the main text, with the remaining data provided in Appendix B. Table 3.1 presents the overall data collected for Section No. 1, while Figure B.1 illustrates the spatial data for this section.

Table 3.1

Overall Data Collected for All Sub-Indicators in Section No. 1

No	Efficiency	Convenience	Safety & Security	Attractiveness	Weather	Environmental	Accessibility	Facilities	Pleasantness	Streetscape
1	(R) 0.5	(La) 1	(I) 0.5	(P) 0.75	(T) 0.8	(K) 1	(A) 1	(L) 0.53	(Clf) 1	(P)
2	(T) 0.5	(Ss)	(P) 0.5	(G) 0.75	(W) 1	(C) 1	(T) 1	(Lo) 0.29	(Cof) 1	(B)
3	(S) 1	(D)	(S) 0.5	(O)		(L) 1	(V) 0.75	(W) 0.75	(Clo) 1	(O)
4	(L) 0	(Fs) 0.25	(W) 1	(S) 0.22		(D) 1		(Wo) 1	(Coo) 1	(L) 0.25
5	(Sr) 0.5	(Fc)	(L) 0.65	(Sc)		(L) 0.09		(P) 0.34		
6	(C) 0.8	(Pa) 0.6	(U) 1	(Os)		(W) 0.75		(Po) 0.36		
7	(D) 0.75	(Pc) 1	(Co) 0.75	(U)		(De) 0.5		(Pw) 0.75		
8			(Cl) 0.5			(Du)		(Pow) 0.5		
9			(Fb)			(R) 0.25		(Lb)		
10			(Ob)					(Lob)		
11			(K) 0.75					(C)		
12			(N) 0.25					(Cd)		
13			(I) 1					(Be)		
14			(D) 1					(To)		
15								(Tr) 0.5		
16								(Te)		
17								(Bo)		
18								(Cr) 0.5		
19								(R) 1		
20								(Sr)		
21								(Sl)		
22								(Cw) 1		
23								(Cl) 1		

Note: Table 3.1 presents the key terms for the sub-indicators; for a full description, refer to the tables in Appendix B. All empty data equals zero.

Data collection documentation for the other 34 sections of the study area, the overall data collected is presented in Appendix B, with Tables B.1 to B.1 providing detailed data for each element individually. The corresponding spatial data is shown in Figures B.1 to B.35, also located in Appendix B.

The distribution of weights for elements and sub-indicators in the study was based on responses from 12 experts who completed a detailed questionnaire. The collected data were categorized by various demographic and professional factors, including gender, age, educational degree, work sector, and years of experience. Additionally, the responses regard to the use of walking as a mode of transportation and further broken down by daily walking time.

General information about the experts is shown in Table 3.2 and is further detailed in Tables B.11 to B.17 in Appendix B. The detailed data on the weights assigned by the experts is presented in Tables B.18 to B.28, also in Appendix B. Tables B.29 to B.33 display the data collected for different aspects of the study. Table B.29 provides details on the crashes data, offering insights into the frequency and nature of incidents. Table B.30 and B.31 presents the weather data collected, including information on how weather conditions affected the study outcomes. Lastly, Table B.32 and B.33 summarizes the taxi data collected, highlighting metrics related to taxi activity relevant to the study.

Table 3.2

Experts General Information Collected

Gender	Age	Educational	Work	Experience	Mode	Walking							
Male	8	30 - 34	1	Ph.D.	6	Acad.	5	0 - 14	2	Yes	10	0 min.	1
Female	4	35 - 39	1	BD	4	Gov.	4	15 - 19	1	No	2	- 5 min.	1
		40 - 44	4	MD	2	Private	1	20 - 24	5			5 - 10 min.	3
		45 - 50	3			Other	2	25 - 29	2			+ 10 min.	7
		50 - 54	1					30+	2				
		55 - 60	0										
	60+	2											

Chapter Four

Data Analysis

4.1 Introduction

Data analysis is a critical process in research that involves systematically examining data to extract meaningful insights and draw conclusions. The primary goal of data analysis is to transform raw data into actionable information that can inform decision-making, support hypotheses, or reveal trends and patterns. Overall, this chapter aims to provide a structured and detailed examination of the data, setting the stage for the subsequent discussion of results and recommendations.

The data analysis was conducted at two levels: first, for the overall study area, and second, for each segment as described earlier in Figure 1.1. This approach allows for a better understanding of the walkability environment within each segment of the study area. Each segment has distinct characteristics, varying in pattern, length, and environmental context. The analysis also involves breaking down the data into four distinct segments. This segmentation allows for a more granular understanding of the data.

4.2 Data Preparation

Data preparation for analysis involves a series of steps to transform raw data into a structured, clean, and usable format for analysis. This process is essential for ensuring that the data is accurate, consistent, and suitable for generating meaningful insights. Key steps in data preparation include:

4.2.1 Data Collection

The data collection process has already been completed in the previous stage, with a detailed explanation of the collection methods, sources, and procedures provided in Chapters Three and Four. Appendix A further illustrates the collected data. The data present in Appendix it is already has been cleaning.

4.2.2 Data Cleaning

Data cleaning is an essential step in data preparation that focuses on identifying and resolving issues within the dataset to enhance data quality. The following issues are raised related to the following variables such as crashes, temperature, wind speed, taxi frequency, and tree shade.

Crashes

The crash data was gathered over the past three years (2021, 2022, and 2023). It includes information on the number of injuries, their severity, and the crash locations. However, in some cases, the location was not specified, accounting for 25 crashes. To assign locations to these unspecified crashes, they were distributed proportionally based on the percentage of crashes with specified locations. Table C.1 in Appendix C provides details on these adjustments.

Watchers

Street observations were conducted multiple times on different days, with data collected in the morning between 7:00 and 9:00 to record the number of walkers during off-peak hours. This data was used to calculate the average number of walkers.

Weather

The collected data for temperature and wind speed required some adjustments due to missing information for certain days. This gap can be addressed by redistributing the available data proportionally across the missing days. After this redistribution process, the data for both weather indicators is ready for evaluation and analysis. Table C.2 and Table C.3 display the adjustment weather data in Appendix C.

Taxi

There are 185 taxis serving the study area. However, due to the taxi count being conducted at two intersections, the service routes have endpoints that result in some vehicles returning to the same intersection. This creates a likelihood of counting the same taxi twice. Therefore, adjustments are necessary to account for this duplication. The data in Tables B.33 and B.34 in Appendix B should be adjusted to reflect the average vehicle count from three locations: the City Center, Rafidia Hospital, and the Arab Bank intersection.

The modification of vehicle distribution is based on off-peak hour data from the collected information. According to the literature, walking 400 meters takes about 5 minutes, so walking 3.5 km across the study area would take approximately 45 minutes. During off-peak hours, an average of 72 vehicles pass through per hour, meaning that 54 vehicles travel across the study area in 45 minutes. This results in an average of 2 vehicles per section. The adjustments are detailed in Table C.4 in Appendix C.

Sidewalk and Refuge Island Width

The width of sidewalks and refuges varies throughout the study area. Therefore, the average width for these sub-indicators was calculated individually for each section, and the data was adjusted accordingly.

Tree and Umbrella Shades

The shade coverage within the R-O-W may extend over both the sidewalk and vehicle lanes. In some cases, large coverage areas can lead to errors when evaluating this sub-indicator. To minimize these errors, adjustments were made by identifying the specific area covered by trees. This was done using GIS intersect tools to isolate the shade coverage over the sidewalk.

4.2.3 Data Transformation

The data transformation process, already described in the methodology chapter, involves rearranging the data on a scale from 0 to 1, where 1 represents the best outcome and 0 represents the worst. Refer to Appendix A for more details.

4.3 Segment Characteristics

This section outlines the properties of each segment, including the segment name, length, number of sections, and start and end points. The study area consists of 35 sections, each 100 meters in length, resulting in a total length of 3,500 meters. Figure 1.1 displays the three segments. The segments' characteristics are:

4.3.1 Overall Segment

The overall segment has the following characteristics:

- Name: Rafidia Street
- Length: 3,500 meters
- Number of Sections: 35 Sections
- Start and End Points: From Bet Wazan Roundabout to Jamal Abd Al Naser Park.

4.3.2 First Segment

The first segment has the following characteristics:

- Name: New Campus Street
- Length: 1,600 meters
- Number of Sections: 16 Sections
- Start and End Points: From Bet Wazan Roundabout to Arab Bank intersection.

4.3.3 Second Segment

The second segment has the following characteristics:

- Name: Commercial Street
- Length: 800 meters
- Number of Sections: 8 Sections
- Start and End Points: From Arab Bank intersection to Rafidia Hospital intersection.

4.3.4 Third Segment

The third segment has the following characteristics:

- Name: Parks Street
- Length: 1,100 meters
- Number of Sections: 11 Sections
- Start and End Points: From Rafidia Hospital intersection to Jamal Abd Al Naser Park.

4.4 Data Analysis

This section analyzes the elements and sub-indicators from two perspectives: weighting and the individual data collected for each segment, as explained in the previous section. Additionally, it addresses any adjustments made to the collected data.

4.4.1 Weights of Elements and Sub-indicators

This section analyzes the data collected from experts, including general information about the experts and the weights assigned to elements and sub-indicators. Table 4.1 displays the average weights for walkability elements and sub-indicators.

Table 4.1

Overall, Weights Assigned by Experts for Elements and Sub-indicators

	Efficiency	Convenience	Safety & Security	Attractiveness	Weather	Environmental	Accessibility	Facilities	Pleasantness	Streetscape
	12.23	14.71	12.92	7.65	9.95	7.83	12.37	8.06	6.81	7.46
(R)	17.86	(La) 20.61	(I) 11.66	(P) 16.96	(T) 56.49	(K) 14.01	(A) 24.7	(L) 5.61	(Clf) 27.61	(P) 33.77
(T)	18.94	(Ss) 13.86	(P) 6.72	(G) 21.02	(W) 43.51	(C) 12.37	(T) 32.58	(Lo) 5.07	(Cof) 25.54	(B) 19.92
(S)	12.64	(D) 15.43	(S) 11.36	(O) 15.75		(L) 11.96	(V) 42.71	(W) 5.57	(Clo) 24.32	(O) 23.91
(L)	12.41	(Fs) 15.2	(W) 8.96	(S) 14.7		(D) 10.96		(Wo) 5.12	(Coo) 22.53	(L) 22.4
(Sr)	12.51	(Fc) 11.77	(L) 5.43	(Sc) 12.37		(L) 12.77		(P) 3.43		
(C)	11.59	(Pa) 12.44	(U) 7.48	(Os) 9.31		(W) 10.72		(Po) 3.25		
(D)	14.04	(Pc) 10.7	(Co) 7.03	(U) 9.88		(De) 9.55		(Pw) 3.43		
			(Cl) 6.11			(Du) 8.49		(Pow) 2.61		
			(Fb) 4.94			(R) 9.17		(Lb) 2.86		
			(Ob) 5.94					(Lob) 2.59		
			(K) 4.85					(C) 6.48		
			(N) 7.78					(Cd) 5.41		
			(I) 5.87					(Be) 4.38		
			(D) 5.87					(To) 3.36		
								(Tr) 7.97		
								(Te) 1.83		
								(Bo) 2.69		
								(Cr) 4.64		
								(R) 4.64		
								(Sr) 5.05		
								(Sl) 3.78		
								(Cw) 5.78		
								(Cl) 4.42		

Note: Table 4.1 presents the key terms for the sub-indicators; for a full description, refer to the tables in Appendix B. All values are in percentages.

4.4.2 Analysis Elements and Sub-indicators

In this section, the focus is on elements mentioned in the methodology chapter that still require further explanation, which will be provided through data analysis.

If multiple sub-indicators are present in a section, such as having two or more connected roads or intersections in the study area, modifications will be made at this stage. In this case, the walkability score for this sub-indicator will be calculated by averaging the scores assigned to it. The data presented in Table B.2 through Table B.11 in Appendix B, derived from data collection, has already been adjusted accordingly.

Several steps are involved in achieving this:

1. Calculate the average score for each sub-indicator.
2. Determine the achieved score for each sub-indicator by multiplying the score by the weights.
3. Compute the score for each element by summing the achieved sub-indicator scores using equations 3.1, A.2 to A.15.
4. Determine the walkability score for each segment using equation 3.1.

These steps are repeated for each segment. In this research, Excel is used to analyze the data and determine the walkability score.

For detailed information on the sub-indicator scores and the overall achieved scores, refer to Table C.6 to C.15 in Appendix C, which presents the weights, scores, and achieved results of the sub-indicators.

Efficiency

This element reflects the walkability score based on two primary indicators: connected roads and intersections, as previously described. Generally, there are 39 connected roads over a 3.5 km stretch, which means there is, on average, one road connecting to the study area every 90 meters. However, there are actually 28 intersections, and these multi-legged intersections influence the distribution of roads within the study area. Figure C.2 in Appendix C, shows the road distribution.

The calculated scores for this element are:

- Rafidia: 58.70 %
- New Campus: 57.80 %
- Old Rafidia: 54.14 %
- Parks Street: 63.32 %

Convenience

This element reflects the walkability score based on three primary indicators: lighting, transportation, and parking, as described earlier. The lighting index is generally adequate except for the entrance to the old town of Rafidia due to the lack of activity in this part of the study area. Taxis are adequately frequent, but the absence of public buses did have significant effect. The almost non-existent stop stations, located in specific areas, and most of them are in poor condition and unusable, had the greatest impact on the walkability score. While parking is good and the majority of them are paid parking, did not have a significant impact on the walkability score.

The calculated scores for this element are:

- Rafidia: 49.05 %
- New Campus: 53.95 %
- Old Rafidia: 44.78 %
- Parks Street: 45.03 %

Safety & Security

This element reflects the walkability score based on five key indicators: conflict points, speed, refuge islands, street monitors, and accidents. Conflict points, particularly at intersections, are prominent in the New Campus area due to the wider R-O-W compared to the other two sections. The consistency of private entrance conflicts throughout the study area also influences the walkability score. Speed in the study area varies and influenced by the R-O-W; in Old Rafidia and Parks, restrictions due to the area's character result in a lesser impact on walkability compared to the New Campus.

The refuge island (median) is located in the new campus part and is absent from the other parts. The existing median is of sufficient width and length, in good condition, clean and almost free of obstacles, gives a very good score for walkability in this part compared to

the other part. Street watchers are of almost the same type and number with the same frequency and are good indicators of walkability. While crash injuries and their severity are very good indicators of walkability in the study area.

The calculated scores for this element are:

- Rafidia: 57.17 %
- New Campus: 65.88 %
- Old Rafidia: 54.33 %
- Parks Street: 46.58 %

Attractiveness

This item reflects the walkability score based on four main indicators: land use, street grade, trees, and umbrellas. The land use pattern is predominantly commercial along the study area, which serves as a positive indicator for walkability. The overall street grade is generally good; however, there are two steep grades in the New Campus and Old Rafidia segments. In the New Campus, tree obstructions are present, while they are negligible in the other two sections, resulting in less shade from these trees and negatively influencing the walkability score. Additionally, umbrellas are nearly non-existent, further affecting the walkability score.

The calculated scores for this element are:

- Rafidia: 50.19 %
- New Campus: 45.53 %
- Old Rafidia: 56.20 %
- Parks Street: 52.59 %

Weather

This item reflects the walkability score based on two main indicators: temperature and wind. Since the entire study area is located in the same geographical region, temperature and wind speed remain consistent throughout. Both temperature and wind conditions are favorable for walking and have a positive impact on the walkability score.

The calculated scores for this element are:

- Rafidia: 85.88 %
- New Campus: 85.88 %
- Old Rafidia: 85.88 %
- Parks Street: 85.88 %

Environmental

This item reflects the walkability score based on two main indicators: pollution and sidewalk obstacles. The pollution level is moderate, primarily consisting of solid particles from construction activities, with a high concentration. The duration of this pollution varies, ranging from temporary to permanent.

The analysis of obstructions includes communication cabins, traffic signal controller cabins, electrical cabins, kiosks, high-voltage poles, and advertising signs. Although these obstructions are usually limited in length, they are often wide, blocking the sidewalk. The degree of obstruction is generally partial, with both temporary and permanent blockages influencing walk.

Several sidewalk obstacles were neglected in the analysis, including electric poles, lighting poles, telecommunication poles, traffic signs, and tree trunks. The analysis shows that pollution has a smaller impact on walkability compared to sidewalk obstructions.

The calculated scores for this element are:

- Rafidia: 65.95 %
- New Campus: 66.02 %
- Old Rafidia: 66.23 %
- Parks Street: 65.71 %

Accessibility

This item represents the walkability score based on two key indicators: accessibility and pedestrian activity. Access to ATMs is generally good in the study area, with a slight deficiency in the middle of the New Campus segment and at the end of the Parks segment. Figure C.3 in the Appendix C shows the distribution of taxi services line and ATM services.

The taxi service in the area is good and attracts pedestrians from nearby locations, especially from the south, due to the favorable topography. In contrast, the northern part of the study area requires an uphill climb to reach the taxi service line.

Pedestrian activity varies but does not encompass all types of activities. The predominant activity in the area is commercial, including restaurants, shopping, and similar services. The New Campus segment experiences a shortage of activities, as it is still a developing area, as indicated by the aerial image. This shortage moderately impacts walkability.

The calculated scores for this element are:

- Rafidia: 52.40 %
- New Campus: 53.55 %
- Old Rafidia: 54.20 %
- Parks Street: 49.41 %

Facilities

This item reflects the walkability score based on several key indicators: sidewalk characteristics, pedestrian crossings, street furniture, curb ramps, right-of-way (R-O-W), and signage. The sidewalks are generally good in both length and width throughout the study area, but there are no pedestrian barriers present. Marked pedestrian crossings are available near the university in the New Campus segment but are absent in other parts of the study area.

Street furniture is nearly non-existent, with only four trashcans in the New Campus segment and few sidewalk bollards throughout the study area. There are also limited sidewalk ramps in the New Campus and Old Rafidia segments compared to the Parks segment, where ramps are more readily available. The right-of-way (R-O-W) is very good in the New Campus segment, evidenced by the presence of sidewalks and a refuge island, while the R-O-W in the other two segments is more restricted. Signs are present only in the New Campus section and absent in the other two segments, while sign clarity is the same across the study area.

The calculated scores for this element are:

- Rafidia: 27.62 %
- New Campus: 32.19 %
- Old Rafidia: 23.00 %
- Parks Street: 24.31 %

Pleasantness

This item reflects the walkability score based on two primary indicators: cleanliness and condition. Previously, the availability of sidewalks was considered excellent. From the analysis, both the condition and cleanliness in the study area are generally good, which suggests a favorable environment for walking and positively impacts the walkability score.

The calculated scores for this element are:

- Rafidia: 79.88 %
- New Campus: 72.12 %
- Old Rafidia: 91.61 %
- Parks Street: 82.62 %

Streetscape

This item reflects the walkability score based on two primary indicators: landmarks and street landscape. These indicators are almost nonexistent in the study area, with the sidewalk being the only landscape element present. Both indicators are important for creating an enjoyable walking.

The calculated scores for this element are:

- Rafidia: 12.32 %
- New Campus: 12.28 %
- Old Rafidia: 9.12 %
- Parks Street: 14.71 %

4.4.3 Walkability score

Equation 3.1 is used to calculate the total walkability score. The score is based on the results from the previously evaluated elements and sub-indicators, which, as noted, were not favorable. Consequently, the overall walkability score for the study area is affected by the absence of certain sub-indicators in some sections, which has negatively impacted the scores of other segments.

$$W_s = SW_{Ef} + SW_C + SW_{SS} + SW_{At} + SW_{We} + SW_{En} + SW_{Ac} + SW_F + SW_P + SW_{St} \dots 3.1$$

Where:

W_s : Walkability score	SS : Safety & Security	F : Facilities
S : Scoring	At : Attractiveness	P : Pleasantness
W : Weight	We : Weather	St : Streetscape
Ef : Efficiency	En : Environmental	
C : Convenience	Ac : Accessibility	

Table 4.2 and Figure 4.1 displays scores of walkability calculated based on the elements scored and weights by segments, are as follows:

- Rafidia: 54.40 %
- New Campus: 55.76 %
- Old Rafidia: 53.74 %
- Parks Street: 52.89 %

Figure 4.1

Walkability Scoring Achieved from Elements for Rafidia

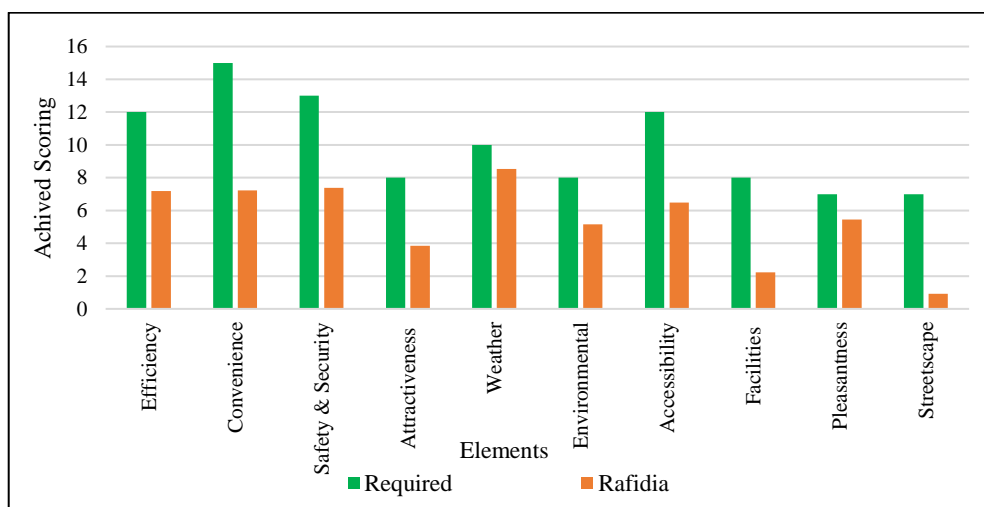


Table 4.2*Walkability Scoring Achieved from Elements by Segment*

Elements			Segment							
			Scoring				Achieved			
No	Name	Weights	Rafidia	New Campus	Old Rafidia	Parks	Rafidia	New Campus	Old Rafidia	Parks
1	Efficiency	12.23%	58.70%	57.80%	54.14%	63.32%	7.18%	7.07%	6.62%	7.74%
2	Convenience	14.71%	49.05%	53.95%	44.78%	45.03%	7.22%	7.94%	6.59%	6.62%
3	Safety & Security	12.92%	57.17%	65.88%	54.33%	46.58%	7.39%	8.51%	7.02%	6.02%
4	Attractiveness	7.65%	50.19%	45.53%	56.20%	52.59%	3.84%	3.48%	4.30%	4.02%
5	Weather	9.95%	85.88%	85.88%	85.88%	85.88%	8.54%	8.54%	8.54%	8.54%
6	Environmental	7.83%	65.95%	66.02%	66.23%	65.71%	5.16%	5.17%	5.19%	5.15%
7	Accessibility	12.37%	52.40%	53.55%	54.20%	49.41%	6.48%	6.62%	6.70%	6.11%
8	Facilities	8.06%	27.62%	32.19%	23.00%	24.31%	2.23%	2.59%	1.85%	1.96%
9	Pleasantness	6.81%	79.88%	72.12%	91.61%	82.62%	5.44%	4.91%	6.24%	5.63%
10	Streetscape	7.46%	12.32%	12.28%	9.12%	14.71%	0.92%	0.92%	0.68%	1.10%
Sum		100%					54.40%	55.76%	53.74%	52.89%

Note: Table 4.2 presents the Walkability Index, and the results show no significant differences between the scores of other segments. Based on the Walk Score, this community is classified as 'somewhat walkable'. While Figures C.3 to C.6 presents the segment result scores in Appendix C.

Chapter Five

Conclusions and Recommendations

By thoroughly analyzing various main and sub-indicators, the results offer a detailed understanding of the current state of walkability. Based on these insights, specific recommendations have been suggested to improve walkability in the study area. These proposals are intended to foster a more walkable environment, encouraging healthier, sustainable urban living and supporting broader urban mobility objectives.

5.1 Conclusions

The walkability results obtained in this thesis cannot be directly compared with other studies, as the researcher developed unique main and sub-indicators. Never the less if compared to the Walk Score it is ranked as 'Somewhat walkable' the primary basis for comparison in this study comes from the weights assigned to these elements by experts. This allows us to evaluate the results in relation to the expert-assigned weights, assuming they represent the true value for comparison. Figure C.7 illustrates the results used for this comparison. The conclusions of the 12 elements are as follows:

- **Comfort:** As previously mentioned, it relies on the other 11 elements and the analysis to conclude that the study area is moderately comfortable for walking.
- **Efficiency:** The roads and intersections in the study area do not follow a regular geometric pattern.
- **Convenience:** The area has an excellent lighting system and good parking services, but it lacks public transportation services.
- **Safety & Security:** The conflict points and speed in the area are satisfactory, but there is a lack of medians. Additionally, the number of crashes injuries is low, and the presence of street watchers is good and quite positive.
- **Attractiveness:** The land use pattern is consistent and suitable for walkability, with good street grades; however, the area lacks shade.
- **Weather:** Both wind speed and temperature are suitable and pleasant for walking.
- **Environmental:** The study area has low pollution levels, but there are obstacles on the sidewalks that hinder walkability.
- **Accessibility:** Access to ATMs is good; however, the surrounding area has limited appeal for using the transportation system and along with limited available services.

- Facilities: While there are good sidewalks, there is a lack of other walking-related facilities in the study area.
- Pleasantness: The sidewalks are in good condition and clean.
- Streetscape: There are significant gaps in the availability of streetscape elements.
- Overall Sustainability: It depends on all the previously mentioned elements, each of which needs improvement to reach sustainability; thus, achieving it remains a distant goal. Also, there is a deficiency in two key elements for sustainability: facilities and streetscape.

The overall walkability in the study area is moderate. Based on walkability assessment, it was observed that activities can be performed in two ways: on foot or by car. Referring to the Walk Score percentages and their corresponding descriptions in Table 2.3, the term "Somewhat Walkable" aligns with the observation that "some errands can be accomplished on foot."

The linear layout of the study area makes this result reasonable, as the distance between activities and services means they can't always be reached on foot. In Rafidia, two or three activities might be completed on foot, but a car is still needed to reach other destinations.

5.2 Improving Walkability

Improving walkability in the study area, involves identifying the necessary improvements for each sector. Weaknesses in certain indicators impacted the scores of each sector, thereby influencing the overall walkability score. This outcome is logical for the study; however, the linear layout of the area may also contribute to these results, as services are provided in a linear, rather than central, manner. The proposed development scenario for the area is as follows.

Several key measures can be implemented. First, organizing road links and intersections can enhance flow and safety of pedestrians. Properly designed intersections with designated crossing areas, barriers, sidewalks, and refuge islands will further improve safety and accessibility for pedestrians. Parking areas should also be organized, and public transportation stations equipped with essential facilities should be established to support efficient movement.

Additionally, efforts should be made to enhance the pedestrian experience by improving environmental conditions. Planting trees and installing umbrellas along pathways can provide the much-needed shade, reducing heat and encouraging more people to walk. These measures can also lower temperatures, making walking more comfortable. To ensure unobstructed pedestrian pathways, regulations can be introduced to control the placement of goods on sidewalks, reducing pollution and clutter. Time restrictions may also be imposed to manage sidewalk usage more effectively.

Moreover, various pedestrian activities should be encouraged to promote a lively and dynamic environment. Improvements to walking facilities, such as adding benches and maintaining uniform sidewalk patterns, will enhance comfort for pedestrians. The streetscape can be further improved by incorporating greenery, small open spaces, decorative elements, and landmarks in different locations, contributing to the overall aesthetics and appeal of the area. Through these combined efforts, the walkability and livability of urban areas can be significantly enhanced.

The proposed improving walkability emphasizes enhancing key elements such as infrastructure. By addressing deficiencies in pedestrian facilities, the plan aims to create a more walkable and interconnected environment. This approach will encourage increased pedestrian activity, enhance comfort, and support sustainable urban development.

5.3 Recommendations

Recommendations are proposed to improve walkability at both the regional and local levels within the study area, along with suggestions for measurement methods and future research. Drawing from a comprehensive analysis of factors affecting pedestrian walkability, these suggestions aim to tackle existing challenges and foster a more walkable environment, while also achieving sustainability.

5.3.1 Recommendation for the Study Area

To enhance the infrastructure pedestrian, several recommendations are proposed.

- First, set up public transportation stations with essential amenities throughout the study area at intervals of 400 to 600 meters.

- Upgrade walking infrastructure in the Rafidia segment by standardizing sidewalk patterns and incorporating features like signs, benches, restrooms, and bollards.
- Install barriers along the sidewalks throughout the study area and designate crossing points every 300 meters or less along the Rafidia segment and, in areas with limited right-of-way, such as Old Rafidia and Parks segments, where refuge islands cannot be installed. Additionally, reduce sidewalk obstructions by enforcing time restrictions and regulating the placement of goods and kiosks.
- Shade should be enhanced by planting trees and installing umbrellas along the Rafidia segment. Additionally, the streetscape can be enriched by incorporating decorations, greenery, small open spaces, and landmarks.
- Finally, pedestrian activities should be encouraged, particularly in the New Campus segment, to include both systematic and non-systematic activities.

5.3.2 Recommendation for Local and Regional Levels

To improve walkability, it is crucial to organize urban areas more effectively by ensuring consistent spacing between crossings and intersections, maintaining a distance of less than a 5-minute walk (approximately 400 meters). Additionally, parking areas and transportation stations should be strategically located within a 400-meter radius, equipped with essential facilities such as lighting and seating to improve convenience for pedestrians.

Pedestrian safety at intersections should be enhanced by clearly marking crossing areas and implementing speed control measures like speed humps or speed tables and radar systems. Pedestrian islands and sidewalks should be installed where missing, and barriers should be placed to further ensure pedestrian safety. These actions will help reduce accidents and create a safer walking environment.

When designing sidewalks, land use classification should be prioritized. Sidewalks in commercial areas should be widened, and pedestrian walkways should be graded appropriately, avoiding the use of stairs where possible. Shade should be enhanced by planting trees and installing umbrellas along sidewalks, which will provide comfort to pedestrians in hot weather.

Although completely eliminating environmental challenges is difficult, measures such as planting trees can help reduce temperatures and increase shade, improving the overall

pedestrian experience. To reduce pollution, time restrictions should be enforced for placing items on streets, limiting construction materials to a maximum of three hours. Goods and kiosks should only be placed on sidewalks for short periods (e.g., half an hour), and proper zoning should be enforced to ensure clear pathways for pedestrians.

Every 400 meters should feature essential amenities such as primary schools, community centers, or open spaces to encourage a variety of pedestrian activities. This ensures that walking remains a viable and attractive mode of transportation within the urban area.

Walkability can be improved by installing and maintaining essential pedestrian infrastructure such as sidewalks, crosswalks, pedestrian signals, benches, trash bins, bollards, signage, and adequate right-of-way (ROW) width. Regular maintenance and cleaning should also be prioritized to keep sidewalks in good condition and ensure they remain safe and usable for all pedestrians.

Installing landscaping elements such as plants, street furniture, decorative features, and landmarks can significantly enhance the pedestrian environment. Sidewalks should be aesthetically pleasing and functional, contributing to a vibrant and walkable urban landscape.

These improvements will increase comfort and walkability, promote sustainability, and reinforce walking as a viable mode of transportation. These recommendations can serve as a framework for planning or enhancing walkability in urban areas, supporting the goal of sustainable urban mobility. Lastly, develop guidelines for organizing walkable environments across various urban areas.

5.3.3 Recommendation for Measurement Methods

To accurately assess and improve walkability in urban areas such as Rafidia, it is recommended to adopt a structured measurement approach that incorporates the 10 key elements, 30 indicators, and 80 sub-indicators. These sub-indicators, detailed in Appendix A of this study, provide a comprehensive framework for evaluating walkability across various aspects of urban design and functionality.

Collect data on each of the sub-indicators, ensuring a thorough understanding of walkability across all relevant dimensions. Adhere to the measurement descriptions

provided in Appendix A to maintain consistency and accuracy when evaluating walkability in different segments of the study area.

When collecting information, several considerations must be taken into account, as previously outlined. This includes the cumulative collection of data, such as the types of available activities, as well as information that can be gathered repeatedly to ensure accuracy, such as identifying obstacles on sidewalks.

Continuously monitor and measure walkability using this established framework to track the effectiveness of proposed improvements. This will help identify areas that may require further enhancement. By implementing these methods and adhering to the detailed walkability indicators, the quality of pedestrian can be systematically evaluated, ensuring that necessary changes are made to optimize the urban environment for walking.

5.3.4 Recommendation for Future Research

It is essential to enhance data collection methods to achieve more accurate information. For instance, using sensors to measure noise and pollution levels in the area can provide valuable insights. Additionally, incorporating new elements, such as the socio-economic characteristics of users and the interaction between pedestrians and other road users highlights that pedestrian, along with bicyclists and motorcyclists, are among the most physically vulnerable on the road. Involving local institutions in developing the methodology is crucial for creating a more effective approach than merely assigning weights to sub-indicators. This approach should also focus on retaining important sub-indicators, even if they are repeated in another elements, to emphasize their significance.

List of Abbreviations

Abbreviation	Meaning
WAPC	Western Australian Planning Commission
WHO	World Health Organization
NGO	Non-Governmental Organization
3Ds	Density, Diversity, and Design
5Cs	Comfortable, conspicuous, connected, convivial, and convenient
C°	Celsius
LOS	Level Of Service
MITRANS	Malaysia Institute of Transport
OECD	Organization for Economic Co-operation and Development
CST	Centre for Sustainable Transportation
ATMs	Automated Teller Machine
ROW	Right of Way
GPS	Global Positioning System
GIS	Geographic Information System
Ph.D.	Doctoral Degrees
MD	Master's Degrees
BD	Bachelor's Degrees
Acad.	Academic
Gov.	Governmental

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Appendices

Appendix A

Data Collection Methodology and Equations

Table A.1

Efficiency Element Data Collection Methodology

Indicators		Sub-indicators		Tools	Description		
#	Name	#	Name		How to Measure	Score	Option description
1	Connecting	1	Number (R)	Checklists	How many roads connect to the street?		
					None	0	No polarization and no contact with other sites.
					One	0.5	Low polarization and poor contact with other sites.
					Two	0.75	Medium polarization and moderate contact with other sites.
					Three and more	1	High polarization and strong contact with other sites.
2			Type (T)	Checklists	What type of roads connect? Are they minor, major, or staircases?		
					None	0	Pedestrian traffic will be reduced if the road connected to a major road.
					Major	0.5	Because it attracts pedestrian traffic, it poses a challenge for the road under study.
					Staircases	0.75	Access is easy without hazards but difficult for users.
					Minor	1	It depends entirely on the major street under study.
3			Staircases (S)	Checklists	Do you need to ascend or descend stairs to access the road?		
					Up	0.5	It is difficult to use stairs to go up.
					Down	0.75	It is easy to use stairs when moving down.
					Non	1	Without stairs, the street will be more accessible and easier to navigate.

4	Length (L)	Arial Image	What are the lengths of these connecting roads (250, 400, 800, 1000+ meters)? (User Difficulty)
			None or > 1200+ m 0 Very difficult for users to walk this distance.
			800 m < 1200 m 0.25 Difficult for users to walk this distance.
			400 m < 800 m 0.5 Moderately difficult for users to walk this distance.
			250 m < 400 m 0.75 Easy for users to walk this distance.
			Less 250 m 1 Very easy for users to walk this distance.
5	State (Sr)	Arial Image	Are the connecting roads continuous or non-continuous?
			None 0 There are no connecting roads.
			Continuous 0.5 Road connects with another.
			Not Continuous 1 The road is non-continuous.
2	# of Cross	6	Number (C)
			Checklists
			How many intersections are there per section?
			None 0 No crossings, which impede accessibility.
			1 Cross 0.8 One crossing, which provides adequate accessibility.
			2 Cross & more 1 Two or more crossings, which offer excellent accessibility.
7	Distance (D)	Arial Image	What is the distance between intersections?
			More 400 m 0 Poor effectiveness in walkability
			300 m < 400 m 0.25 Low effectiveness in walkability
			200 m < 300 m 0.5 Moderate effectiveness in walkability
			100 m < 200 m 0.75 Good effectiveness in walkability
			Less 100 m 1 High effectiveness in walkability

The Evaluation of Efficiency Element Equation A.1

$$Ef = SW_R + SW_T + SW_S + SW_L + SW_{Sr} + SW_C + SW_D$$

Where:

- Ef: Efficiency
- S: Scoring
- W: Weight

Table A.2*Convenience Element Data Collection Methodology*

Indicators		Sub-indicators		Tools	Description		
#	Name	#	Name		How to Measure	Score	Option description
3	Street lighting	8	Availability (La)	Checklists	Is there lighting along the study area?		
					No	0	No lighting, user feels intimidated.
					Yes, not enough	0.5	Some lighting, but it is not sufficient, acceptable.
					Yes enough	1	Adequate lighting, user feels comfortable.
4	Transit	9	Station / Section (Ss)	GPS	How many stations are there per section?		
					None	0	Poor transit service.
					One	1	Very good transit service.
		10	Distance (D)	Arial Image	What is the distance between stations (400, 800+ meters)?		
					More 800 m	0.5	Difficult for users to reach and use.
					400 m < 800 m	0.75	Moderate for users to reach and use.
					Less 400 m	1	Easy for users to reach and use.
		11	Frequency / Section (Fs)	Field Notes	How many taxi vehicles are there per 100 meters?		
					None	0	Very bad service.
					One	0.25	Poor service.
					Two	0.5	Moderate service.
					Three	0.75	Good service.
					Four or more	1	Very good service.
		12	Furniture (Fc)	Checklists	Is there any furniture at the taxi station, and what is its condition?		
					None	0	Protects from the weather.
					Yes, but in bad condition	0.5	Protects from the weather but isn't usable by all users.
					Yes, and in good condition	1	Protects from the weather and is usable by all users.

5	Parking	13	Available (Pa)	Checklists	Are there parking lots on this road? What type of parking is available?	
				None	0	Does not create barriers and does not provide service.
				Off-street	0.2	Does not create barriers but provides service.
				On-street, one side partial	0.4	Creates barriers on one side and provides partial service.
				On-street, two sides partial	0.6	Creates barriers on two sides and provides partial service.
				On-street, one side full	0.8	Creates barriers on one side and provides full service.
				On-street, two sides full	1	Creates barriers on two sides and provides full service.
14	Cost (Pc)			Interview	Is it free or paid?	
				None	0	No parking is available.
				Paid	0.5	Not all users can use it.
				Free	1	All users can use it.

The Evaluation of Convenience Element Equation A.2

$$C = SW_{La} + SW_{Ss} + SW_D + SW_{Fs} + SW_{Fc} + SW_{Pa} + SW_{Pc}$$

Where:

- C: Convenience
- S: Scoring
- W: Weight

Table A.3*Safety & Security Element Data Collection Methodology*

Indicators		Sub-indicators		Tools	Description		
#	Name	#	Name		How to Measure	Score	Option description
6	Conflict Point	15	Intersection (I)	Aerial Image	The number of conflict points at intersections?		
					Point > 32	0	Very dangerous intersection.
					Point 25 - 32	0.25	Dangerous intersection.
					Point 10 - 24	0.5	Moderately dangerous intersection.
					Point 0 - 9	0.75	Safe intersection.
			None	1	Very safe intersection.		
16	Privet Space (P)			GPS	The number of private entrances per 100 meters.		
					More 6	0	Very high number of conflict points.
					Bet 5 - 6	0.25	High number of conflict points.
					Bet 3 - 4	0.5	Moderate number of conflict points.
					Bet 1 - 2	0.75	Small number of conflict points.
			Zero	1	No conflict points.		
7	Street Speed	17	Speed (S)	Experiments	What is the likely driving speed? / What is the probable speed on this road?		
					More 50 km\hr.	0.5	Pedestrians use the street with high caution and care.
					Bet. 30 - 50 km\hr.	0.75	Pedestrians use the street with moderate caution and care.
			Less 30 km\hr.	1	Pedestrians use the street with minimal caution and care.		
8	Refuge Islands	18	Widths (W)	GPS	Are there refuge islands, and what are their widths?		
					No	0	There are no medians.
					Less than 60 cm	0.25	The medians are available but not wide enough.
					60 cm < 120 cm	0.5	The medians are available and moderately wide.
					120 m < 240	0.75	The medians are available and sufficiently wide.
			More 240 cm	1	The medians are available and extremely wide.		

19	Length (L)	GPS	How long are these islands?		
			None	0	There are no refuge islands.
			Equal 50 m	0.5	There is a refuge island that is 50 meters long.
			Equal 100 m	1	This section is entirely covered by refuge islands.
20	Useable (U)	Checklists	Are these refuge islands usable?		
			None or not	0	Pedestrians cannot use them.
			Yes	1	Pedestrians can use them.
21	Condition (Co)	Checklists	What is the condition of the refuge islands?		
			None	0	No refuge islands
			Poor	0.25	Low comfort for pedestrians
			Fair	0.5	Moderate comfort for pedestrians
			Acceptable	0.75	Good comfort for pedestrians
			Good	1	High comfort for pedestrians
22	Clean (Cl)	Checklists	What is the degree of cleanliness of the refuge islands?		
			None	0	There are no refuge islands.
			Not clean	0.5	This level of cleanliness is not acceptable to all users.
			Clean	1	This level of cleanliness is acceptable to all users.
23	first side barrier (Fb)	GPS	What is the length of the barriers on the first side?		
			Zero	0	There are no barriers.
			Equal 50 m	0.5	There is a barrier that is 50 meters long.
			Equal 100 m	1	This section is entirely covered by a barrier.
24	other side barrier (Ob)	GPS	What is the length of the barriers on the other side?		
			Zero	0	There are no barriers.
			Equal 50 m	0.5	There is a barrier that is 50 meters long.
			Equal 100 m	1	This section is entirely covered by a barrier.

9	Watchers	25	Kind (K)	Field Notes	What kind of street watchers are present?
				None	0 No observers for pedestrians.
				Driver	0.25 Few observers for pedestrians.
				Shop owners	0.25 Moderate observers for pedestrians.
				Police	0.25 Good observers for pedestrians.
				Pedestrian	0.25 Very good observers for pedestrians.
26	Number / Section (N)		Field Notes	What is the number of pedestrians per 100 meters?	
				None	0 No comfort for pedestrians.
				Less than 4	0.25 Low comfort for pedestrians.
				Bet. 4 - 8	0.5 Moderate comfort for pedestrians.
				Bet. 8 - 12	0.75 Good comfort for pedestrians.
				More than 12	1 High comfort for pedestrians.
10	Crashes	27	Injuries (I)	Reports	What is the number of injuries per 100 meters?
				More than 6	0.25 Very dangerous pedestrian environment.
				Bet. 3 - 6	0.5 Dangerous pedestrian environment.
				Bet. 1 -3	0.75 Good pedestrian environment.
				None	1 Very good pedestrian environment.
28	Degree of Injuries (Di)		Reports	What is the degree of injuries: fatal, difficult, moderate, or low?	
				Fatal	0 This section is not secure.
				Difficult	0.25 This section has low security.
				Moderate	0.5 This section is moderately secure.
				Low	0.75 This section is very secure.
				None	1 This section is full secure.

The Evaluation of Safety & Security Element Equation A.3

$$SS = SW_I + SW_P + SW_S + SW_W + SW_L + SW_U + SW_{Co} + SW_{Ci} + SW_{Fb} + SW_{Ob} + SW_K + SW_N + SW_I + SW_{Di}$$

Table A.4*Attractiveness Element Data Collection Methodology*

Indicators		Sub-indicators		Tools	Description		
#	Name	#	Name		How to Measure	Score	Option description
11	Land Use	29	Patterns (P)	Checklists	To what extent is walking required? What type of land use is present? Is it industrial, residential, etc.		
					Industrial	0	No need for walking.
					Residential	0.5	Low reliance on walking.
					Mix	0.75	Moderate reliance on walking.
					Commercial	1	Full reliance on walking.
12	Street	30	Grade (G)	GPS	What is the street slope? Is it steep, moderate, or level?		
					Very Steep > 10%	0.25	Walkability does not exist.
					Steep 5% - 10%	0.5	Low dependence on walkability.
					Moderate 3% - 5%	0.75	Moderate dependence on walkability.
					Level 0% - 3%	1	Full dependence on walkability.
13	Tree	31	Obstruction (O)	Checklists	What is the vertical clearance between the sidewalk and the lower branches?		
					Less 150 Cm	0	It's an obstruction.
					Bet. 150 - 180 Cm	0.5	Not comfortable and an obstruction.
					Bet. 180 - 210 Cm	0.75	Not comfortable but not an obstruction.
					More 210 Cm	1	Typically, comfortable and not an obstruction.
		32	Shadows (S)	Arial Image	What percentage of the sidewalk is covered by tree shadows?		
					Empty 0%	0	There are no shadows.
					Partial 50%	0.5	Shadows cover half of the sidewalk area.
					Full 100%	1	The section is fully covered by shadows.

14	Shades	33	Available & Coverage (Sc)	GPS	Are there umbrellas available and covering the sidewalk? What is the coverage area?
					Empty 0 There are no shadows.
					Partial 0.5 Shadows cover half of the sidewalk area.
					Full 1 The section is fully covered by shadows.
34	Owns (So)		Checklists		What is the ownership of these umbrellas? Is it private or public owned?
					None 0 There are no umbrellas.
					Private 0.5 There are private shades.
					Public 1 There are public shades.
35	Useable (U)		Checklists		Can pedestrians use it? Is it partially or fully usable?
					No 0 Pedestrians cannot use it.
					Partial 0.5 Pedestrians can partially use it.
					Yes 1 Pedestrians can fully use it.

The Evaluation of Attractiveness Element Equation A.4

$$At = SW_P + SW_G + SW_O + SW_S + SW_{Sc} + SW_{So} + SW_U$$

Where:

- At: Attractiveness
- S: Scoring
- W: Weight

Table A.5

Weather Element Data Collection Methodology

Indicators		Sub-indicators		Tools	Description		
#	Name	#	Name		How to Measure	Score	Option description
15	Temperature	36	Degree (T)	Reports	How many days are suitable for walking with temperatures between 15°C and 20°C?		
					0 - 91 days	0.25	1/4 of the year is comfortable for walking.
					92 - 182 days	0.5	Half of the days in the year are comfortable for walking.
					183 - 274 days	0.75	3/4 of the year is comfortable for walking.
					275 - 365 days	1	The entire year is comfortable for walking.
16	Wind	37	Speed (W)	Reports	How many days are suitable for walking with wind speeds less than 19 km/h?		
					0 - 91 days	0.25	1/4 of the year is comfortable for walking.
					92 - 182 days	0.5	Half of the days in the year are comfortable for walking.
					183 - 274 days	0.75	3/4 of the year is comfortable for walking.
					275 - 365 days	1	The entire year is comfortable for walking.

The Evaluation of Weather Element Equation A.5

$$We = SW_T + SW_W \dots \dots A. 5$$

Where:

- W: Weather
- S: Scoring
- W: Weight

Table A.6*Environmental Element Data Collection Methodology*

Indicators		Sub-indicators		Tools	Description		
#	Name	#	Name		How to Measure	Score	Option description
17	Pollution	38	Kind (K)	Checklists	Is there pollution present? What type is it: solid, water, air, noise, or visual?		
					Solid	0	Low walkability, pedestrians may need to find alternative routes.
					Water	10.2	Water obstacles pedestrians can cross.
					Air	0.4	Affecting overall pedestrian comfort and well-being.
					Hearing	0.6	Discomfort reducing the appeal of walking.
					Visual	0.8	Aesthetic displeasure deterring pedestrians from using or enjoying the area.
					None	1	No effect on walkability.
39			Cause (C)	Checklists	What is the source of this pollution? Is it from construction, sewage, or commercial/retail activities?		
					Construction	0.25	Poses high harm to pedestrians.
					Sewage	0.5	Poses moderate harm to pedestrians.
					Commercial/retail	0.75	Poses low harm to pedestrians.
					None	1	No harm.
40			Level (L)	Checklists	What is the degree of pollution? Is it high, moderate, or low? Is it acceptable or not?		
					High	0	High degree of pollution, not acceptable.
					Moderate	0.5	Moderate degree of pollution, moderately acceptable.
					Low	1	Low degree of pollution, acceptable.
41			Duration (D)	Checklists	What is the duration of this pollution? Is it permanent, temporary, or instantaneous?		
					Permanent	0	Sidewalk permanently blocked.
					Temporary	0.5	Temporary construction materials.
					Instantaneous	0.75	Instantaneous obstruction due to maintenance.
					None	1	Clean.

18	Obstacles	42	Length (L)	GPS	Are there any obstacles on the sidewalk? And, what is the length of this obstacles from 100 m?
					Equal 100 m 0 This section is fully blocked.
					Equal 50 m 0.5 There is a block with a length of 50 meters.
					Zero 1 There are no obstacles.
43	Width (W)		Arial Image		How much sidewalk width is left after this obstacle?
					No 0 Fully blocked sidewalk.
					Less 60 cm 0.25 Low width sidewalk for users.
					Bet. 60 - 120 cm 0.5 Moderate width sidewalk for users.
					Bet. 120 - 300 cm 0.75 Good width sidewalk for users.
					More 300 cm 1 Excellent sidewalk for users.
44	Degree (De)		Checklists		What is the size or extent of these obstacles? Are they fully obstructed, partially obstructed, or empty?
					Full 0 The sidewalk is fully blocked.
					Partial 0.5 The sidewalk is partially blocked.
					Empty 1 There are no obstacles on the sidewalk.
45	Duration (Du)		Checklists		How long do these obstacles last? Are they permanent, temporary, or instantaneous?
					Permanent 0 Permanent, such as street furniture.
					Temporary 0.5 Temporary, such as illegal parking.
					Instantaneous 0.75 Instantaneous, such as maintenance.
					None 1 Clean sidewalk.
46	Reason (R)		Checklists		What are the causes of these obstacles? Construction, street furniture, kiosks, or maintenance?
					Construction 0 Materials blocking the sidewalk due to construction activities.
					Street furniture 0.25 Permanent fixtures such as benches or planters.
					Kiosk 0.5 Obstruction from kiosks set up on the sidewalk.
					Maintenance 0.75 Repair or maintenance activities on the sidewalk or infrastructure.
					None 1 No obstacles present; the sidewalk is clear and usable.

The Evaluation of Environmental Element Equation A.6

$$En = SW_K + SW_C + SW_L + SW_D + SW_{Le} + SW_W + SW_{De} + SW_{Du} + SW_R \dots \dots A. 6$$

Where: • En: Environmental • S: Scoring • W: Weight

Table A.7

Accessibility Element Data Collection Methodology

Indicators		Sub-indicators		Tools	Description		
#	Name	#	Name		How to Measure	Score	Option description
19	Access	47	ATM (A)	GPS	Are ATMs accessible within the study area, and how far is the walking distance to reach them?		
					More 1000 m	0	Very difficult to access.
					800 - 1000 m	0.25	Difficult to access.
					400 - 800 m	0.5	Moderately accessible.
					250 - 400 m	0.75	Good access.
0 - 250 m	1	Very good access.					
48	Taxi (T)		Taxi (T)	Aerial Image	Are taxis accessible within the study area, and what is the walking distance required to reach them?		
					More 1000 m	0	Very difficult to access.
					800 - 1000 m	0.25	Difficult to access.
					400 - 800 m	0.5	Moderately accessible.
					250 - 400 m	0.75	Good access.
0 - 250 m	1	Very good access.					

20	Pedestrian Activity	49	Variety (V)	Cameras	What variety of activities are available in the study area?		
					None	0	No pedestrian activity
					One from them	0.25	Low pedestrian activity
					Two of them	0.5	Moderate pedestrian activity
					Three from them	0.75	High pedestrian activity
					All of them	1	Very high pedestrian activity

The Evaluation of Accessibility Element Equation A.7

$$Ac = SW_A + SW_T + SW_V \dots \dots A7$$

Where:

- Ac: Accessibility
- S: Scoring
- W: Weight

Table A.8

Facilities Element Data Collection Methodology

Indicators		Sun-indicators		Tools	Description		
#	Name	#	Name		How to Measure	Score	Option description
21	Sidewalks	50	Length of first sidewalk (L)	GPS	What is the length of the first sidewalk?		
					Zero	0	No sidewalk present.
					Equal 50 m	0.5	Sidewalk extends for 50 meters.
					Equal 100 m	1	This section is fully covered by sidewalk.
51	Length of other sidewalk (Lo)			GPS	What is the length of the other sidewalk?		
					Zero	0	No sidewalk present.
					Equal 50 m	0.5	Sidewalk extends for 50 meters.
					Equal 100 m	1	This section is fully covered by sidewalk.

52	Width of first sidewalk (W)	GPS	What is the width of the first sidewalk?	
			None	0 No sidewalk present.
			Less 60 cm	0.25 Sidewalk is available but not wide enough.
			Bet. 60 - 120 cm	0.5 Sidewalk is available and moderately wide.
			Bet. 120 - 200 cm	0.75 Sidewalk is available and sufficiently wide.
			More 200 cm	1 Sidewalk is available and extremely wide.
53	Width of other sidewalk (Wo)	GPS	What is the width of the other sidewalk?	
			None	0 No sidewalk present.
			Less 60 cm	0.25 Sidewalk is available but not wide enough.
			Bet. 60 - 120 cm	0.5 Sidewalk is available and moderately wide.
			Bet. 120 - 200 cm	0.75 Sidewalk is available and sufficiently wide.
			More 200 cm	1 Sidewalk is available and extremely wide.
54	Length of first parking offset (P)	GPS	What is the length of the first frontage offset (parking)?	
			Zero	0 No sidewalk present.
			Equal 50 m	0.5 Sidewalk extends for 50 meters.
			Equal 100 m	1 This section is fully covered by sidewalk.
55	Length of other parking offset (Po)	GPS	What is the length of the other frontage offset (parking)?	
			Zero	0 No sidewalk present.
			Equal 50 m	0.5 Sidewalk extends for 50 meters.
			Equal 100 m	1 This section is fully covered by sidewalk.
56	Width of first parking offset (Pw)	GPS	What is the width of the first frontage offset (parking)?	
			None	0 No sidewalk present.
			Less 610 cm	0.25 Sidewalk is available but not wide enough.
			Bet. 610 - 670 cm	0.5 Sidewalk is available and moderately wide.
			Bet. 670 - 7500 cm	0.75 Sidewalk is available and sufficiently wide.
			More 750 cm	1 Sidewalk is available and extremely wide.

57	Width of other parking offset (Pow)	GPS	What is the width of the other frontage offset (parking)?		
			None	0	No sidewalk present.
			Less 610 cm	0.25	Sidewalk is available but not wide enough.
			Bet. 610 - 670 cm	0.5	Sidewalk is available and moderately wide.
			Bet. 670 - 7500 cm	0.75	Sidewalk is available and sufficiently wide.
			More 750 cm	1	Sidewalk is available and extremely wide.
22	Barriers	58	Length of first side (Lb)	GPS	What is the length of the barriers on the first side?
			Zero	0	No barriers present.
			Equal 50 m	0.5	Barrier extends for 50 meters.
			Equal 100 m	1	This section is fully covered by barriers.
		59	Length of other side (Lob)	GPS	What is the length of the barriers on the other side?
			Zero	0	No barriers present.
			Equal 50 m	0.5	Barrier extends for 50 meters.
			Equal 100 m	1	This section is fully covered by barriers.
23	Pedestrian Crossing	60	Available (C)	Checklists	Are there pedestrian crossings? What type of crossing; is it overpass, underpass, on-street?
			No	0	Worst case: no crossing.
			Over / Under pass	0.5	Moderate: difficult for pedestrians.
			On-Street	1	Good: easy for pedestrians to use.
		61	Distance between (Cd)	Arial Image	What is the spacing between pedestrian crossings? Is it more or less than 300 meters?
			More 300 m	0	Difficult for the user.
			Bet. 100 - 200 m	0.5	Moderate for the user.
			Less 100 m	1	Easy for the user.

24	Street Furniture	62	Benches (Be)	Checklists	Are there benches?		
					No	0	Bad indicators.
					Yes, one	0.5	Good indicators.
					Yes, more than 2	1	Excellent indicators.
		63	Toilets (To)	Checklists	Are there public toilets?		
					No	0	Bad indicators.
					Yes, one	0.5	Good indicators.
					Yes, more than 2	1	Excellent indicators.
		64	Trash (Tr)	Checklists	Are there trash bins?		
					No	0	Bad indicators.
					Yes, one	0.5	Good indicators.
					Yes, more than 2	1	Excellent indicators.
		65	Telephone (Te)	Checklists	Is there a public telephone?		
					No	0	Bad indicators.
					Yes, one	0.5	Good indicators.
					Yes, more than 2	1	Excellent indicators.
		66	Bollards (Bo)	GPS	Are there bollards? What is their length?		
					Zero	0	No bollards are present.
					Equal 50 m	0.5	Bollards cover 50 meters.
					Equal 100 m	1	Bollards fully cover this section.
25	Curb Ramps	67	Available (Cr)	GPS	How many curb ramps are available per section?		
					No	0	Bad indicators.
					Yes, one	0.5	Good indicators.
					Yes, more than 2	1	Excellent indicators.

26	Street	68	R-O-W Width (R)	Reports	What is the (R-O-W) width? Is the width sufficient to design a good sidewalk?		
					Less 10	0	Low likelihood of sufficient sidewalk width.
					Bet. 12 - 15	0.5	Moderate likelihood of sufficient sidewalk width.
					more 15 m	1	High likelihood of sufficient sidewalk width.
27	Sign	69	Speed reduction (Sr)	Checklists	Are there speed reduction signs?		
					No	0	Bad indicators.
					Yes	1	Good indicators.
		70	Stop line (Sl)	Checklists	Are there stop line markers?		
					No	0	Bad indicators.
					Yes	1	Good indicators.
		71	Cross walk (Cw)	Checklists	Are there crosswalk signs?		
					No	0	Bad indicators.
					Yes	1	Good indicators.
		72	Clear (Cl)	Checklists	Are the signs clear for users?		
					No	0	Bad indicators.
					Yes, non-clear	0.5	Good indicators.
					Yes, clear	1	Excellent indicators.

The Evaluation of Facilities Element Equation A.8

$$F = \textit{Sidwalk} + \textit{Crossing} + \textit{Furniture} + \textit{Sign} + \textit{Other} \dots \dots \textit{A.8}$$

The other Equation A.9 to A.13

$$Sidwealk = SW_L + SW_{Lo} + SW_W + SW_{Wo} + SW_{Lp} + SW_{Lop} + SW_{Wp} + SW_{Wop} + SW_{Lb} + SW_{Lob} \dots A. 9$$

$$Crossing = SW_C + SW_{Cd} \dots A. 10$$

$$Furniture = SW_{Be} + SW_{To} + SW_{Tr} + SW_{Te} + SW_{Bo} \dots A. 11$$

$$Sign = SW_{Sr} + SW_{Sl} + SW_{Sw} + SW_{Cl} \dots A. 12$$

$$Other = SW_{Cr} + SW_R \dots A. 13$$

Where:

- F: Facilities
- S: Scoring
- W: Weight

Table A.9

Pleasantness Element Data Collection Methodology

Indicators		Sun-indicators		Tools	Description		
#	Name	#	Name		How to Measure	Score	Option description
28	Sidewalk	73	Cleanliness of first (Clf)	Checklists	Is the first sidewalk clean? How comfortable is it for pedestrians?		
					None	0	Bad indicators.
					Partial	0.5	Good indicators.
					Full	1	Excellent indicators.

74	Condition of first (Cof)	Checklists	What is the state of the first sidewalk? Is it in poor, or good condition?
			No sidewalk 0 Uncomfortable for pedestrians.
			Poor 0.25 Low comfort for pedestrians.
			Fair 0.5 Moderate comfort for pedestrians.
			Acceptable 0.75 Good comfort for pedestrians.
			Good 1 High comfort for pedestrians.
75	Cleanliness of other (Clo)	Checklists	Is the other sidewalk clean? How comfortable is it for pedestrians?
			None 0 Bad indicators.
			Partial 0.5 Good indicators.
			Full 1 Excellent indicators.
76	Condition of other (Coo)	Checklists	What is the state of another sidewalk? Is it in poor, or good condition?
			No sidewalk 0 Uncomfortable for pedestrians.
			Poor 0.25 Low comfort for pedestrians.
			Fair 0.5 Moderate comfort for pedestrians.
			Acceptable 0.75 Good comfort for pedestrians.
			Good 1 High comfort for pedestrians.

The Evaluation of Pleasantness Element Equation A.14

$$P = SW_{Ctf} + SW_{Cof} + SW_{Clo} + SW_{Coo} \dots \dots A.14$$

Where:

- P: Pleasantness
- S: Scoring
- W: Weight

Table A.10

Streetscape Element Data Collection Methodology

Indicators		Sun-indicators		Tools	Description		
#	Name	#	Name		How to Measure	Score	Option description
27	Land Mark	77	Attraction point (P)	Checklists	Are there any attraction points? Are there any historical sites?		
					No	0	Bad indicators.
					Yes	1	Good indicators.
78	Building (B)			Checklists	Are there any distinctive buildings?		
					No	0	Bad indicators.
					Yes	1	Good indicators.
79	Open Spaces (O)			Checklists	What types of open spaces exist?		
					None	0	Poor indicators.
					Private	0.75	Good indicators, limited use.
					Public	1	Very good indicators, unrestricted use.
28	Street	80	Landscape (L)	Checklists	Does the street have landscaping? This includes the availability of plants, decorations, furniture, and sidewalks.		
					None	0	No landscaping.
					One from them	0.25	Poor landscaping.
					Two of them	0.5	Moderate landscaping.
					Three from them	0.75	Good landscaping.
					All of them	1	Excellent landscaping.

The Evaluation of Pleasantness Element Equation A.15

$$St = SW_P + SW_B + SW_O + SW_L \dots \dots A. 15$$

Where:

- P: Pleasantness
- S: Scoring
- W: Weight

Table A.11

Expert's assigns a weight of 100% to the walkability elements.

No	Percentage	Elements	Description
1		Efficiency	It measures the efficiency of the street network for pedestrians, evaluating various indicators and sub-indicators. These include connections and intersections. Connections encompass the number, type, staircases, lengths, and state of roads connected to the road. Intersections are assessed based on the number per 100 meters and the distance between intersections.
2		Convenience	It measures the convenience of the surrounding environment for pedestrians, evaluated based on various indicators and sub-indicators. These include street lighting, transit, and parking. Lighting availability is considered, while transit includes stations per 100 meters, distance between stations, frequency, and furniture. Parking is assessed based on availability and cost.
3		Safety & Security	The safety and security of the pedestrian environment are assessed based on factors such as conflict points, speed, refuge islands, street watchers, and crashes. These factors include intersection and private entrance conflict points, speed, availability, and width of refuge islands, as well as the length, usability, condition, and availability of barriers. Also considered are the types of street watchers and their numbers per 100 meters, along with the number of injuries and the degree of crashes per 100 meters.
4		Attractiveness	The attractiveness elements in the pedestrian environment include land use, street gradients, trees, and shade indicators. Land use patterns may be industrial, residential, mixed, or commercial. Other attractiveness indicators include the street gradient, which can be steep, moderate, or level, as well as trees that may obstruct walkers and the area covered by their shadows. Finally, the availability and coverage of shade, ownership, and usability are considered.
5		Weather	The weather element considers the number of days in a year that are suitable for walking, based on two indicators: temperature and wind speed.
6		Environmental	The environmental element will be assessed based on two indicators related to facilities and the surrounding area: pollution and sidewalks. Pollution is evaluated through sub-indicators such as type, causes, level, and duration. Sidewalks are assessed for obstacles, considering aspects such as length, remaining width, degree, duration, and cause.
7		Accessibility	Accessibility in this study area is defined by pedestrian access and activity within varying walkable distances of 250, 400, 800, and over 1000 meters. Access indicators include availability of ATMs and taxis, as well as the diversity of pedestrian activities.
8		Facilities	The facilities element focuses on the environment of the facilities, encompassing various indicators such as sidewalks, pedestrian crossings, street furniture, curb ramps, streets, and signage. The sidewalk indicator is further divided into several sub-indicators to assess facilities, including availability, length of the sidewalk, width of the sidewalk, and length of the barriers. Pedestrian crossing indicators include availability and distance between crossings. Street furniture is evaluated based on the availability of benches, toilets, trash bins, telephones, and bollards. Additionally, the availability of ramps, the street right-of-way (R-O-W), and signage such as speed reduction, stop lines, crosswalks, and clarity are assessed.
9		Pleasantness	Pleasantness refers to the quality or state of being agreeable or enjoyable. The assessment of sidewalk pleasantness focuses on two indicators: its condition and cleanliness. The condition of the sidewalk is categorized as poor or acceptable, while cleanliness determines how comfortable.
10		Streetscape	Streetscape refers to the visual appearance and overall environment of a street. This element is assessed through two indicators: landmarks and streets. Landmarks focus on attraction points and historical sites, buildings, and open spaces, while streets focus on the landscape design.

Table A.12*Distributes 100% marks for efficiency sub-indicators.*

No	Percentage	Sub-indicators	Description
1		Number	How many roads connect to the street?
2		Type	What type of roads connect? Are they minor, major, or staircases?
3		Staircase	Do you need to ascend or descend stairs to access the road?
4		Lengths	What are the lengths of these connecting roads (250, 400, 800, 1000+ meters)?
5		State	Are the connecting roads continuous or non-continuous?
6		Number	How many intersections are there per 100 meters?
7		Distance	What is the distance between intersections?
Sum	100%		

Table A.13*Distributes 100% marks for convenience sub-indicators.*

No	Percentage	Sub-indicators	Description
1		Availability	Is there adequate lighting available throughout the study area, and is it sufficient?
2		Stations	How many stations are there per 100 meters?
3		Distance	What is the distance between stations (400, 800+ meters)?
4		Frequency	How many taxi vehicles are there per 100 meters?
5		Furniture	Is there any furniture at the taxi station, and what is its condition?
6		Availability	Are there parking lots on this road? What type of parking is available?
7		Cost	Is it free or paid?
Sum	100%		

Table A.14*Distributes 100% marks for attractiveness sub-indicators.*

No	Percentage	Sub-indicators	Description
1		Pattern	To what extent is walking required? What type of land use is present? Is it industrial, residential, mixed, or commercial?
2		Grade	What is the street slope? Is it steep, moderate, or level?
3		Obstruction	What is the vertical clearance between the sidewalk and the lower branches?
4		Shadows	What percentage of the sidewalk is covered by tree shadows?
5		Available	Are there umbrellas available and covering the sidewalk? What is the coverage area?
6		Owns	What is the ownership of these umbrellas? Is it private or public owned?
7		Usability	Can pedestrians use it? Is it partially or fully usable?
Sum	100%		

Table A.15*Distributes 100% marks for environmental sub-indicators.*

No	Percentage	Sub-indicators	Description
1		Type	Is there pollution present? What type is it: solid, water, air, noise, or visual?
2		Cause	What is the source of this pollution? Is it from construction, sewage, or commercial/retail activities?
3		Level	What is the degree of pollution? Is it high, moderate, or low? Is it acceptable or not?
4		Duration	What is the duration of this pollution? Is it permanent, temporary, or instantaneous?
5		Length	Are there any obstacles on the sidewalk? If so, what is the length of these obstacles per 100 meters?
6		Width	How much sidewalk width is left after this obstacle?
7		Degree	What is the size or extent of these obstacles? Are they fully obstructed, partially obstructed, or empty?
8		Duration	How long do these obstacles last? Are they permanent, temporary, or instantaneous?
9		Cause	What are the causes of these obstacles? Construction, street furniture, kiosks, or maintenance?
Sum	100%		

Table A.16*Distributes 100% marks for safety & security sub-indicators.*

No	Percentage	Sub-indicators	Description
1		Intersection	The number of conflict points at intersections.
2		Entrances	The number of private entrances per 100 meters.
3		Speed	What is the likely driving speed? / What is the probable speed on this road?
4		Availability	Are there refuge islands, and what are their widths?
5		Length	How long are these islands? Do they cover the road completely or partially?
6		Usability	Are these refuge islands usable?
7		Condition	What is the condition of the refuge islands? Are they in good or poor condition?
8		Clean	What is the degree of cleanliness of the refuge islands?
9		Barrier	What is the length of the barriers on the first side? Do they fully or partially cover the road?
10		Barrier	What is the length of the barriers on the other side? Do they fully or partially cover the road?
11		Kind	What type of street watchers are present? Are they drivers, shop owners, police, pedestrians, or a combination of these?
12		Number	What is the number of pedestrians per 100 meters?
13		Injuries	What is the number of injuries per 100 meters?
14		Degree	What is the degree of injuries: fatal, difficult, moderate, or low?
Sum	100%		

Table A.17*Distributes 100% marks for weather sub-indicators.*

No	Percentage	Sub-indicators	Description
1		Degree	How many days are suitable for walking with temperatures between 15°C & 20°C?
2		Speed	How many days are suitable for walking with wind speeds less than 19 km/h?
Sum	100%		

Table A.18*Distributes 100% marks for accessibility sub-indicators.*

No	Percentage	Sub-indicators	Description
1		ATM	Are ATMs accessible within the study area, and how far is the walking distance to reach them? Is it within an acceptable distance?
2		Taxi	Are taxis accessible within the study area, and what is the walking distance required to reach them? Is it within an acceptable distance?
3		Variety	What variety of activities are available in the study area? What types of activities can be conducted on the street, such as government institutions, shopping, restaurants & cafes, recreation, or a combination thereof?
Sum	100%		

Table A.19*Distributes 100% marks for streetscape sub-indicators.*

No	Percentage	Sub-indicators	Description
1		Attraction	Are there any attraction points? Are there any historical sites?
2		Buildings	Are there any distinctive buildings?
3		Open spaces	What types of open spaces exist?
4		Landscape	Does the street have landscaping? This includes the availability of plants, decorations, furniture, and sidewalks.
Sum	100%		

Table A.20*Distributes 100% marks for pleasantness sub-indicators.*

No	Percentage	Sub-indicators	Description
1		Condition	What is the state of the first sidewalk? Is it in poor, or good condition?
2		Cleanliness	Is the first sidewalk clean? How comfortable is it for pedestrians?
3		Condition	What is the state of another sidewalk? Is it in poor, or good condition?
4		Cleanliness	Is the other sidewalk clean? How comfortable is it for pedestrians?
Sum	100%		

Table A.21*Distributes 100% marks for facilities sub-indicators.*

No	Percentage	Sub-indicators
1		Length What is the length of the first sidewalk?
2		Length What is the length of the other sidewalk?
3		Width What is the width of the first sidewalk?
4		Width What is the width of the other sidewalk?
5		Barriers What is the length of the barriers on the first side?
6		Barriers What is the length of the barriers on the other side?
7		Length What is the length of the first frontage offset (parking)?
8		Length What is the length of the other frontage offset (parking)?
9		Width What is the width of the first frontage offset (parking)?
10		Width What is the width of the other frontage offset (parking)?
11		Availability Are there pedestrian crossings? What type of crossing; is it overpass, underpass, on-street?
12		Distance What is the spacing between pedestrian crossings? Is it more or less than 300 meters?
13		Benches Are there benches?
14		Toilets Are there public toilets?
15		Trash Are there trash bins?
16		Telephone Is there a public telephone?
17		Bollards Are there bollards? What is their length?
18		Availability How many curb ramps are available per 100 meters?
19		R-O-W What is the (R-O-W) width? Is the width sufficient to design a good sidewalk?
20		Speed Are there speed reduction signs?
21		Stop line Are there stop line markers?
22		Crosswalk Are there crosswalk signs?
23		Clarity Are the signs clear for users?
Sum	100%	

Appendix B

Data Collected

Table B.1

Efficiency Element Scoring

Section	Connecting					Cross	
No	(R)	(T)	(S)	(L)	(Sr)	(C)	(D)
1	0.50	0.50	1.00	0.00	0.50	0.80	0.75
2	0.50	1.00	1.00	0.50	0.50	0.80	0.75
3			1.00				
4	0.75	1.00	1.00	0.63	0.50	1.00	0.75
5			1.00				
6	0.50	1.00	1.00	1.00	0.50	0.80	0.75
7	0.50	1.00	1.00	1.00	0.50	0.80	0.75
8	0.50	1.00	1.00	1.00	0.50	0.80	0.75
9			1.00				
10			1.00				
11	0.75	1.00	1.00	1.00	0.50	0.80	0.75
12	0.75	1.00	1.00	1.00	0.50	0.80	1.00
13			1.00				
14	0.50	1.00	1.00	1.00	0.50	0.80	0.75
15	0.50	1.00	1.00	1.00	0.50	0.80	0.75
16	1.00	0.83	1.00	0.58	0.50	1.00	1.00
17	0.50	1.00	1.00	1.00	0.50	0.80	1.00
18	0.50	1.00	1.00	1.00	0.50	0.80	1.00
19	0.50	1.00	0.75	1.00	0.50	0.80	0.75
20	0.75	1.00	0.75	0.50	0.50	1.00	0.75
21			1.00				
22	1.00	1.00	1.00	0.67	0.50		1.00
23			1.00				
24			1.00				
25	1.00	1.00	1.00	0.83	0.50	1.00	0.75
26	0.50	1.00	1.00	1.00	1.00	0.80	0.75
27	0.50	1.00	1.00	1.00	0.50	0.80	0.75
28	0.75	1.00	0.75	1.00	0.38	1.00	0.75
29			0.75				
30	0.50	1.00	0.75	1.00	0.50	0.80	0.75
31	0.75	1.00	1.00	0.75	0.75	1.00	0.75
32			1.00				
33	0.75	1.00	1.00	0.88	0.50	1.00	1.00
34	0.50	1.00	1.00	1.00	0.50	0.80	0.75
35			1.00				

Where:

(R) Number of roads (S) Staircases (Sr) State of roads (D) Distance between cross
 (T) Type of roads (L) Length of roads (C) Number of cross

Table B.2*Convenience Element Scoring*

Section No	Lighting	Transit				Parking	
	(La)	(Ss)	(D)	(Fs)	(Fc)	(Pa)	(Pc)
1	1.00			0.25		0.60	1.00
2	1.00	1.00	1.00		1.00	1.00	1.00
3	1.00	1.00	1.00	0.75	1.00	1.00	1.00
4	1.00			0.75		1.00	1.00
5	1.00			0.25		1.00	1.00
6	1.00			0.25		0.20	1.00
7	1.00			0.25		1.00	1.00
8	1.00					1.00	1.00
9	1.00			0.25		1.00	1.00
10	1.00					1.00	1.00
11	1.00					1.00	1.00
12	1.00			0.25		1.00	1.00
13	1.00			0.25		1.00	1.00
14	1.00			0.25		1.00	1.00
15	1.00	1.00	0.50	0.5	0.50	1.00	1.00
16	1.00			1		0.40	1.00
17	1.00			0.5		1.00	0.75
18	0.50			0.75		1.00	0.50
19	1.00			1		1.00	0.50
20	1.00			0.5		0.40	1.00
21	1.00			0.25		1.00	0.50
22	1.00			0.25		1.00	0.50
23	1.00					1.00	0.50
24	1.00			0.75		1.00	0.50
25	1.00					1.00	1.00
26	1.00			0.25		1.00	0.50
27	1.00			0.5		1.00	0.75
28	1.00			0.75		1.00	0.75
29	1.00			0.5		1.00	0.50
30	1.00			0.25		1.00	0.50
31	1.00			0.5		1.00	0.75
32	1.00			0.25		0.60	1.00
33	1.00					1.00	1.00
34	1.00					1.00	1.00
35	1.00					0.80	1.00

Where:

(La) Lighting availability
(Ss) Station / Section(D) Distance between station
(Fs) Frequency / Section(Fc) Furniture condition
(Pa) Parking available

(Pc) Parking cost

Table B.3*Safety & Security Element Scoring*

Section No	Conflict		Street	Refuge Islands						
	(I)	(P)	(S)	(W)	(L)	(U)	(Co)	(Cl)	(Fb)	(Ob)
1	0.50	0.50	0.50	1.00	0.65	1.00	0.75	0.50		
2	0.50	0.25	0.50	1.00	0.80	1.00	0.75	1.00	0.40	
3	1.00	0.50	0.50	1.00	0.80	1.00	0.75	1.00	0.35	
4	0.50	1.00	0.50	1.00	1.00	1.00	1.00	1.00		
5	0.50	0.25	0.50	1.00	0.65	1.00	1.00	1.00		
6	0.50	0.50	0.50	1.00	0.95	1.00	0.75			
7	0.50	0.50	0.50	1.00	1.00	1.00	0.25	0.50		
8	0.50	1.00	0.50	1.00	0.80	1.00	0.25	0.50		
9	1.00	0.75	0.50	1.00	0.75	1.00	0.25	0.75		
10	0.50	0.50	0.50	1.00	0.75	1.00	0.75	0.75		
11	1.00	0.75	0.75	1.00	0.80	1.00	0.75	0.50		
12	0.50	0.50	0.75	1.00	0.45	1.00	1.00	0.75		
13	1.00	0.75	0.75	1.00	0.60	1.00	1.00	1.00		
14	0.50	0.50	0.75	1.00	0.60	1.00	1.00	1.00		
15	0.50	0.50	0.75	1.00	0.75	1.00	1.00	1.00		
16	0.25	0.50	1.00	0.25	0.10	1.00	1.00	1.00		
17	0.50	0.50	1.00	1.00	0.15	1.00	1.00	1.00		
18	0.80	0.75	1.00							
19	0.75	0.75	1.00							
20	0.50	0.75	1.00	0.50	0.35	1.00	1.00	1.00		
21	1.00	0.50	1.00	0.50	0.25	1.00	1.00	1.00		
22	0.50	0.75	1.00							
23	1.00	0.50	1.00							
24	0.75	0.75	1.00							
25	1.00	0.75	1.00	0.75	0.10	1.00	1.00	1.00		
26	1.00	0.50	0.75							
27	0.75	0.50	0.75							
28	0.50	0.75	0.75							
29	1.00	0.50	0.75							
30	0.50	1.00	0.75							
31	0.75	0.25	0.75	0.50	0.10	1.00	1.00	1.00		
32	0.75	0.75	0.50							
33	0.75	0.75	0.50					1.00		
34	0.75	0.75	0.50							
35	0.75	0.50	0.50					1.00		

Where:

(I) Intersection conflict
(P) Privet space conflict
(S) Street speed
(W) Islands widths

(L) Islands length
(U) Islands useable
(Co) Islands condition
(Cl) Islands cleanliness

(Fb) First side barrier
(Ob) Other side barrier

Table B.3 Continue.*Safety & Security Element Scoring*

Section No	Watchers		Crashes	
	(K)	(N)	(I)	(D)
1	0.75	0.25	1.00	1.00
2	0.75	0.50	0.75	0.75
3	0.75	0.50	1.00	1.00
4	0.75	1.00	0.50	0.50
5	0.75	0.50	1.00	1.00
6	0.75	0.25	1.00	1.00
7	0.75	0.50	1.00	1.00
8	0.50	0.25	1.00	1.00
9	0.50	0.25	1.00	1.00
10	0.50	0.25	1.00	1.00
11	0.75	0.75	0.75	0.50
12	0.75	0.25	0.75	0.50
13	0.75	0.50	1.00	1.00
14	0.75	0.50	1.00	1.00
15	0.75	1.00	1.00	1.00
16	1.00	1.00	0.50	0.50
17	1.00	1.00	0.75	0.50
18	0.75	0.75	1.00	1.00
19	0.75	0.50	1.00	1.00
20	1.00	0.50	0.75	0.75
21	0.75	0.75	1.00	1.00
22	0.75	1.00	0.50	0.50
23	0.75	0.50	1.00	1.00
24	0.75	0.75	1.00	1.00
25	1.00	0.50	0.50	0.50
26	0.75	0.75	1.00	1.00
27	0.75	1.00	0.50	0.50
28	1.00	0.75	1.00	1.00
29	0.75	0.75	1.00	1.00
30	0.75	0.50	1.00	1.00
31	0.75	0.75	1.00	1.00
32	0.75	0.75	1.00	1.00
33	0.75	1.00	1.00	1.00
34	0.50	0.75	0.50	0.75
35	0.50	0.50	1.00	1.00

Where:

- (K) Watchers' kind
- (N) Number / Section
- (I) Crashes injuries
- (D) Degree of injuries

Table B.4*Attractiveness Element Scoring*

Section No	Land Use	Street	Tree		Shades		
	(P)	(G)	(O)	(S)	(Sc)	(Os)	(U)
1	0.75	0.75		0.22			
2	0.75	1.00	0.50	0.22	0.04	1.00	1.00
3	0.75	0.50	0.50	0.32	0.10	1.00	1.00
4	0.75	1.00	0.50	0.14	0.04	1.00	1.00
5	0.75	0.50	0.50	0.03			
6	0.75	0.50		0.03			
7	0.75	0.75	0.25	0.44			
8	0.75	1.00	0.25	0.30			
9	0.75	1.00	0.25	0.24			
10	0.75	1.00	0.75	0.24			
11	0.75	1.00	0.75	0.20			
12	0.75	1.00	0.50	0.11			
13	0.75	1.00	0.75	0.06			
14	0.75	0.75	0.75	0.02	0.05	0.50	1.00
15	0.75	0.75	0.75	0.10			
16	0.75	1.00	1.00	0.07			
17	0.75	1.00	1.00	0.34			
18	0.75	1.00	1.00	0.11	0.25	0.50	1.00
19	0.75	1.00		0.01	0.09	1.00	1.00
20	0.75	1.00	1.00	0.05	0.08	0.50	0.50
21	0.75	1.00	1.00	0.12			
22	0.75	0.75	1.00	0.02	0.02	0.50	0.50
23	0.75	0.25	1.00	0.32			
24	0.75	0.75	1.00	0.06	0.62	0.50	1.00
25	0.75	1.00	1.00	0.30	0.05	0.50	0.50
26	0.75	0.50	1.00	0.21			
27	0.75	0.50	1.00	0.12			
28	0.75	1.00		0.01	0.27	0.50	0.50
29	0.75	0.75	1.00	0.29			
30	0.75	0.75	1.00	0.53	0.16	0.50	1.00
31	0.75	1.00	1.00	0.37	0.12	0.50	1.00
32	0.75	0.75	1.00	0.23			
33	0.75	1.00	1.00	0.12			
34	0.75	0.75	1.00	0.16			
35	0.75	1.00	1.00	0.12			

Where:

(P) Land use patterns
(G) Street grade(O) Tree obstruction
(S) Tree shadows(Sc) Shades available & coverage
(So) Shades owns

(U) Shades useable

Table B.5*Weather Element Scoring*

Section	Temperature	Wind
No	(T)	(W)
1	0.75	1.00
2	0.75	1.00
3	0.75	1.00
4	0.75	1.00
5	0.75	1.00
6	0.75	1.00
7	0.75	1.00
8	0.75	1.00
9	0.75	1.00
10	0.75	1.00
11	0.75	1.00
12	0.75	1.00
13	0.75	1.00
14	0.75	1.00
15	0.75	1.00
16	0.75	1.00
17	0.75	1.00
18	0.75	1.00
19	0.75	1.00
20	0.75	1.00
21	0.75	1.00
22	0.75	1.00
23	0.75	1.00
24	0.75	1.00
25	0.75	1.00
26	0.75	1.00
27	0.75	1.00
28	0.75	1.00
29	0.75	1.00
30	0.75	1.00
31	0.75	1.00
32	0.75	1.00
33	0.75	1.00
34	0.75	1.00
35	0.75	1.00

Where:

(T) Temperature degree

(W) Wind speed

Table B.6*Environmental Element Scoring*

Section No	Pollution				Sidewalk				
	(K)	(C)	(L)	(D)	(L)	(W)	(De)	(Du)	(R)
1	1.00	1.00	1.00	1.00	0.09	0.75	0.50		0.25
2	1.00	1.00	1.00	1.00	0.25	0.75	0.50		0.25
3	1.00	1.00	1.00	1.00	0.10	0.50	0.50		0.25
4	1.00	1.00	1.00	1.00	0.08	0.50	0.50	0.50	0.50
5		0.25	1.00	0.50	0.12				1.00
6	0.80	0.25	0.50	0.50	1.00	1.00	1.00	1.00	5.00
7	1.00	1.00	1.00	1.00	0.08	0.75	0.50		0.25
8	1.00	1.00	1.00	1.00	0.05				
9	1.00	1.00	1.00	1.00	0.03	0.50	0.50	0.50	0.50
10		0.25	0.50	0.50	0.08			0.50	0.50
11	1.00	1.00	1.00	1.00	0.20			0.50	0.50
12		0.25	1.00	0.50	0.04	0.50	0.50	0.50	0.50
13	1.00	1.00	1.00	1.00	0.20			0.50	0.50
14		0.25	1.00	0.50	0.03	1.00	0.50		0.50
15		0.25	1.00	0.50	0.03	0.50	0.50	0.75	0.25
16	1.00	1.00	1.00	0.50	0.07			0.50	0.50
17	0.40	0.75	1.00		0.10			0.50	0.25
18	1.00	1.00	1.00	1.00	0.20	0.50	0.50	0.50	0.50
19		0.25	1.00	0.50	0.05	0.75	0.50	0.50	0.25
20	1.00	1.00	1.00	1.00	0.15	0.50	0.50		0.25
21	1.00	1.00	1.00	1.00	0.03	0.75	0.50		0.25
22		0.75	0.50	0.50	0.10	0.75	0.50		0.25
23	1.00	1.00	1.00	1.00	0.03		1.00	0.50	0.50
24	1.00	1.00	1.00	1.00	0.15	0.75	0.50		0.50
25	1.00	1.00	1.00	1.00	0.04	0.50	0.50	0.50	0.50
26	1.00	1.00	1.00	1.00	0.10	0.25		0.50	1.00
27		0.25	0.50	0.50	0.01	0.50	0.50		0.75
28		0.25	0.50	0.50	0.08	0.25	0.50		0.50
29		0.25		0.50	0.08	0.75	0.50		0.25
30	1.00	1.00	1.00	1.00	0.03	0.50	0.50	0.50	0.50
31	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
32	1.00	1.00	1.00	1.00	0.06	0.50	0.50		0.25
33		0.25		0.50	1.00	1.00	1.00	1.00	1.00
34	1.00	1.00	1.00	1.00	0.06	0.50	0.50		
35	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Where:

(K) Pollution kind
(C) Pollution cause
(L) Pollution level

(D) Pollution duration
(L) Obstacles length
(W) Obstacles width

(De) Obstacles degree
(Du) Obstacles duration
(R) Obstacles reason

Table B.7*Accessibility Element Scoring*

Section No	Access		Activity
	(A)	(T)	(V)
1	1.00	1.00	0.75
2	1.00		0.75
3	1.00	0.75	1.00
4	0.75	0.50	1.00
5	0.50		0.25
6	0.50	0.25	0.25
7	0.50	0.25	0.25
8	0.50	0.75	0.25
9	0.75		
10	0.75		0.25
11	1.00	0.75	0.25
12	1.00	0.75	0.50
13	1.00		0.25
14	1.00	0.25	0.50
15	1.00	0.75	0.50
16	1.00	0.75	0.50
17	1.00	0.25	0.25
18	1.00	0.25	0.50
19	1.00	0.75	0.50
20	1.00	0.50	0.25
21	1.00		0.75
22	1.00	0.25	0.75
23	1.00		0.50
24	1.00		0.50
25	1.00	0.25	0.50
26	1.00	0.25	0.25
27	1.00	0.25	0.50
28	1.00	0.50	1.00
29	1.00		0.50
30	0.75	0.50	0.75
31	0.50	0.50	0.50
32	0.50		0.50
33	0.50	0.25	0.75
34	0.50	0.25	0.50
35	0.25		0.25

Where:

(A) ATM access

(T) Taxi access

(V) Variety of pedestrian activity

Table B.8*Facilities Element Scoring*

Section No	Sidewalks								Barriers		Crossing	
	(L)	(Lo)	(W)	(Wo)	(P)	(Po)	(Pw)	(Pow)	(Lb)	(Lob)	(C)	(Cd)
1	0.53	0.29	0.75	1.00	0.34	0.36	0.75	0.50				
2	0.91	0.63	1.00	1.00		0.08		0.50			1.00	0.75
3	1.00	0.29	1.00	0.75		0.25		0.50			1.00	0.75
4	1.00	0.75	1.00	0.75								
5	0.97	0.82	1.00	1.00							1.00	0.75
6	0.08	0.27	1.00	1.00								
7	0.82	0.47	1.00	1.00								
8	1.00	0.86	1.00	1.00								
9	1.00	0.87	1.00	1.00		0.10		0.25				
10	0.81	0.49	1.00	1.00	0.19	0.30	0.75	0.75				
11	0.51	0.96	1.00	1.00	0.11		0.25					
12	0.07	0.86	1.00	1.00	0.07							
13	1.00	0.90	1.00	1.00								
14	0.55	0.47	0.75	0.75		0.35						
15	0.83	0.43	1.00	1.00		0.46						
16	0.68	0.64	1.00	1.00	0.21	0.08		0.25				
17	0.64	0.63	0.75	1.00	0.27	0.25		0.25				
18	0.85	0.87	1.00	1.00								
19	0.90	0.94	0.75	1.00								
20	0.99	0.75	0.75	0.75					0.03			
21	0.79	0.94	0.75	1.00								
22	0.77	0.83	1.00	1.00								
23	0.74	0.96	1.00	1.00	0.29		0.75					
24	0.78	0.88	1.00	1.00	0.18		0.50					
25	0.78	0.89	1.00	1.00								
26	1.00	0.87	1.00	1.00								
27	0.82	0.38	1.00	0.75		0.53		0.50				
28	0.35	0.21	0.75	1.00	0.37	0.73	0.25	0.25				
29	0.97	0.70	1.00	1.00								
30	0.92	1.00	1.00	1.00								
31	0.92	0.34	1.00	1.00	0.05	0.39	0.25					
32	0.68	0.96	1.00	0.75	0.34		0.50					
33	0.92	0.40	1.00	1.00					0.04			
34	0.72	0.98	1.00	1.00								
35	0.87	0.89	1.00	1.00								

Where:

(L) Length of first sidewalk

(Lo) Length of other sidewalk

(W) Width of first sidewalk

(Wo) Width of other sidewalk

(P) Length of first parking offset

(Po) Length of other parking offset

(Pw) Width of first parking offset

(Pow) Width of other parking offset

(Lb) Length of first side

(Lob) Length of other side

(C) Pedestrian crossing available

(Cd) Distance between

Table B.8 Continue

Facilities Element Scoring

Section No	Street Furniture					Ramps	Street	Sign			
	(Be)	(To)	(Tr)	(Te)	(Bo)	(Cr)	(R)	(Sr)	(Sl)	(Cw)	(Cl)
1			0.50			0.50	1.00			1.00	1.00
2			0.50		0.02		1.00			1.00	1.00
3					0.03	0.50	1.00			1.00	1.00
4							1.00			1.00	1.00
5			0.50		0.03		1.00			1.00	1.00
6							1.00				
7							1.00				
8			1.00			0.50	1.00				
9							1.00				
10							1.00	1.00		1.00	1.00
11					0.13	0.50	1.00				
12					0.03		1.00				
13							1.00				
14						1.00	1.00				
15						0.50	1.00				
16						0.50	1.00				
17			0.50		0.18		0.50				
18					0.10		0.50				
19					0.04		0.50				
20					0.04		0.50				
21					0.04		0.50				
22							0.50				
23						0.50	0.50				
24					0.11		0.50				
25							0.50				
26				0.01		0.50					
297						0.50					
28				0.02	0.50	0.50					
29						0.50					
30						0.50					
31						0.50					
32					0.50	0.50					
33						0.50					
34						0.50					
35						0.50					

Where:

- | | | |
|----------------|---------------------------|-----------------|
| (Be) Benches | (Bo) Bollards | (Sl) Stop line |
| (To) Toilets | (Cr) Curb ramps available | (Cw) Cross walk |
| (Tr) Trash | (R) R-O-W width | (Cl) Clear |
| (Te) Telephone | (Sr) Speed reduction | |

Table B.9*Pleasantness Element Scoring*

Section No	Sidewalk			
	(Clf)	(Cof)	(Clo)	(Coo)
1	1.00	1.00	1.00	1.00
2	1.00	1.00	1.00	1.00
3	1.00	1.00	1.00	0.75
4	1.00	1.00	1.00	1.00
5	0.75	1.00	0.75	0.75
6			0.00	
7	0.50	0.75	0.50	0.25
8	0.25	0.25	0.25	0.50
9	0.50	0.75	0.50	0.50
10	0.75	0.75	0.75	0.75
11	0.50	0.75	0.50	0.25
12	0.50		0.50	0.50
13	1.00	1.00	1.00	0.25
14	1.00	1.00	1.00	0.75
15	1.00	1.00	1.00	1.00
16	1.00	1.00	1.00	1.00
17	1.00	1.00	1.00	1.00
18	1.00	1.00	1.00	1.00
19	1.00	1.00	1.00	0.75
20	0.75	1.00	0.75	0.75
21	1.00	1.00	1.00	1.00
22	1.00	1.00	1.00	1.00
23	0.50	1.00	0.50	0.50
24	1.00	1.00	1.00	0.75
25	0.75	1.00	0.75	0.50
26	1.00	0.75	1.00	1.00
27	1.00	1.00	1.00	1.00
28	0.75	1.00	0.75	1.00
29	0.75	0.75	0.75	1.00
30	1.00	1.00	1.00	1.00
31	0.75	0.75	0.75	1.00
32	0.75	0.50	0.75	0.50
33	0.75	1.00	0.75	0.25
34	1.00	0.75	1.00	0.75
35	0.75	1.00	0.75	0.25

Where:

- (Clf) Cleanliness of first
- (Cof) Condition of first
- (Clo) Cleanliness of other
- (Coo) Condition of other

Table B.10*Streetscape Element Scoring*

Section No	Land Mark			Street
	(P)	(B)	(O)	(L)
1				0.25
2	1.00			0.25
3	1.00			0.25
4				0.25
5				0.25
6				0.25
7				0.25
8				0.25
9				0.25
10				0.25
11				0.25
12				0.25
13				0.25
14				0.25
15	1.00			0.50
16				0.25
17				0.25
18				0.25
19				0.25
20				
21				0.50
22				
23				0.25
24	1.00			0.25
25				0.25
26		1.00		0.25
27	1.00			
28				
29				0.25
30				0.50
31				0.25
32				0.25
33				0.25
34				0.25
35	1.00		1.00	

Where:

- (P) Attraction point
- (B) Building
- (O) Open Spaces
- (L) Landscape

Table B.11*Response to the Questionnaire by Gender*

Gender	
Male	8
Female	4
Sum	12

Table B.12*Response to the Questionnaire by Age*

Age	
30 - 34	1
35 - 39	1
40 - 44	4
45 - 50	3
50 - 54	1
55 - 60	0
60+	2
Sum	12

Table B.13*Response to the Questionnaire by Educational Degree*

Educational Degree	
Doctorate (Ph.D.)	6
Bachelor's Degree	4
Master's Degree	2
Sum	12

Table B.14*Response to the Questionnaire by Work Sectors*

Work Sectors	
Academic	5
Governmental	4
Private	1
Other (Institutional, etc.)	2
Sum	12

Table B.15*Response to the Questionnaire by Years of Experience*

Years of Experience	
10 - 14	2
15 - 19	1
20 - 24	5
25 - 29	2
30+	2
Sum	12

Table B.16*Response to the Questionnaire by Use of Walking as a Mode of Transportation*

Mode of Transportation	
Yes	10
No	2
Sum	12

Table B.17*Questionnaire Responses Based on Daily Walking Time*

Daily Walking Time	
I do not walk	1
Less than 5 minutes	1
Between 5 - 10 minutes	3
More than 10 minutes	7
Sum	12

Table B.18*Distributes 100% Marks for Elements.*

No	Elements	Experts											
1	Efficiency	15.00%	10.00%	8.00%	15.00%	15.00%	16.00%	11.90%	10.00%	9.94%	15.00%	10.00%	10.87%
2	Convenience	15.00%	20.00%	8.00%	15.00%	15.00%	12.00%	9.52%	20.00%	11.80%	20.00%	15.00%	15.22%
3	Safety & Security	10.00%	20.00%	15.00%	15.00%	15.00%	18.00%	7.14%	10.00%	11.18%	10.00%	15.00%	8.70%
4	Attractiveness	10.00%	5.00%	8.00%	7.00%	0.00%	12.00%	7.14%	5.00%	11.18%	10.00%	10.00%	6.52%
5	Weather	10.00%	20.00%	10.00%	10.00%	0.00%	5.00%	14.29%	10.00%	9.94%	5.00%	10.00%	15.22%
6	Environmental	10.00%	10.00%	8.00%	8.00%	5.00%	8.00%	11.90%	5.00%	8.70%	5.00%	10.00%	4.35%
7	Accessibility	10.00%	5.00%	15.00%	10.00%	30.00%	9.00%	14.29%	10.00%	9.94%	10.00%	10.00%	15.22%
8	Facilities	5.00%	5.00%	8.00%	10.00%	5.00%	8.00%	7.14%	15.00%	9.94%	5.00%	10.00%	8.70%
9	Pleasantness	5.00%	2.00%	10.00%	5.00%	0.00%	5.00%	9.52%	10.00%	8.70%	15.00%	5.00%	6.52%
10	Streetscape	10.00%	3.00%	10.00%	5.00%	15.00%	7.00%	7.14%	5.00%	8.70%	5.00%	5.00%	8.70%
	Sum	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Table B.19*Distributes 100% Marks for Efficiency Sub-indicators.*

No	Sub-indicators	Experts											
1	Number	20.00%	20.00%	12.00%	10.00%	20.00%	20.00%	9.29%	10.00%	13.33%	14.29%	20.00%	45.45%
2	Type	15.00%	20.00%	15.00%	10.00%	20.00%	20.00%	21.67%	10.00%	15.83%	14.29%	20.00%	45.45%
3	Staircase	5.00%	20.00%	20.00%	15.00%	10.00%	10.00%	3.10%	20.00%	15.00%	9.52%	15.00%	9.09%
4	Lengths	10.00%	10.00%	15.00%	15.00%	10.00%	20.00%	15.48%	15.00%	14.17%	14.29%	10.00%	0.00%
5	State	20.00%	10.00%	12.00%	15.00%	15.00%	10.00%	15.48%	10.00%	13.33%	14.29%	15.00%	0.00%
6	Number	10.00%	10.00%	12.00%	15.00%	15.00%	15.00%	19.50%	5.00%	13.33%	14.29%	10.00%	0.00%
7	Distance	20.00%	10.00%	14.00%	20.00%	10.00%	5.00%	15.48%	30.00%	15.00%	19.05%	10.00%	0.00%
	Sum	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Table B.20*Distributes 100% Marks for Safety & Security Sub-indicators.*

No	Sub-indicators	Experts											
1	Intersection	15.00%	15.00%	7.00%	5.00%	0.00%	15.00%	12.96%	5.00%	7.96%	10.00%	15.00%	32.00%
2	Entrances	5.00%	5.00%	6.00%	5.00%	0.00%	10.00%	7.41%	5.00%	6.19%	5.00%	10.00%	16.00%
3	Speed	15.00%	15.00%	10.00%	10.00%	20.00%	10.00%	9.26%	10.00%	7.08%	5.00%	5.00%	20.00%
4	Availability	10.00%	10.00%	6.00%	5.00%	10.00%	5.00%	5.56%	12.50%	7.52%	15.00%	5.00%	16.00%
5	Length	5.00%	5.00%	6.00%	10.00%	0.00%	5.00%	3.70%	7.50%	7.96%	10.00%	5.00%	0.00%
6	Usability	10.00%	5.00%	6.00%	5.00%	10.00%	9.00%	9.26%	13.00%	7.52%	10.00%	5.00%	0.00%
7	Condition	5.00%	5.00%	8.00%	5.00%	15.00%	5.00%	9.26%	7.00%	7.08%	5.00%	5.00%	8.00%
8	Clean	5.00%	5.00%	9.00%	10.00%	0.00%	5.00%	9.26%	5.00%	7.08%	5.00%	5.00%	8.00%
9	Barrier	0.00%	10.00%	6.00%	10.00%	0.00%	7.00%	3.70%	5.00%	7.52%	5.00%	5.00%	0.00%
10	Barrier	0.00%	10.00%	6.00%	10.00%	10.00%	4.00%	3.70%	5.00%	7.52%	5.00%	10.00%	0.00%
11	Kind	5.00%	5.00%	6.00%	5.00%	0.00%	5.00%	12.96%	3.00%	6.19%	5.00%	5.00%	0.00%
12	Number	5.00%	2.00%	10.00%	5.00%	15.00%	10.00%	9.26%	10.00%	7.08%	10.00%	10.00%	0.00%
13	Injuries	10.00%	4.00%	8.00%	5.00%	10.00%	5.00%	1.85%	5.00%	6.64%	5.00%	10.00%	0.00%
14	Degree	10.00%	4.00%	6.00%	10.00%	10.00%	5.00%	1.85%	7.00%	6.64%	5.00%	5.00%	0.00%
	Sum	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Table B.21*Distributes 100% Marks for Weather Sub-indicators.*

No	Sub-indicators	Experts											
1	Degree	70.00%	70.00%	60.00%	50.00%	40.00%	60.00%	54.55%	40.00%	53.33%	70.00%	60.00%	50.00%
2	Speed	30.00%	30.00%	40.00%	50.00%	60.00%	40.00%	45.45%	60.00%	46.67%	30.00%	40.00%	50.00%
	Sum	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Table B.22*Distributes 100% Marks for Attractiveness Sub-indicators.*

No	Sub-indicators	Experts											
1	Pattern	25.00%	25.00%	12.00%	10.00%	20.00%	30.00%	21.43%	10.00%	15.13%	15.00%	20.00%	0.00%
2	Grade	25.00%	25.00%	25.00%	15.00%	20.00%	15.00%	17.86%	25.00%	15.97%	10.00%	20.00%	38.46%
3	Obstruction	10.00%	10.00%	13.00%	15.00%	10.00%	10.00%	17.86%	10.00%	14.29%	10.00%	15.00%	53.85%
4	Shadows	15.00%	10.00%	13.00%	15.00%	20.00%	15.00%	21.43%	20.00%	14.29%	10.00%	15.00%	7.69%
5	Available	10.00%	10.00%	12.00%	15.00%	15.00%	15.00%	7.14%	20.00%	14.29%	20.00%	10.00%	0.00%
6	Owns	5.00%	10.00%	10.00%	15.00%	10.00%	7.00%	7.14%	5.00%	12.61%	20.00%	10.00%	0.00%
7	Usability	10.00%	10.00%	15.00%	15.00%	5.00%	8.00%	7.14%	10.00%	13.45%	15.00%	10.00%	0.00%
	Sum	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Table B.23*Distributes 100% Marks for Environmental Sub-indicators.*

No	Sub-indicators	Experts											
1	Type	20.00%	20.00%	13.00%	15.00%	5.00%	20.00%	9.62%	15.00%	9.40%	10.00%	20.00%	11.11%
2	Cause	10.00%	10.00%	12.00%	15.00%	20.00%	10.00%	9.62%	10.00%	10.74%	15.00%	15.00%	11.11%
3	Level	15.00%	10.00%	12.00%	10.00%	15.00%	5.00%	9.62%	15.00%	10.74%	15.00%	15.00%	11.11%
4	Duration	10.00%	10.00%	12.00%	10.00%	15.00%	5.00%	7.69%	20.00%	10.74%	10.00%	10.00%	11.11%
5	Length	15.00%	20.00%	12.00%	10.00%	10.00%	20.00%	11.54%	10.00%	11.41%	10.00%	10.00%	13.33%
6	Width	10.00%	20.00%	15.00%	10.00%	5.00%	10.00%	7.69%	10.00%	12.08%	10.00%	10.00%	8.89%
7	Degree	10.00%	5.00%	8.00%	10.00%	10.00%	5.00%	13.46%	10.00%	12.08%	10.00%	10.00%	11.11%
8	Duration	0.00%	4.00%	8.00%	10.00%	15.00%	5.00%	17.31%	5.00%	11.41%	10.00%	5.00%	11.11%
9	Cause	10.00%	1.00%	8.00%	10.00%	5.00%	20.00%	13.46%	5.00%	11.41%	10.00%	5.00%	11.11%
	Sum	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Table B.24*Distributes 100% Marks for Convenience Sub-indicators.*

No	Sub-indicators	Experts											
1	Availability	20.00%	25.00%	20.00%	15.00%	20.00%	20.00%	26.92%	20.00%	16.81%	20.00%	20.00%	23.53%
2	Stations	10.00%	15.00%	10.00%	20.00%	15.00%	15.00%	7.69%	15.00%	15.04%	5.00%	15.00%	23.53%
3	Distance	20.00%	10.00%	15.00%	10.00%	15.00%	15.00%	11.54%	20.00%	15.04%	15.00%	15.00%	23.53%
4	Frequency	20.00%	20.00%	15.00%	10.00%	10.00%	15.00%	11.54%	20.00%	12.39%	15.00%	10.00%	23.53%
5	Furniture	10.00%	10.00%	15.00%	15.00%	15.00%	15.00%	3.85%	10.00%	12.39%	20.00%	15.00%	0.00%
6	Availability	10.00%	10.00%	10.00%	15.00%	15.00%	10.00%	19.23%	5.00%	14.16%	20.00%	15.00%	5.88%
7	Cost	10.00%	10.00%	15.00%	15.00%	10.00%	10.00%	19.23%	10.00%	14.16%	5.00%	10.00%	0.00%
	Sum	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Table B.25*Distributes 100% Marks for Accessibility Sub-indicators.*

No	Sub-indicators	Experts											
1	ATM	10.00%	15.00%	30.00%	20.00%	28.57%	20.00%	31.82%	25.00%	32.73%	20.00%	30.00%	33.33%
2	Taxi	30.00%	35.00%	40.00%	40.00%	28.57%	30.00%	36.36%	35.00%	32.73%	10.00%	40.00%	33.33%
3	Variety	60.00%	50.00%	30.00%	40.00%	42.86%	50.00%	31.82%	40.00%	34.55%	70.00%	30.00%	33.33%
	Sum	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Table B.26*Distributes 100% Marks for Pleasantness Sub-indicators.*

No	Sub-indicators	Experts											
1	Condition	30.00%	25.00%	25.00%	30.00%	25.00%	35.00%	29.41%	20.00%	24.64%	35.00%	30.00%	22.22%
2	Cleanliness	20.00%	35.00%	25.00%	20.00%	25.00%	30.00%	23.53%	25.00%	24.64%	15.00%	30.00%	33.33%
3	Condition	30.00%	20.00%	25.00%	30.00%	25.00%	20.00%	23.53%	20.00%	26.09%	30.00%	20.00%	22.22%
4	Cleanliness	20.00%	20.00%	25.00%	20.00%	25.00%	15.00%	23.53%	35.00%	24.64%	20.00%	20.00%	22.22%
	Sum	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %

Table B.27*Distributes 100% Marks for Streetscape Sub-indicators*

No	Sub-indicators	Experts											
1	Attraction	20.00%	30.00%	25.00%	30.00%	16.67%	40.00%	42.86%	20.00%	25.71%	35.00%	20.00%	100.00%
2	Buildings	20.00%	20.00%	20.00%	20.00%	16.67%	20.00%	38.10%	20.00%	24.29%	10.00%	30.00%	0.00%
3	Open spaces	35.00%	30.00%	25.00%	20.00%	33.33%	20.00%	14.29%	30.00%	24.29%	35.00%	20.00%	0.00%
4	Landscape	25.00%	20.00%	30.00%	30.00%	33.33%	20.00%	4.76%	30.00%	25.71%	20.00%	30.00%	0.00%
	Sum	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %

Table B.28*Distributes 100% Marks for Facilities Sub-indicators*

No	Sub-indicators	Experts											
1	Length	5.00%	3.00%	5.00%	3.00%	0.00%	10.00%	6.80%	2.00%	4.66%	5.00%	3.00%	14.29%
2	Length	5.00%	3.00%	4.00%	3.00%	0.00%	5.00%	6.80%	2.00%	4.66%	5.00%	3.00%	14.29%
3	Width	5.00%	2.00%	4.00%	3.00%	0.00%	7.00%	6.80%	3.00%	4.66%	5.00%	3.00%	17.86%
4	Width	5.00%	2.00%	4.00%	3.00%	0.00%	2.00%	6.80%	3.00%	4.66%	5.00%	3.00%	17.86%
5	Barriers	5.00%	3.00%	4.00%	5.00%	0.00%	5.00%	1.36%	2.00%	4.40%	5.00%	3.00%	0.00%
6	Barriers	5.00%	3.00%	5.00%	5.00%	0.00%	2.00%	1.36%	2.00%	4.40%	5.00%	3.00%	0.00%
7	Length	0.00%	3.00%	4.00%	4.00%	0.00%	5.00%	1.36%	3.00%	4.40%	10.00%	3.00%	0.00%
8	Length	0.00%	2.00%	4.00%	4.00%	0.00%	2.00%	1.36%	3.00%	4.40%	5.00%	3.00%	0.00%
9	Width	0.00%	2.00%	3.00%	4.00%	0.00%	5.00%	1.36%	4.00%	4.15%	5.00%	3.00%	0.00%
10	Width	0.00%	2.00%	3.00%	4.00%	0.00%	2.00%	1.36%	4.00%	4.15%	5.00%	3.00%	0.00%
11	Availability	10.00%	10.00%	4.00%	5.00%	0.00%	10.00%	8.16%	5.00%	4.15%	10.00%	5.00%	0.00%
12	Distance	10.00%	5.00%	5.00%	5.00%	0.00%	5.00%	6.80%	8.00%	4.66%	5.00%	5.00%	0.00%
13	Benches	5.00%	10.00%	5.00%	5.00%	0.00%	2.00%	2.72%	6.00%	4.40%	3.00%	5.00%	0.00%
14	Toilets	0.00%	8.00%	5.00%	5.00%	0.00%	0.00%	0.00%	7.00%	4.92%	2.00%	5.00%	0.00%
15	Trash	5.00%	8.00%	5.00%	5.00%	0.00%	5.00%	6.80%	6.00%	4.15%	2.00%	5.00%	35.71%
16	Telephone	0.00%	2.00%	4.00%	5.00%	0.00%	0.00%	0.00%	1.00%	4.15%	1.00%	3.00%	0.00%
17	Bollards	0.00%	2.00%	3.00%	5.00%	0.00%	5.00%	0.00%	5.00%	3.63%	1.00%	5.00%	0.00%
18	Availability	5.00%	3.00%	4.00%	5.00%	0.00%	2.00%	0.68%	7.00%	4.40%	10.00%	10.00%	0.00%
19	R-O-W	5.00%	2.00%	5.00%	3.00%	0.00%	5.00%	10.88%	8.00%	4.15%	3.00%	5.00%	0.00%
20	Speed	10.00%	3.00%	5.00%	5.00%	0.00%	5.00%	8.16%	7.00%	4.40%	3.00%	5.00%	0.00%
21	Stop line	5.00%	2.00%	5.00%	5.00%	0.00%	5.00%	2.72%	6.00%	3.89%	2.00%	5.00%	0.00%
22	Crosswalk	10.00%	15.00%	5.00%	5.00%	0.00%	6.00%	8.16%	2.00%	4.40%	1.00%	7.00%	0.00%
23	Clarity	5.00%	5.00%	5.00%	4.00%	0.00%	5.00%	9.52%	4.00%	4.15%	2.00%	5.00%	0.00%
	Sum	100 %	100 %	100 %	100 %	0.00%	100 %	100 %	100 %	100 %	100 %	100 %	100 %

Table B.29

Pedestrian Injuries from Vehicle Crashes by Age and Degree

Section No	2021					2022					2023				
	(I)	(Mi)	(Mo)	(S)	(D)	(I)	(Mi)	(Mo)	(S)	(D)	(I)	(Mi)	(Mo)	(S)	(D)
2						1	70								
4	7	19									3	16			
		26											21		
		17										34			
		19													
		36													
		20													
		49													
11						1		21			1	49			
12						1	56				2			4	
														22	
16	2	19				1		13			2			10	
		48												22	
17						1		12							
20	1	55									1	23			
22	1		17								4	64			
												9			
												2			
												18			
25	3	11									6			40	
		9												15	
		7													
												22			
												59			
												37			
												10			
27						1			42		1	27			
34	5	20				2		52			2	17			
		46						20				37			
		47													
		8													
		43													
Unknown	5	24				10	37				10			30	
		57					32					72			
		28							69					50	
		22					21					21			
		25										3			
								72				11			
								5				18			
							27					7			
							30					46			
							50							13	
Sum	24	23	1			18	8	8	2		32	22	9	1	

Where:

- (I) Number of Injures
- (Mi) Mild Injures
- (Mo) Moderate Injures
- (S) Severe Injures
- (D) Death

Table B.30*Wind Speed Frequency Over the Past 10 Years.*

Wind Speed				
< 10	10 - 15	15 - 20	20 - 25	25 +
28.80	59.50	63.50	75.30	105.00

(Meteoblue, 2024)

Note: All Value indicate the number of days.

Table B.31*Temperature Degree Frequency Over the Past 10 Years.*

Temperature Degree		
< 15	15 - 25	25 +
41.7	112.8	211.5

(Meteoblue, 2024)

Note : All Value indicate the number of days.

Table B.32*Taxi Count at Arab Bank Intersection*

Arab Bank Intersection									
Time	To West	To East	To South	Time	To West	To East	To South		
7:00	7:15	9	5	0	14:00	14:15	23	16	8
7:15	7:30	15	17	5	14:15	14:30	16	16	11
7:30	7:45	24	22	4	14:30	14:45	9	11	3
7:45	8:00	45	18	17	14:45	15:00	22	9	6
8:00	8:15	33	26	12	15:00	15:15	24	11	13
8:15	8:30	32	20	8	15:15	15:30	17	17	6
8:30	8:45	28	24	13	15:30	15:45	18	5	8
8:45	9:00	23	19	5	15:45	16:00	22	10	10

Table B.33*Taxi Count at Rafidia Hospital Intersection*

Rafidia Hospital Intersection							
Time	To West	To East	Time	To West	To East		
7:00	7:15	14	13	14:00	14:15	23	16
7:15	7:30	19	20	14:15	14:30	16	16
7:30	7:45	25	27	14:30	14:45	9	11
7:45	8:00	27	18	14:45	15:00	22	9
8:00	8:15	29	45	15:00	15:15	24	11
8:15	8:30	30	33	15:15	15:30	17	17
8:30	8:45	29	32	15:30	15:45	18	5
8:45	9:00	31	29	15:45	16:00	22	10

Figure B.1

Spatial Data Collected for Section 1



Figure B.2

Spatial Data Collected for Section 2



Figure B.3

Spatial Data Collected for Section 3



Figure B.4

Spatial Data Collected for Section 4

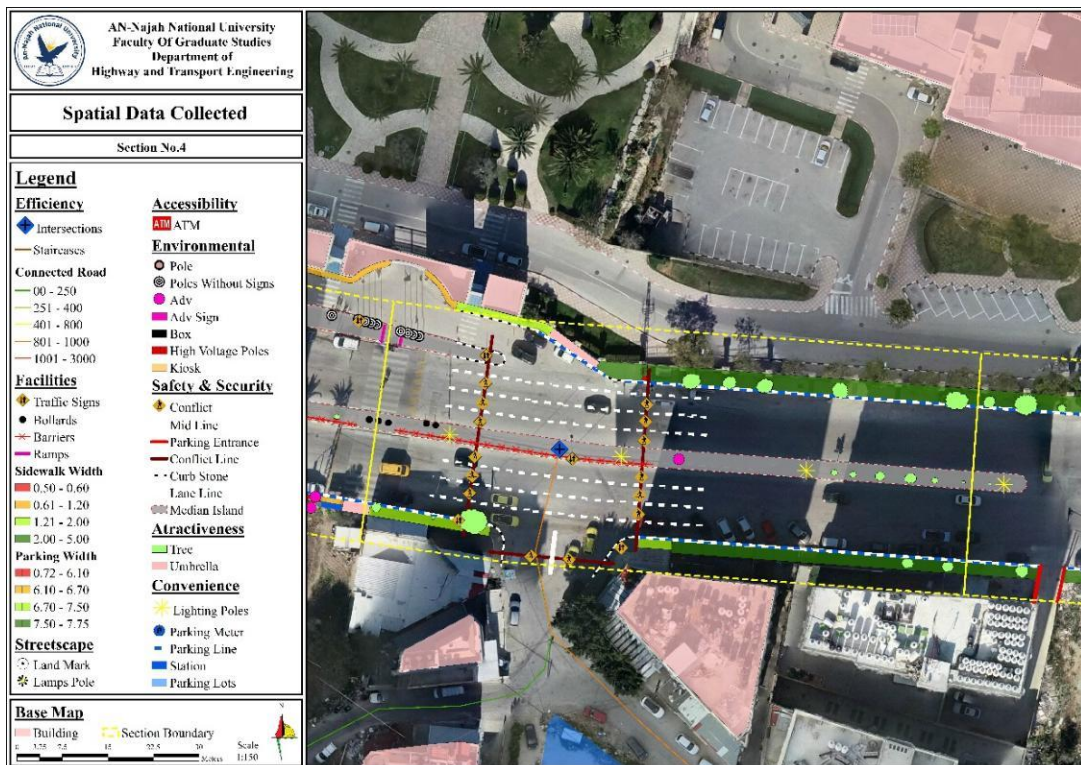


Figure B.5

Spatial Data Collected for Section 5



Figure B.6

Spatial Data Collected for Section 6

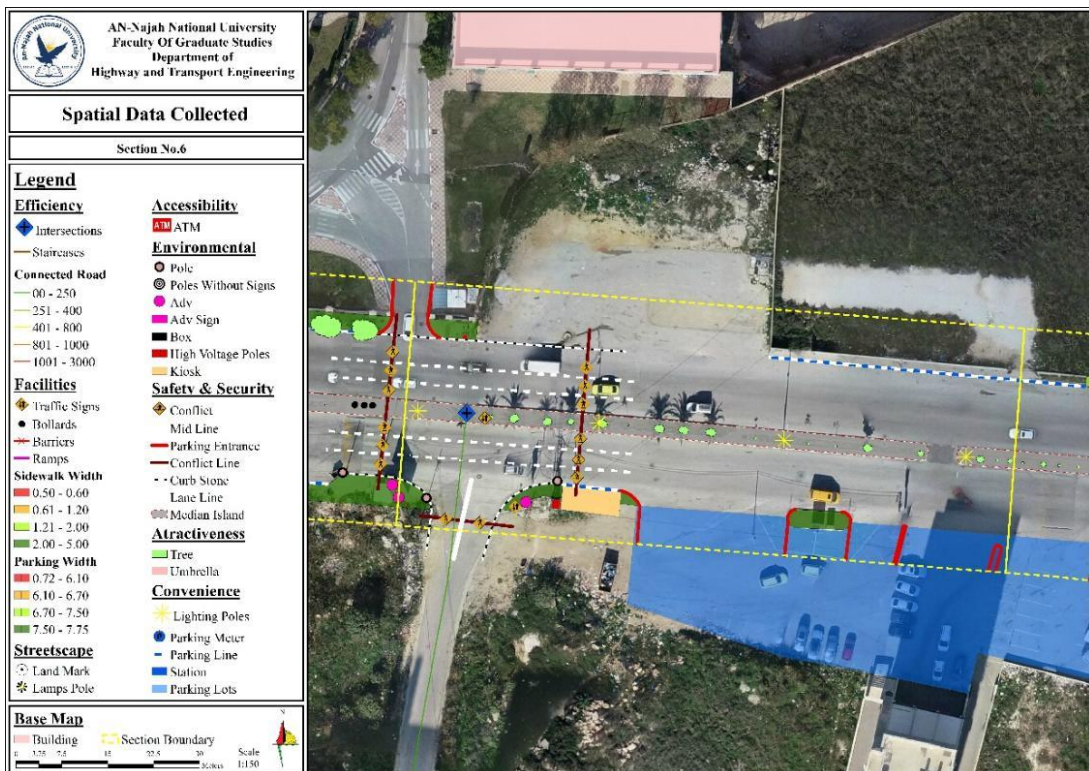


Figure B.7

Spatial Data Collected for Section 7

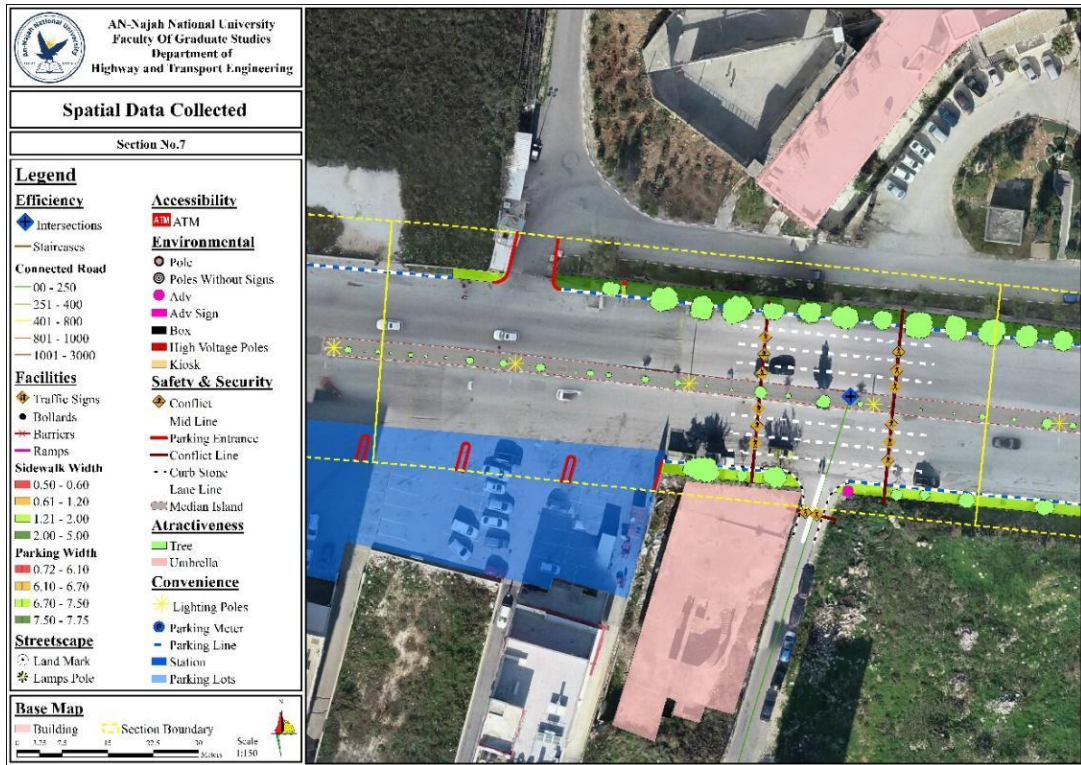


Figure B.8

Spatial Data Collected for Section 8



Figure B.9

Spatial Data Collected for Section 9

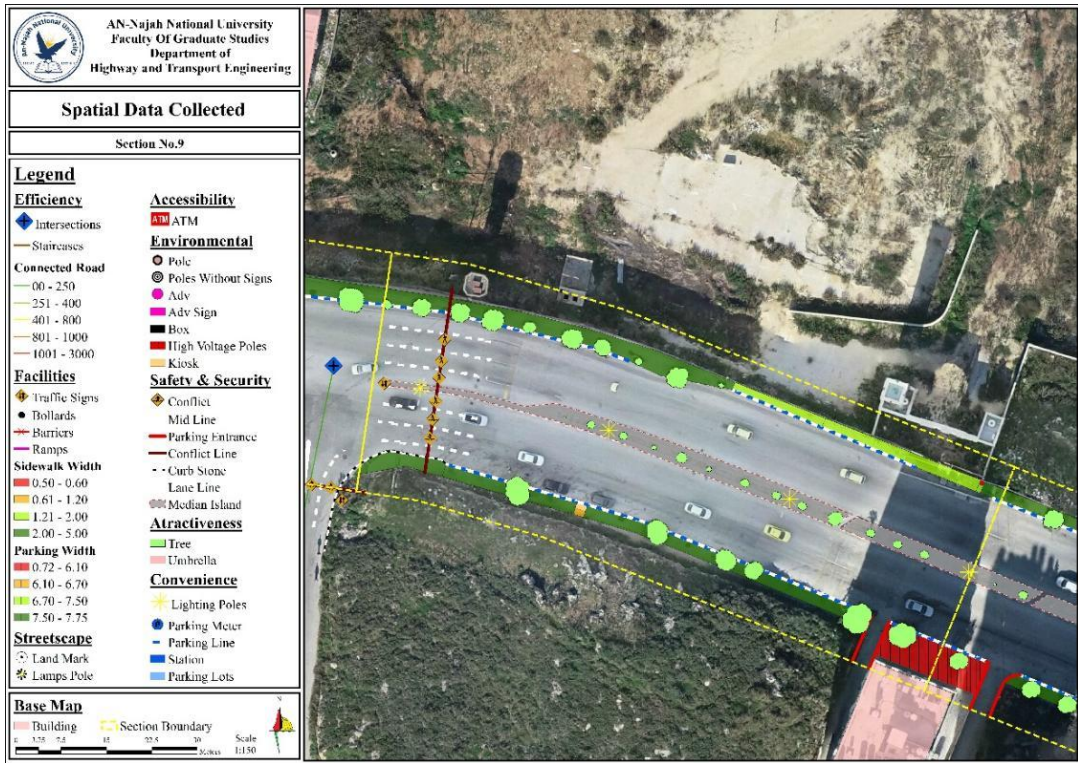


Figure B.10

Spatial Data Collected for Section 10

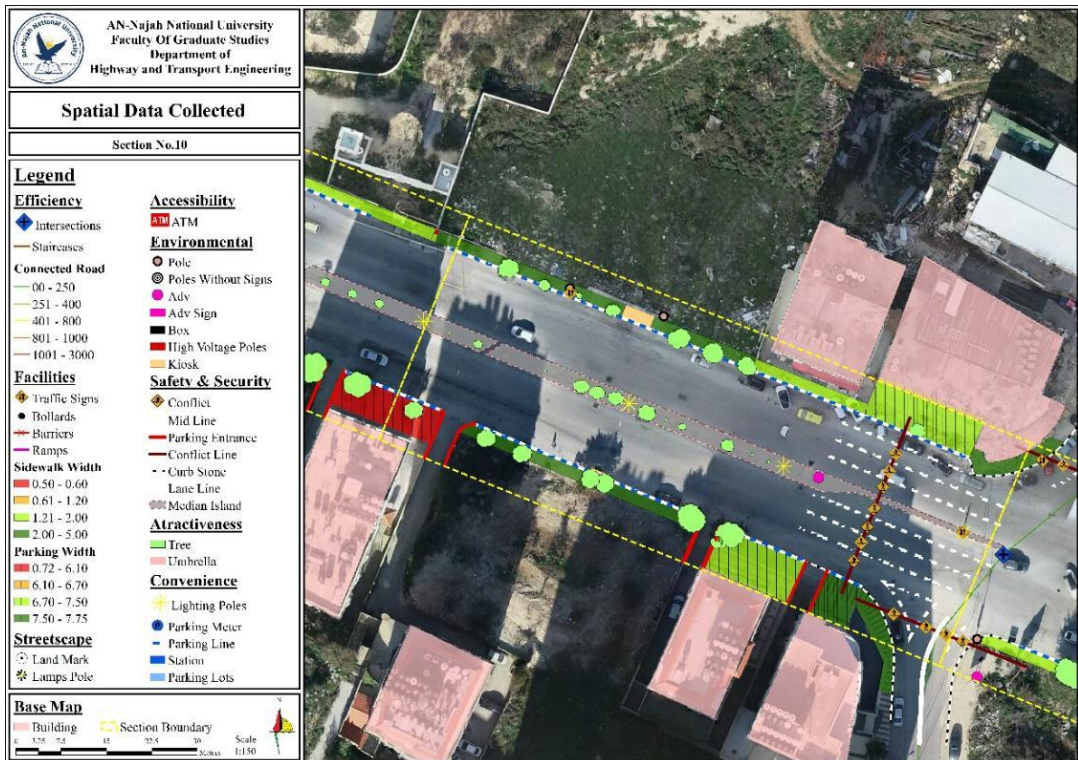


Figure B.11

Spatial Data Collected for Section 11

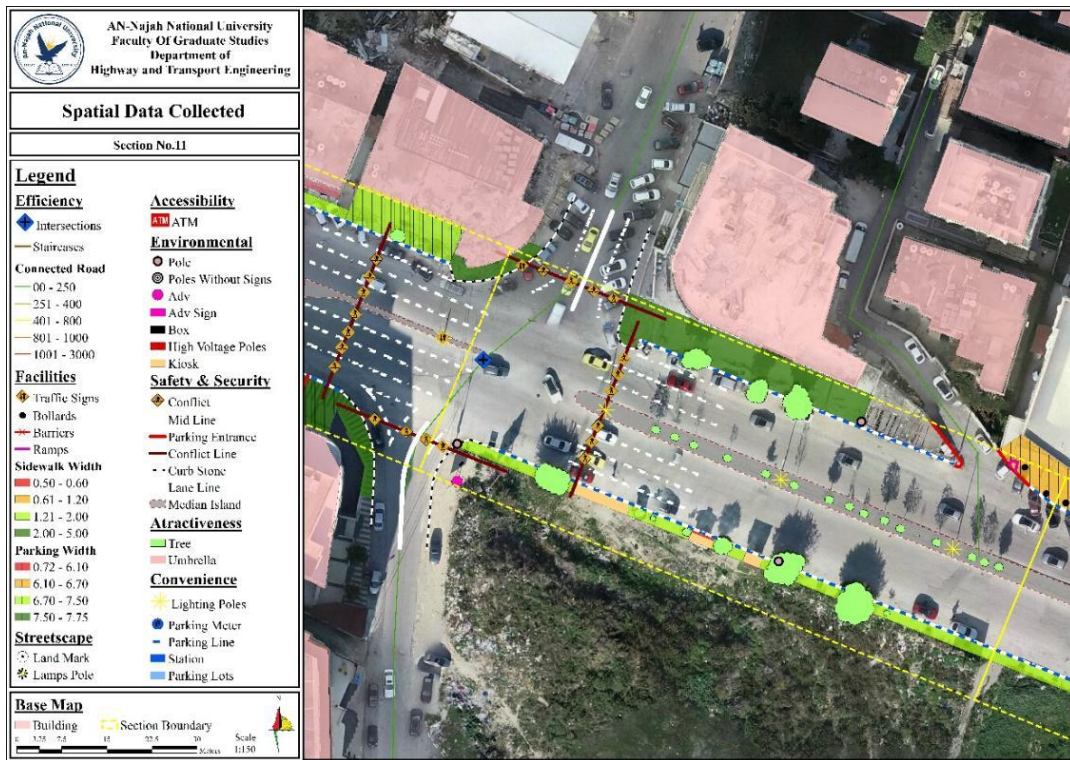


Figure B.12

Spatial Data Collected for Section 12

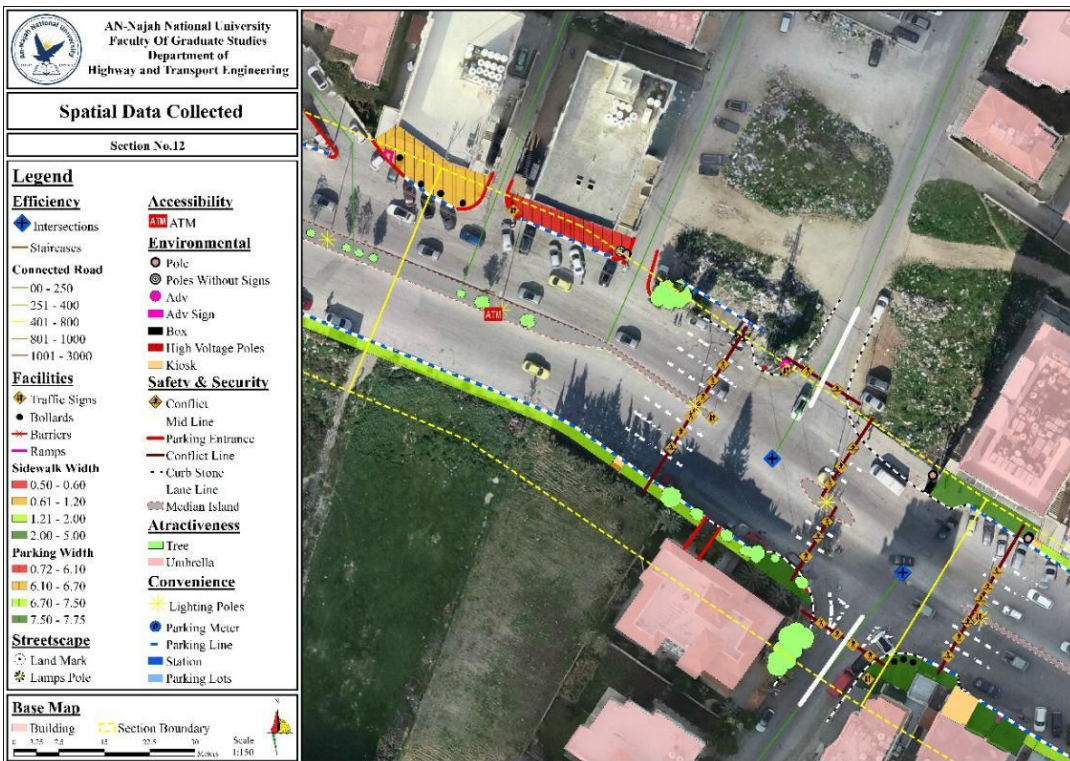


Figure B.13

Spatial Data Collected for Section 13



Figure B.14

Spatial Data Collected for Section 14

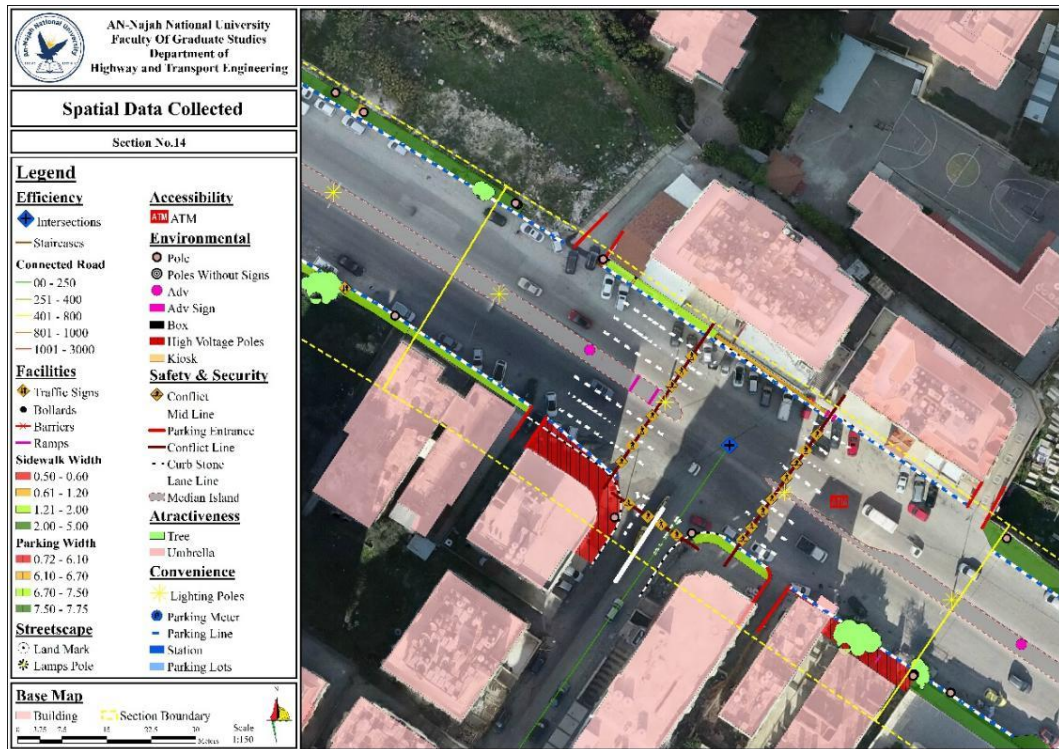


Figure B.15

Spatial Data Collected for Section 15

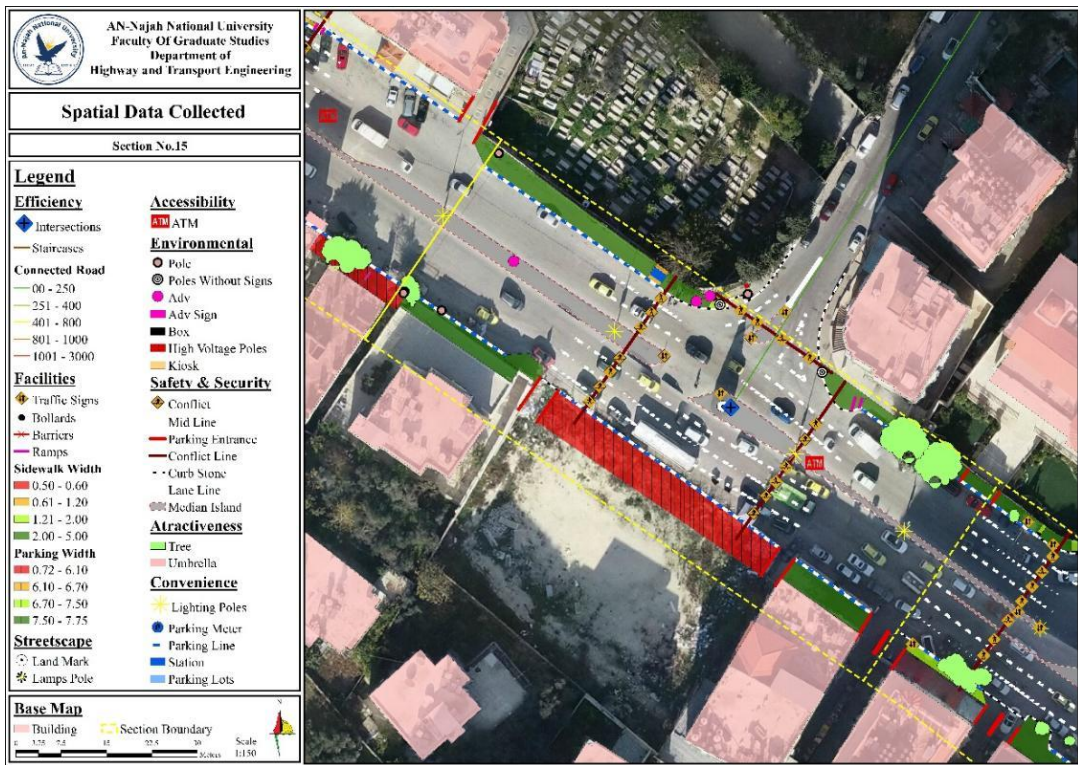


Figure B.16

Spatial Data Collected for Section 16

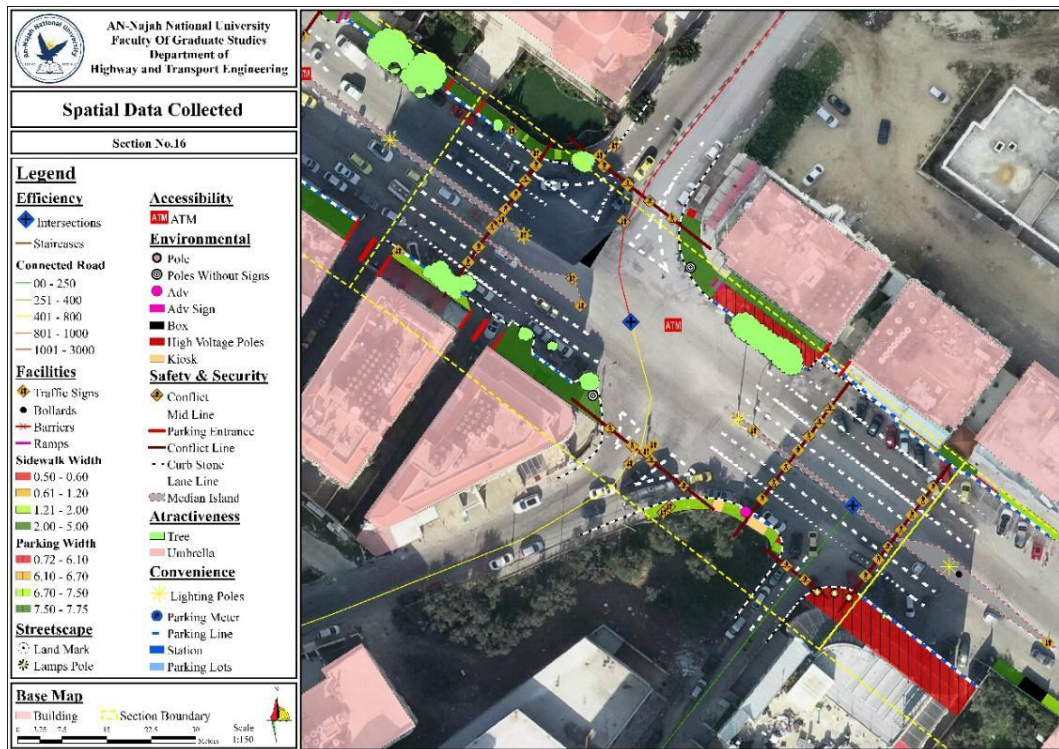


Figure B.17

Spatial Data Collected for Section 17

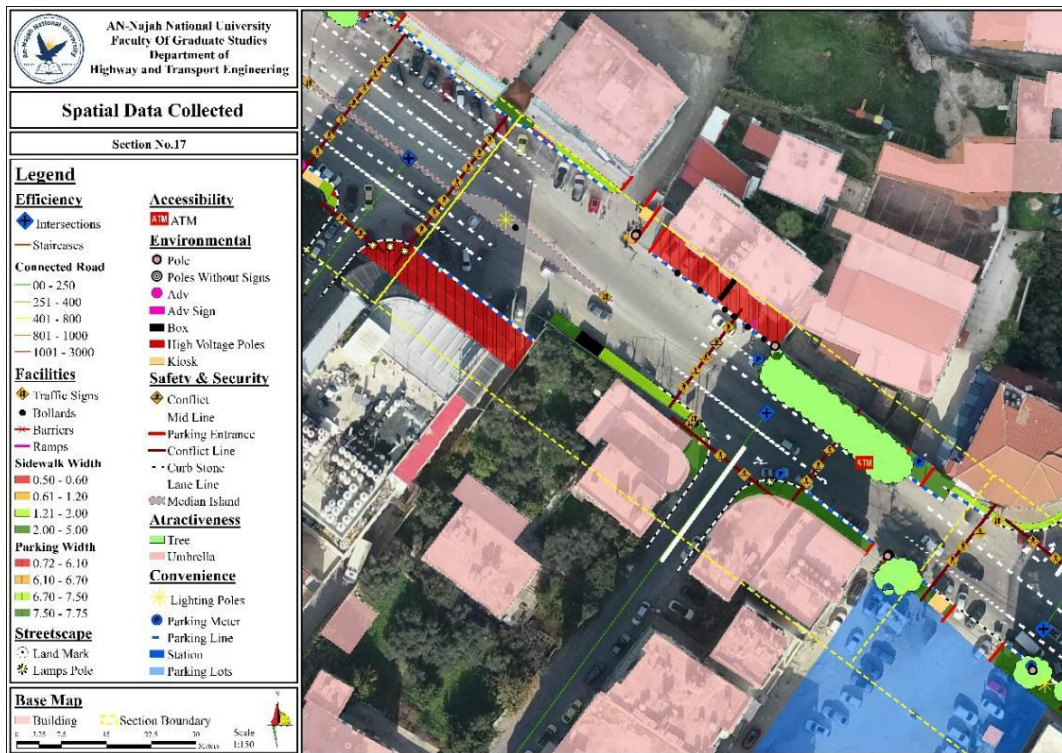


Figure B.18

Spatial Data Collected for Section 18

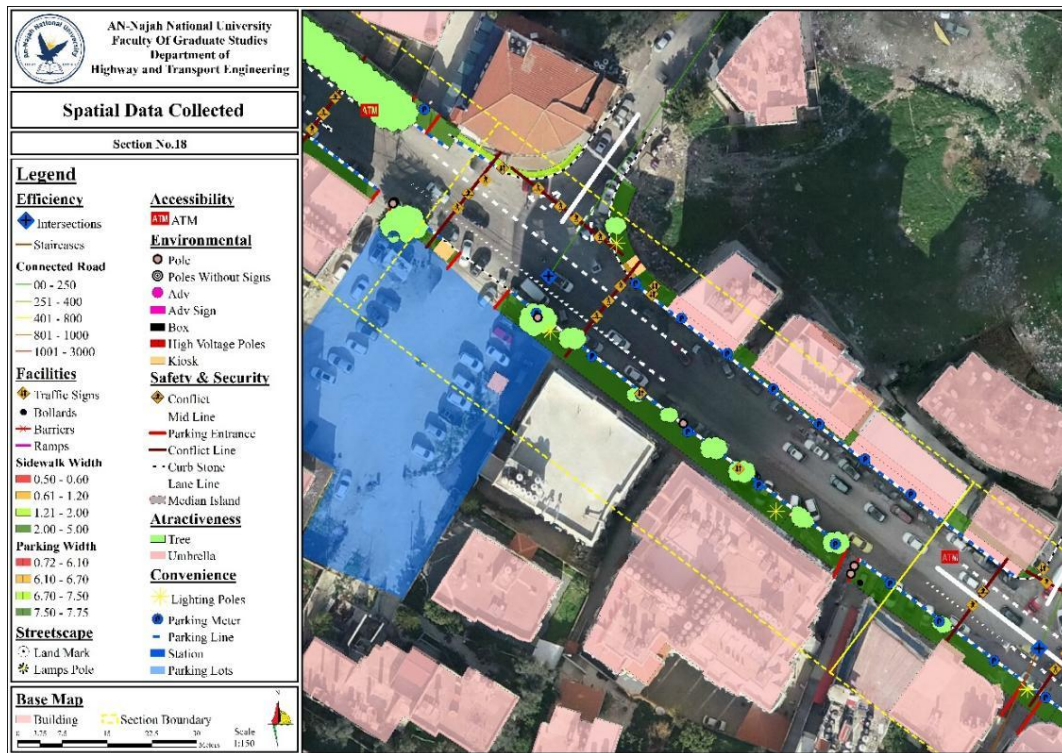


Figure B.19

Spatial Data Collected for Section 19



Figure B.20

Spatial Data Collected for Section 20



Figure B.21

Spatial Data Collected for Section 21



Figure B.22

Spatial Data Collected for Section 22



Figure B.23

Spatial Data Collected for Section 23



Figure B.24

Spatial Data Collected for Section 24

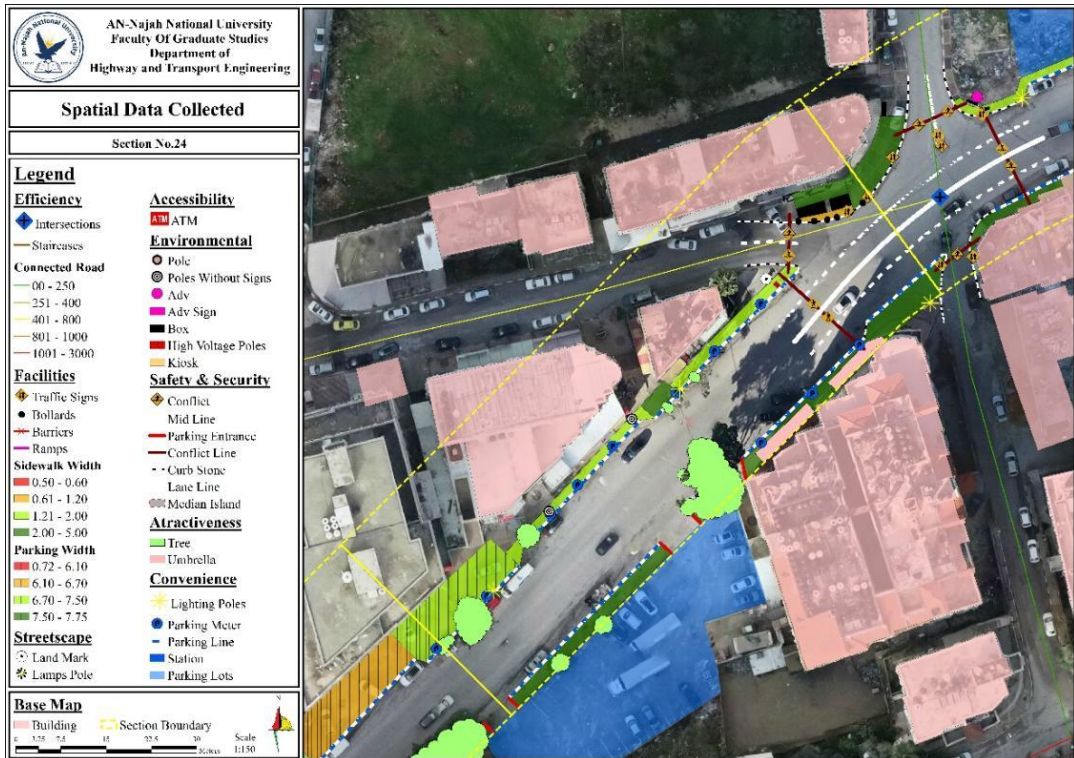


Figure B.25

Spatial Data Collected for Section 25

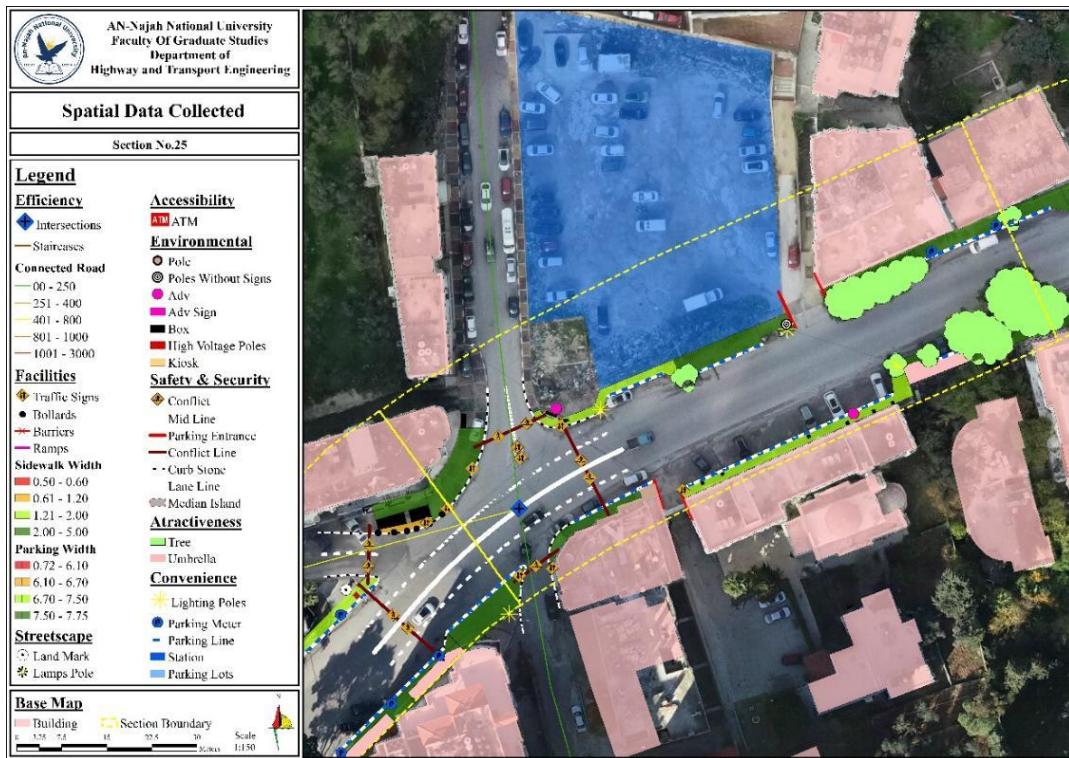


Figure B.26

Spatial Data Collected for Section 26



Figure 4.27

Spatial Data Collected for Section 27



Figure B.28

Spatial Data Collected for Section 28

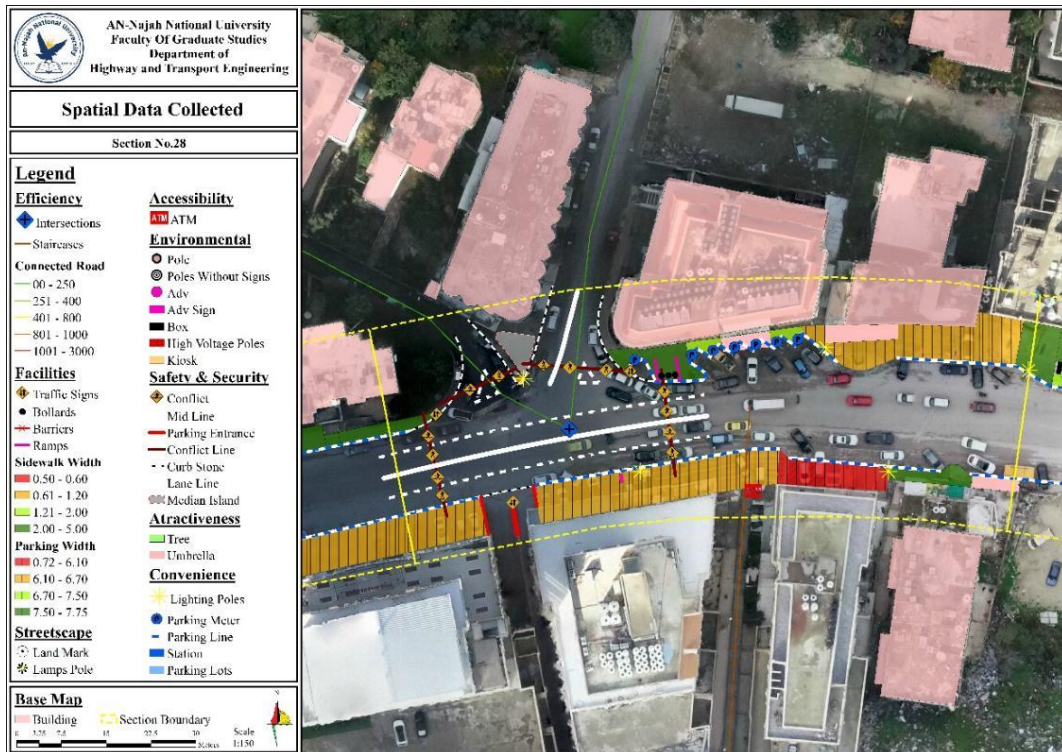


Figure B.29

Spatial Data Collected for Section 29



Figure B.30

Spatial Data Collected for Section 30



Figure B.31

Spatial Data Collected for Section 31

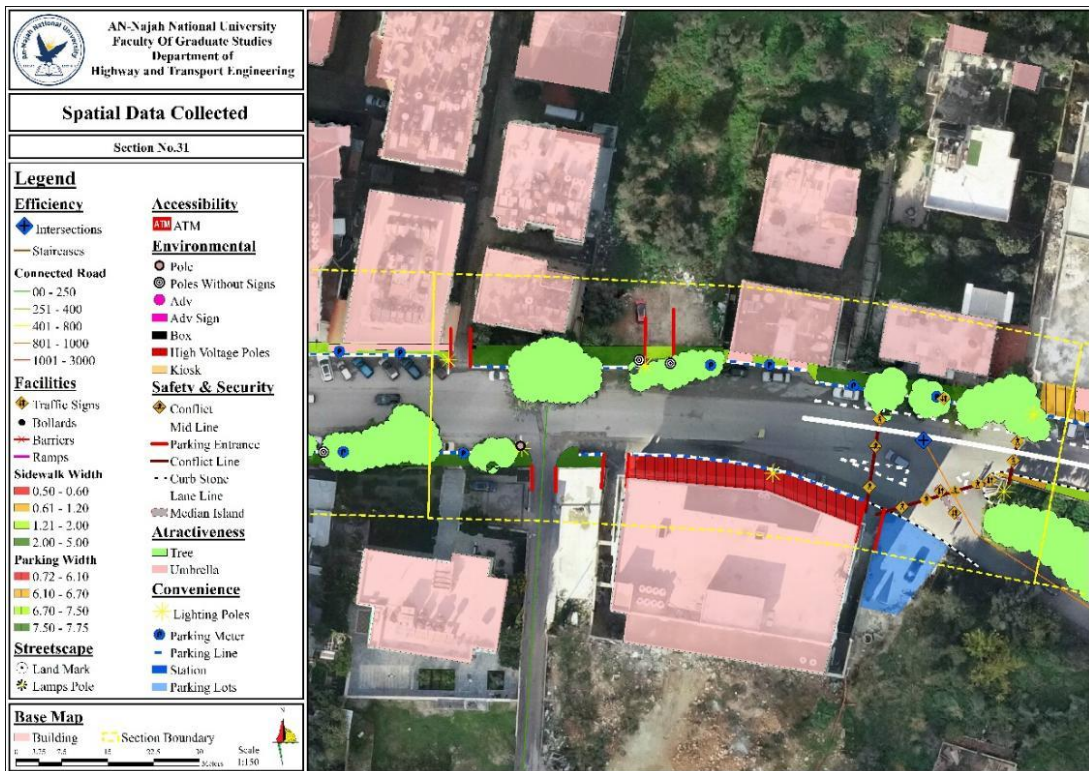


Figure B.32

Spatial Data Collected for Section 32



Figure B.33

Spatial Data Collected for Section 33

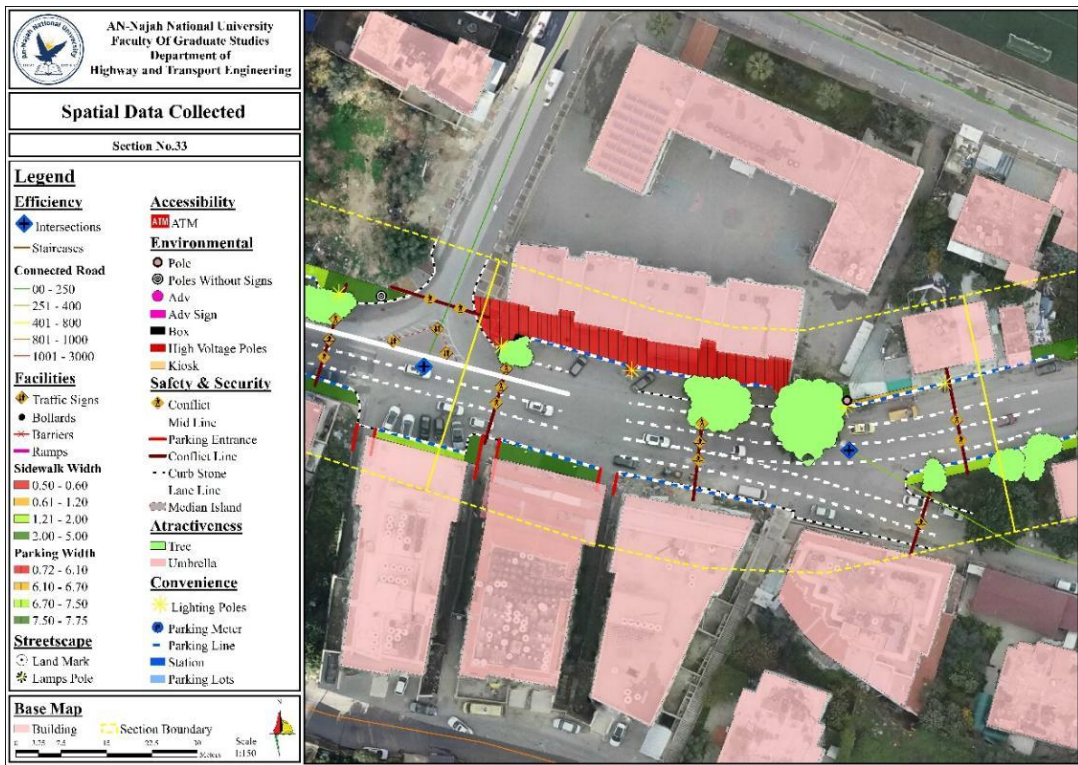


Figure B.34

Spatial Data Collected for Section 34

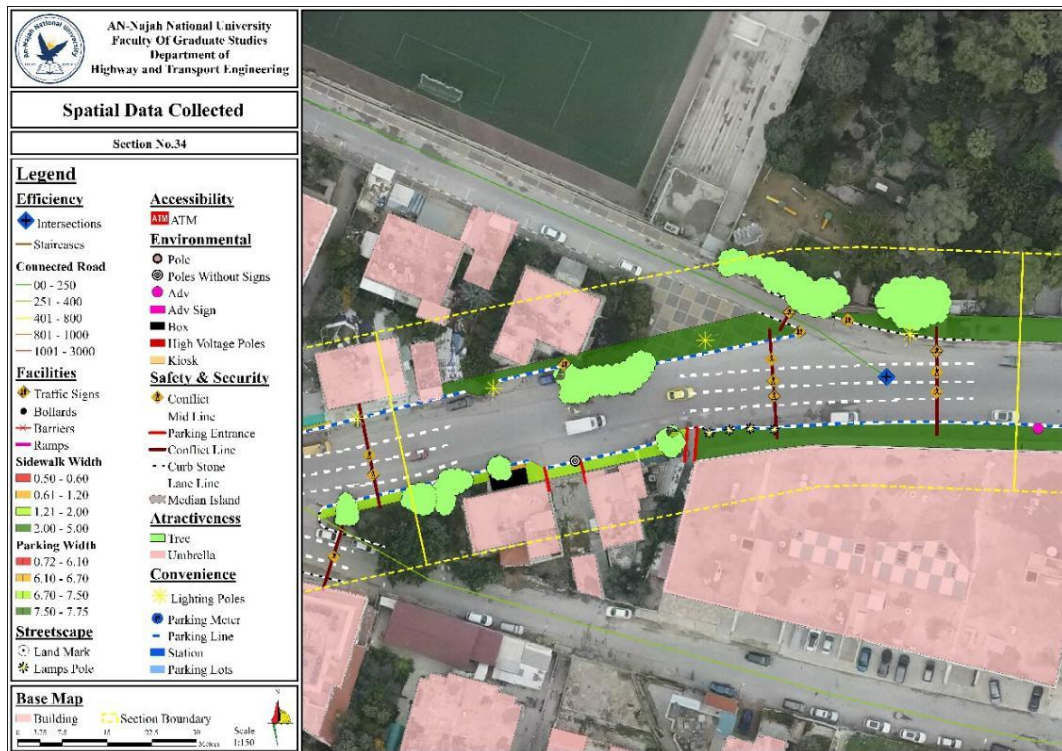
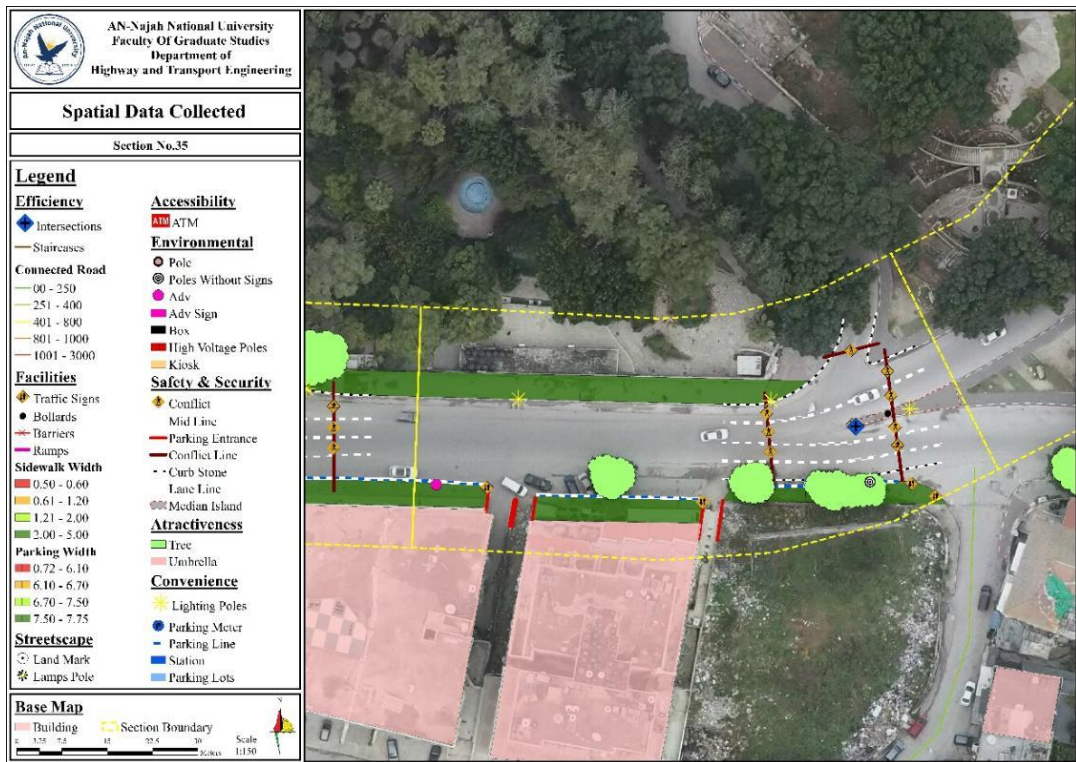


Figure 4.35

Spatial Data Collected for Section 35



Appendix C

Data Analysis

Table C.1

Crashes Adjustment

Section No	Crashes				
	#	%	25	Adjustment	Average
2	1	2%	1	2	1
4	10	20%	6	16	6
11	2	4%	2	4	2
12	3	6%	2	5	2
16	5	10%	3	8	3
17	1	2%	1	2	1
20	2	4%	2	4	2
22	5	10%	3	8	3
25	9	18%	5	14	5
27	2	4%	2	4	2
34	9	18%	5	14	5
Unknown	25				
Sum	74			81	31

Table C.2

Temperatures Days Adjustment

Temperatures	Days		
	Collected	Percentage	Adjustment
- 15	39.6	10.91%	39.8
15 - 20	64.2	17.68%	64.5
+ 20	259.3	71.41%	260.6
Sum	363.1	100.00%	365

Table C.3

Wind Speed Days Adjustment

Wind Speed	Days		
	Collected	Percentage	Adjustment
- 19	342.3	93.63%	341.7
+ 20	23.3	6.37%	23.3
Sum	365.6	100.00%	365

Table C.4*Taxi Vehicles Adjustment*

Time		Vehicles			
From	To	To West	To East	Adjustment	Peck
7:00	7:15	9	5	7	
7:15	7:30	15	22	11	
7:30	7:45	24	26	17	
7:45	8:00	45	35	32	67
8:00	8:15	33	38	24	84
8:15	8:30	32	28	23	96
8:30	8:45	28	37	20	99
8:45	9:00	23	24	17	84
14:00	14:15	23	24	17	77
14:15	14:30	16	27	12	66
14:30	14:45	9	14	7	53
14:45	15:00	22	15	16	52
15:00	15:15	24	24	17	52
15:15	15:30	17	23	12	52
15:30	15:45	18	13	13	58
15:45	16:00	22	20	16	58
7:00	7:15	14	13	10	51
7:15	7:30	19	20	14	53
7:30	7:45	25	27	18	58
7:45	8:00	27	18	19	61
8:00	8:15	29	45	21	72
8:15	8:30	30	33	21	79
8:30	8:45	29	32	21	82
8:45	9:00	31	29	22	85
14:00	14:15	23	16	17	81
14:15	14:30	16	16	12	72
14:30	14:45	9	11	7	58
14:45	15:00	22	9	16	52
15:00	15:15	24	11	17	52
15:15	15:30	17	17	12	52
15:30	15:45	18	5	13	58
15:45	16:00	22	10	16	58

Table C.6*Efficiency Scoring Achieved from Sub-Indicators by Segment*

Indicators				Segment							
				Scoring				Achieved			
No	Primary	Sub	Weights	Rafidia	New Campus	Old Rafidia	Parks	Rafidia	New Campus	Old Rafidia	Parks
1		(R)	17.86%	0.44	0.42	0.41	0.48	7.78%	7.53%	7.26%	8.52%
2		(T)	18.94%	0.67	0.65	0.63	0.73	12.62%	12.23%	11.84%	13.77%
3	Connecting	(S)	12.64%	0.96	1.00	0.94	0.93	12.19%	12.64%	11.85%	11.78%
4		(L)	12.41%	0.58	0.54	0.52	0.68	7.21%	6.76%	6.47%	8.42%
5		(Sr)	12.51%	0.36	0.34	0.31	0.42	4.51%	4.30%	3.91%	5.27%
6	Cross	(C)	11.59%	0.57	0.58	0.43	0.65	6.56%	6.66%	4.93%	7.59%
7		(D)	14.04%	0.56	0.55	0.56	0.57	7.82%	7.68%	7.90%	7.98%
Sum			100%					58.70%	57.80%	54.14%	63.32%

Table C.7*Convenience Scoring Achieved from Sub-Indicators by Segment*

Indicators				Segment							
				Scoring				Achieved			
No	Primary	Sub	Weights	Rafidia	New Campus	Old Rafidia	Parks	Rafidia	New Campus	Old Rafidia	Parks
8	Lighting	(La)	20.61%	0.99	1.00	0.94	1.00	20.32%	20.61%	19.32%	20.61%
9		(Ss)	13.86%	0.09	0.19	0.00	0.00	1.19%	2.60%	0.00%	0.00%
10	Transit	(D)	15.43%	0.07	0.16	0.00	0.00	1.10%	2.41%	0.00%	0.00%
11		(Fs)	15.20%	0.34	0.31	0.50	0.27	5.21%	4.75%	7.60%	4.15%
12		(Fc)	11.77%	0.07	0.16	0.00	0.00	0.84%	1.84%	0.00%	0.00%
13	Parking	(Pa)	12.44%	0.91	0.89	0.93	0.95	11.37%	11.04%	11.51%	11.76%
14		(Pc)	10.70%	0.84	1.00	0.59	0.80	9.02%	10.70%	6.35%	8.51%
Sum			100%					49.05%	53.95%	44.78%	45.03%

Table C.8

Safety & Security Scoring Achieved from Sub-Indicators by Segment

Indicators				Segment							
				Scoring				Achieved			
No	Primary	Sub	Weights	Rafidia	New Campus	Old Rafidia	Parks	Rafidia	New Campus	Old Rafidia	Parks
15	Conflict	(I)	11.66%	0.69	0.61	0.73	0.77	8.01%	7.11%	8.45%	9.01%
16		(P)	6.72%	0.61	0.58	0.66	0.64	4.13%	3.89%	4.41%	4.28%
17	Street	(S)	11.36%	0.72	0.61	1.00	0.68	8.20%	6.92%	11.36%	7.75%
18		(W)	8.96%	0.53	0.95	0.25	0.11	4.74%	8.54%	2.24%	1.02%
19		(L)	5.43%	0.35	0.72	0.09	0.02	1.92%	3.89%	0.51%	0.10%
20		(U)	7.48%	0.60	1.00	0.38	0.18	4.49%	7.48%	2.81%	1.36%
21	Islands	(Co)	7.03%	0.49	0.77	0.38	0.18	3.46%	5.38%	2.64%	1.28%
22		(CI)	6.11%	0.55	0.77	0.38	0.36	3.36%	4.68%	2.29%	2.22%
23		(Fb)	4.94%	0.02	0.05	0.00	0.00	0.11%	0.23%	0.00%	0.00%
24		(Ob)	5.94%	0.00	0.00	0.00	0.00	0.00%	0.00%	0.00%	0.00%
25	Watchers	(K)	4.85%	0.75	0.72	0.81	0.75	3.64%	3.49%	3.94%	3.64%
26		(N)	7.78%	0.63	0.52	0.72	0.73	4.89%	4.01%	5.59%	5.66%
27	Crashes	(I)	5.87%	0.88	0.89	0.88	0.86	5.16%	5.23%	5.14%	5.07%
28		(D)	5.87%	0.86	0.86	0.84	0.89	5.07%	5.04%	4.95%	5.20%
Sum			100%					57.17%	65.88%	54.33%	46.58%

Table C.9*Attractiveness Scoring Achieved from Sub-Indicators by Segment*

Indicators				Segment							
				Scoring				Achieved			
No	Primary	Sub	Weights	Rafidia	New Campus	Old Rafidia	Parks	Rafidia	New Campus	Old Rafidia	Parks
29	Land Use	(P)	16.96%	0.75	0.75	0.75	0.75	12.72%	12.72%	12.72%	12.72%
30	Street	(G)	21.02%	0.84	0.84	0.84	0.82	17.57%	17.74%	17.74%	17.20%
31	Tree	(O)	15.75%	0.71	0.50	0.88	0.91	11.25%	7.88%	13.78%	14.32%
32		(S)	14.70%	0.18	0.17	0.13	0.22	2.62%	2.52%	1.89%	3.29%
33		(Sc)	12.37%	0.05	0.01	0.13	0.05	0.67%	0.18%	1.64%	0.67%
34	Shades	(Os)	9.31%	0.24	0.22	0.38	0.18	2.26%	2.04%	3.49%	1.69%
35		(U)	9.88%	0.31	0.25	0.50	0.27	3.11%	2.47%	4.94%	2.69%
Sum			100%					50.19%	45.53%	56.20%	52.59%

Table C.10*Weather Scoring Achieved from Sub-Indicators by Segment*

Indicators				Segment							
				Scoring				Achieved			
No	Primary	Sub	Weights	Rafidia	New Campus	Old Rafidia	Parks	Rafidia	New Campus	Old Rafidia	Parks
36	Temperature	(T)	56.49%	0.75	0.75	0.75	0.75	42.37%	42.37%	42.37%	42.37%
37	Wind	(W)	43.51%	1.00	1.00	1.00	1.00	43.51%	43.51%	43.51%	43.51%
Sum			100%					85.88%	85.88%	85.88%	85.88%

Table C.11*Environmental Scoring Achieved from Sub-Indicators by Segment*

Indicators				Segment							
				Scoring				Achieved			
No	Primary	Sub	Weights	Rafidia	New Campus	Old Rafidia	Parks	Rafidia	New Campus	Old Rafidia	Parks
38		(K)	14.01%	0.66	0.68	0.68	0.64	9.29%	9.46%	9.46%	8.92%
39	Pollution	(C)	12.37%	0.75	0.72	0.84	0.73	9.28%	8.89%	10.44%	9.00%
40		(L)	11.96%	0.87	0.94	0.94	0.73	10.42%	11.21%	11.21%	8.70%
41		(D)	10.96%	0.79	0.78	0.75	0.82	8.61%	8.56%	8.22%	8.97%
42		(L)	12.77%	0.19	0.15	0.10	0.31	2.45%	1.96%	1.29%	4.02%
43		(W)	10.72%	0.50	0.42	0.50	0.61	5.36%	4.52%	5.36%	6.58%
44	Sidewalk	(De)	9.55%	0.46	0.34	0.50	0.59	4.37%	3.28%	4.78%	5.64%
45		(Du)	8.49%	0.34	0.33	0.25	0.41	2.85%	2.79%	2.12%	3.47%
46		(R)	9.17%	0.59	0.70	0.34	0.61	5.44%	6.45%	3.15%	5.63%
Sum			100%					58.06%	57.12%	56.03%	60.92%

Table C.12*Accessibility Scoring Achieved from Sub-Indicators by Segment*

Indicators				Segment							
				Scoring				Achieved			
No	Primary	Sub	Weights	Rafidia	New Campus	Old Rafidia	Parks	Rafidia	New Campus	Old Rafidia	Parks
47	Access	(A)	24.70%	0.84	0.83	1.00	0.73	20.64%	20.45%	24.70%	17.96%
48		(T)	32.58%	0.33	0.42	0.25	0.25	10.70%	13.74%	8.15%	8.15%
49	Activity	(V)	42.71%	0.49	0.45	0.50	0.55	21.05%	19.35%	21.36%	23.30%
Sum			100%					52.40%	53.55%	54.20%	49.41%

Table C.13

Facilities Scoring Achieved from Sub-Indicators by Segment

Indicators				Segment								
				Scoring				Achieved				
No	Primary	Sub	Weights	Rafidia	New Campus	Old Rafidia	Parks	Rafidia	New Campus	Old Rafidia	Parks	
50		(L)	5.61%	0.78	0.74	0.81	0.81	4.35%	4.12%	4.53%	4.56%	
51		(Lo)	5.07%	0.70	0.63	0.85	0.69	3.54%	3.17%	4.31%	3.51%	
52		(W)	5.57%	0.95	0.97	0.88	0.98	5.29%	5.40%	4.87%	5.44%	
53	Sidewalks	(Wo)	5.12%	0.96	0.95	0.97	0.95	4.90%	4.88%	4.96%	4.89%	
54		(P)	3.43%	0.07	0.06	0.09	0.07	0.24%	0.20%	0.32%	0.24%	
55		(Po)	3.25%	0.11	0.12	0.03	0.15	0.36%	0.40%	0.10%	0.49%	
56		(Pw)	3.43%	0.11	0.11	0.16	0.09	0.39%	0.38%	0.54%	0.31%	
57		(Pow)	2.61%	0.11	0.17	0.03	0.07	0.28%	0.45%	0.08%	0.18%	
58		Barriers	(Lb)	2.86%	0.00	0.00	0.00	0.00	0.01%	0.00%	0.01%	0.01%
59			(Lob)	2.59%	0.00	0.00	0.00	0.00	0.00%	0.00%	0.00%	0.00%
60	Crossing	(C)	6.48%	0.09	0.19	0.00	0.00	0.56%	1.22%	0.00%	0.00%	
61		(Cd)	5.41%	0.06	0.14	0.00	0.00	0.35%	0.76%	0.00%	0.00%	
62		(Be)	4.38%	0.00	0.00	0.00	0.00	0.00%	0.00%	0.00%	0.00%	
63		(To)	3.36%	0.00	0.00	0.00	0.00	0.00%	0.00%	0.00%	0.00%	
64	Street Furniture	(Tr)	7.97%	0.09	0.16	0.06	0.00	0.68%	1.25%	0.50%	0.00%	
65		(Te)	1.83%	0.00	0.00	0.00	0.00	0.00%	0.00%	0.00%	0.00%	
66		(Bo)	2.69%	0.05	0.02	0.06	0.09	0.13%	0.04%	0.17%	0.24%	
67	Ramps	(Cr)	4.64%	0.27	0.25	0.06	0.45	1.26%	1.16%	0.29%	2.11%	
68	Street	(R)	4.64%	0.59	1.00	0.50	0.05	2.72%	4.64%	2.32%	0.21%	
69		(Sr)	5.05%	0.03	0.06	0.00	0.00	0.14%	0.32%	0.00%	0.00%	
70	Sign	(Sl)	3.78%	0.00	0.00	0.00	0.00	0.00%	0.00%	0.00%	0.00%	
71		(Cw)	5.78%	0.17	0.38	0.00	0.00	0.99%	2.17%	0.00%	0.00%	
72		(Cl)	4.42%	0.17	0.38	0.00	0.00	0.76%	1.66%	0.00%	0.00%	
Sum			100%					26.95%	32.19%	23.00%	22.20%	

Table C.14*Pleasantness Scoring Achieved from Sub-Indicators by Segment*

Indicators				Segment							
				Scoring				Achieved			
No	Primary	Sub	Weights	Rafidia	New Campus	Old Rafidia	Parks	Rafidia	New Campus	Old Rafidia	Parks
73		(Clf)	27.61%	0.81	0.73	0.91	0.84	22.29%	20.28%	25.02%	23.22%
74	Sidewalk	(Cof)	25.54%	0.85	0.77	1.00	0.86	21.71%	19.55%	25.54%	22.06%
75		(Clo)	24.32%	0.81	0.73	0.91	0.84	19.63%	17.86%	22.04%	20.45%
76		(Coo)	22.53%	0.72	0.64	0.84	0.75	16.25%	14.43%	19.01%	16.90%
Sum			100%					79.88%	72.12%	91.61%	82.62%

Table C.15*Streetscape Scoring Achieved from Sub-Indicators by Segment*

Indicators				Segment							
				Scoring				Achieved			
No	Primary	Sub	Weights	Rafidia	New Campus	Old Rafidia	Parks	Rafidia	New Campus	Old Rafidia	Parks
77		(P)	33.77%	0.17	0.19	0.13	0.18	5.79%	6.33%	4.22%	6.14%
78	Land Mark	(B)	19.92%	0.03	0.00	0.00	0.09	0.57%	0.00%	0.00%	1.81%
79		(O)	23.91%	0.03	0.00	0.00	0.09	0.68%	0.00%	0.00%	2.17%
80	Street	(L)	22.40%	0.24	0.27	0.22	0.20	5.28%	5.95%	4.90%	4.58%
Sum			100%					12.32%	12.28%	9.12%	14.71%

Figure C.1

Analysis of Efficiency Elements and Road Distribution

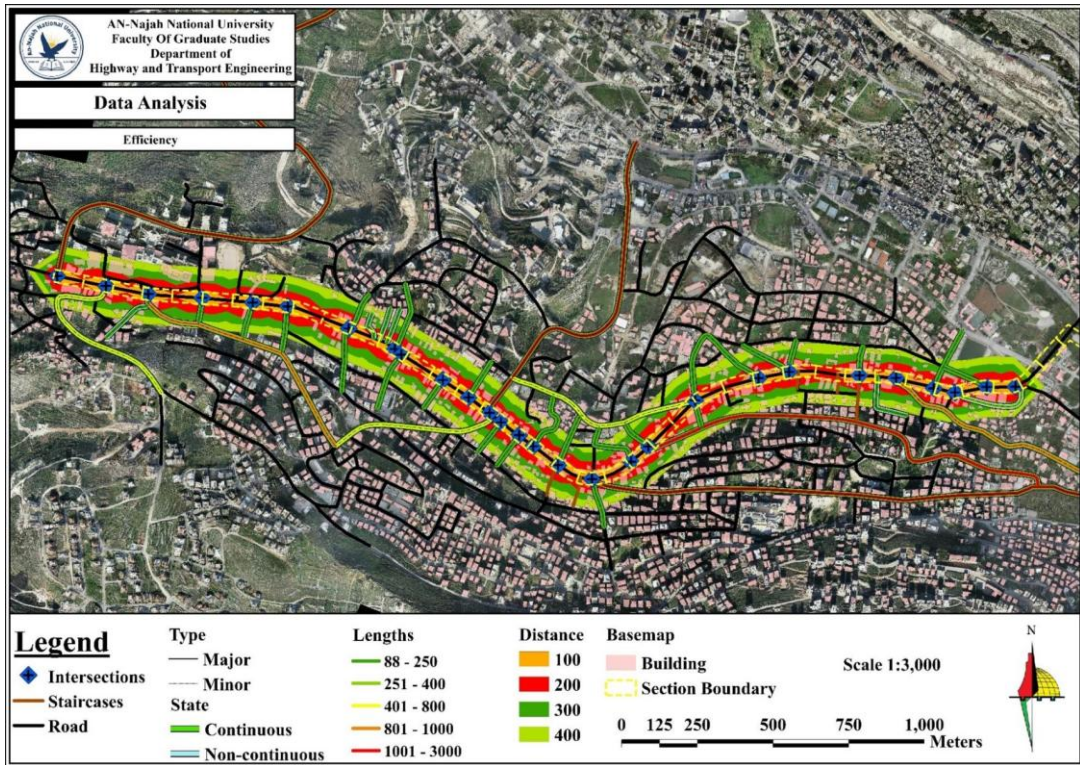


Figure C.2

Analysis of Accessibility Elements and ATM's Distribution

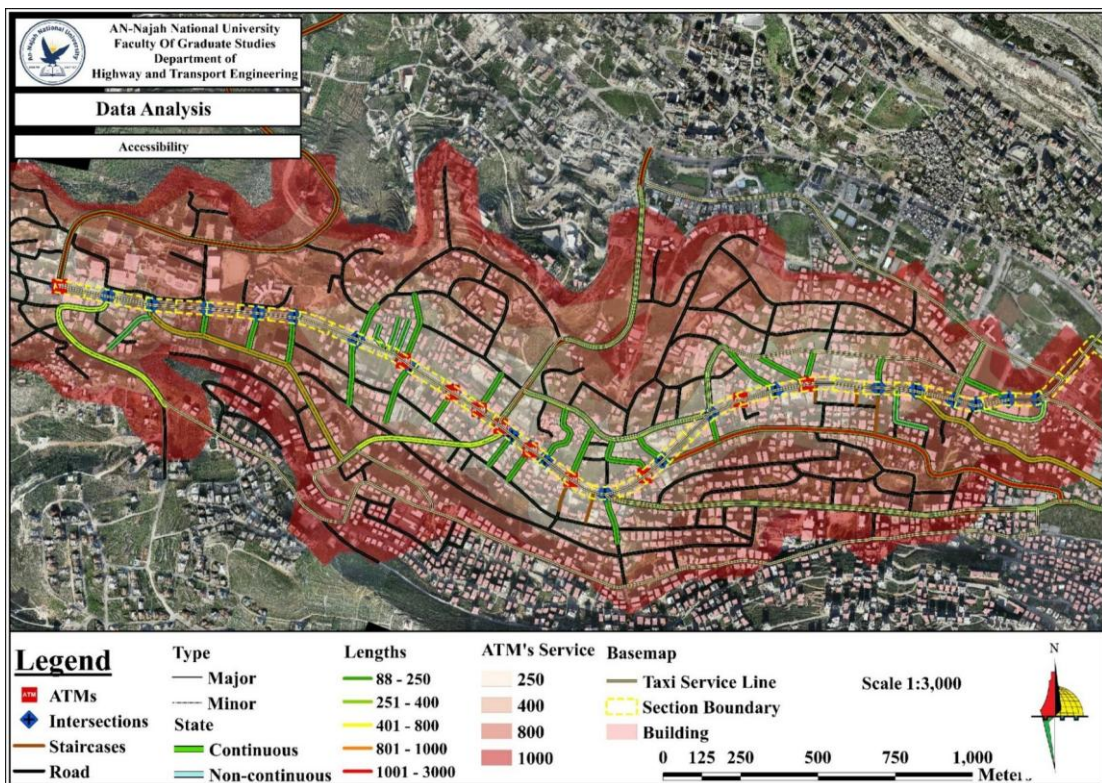


Figure C.3

Rafidia Segment Results by Elements with a Comparison Between Required and Achieved

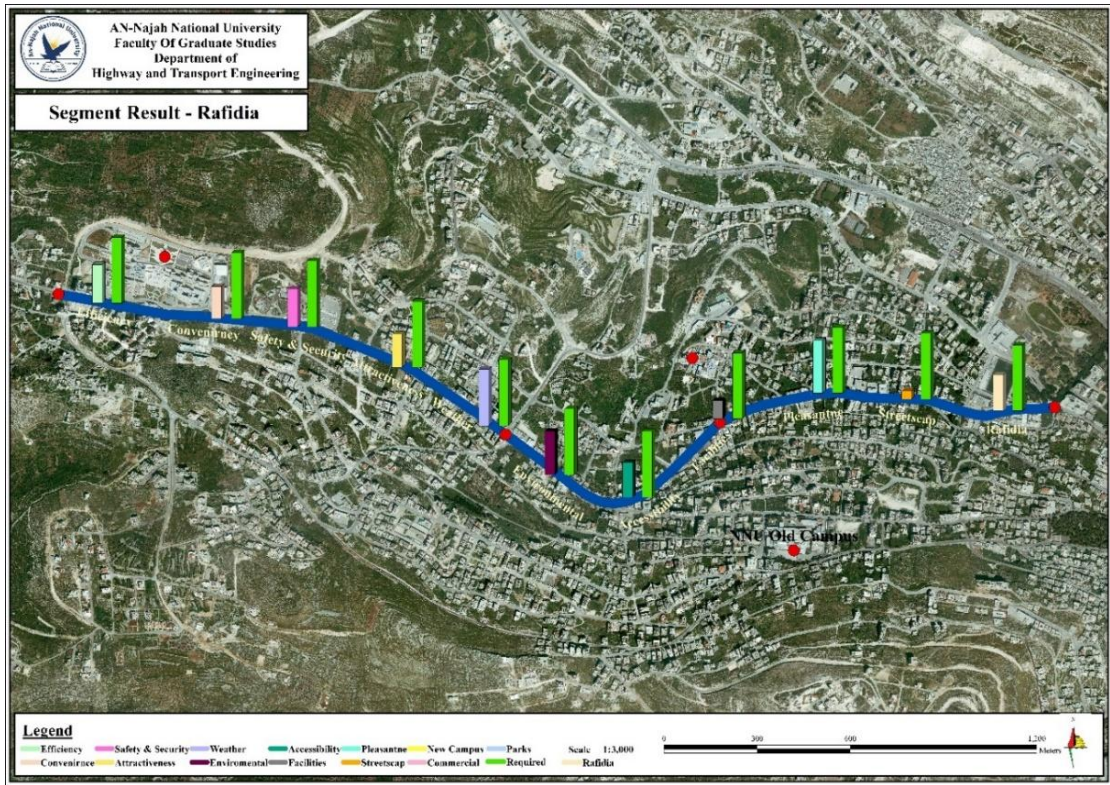


Figure C.4

New Campus Segment Results by Elements with a Comparison Between Required and Achieved

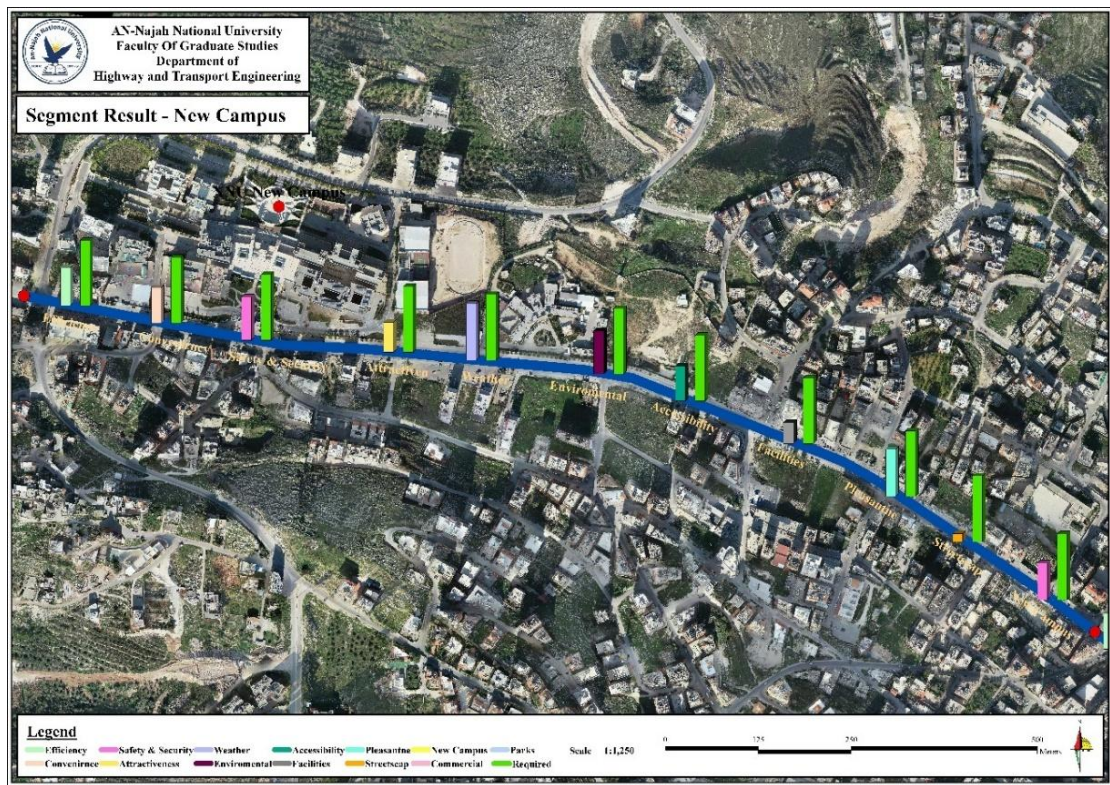


Figure C.5

Commercial Segment Results by Elements with a Comparison Between Required and Achieved

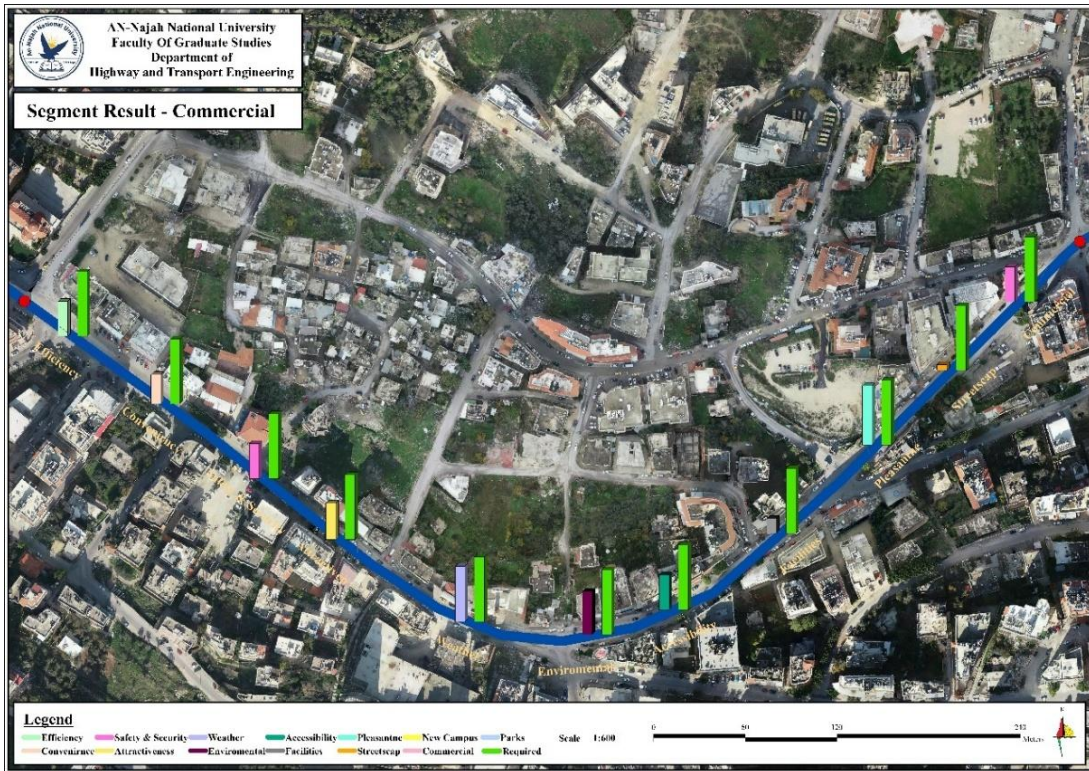


Figure C.6

Parks Segment Results by Elements with a Comparison Between Required and Achieved

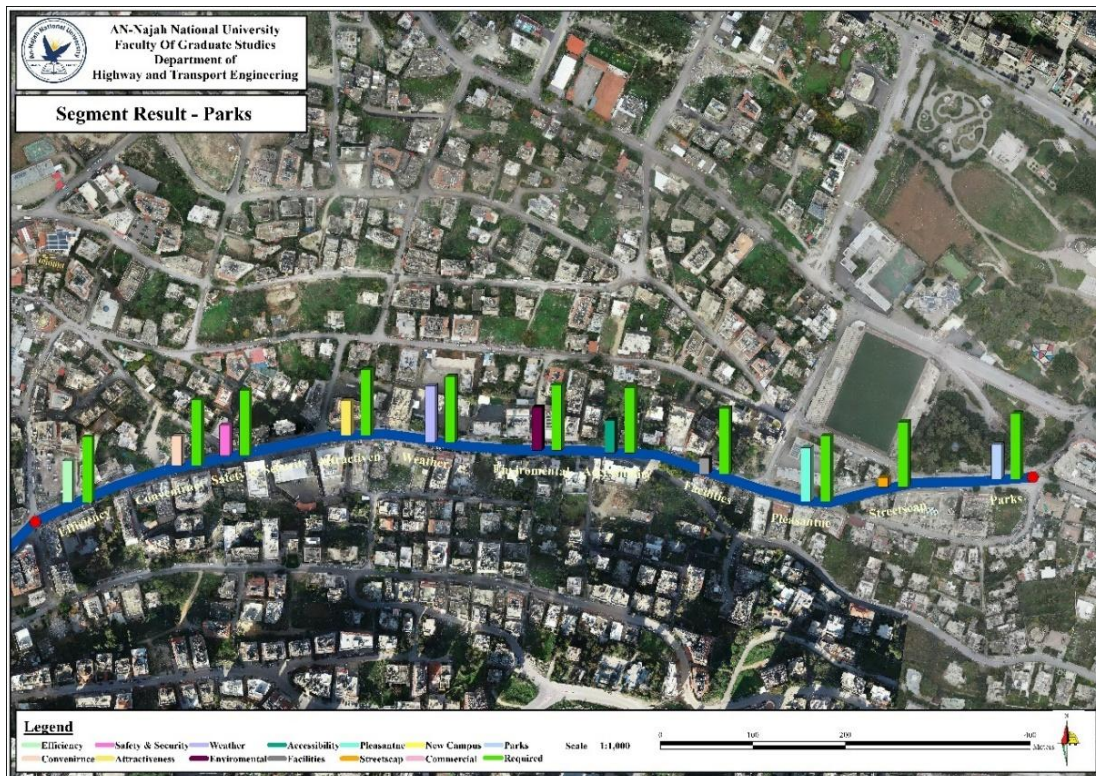
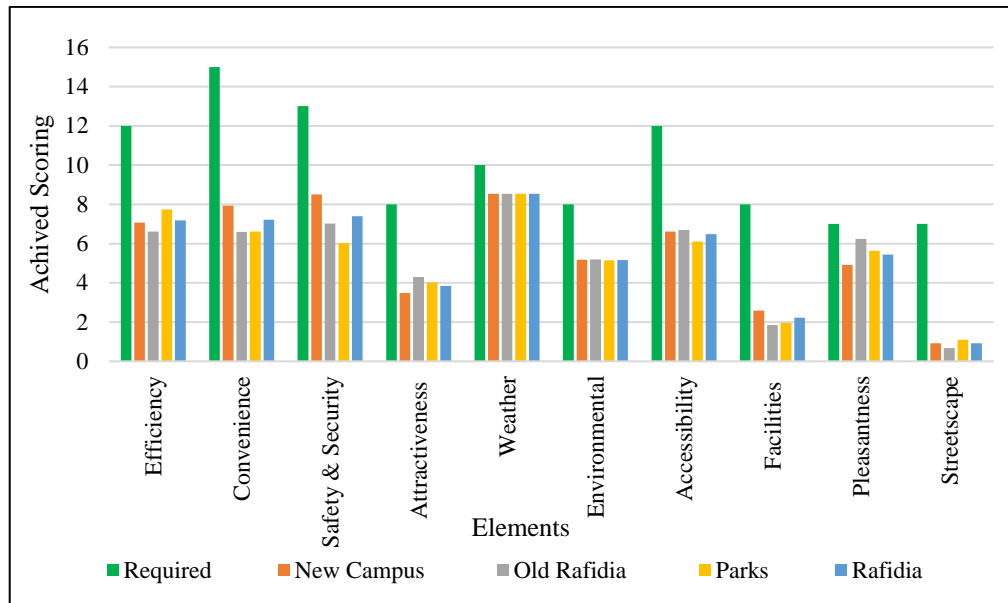


Figure C.7

Comparison of Achieved with Required Scores by Segments





جامعة النجاح الوطنية
كلية الدراسات العليا

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كحالة دراسية

إعداد

زكي ركان زكي علاونة

إشراف

أ.د. خالد الساحلي

قدمت هذه الرسالة استكمالاً لمتطلبات الحصول على درجة الماجستير في هندسة الطرق والمواصلات، من كلية الدراسات العليا،
في جامعة النجاح الوطنية، نابلس - فلسطين

2024

قابلية المشي في المناطق الحضرية والعوامل المؤثرة؛ شارع رفيديا - نابلس، كحالة دراسية

إعداد

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إشراف

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الملخص

إن قابلية المشي تشكل عنصراً أساسياً في التنمية الحضرية المستدامة، حيث تؤثر بشكل مباشر على جودة الحياة في المدن من خلال تعزيز حركة المشاة، والحد من الازدحام المروري، وتعزيز الصحة البيئية. تبحث هذه الدراسة في قابلية المشي من خلال تحديد العناصر والمؤشرات الرئيسية التي تؤثر على حركة المشاة والوصول في المناطق الحضرية. وقد تم تطوير مؤشر شامل لقابلية المشي لقياس وتقييم هذه العوامل، مما يوفر إطاراً موحداً لتقييم قابلية المشي في بيئات مختلفة.

في البلدان النامية، يتم تجاهل بيئة المشي بسبب مجموعة متنوعة من العوامل، مثل القيود المالية، ونقص السياسات والدراسات ذات الصلة حول العوامل المؤثرة على قابلية المشي، وإهمال المجتمع وصناع القرار لأهمية هذا الوسيلة. كما أن المشي في أنواع مختلفة من استخدامات الأراضي، مثل مركز المدينة، أو المنطقة التجارية، أو المنطقة السكنية، ليس آمناً دائماً بسبب أكثر من عامل واحد. قد يشمل هذا الافتقار إلى مرافق المشاة مثل الأرصفة واللافتات وما إلى ذلك.

تم تطوير منهجية قابلية المشي من خلال دمج 10 عناصر و 29 مؤشراً و 80 مؤشراً فرعياً لتقييم قابلية المشي. تم ترجيح العناصر والمؤشرات من قبل خبراء لضمان أن يكون التقييم النهائي لقابلية المشي 100%. تم جمع البيانات باستخدام طرق مختلفة، بما في ذلك الاستبيانات والملاحظات الميدانية والصور الجوية. تم تحويل كل من البيانات النوعية والكمية إلى درجات كمية قابلة للقياس، تتراوح من 0 إلى 1، للتحليل والتقييم.

ومن خلال التحليل والتقييم، تبين أن بيئة المشي في منطقة الدراسة تعاني من عدة نقاط ضعف. وتتبع هذه المشاكل من عوامل مثل سوء التنظيم، والتخطيط الخطي، وعدم الاهتمام بمرافق المشاة، والتوزيع غير الكافي للخدمات. وتشمل العوامل المساهمة الإضافية عدم اتساق حق المرور على الطرق في جميع أنحاء المنطقة، وغياب الحواجز التي تفصل المشاة عن المركبات، والافتقار إلى تصميم أساسي لمناظر الشوارع.

وفي الختام، لا تقدم هذه الدراسة تحليلاً مفصلاً لإمكانية المشي في شارع رفيديا فحسب، بل تقدم أيضاً حلولاً عملية لتحسين تجارب المشاة في المناطق الحضرية. ومن خلال تطوير إطار واضح لتقييم وتحسين إمكانية المشي، تساهم الدراسة في الجهود الأوسع نطاقاً لإنشاء مدن مستدامة صالحة للعيش تعطي الأولوية لحركة المشاة ورفاهيتهم.

الكلمات المفتاحية: المشي، قابلية المشي، عناصر قابلية المشي، مؤشرات قابلية المشي والمؤشرات الفرعية، قياس قابلية المشي.