Ain Shams University
Egypt

Towards elaborating people-oriented streets in Cairo: Examining the degree of applicability of applying complete street policy on Khedival Cairo streets

A Thesis submitted in the Partial Fulfillment for the Requirement of the Degree of Master of Science in Integrated Urbanism and Sustainable Design

by

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07/22/2023

Laura Medhat Girgis

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Laura Medhat

Abstract

The population of Greater Cairo (GCR) is experiencing rapid growth, leading to a surge in the number of vehicles, resulting in significant traffic congestion. The Egyptian government has made efforts to alleviate this issue by expanding the road network and introducing new routes to reduce traffic jams and address overcrowding. Nevertheless, these automobile-oriented advancements have had adverse effects on the infrastructure of streets and sidewalks, hindering the convenience and safety of pedestrians, cyclists, and public transportation users. Consequently, it is imperative to establish street environments that prioritize the needs of individuals, ensuring their safety, well-being, and accessibility, rather than solely emphasizing the expansion of road networks. According to the scope of the study, Khedival Cairo was selected as the case study for numerous reasons, as it was meticulously planned and designed, its prominent location as a central business district, and it has public transportation network. Hence, this thesis aims to examine the degree of applicability of applying one of the appropriate approaches/policies of people-oriented planning in Khedival Cairo streets. This is achieved by two main objectives, which are investigating the appropriate approaches/policies that address the research problem and developing an assessment model to measure the degree of applicability of transforming the selected streets in Khedival Cairo.

To attain this, the framework begins by building a theoretical background to review design considerations for global policies/approaches such as “Living Streets”, “Non-motorized Transportation” and “Complete Streets”. Then, the research examined the most applicable street design elements that are significantly applied in the seven international case studies. Also, to conclude the characteristics of the transformed streets, in order to utilize them while formulating the criteria for selecting streets in the case study of

Khedival Cairo. Then, Egyptian street planning guidelines and codes were reviewed to investigate the existing gaps. Regarding the case study, data collection and data analysis went through three steps. The first step is a checklist evaluation of the achieved/non-achieved Complete Street design elements, secondly, assessing the achieved street elements in terms of numerical and visual data. It was concluded that Talaat Harb Street and Kasr El-Nil Street are the most streets achieving Complete Street design elements. For validating results, a questionnaire was conducted to understand the level of satisfaction of street users. Lastly, recommendations were provided concerning the significant Complete Street elements that are lacking in Khedival Cairo streets.

Keywords: Traffic congestion, car-centric development, street users, people-oriented streets, commercial streets, street design considerations, complete streets, streets selection criteria, assessment model, Khedivial Cairo

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Introduction: Impacts of Automobile dependency

The late 1920s witnessed a significant rise in car ownership, accompanied by the development of new roads, street widening, extensions, and motorways (Hass-Klau, 2015). Although walking, bicycling, and public transit were acknowledged as essential means of transportation, the predominant focus of transport planning throughout most of the last century was on automobiles (Litman, 2022). The concept of automobile dependency is characterized by elevated levels of per capita automobile travel, land use patterns that prioritize automobiles, and limited options for alternative transportation (Litman and Laube, 1999). In simpler terms, automobile dependence occurs when a city prioritizes automobile use as the primary consideration in decisions related to transportation, infrastructure, and land use. Consequently, the majority of communities have now established highly developed road infrastructures, enabling motorists to conveniently and safely reach most destinations (Litman, 2022). However, the

drawbacks, such as reduced travel options and the resulting additional costs, are often disregarded in planning analyses (Litman, 2019).

One of the primary consequences of relying heavily on automobiles is the proliferation of personal car usage, which has resulted in an inevitable increase in traffic congestion and deteriorating traffic conditions (Jonuschat et al., 2015). Although widening streets might seem like a viable solution to improve traffic flow. Nevertheless, Litman (2019) introduced the concept of a self-reinforcing cycle of automobile dependency and sprawl two decades ago (see Figure 1.1), the projection of increased motor vehicle ownership often prompts the expansion of roads and parking requirements. This pattern, in turn, contributes to dispersed development patterns and reinforces higher car ownership rates, perpetuating a sequential loop of mutual reinforcement that exacerbates the problem (Okeke et al., 2020). In other words, the implementation of infrastructure expansion to mitigate travel demand may initially yield seemingly positive outcomes, but after a few months, it results in significantly heightened congestion compared to the previous state, ultimately exacerbating the problem instead of resolving it (Neyestani, 2015).

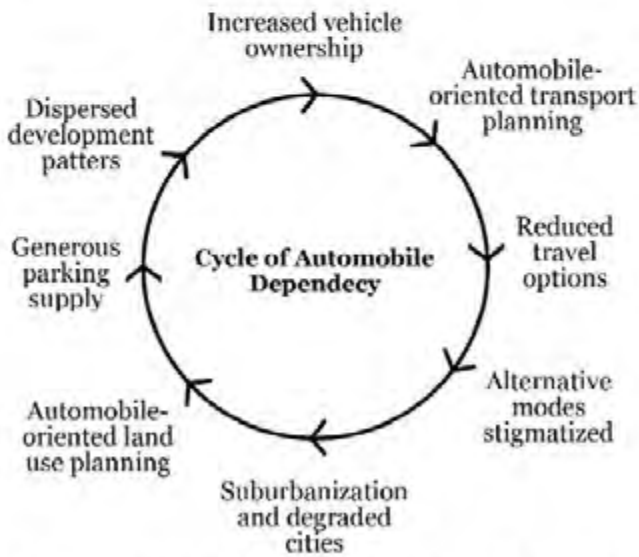


Figure 1. 1 - the self-reinforcing cycle of automobile dependency. Source: Litman (2011). Victoria Transport Policy Institute

Additionally, there are substantial health costs associated with road vehicles, and a considerable portion of these costs is borne by non-motor vehicle users (Newman, 1996). This is evident when streets are planned and designed without providing safe infrastructure for walking, crossing, using public transport, or cycling, putting pedestrians and non-motorists at risk (Chicago Metropolitan Agency for Planning et al., 2015). Despite the presence of various traffic control mechanisms, street safety remains a chronic concern, particularly due to inadequate sidewalk provision along the roads (Okeke et al., 2020). As a result, annually, around 1.3 million lives are tragically lost due to road traffic crashes (World Health Organization, 2022). Despite the considerable achievements in reducing road fatalities observed in numerous high-income countries, low- and middle-income countries have not experienced significant tangible advancements in this regard (Haghani et al., 2022). Data provided by the World Health Organization (2022) validates that over 90% of road traffic deaths occur in low- and middle-income countries.

Conversely, improved street design has the potential to mitigate road safety risks and effectively slow down cars without impeding their flow (Sarmiento and Priego, 2014). In response to the recognized impacts of car dependency, some cities are actively working towards reducing reliance on cars and transitioning to more sustainable modes of transportation, including walking, cycling, and public transit (Nieuwenhuijsen et al., 2019). The subsequent section reviews the case of Cairo, specifically addressing the ongoing developments that prioritize car-oriented infrastructure.

1.1. Study area: The Case of Cairo

The Greater Cairo Metropolitan Area stands as one of the largest megacities globally, accommodating over 25 million residents according to the Central Agency for Public Mobilization and Statistics (CAPMAS, 2022). From the 1980s onwards, there was a significant surge in new developments and satellite cities in the East of Cairo, along both sides of the Suez Road. These areas offered

affordable desert land for real estate projects, resulting in a rise in traffic on the western section of the road, connecting the new cities to Heliopolis. The primary reason for this increase in traffic was the inadequate availability of public transportation services in the region (Elkhateeb, 2020). Consequently, the government has taken action to alleviate traffic congestion and bolster the transportation infrastructure in the Greater Cairo region. A key aspect of this effort involves expanding the roadway network's capacity (Samaha and Mostofi, 2020). Notably, Egypt has allocated substantial financial resources to enhance and extend the road networks in recent years, following the initiation of a national road development project by El-Sisi in 2014. The project's ambitious objective is to construct and upgrade approximately 7,000 km of highways (El-Garhy, 2021).

Additionally, the government has introduced the "Road Network Development Plan in the Western Greater Cairo Region" with the primary objective of alleviating traffic congestion for inhabitants using these roads and routes. Simultaneously, they are actively working on establishing new routes, which will play a vital role in mitigating traffic jams and establishing a connection to the New Administrative Capital through the Cairo Suez Desert Road (Mohammed, 2021; Almoghazy, 2020). One of the most striking projects is the road developments in Heliopolis. For further details, this project entailed the creation of additional lanes by utilizing a significant portion of the previously existing green spaces that occupied the street medians in Heliopolis. The implementation of these projects has predominantly underscored the automobile dependency in urban planning and design, with little to no consideration for the adverse consequences faced by individuals relying on alternative modes of transportation such as active travel, encompassing walking and cycling (Almoghazy, 2020).

Despite the potential short-term alleviation of congestion, it is important to note that the expansion of roadways may inadvertently contribute to increased traffic volume and higher vehicle speeds (Almoghazy, 2020). Additionally, the

development of roads has the potential to further encourage reliance on private car usage (Samaha and Mostofi, 2020). This is corroborated by CAPMAS (2021), which reports that cars and taxis constitute a significant proportion (48.82%) of the total vehicle count, whereas public transit and private buses only account for a mere 1.7% of the total vehicles. UN-Habitat identifies two primary factors responsible for the traffic congestion experienced in the Greater Cairo area: a surge in private car ownership and an insufficient level of investment in equitable public transportation systems.

The literature highlights the importance of enhancing the capacity of urban streets in a manner that aligns with the urban environment and promotes a well-designed public realm. Specifically, street design should cater to various transportation options, giving precedence to active and sustainable modes of travel. This entails creating safe, efficient, and pleasant experiences for pedestrians, cyclists, and users of public transit. It is crucial to underscore that street design should prioritize equity and inclusivity, ensuring it meets the requirements and preferences of diverse users, with particular consideration given to individuals with disabilities, and children (Global Designing Cities Initiative and National Association of City Transportation Officials, 2016).

1.2. Problem Statement

Despite the substantial reliance on walking and public transportation among the population in Greater Cairo, inadequate attention has been directed towards enhancing pedestrian and public transportation infrastructure. As a result, the dominance of car-oriented developments has adverse effects on the infrastructure of streets and sidewalks, hindering their capacity to accommodate pedestrians, cyclists, and public transport users. Consequently, there is limited space for people to engage in various activities and even cross streets safely. Consequently, it becomes imperative to shift the focus towards creating people-oriented street environments, rather than continuously expanding road

networks, in order to ensure safety, health, and accessibility for all, including pedestrians, cyclists, children, the elderly, and individuals with disabilities.

1.3. The Scope of Study

The scope of the study is limited to reviewing three of the most relevant approaches/policies to people-oriented planning, followed by a selection of the most appropriate approach/policy. Moreover, the selection criteria for selecting streets of Khedival Cairo are based on the concluded characteristics of transformed streets in the international case studies. Regarding the empirical study, Khedival Cairo was selected as the case study for numerous reasons. Fundamentally, Khedival Cairo was meticulously planned and designed, it has a prominent location as a central business district, and it is supported by a public transportation network. It is worth noting that the case study is focusing on assessing the built environment in terms of street design elements, regardless of the provided level of service. To explain, the study is examining the degree to which the street design elements of the selected streets are corresponding with the selected people-oriented planning approach/policy. However, a questionnaire is conducted to understand the level of satisfaction of street users. In fact, the number of respondents was limited in accordance with the determined sample size, even so, it is relatively acceptable as this questionnaire aimed to validate the results only.

1.4. Research Aim & Objectives

This research aims to examine the degree of applicability of applying one of the appropriate approaches/policies of people-oriented planning on Khedival Cairo streets.

The research has two main objectives:

1. To investigate the appropriate approaches/policies that address the research problem.
2. To assess the degree of applicability of applying the selected policy on the selected streets in Khedival Cairo.

3. While the secondary objectives are:
4. To investigate the gaps in the Egyptian street planning guidelines in accordance with the selected approach/policy of people-oriented planning.
5. To assume and propose context-specific criteria for the selection of the most suitable streets in Khedival Cairo.

1.5. Research Questions

1.5.1. Main Questions

1. How to assess the degree of applicability of applying the selected policy on the selected streets in Khedival Cairo? (Answered in chapter 6)
2. How to create the context-specific criteria for the selection of the most suitable streets in the case of Cairo? (Answered in chapter 5)

1.5.2. Secondary Questions

3. What are the proper global approaches/policies that address the research problem? (Answered in chapter 2)
4. What are the gaps in the Egyptian street planning guidelines in accordance with the selected approach/policy of people-oriented planning? (Answered in chapter 4)

1.6. Research Methodology

1.6.1. Theoretical & Analytical Framework

Initially, the literature review adopts a thematic approach, which entails an exploration of various approaches and policies related to people-oriented planning. It then focuses on a specific and suitable approach or theory that directly pertains to the research problem. The subsequent section provides a comprehensive theoretical background on the chosen approach or policy, encompassing its objectives, definitions, historical context, street design elements, and evaluation techniques (answering research question 3). Concerning the analytical study, the selected international case studies were

examined to conclude the most applicable applied street design elements. Also, to conclude the characteristics of the transformed streets, in order to utilize them while formulating the criteria for selecting streets in the case study of Khedival Cairo (answering research question 2). In order to answer question 4, the ongoing Egyptian street planning guidelines were discussed, followed by an evaluation to explore the gaps and shortages in accordance with the selected people-oriented planning approach/policy.

1.6.2. Data Collection & Analysis

The case study was built on both primary and secondary data collection methods. To explain, Primary data was obtained through on-site observations, field surveys, mapping, geotagged photographs, and a conducted questionnaire. Based on the comprehensive clarification of the selected policy, the secondary data reviews the design benchmarks of the street elements. The collected data were subjected to a systematic analysis protocol, which integrated both quantitative and qualitative data. Qualitative data was analyzed through visualization techniques, such as maps and photos, while quantitative data was processed using numerical analysis, such as tabulations. This analytical approach enabled a thorough examination of each street in comparison to the complete street policy benchmark. At last, the questionnaire was conducted to validate the initial findings, where the final results showed the main shortages of the existing street elements.

1.7. Conceptual Framework & Outline of Thesis

Figure 1.2 illustrates the conceptual framework and the structure of the thesis, which comprises five primary chapters, followed by a concluding chapter that presents the findings, conclusions, and recommendations. The conceptual framework consolidates the theoretical, analytical, and empirical study frameworks discussed earlier in this introduction.

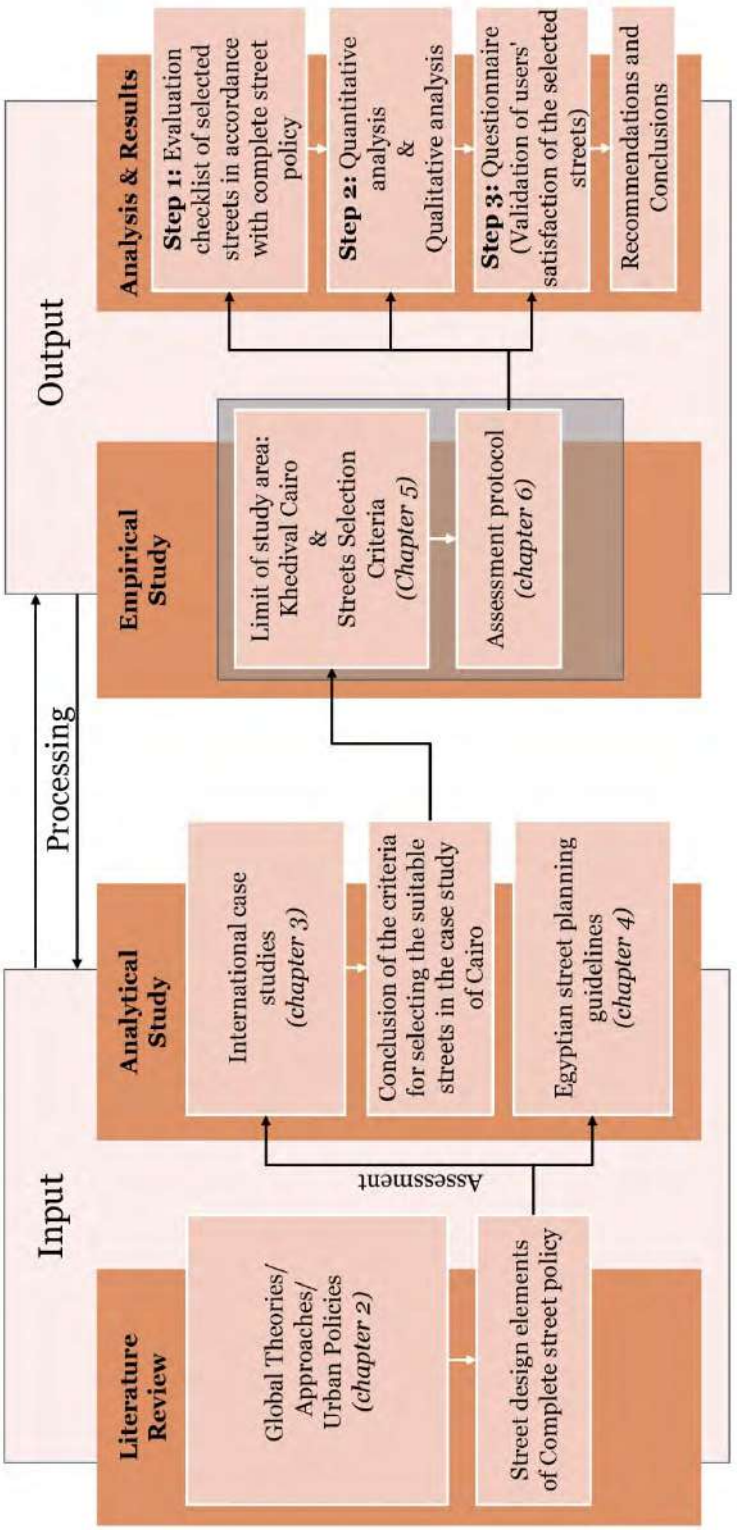


Figure 1. 2 - Conceptual Framework & Outline of Thesis. Source: Author

Theoretical Approaches & Policies

The chapter overviews different approaches that are corresponding with people-oriented development. In particular, this chapter is mainly focusing on the Complete Street policy, which serves as a foundation for understanding the street design element and assessment methods of Complete Streets. This background knowledge is utilized later in the following chapters.

2.1. People-oriented streets

An emerging concern among urban transport researchers and practitioners is the repetition of mistakes initially made in Europe, North America, and Australia, which involved ignoring some road users in urban transportation design. However, developing countries are also neglecting the needs of pedestrians, cyclists, and street vendors over the long term (Meleckidzedeck Khayesi et al., 2010). Alternatively, the concept of people-oriented city design prioritizes individuals and communities over vehicles and other city infrastructure (Norwalk Tomorrow, 2021). To successfully create streets for people, it is

necessary to go beyond simply implementing bike paths, in which the street design should prioritize people and recognize them as essential street users (Melvie, 2020). Over the years, several notions have been established, including "livable" streets, "complete" streets, "streets for all," "quality" streets, "friendly" streets, and "healthy" streets. Although these notions differ slightly, they all aim to enhance people's well-being and contribute to prosperous cities. These initiatives and polices emphasize the need for improved street connectivity that prioritizes people (UN-Habitat, 2013). Consequently, the following section will review three different notions/policies that prioritize people in designing streets.

2.2. Street Design: Theories and Policies

2.2.1. Shared streets (Living streets)

The concept of shared streets -known as woonerfs in the Dutch city of Delft- originated in the late 1960s to create a sense of belonging for residents (Appleyard and Cox, 2006; Appleyard, 1980). These streets are also indicated as "living yards," "streets for living," "living streets," or "home zones" in Great Britain. In detail, shared streets prioritize social interaction among neighbors and provide a safe space for children to play in front of their homes. The design philosophy behind Woonerfs is to promote cycling, walking, and public space utilization while accommodating moving traffic and parking (Appleyard and Cox, 2006; Whitney et al., 2020). In commercial areas, shared streets contribute to the public space network and enhance vibrancy through public seating, artwork, and landscaping. It is recommended to implement formal shared street environments in areas with high pedestrian activity and low vehicle volumes in order tore discourage excessive vehicle usage (NACTO, 2017; Appleyard and Cox, 2006).

As a novel design notion, the primary goal of a shared street is to create a "mental speed bump" effect. This concept aims to encourage drivers to be more attentive by blurring the distinction between areas designated for cars and pedestrians (Lurong Xu, et al., 2022). In addition, a crucial strategy for reducing traffic speed

is to narrow travel lanes while emphasizing the street as a residential space rather than solely a thoroughfare for vehicles. Also, various physical and visual measures are employed to make drivers naturally inclined to drive slowly, such as incorporating slow traffic features, introducing curves in the travel lane to disrupt the driver's line of sight, and removing continuous curbs. Instead, bollards, street furniture, trees, and varied pavement treatments are utilized to guide drivers.

While the designs may differ based on local context and cultural factors, the shared street concept involves the removal of curbs, the allocation of materials and sharing of the space to signify that vehicles are considered guests. In a 2003 study, public health consultant Peter Jacobsen found that increased participation of pedestrians and cyclists in the street environment truly enhances safety. Specifically, he observed a decrease in relative collision rates as the number of pedestrians and cyclists increased, implying that drivers exercise greater caution when anticipating people using the street (Appleyard and Cox, 2006). However, it is worth mentioning that some road users may experience discomfort and perceive shared streets as hazardous due to the absence of physical dividers between pedestrian zones and streets, in contrast to conventional street layouts (Lurong Xu, et al., 2022).

2.2.2. Non-Motorized Transportation (NMT)

Active transport, also known as non-motorized transport (NMT) or human-powered transport, encompasses modes such as walking and cycling that do not depend on motorized power (Litman, 2023; Institute for Transportation and Development Policy, 2020; Parizi and Kazeminiya, 2015). Policymakers and environmentalists increasingly favor NMT, including walking and cycling, as an appealing alternative to motorized commuting (Parizi and Kazeminiya, 2015). To encourage the adoption of NMT, countries should prioritize the protection of vulnerable road users by implementing appropriate physical infrastructure. Well-designed NMT infrastructure, which includes separate spaces for pedestrians and cyclists along with safe facilities for road crossings, has the

potential to significantly reduce the number of road fatalities. The provision of secure pavements and accessible road crossings becomes particularly crucial for the safety of children, the elderly, and individuals with disabilities (UN-Habitat, 2017).

The initial step in identifying priority locations for the development or enhancement of pedestrian infrastructure involves prioritizing the integration with public transport hubs. Areas adjacent to these transit points present ideal starting points for establishing a pedestrian network. Enhancing the quality of sidewalks that directly connect to these accessible transit points plays a significant role in encouraging walking as the preferred mode of transportation for accessing public transport.

Non-motorized transport, particularly walking and cycling, promotes equity as it can be utilized by individuals from various socio-economic backgrounds. In many developing countries, a significant portion of the population does not own cars, and public transportation is mostly unaffordable as well (UN-Habitat, 2017). It should be noted that non-motorized transport users face a higher risk of accidents compared to car users, especially in developing countries (Biggar, 2019). This issue is particularly evident in African cities, where there is a noticeable lack of support for walking and cycling. In other words, many countries and cities in this region do not prioritize these modes of transportation in their plans. (Vanderschuren et al., 2022). As a result, numerous cities and communities lack the necessary safe infrastructure for walking and biking, such as protected bike lanes, sidewalks, footpaths, and pedestrian bridges. These barriers are rooted in underlying problems with urban design and planning. Additionally, the absence of accessible and convenient public transportation further hinders non-motorized transport options, as individuals who are unable to walk or cycle to transit stations are forced to rely on private vehicles to reach their destinations (Biggar, 2019).

2.2.3. Multi-modal mobility: Complete Street policy

The solution to reducing dependence on automobiles does not typically involve creating car-free communities where driving is prohibited. Instead, it involves providing communities with a diverse transportation system that offers various options for accessibility. These options include walking and cycling for local trips, public transit along major travel routes, and using automobiles when they are the most efficient choice (Litman, 2019; Litman, 2023). Enhancing local walking and cycling conditions is often the most effective approach to improving and promoting the use of public transit, particularly if these modes of transportation have access to public transit services (Litman, 2023). By planning for multi-modal mobility and investing in walking, cycling, and public transit, a community would reach better-balanced travel activities (Litman, 2019). Multi-modal planning involves considering diverse transportation options, typically including walking, cycling, public transit, and automobiles, taking into account land use factors that impact accessibility (Litman, 2022).

In other words, multimodal access caters to the needs of all individuals, regardless of their choice to walk, cycle, use public transit, or drive. This leads to improved connectivity and a wider range of transportation choices (Tennessee State Government, n.d.). An example of multimodal planning is implementing the "Complete Street" policy, where streets are designed to ensure safety for all individuals, as well as vulnerable street users such as children, older adults, and those with disabilities. Complete Streets enhance connectivity by including a range of street features such as sidewalks, bike lanes, pedestrian crossings, bus shelters, and other multimodal transportation options (Tennessee State Government, n.d.).

2.3. Why Complete Street Policy?

Inadequate street conditions lead to limited transportation choices for pedestrians, cyclists, and public transportation users, thus, forcing many individuals to rely on driving. In contrast, by modifying policies to meet the requirements of pedestrians, transit users, or bicyclists, individuals with varying

capabilities and ages would have access to a wide range of transportation alternatives (Chicago Metropolitan Agency for Planning et al., 2015). Incomplete streets are mostly a consequence of disregarding the needs of all individuals and relying on outdated criteria for evaluating street functionality. As a result, streets would be uncomfortable and even deadly to those who do not rely on motor vehicles (National Complete Streets Coalition, 2011). Hence, the adoption of the Complete Street policy is supported by several reasons. Firstly, Complete Streets ensure safe accommodation for all types of users, including pedestrians, cyclists, and transit users. In addition, they are context-sensitive, considering the quality of services provided, which is particularly concerning to NMT users (Kumar et al., 2021). Furthermore, the Complete Streets approach aligns with other contemporary planning movements, such as smart growth, context-sensitive solutions, transit-oriented development, and Living Streets. Consequently, Complete Streets can easily merge with these initiatives, as they all emphasize the integration of land use and transportation planning, in addition to promoting safe, convenient, and affordable travel (Chicago Metropolitan Agency for Planning et al., 2015; Active Transportation Alliance, 2012; McCann, 2013).

2.4. Goals of Complete Street policy

The main aim of Complete Streets is to offer guidance in the decision-making and design phases, ensuring that all users are taken into account during the planning process (WSP USA, 2018). This goal can be attained by facilitating safe access to any destination within the street network for all individuals, regardless of their chosen mode of transportation. Additionally, it involves addressing the needs of bicyclists, pedestrians, and transit users within the community (City of Memphis complete streets plan, 2020).

Upon reviewing the goals of the Complete Street policy and reasons for adapting it, it was clear that the main goal of the complete street policy is tackling the research problem directly. The following section reviews further details about the Complete Street policy concerning its definitions, history of emergence, methods

of applying Complete Streets, street design elements and assessment methods of complete streets.

2.5. Definitions of Complete Street Policy

According to the National Complete Streets Coalition (NCSC), Complete Streets refers to a transportation approach that considers the needs of all travelers, regardless of age, ability, or mode of transportation. The Active Transportation Alliance, based in Chicago, takes a comprehensive approach, and defines Complete Streets as a movement that integrates policy, networks, neighborhoods, designs, and destinations. Moreover, the Complete Street policy challenges conventional perceptions about transportation and aims to reclaim streets for people. Although different agencies and organizations may have slightly different definitions, they all emphasize that Complete Streets projects can vary in appearance and function based on the specific neighborhood, community, or land use context. While a single road or a segment may be considered "complete" on its own, it will not fully achieve its objectives and all benefits of Complete Streets, unless it is part of a larger network that accommodates all users safely and conveniently (Chicago Metropolitan Agency for Planning et al., 2015).

2.6. History of Complete Street Policy

During the 1970s, the concept of "routine accommodation" emerged, promoted by community groups and a few states and local governments. This approach aimed to incorporate the needs of pedestrians and bicyclists into roadway projects. In the 1990s, the notion and the application of involving pedestrians of all abilities and cyclists were developed at the federal level by the Americans with Disabilities Act (1990) and the Intermodal Surface Transportation Equity Act (ISTEA) of 1991. Despite the consistent allocation of funds for bicycling and walking projects in federal transportation programs, only a minority of states and cities actively integrated the requirements of these transportation modes into their infrastructure planning and development.

In 2003, the movement for creating a more inclusive street environment was initiated by bicycle advocates. Additionally, it gained support from various stakeholders, including public health professionals, activists for older adults, proponents of smart growth, public transportation agencies, disability advocates, and even real estate agents. These diverse groups present persuasive arguments in favor of fostering a diverse street environment (McCann, 2013; Chicago Metropolitan Agency for Planning et al., 2015). The term "Complete Streets" was introduced by Barbara McCann, a member of the advocacy group American Bikes, to highlight the potential of integrating cycling infrastructure into the existing transportation system. Over time, the concept of Complete Streets expanded to encompass pedestrian planning, all kinds of motorized transit planning, and cycling planning as well (Dehghanmongabadi and Hoşkara, 2022).

In 2005, the NCSC (National Complete Streets Coalition) was established to integrate various professional organizations, including the American Planning Association, the American Society of Landscape Architects, the Institute of Transportation Engineers, and the Association of Pedestrian and Bicycle Professionals. Also, it includes non-profit organizations like Smart Growth America, the Alliance for Biking and Walking, and America Walks. In addition to associations such as AARP, the American Public Transportation Association, and the National Association of Realtors. Moreover, the coalition collaborates with numerous consultants and engineering firms that work with local communities to strategize and execute Complete Streets projects. The primary goal of the NCSC is to promote and guarantee the successful implementation of Complete Streets policies at the local, state, and federal levels (Chicago Metropolitan Agency for Planning et al., 2015). The National Complete Streets Coalition was formed to advocate for the inclusion of Complete Streets policies in all upcoming road projects, ensuring safe and convenient access for all users of the roads (McCann, 2013).

2.7. How to achieve Complete Street policy?

There is no single approach to building Complete Streets as the components contributing to its completeness may not be applicable in all contexts. Therefore, land-use context and various transportation needs must be considered while designing streets (American Planning Association, 2010). Consequently, it is essential to identify current and future land-use contexts adjacent to the planned streets. Taking street contexts into consideration will lead to the development of safe and convenient solutions that cater to the diverse range of users in the area, rather than solely prioritizing the design of the street for vehicular traffic (American Planning Association, 2010; Kumar et al., 2021a).

When designing a street, it is fundamental to consider all modes of transportation. In particular, adopting a mode hierarchy can be a helpful practice for planners in making design decisions and exploring different design options. For further clarification, there are two basic approaches to mode prioritization. The first approach involves implementing a default modal hierarchy, where each mode is ranked based on community-wide goals, such as promoting a shift in transportation modes, ensuring safety, and enhancing community livability. Apart from this, departing from the default hierarchy would necessitate obtaining special authorization. The second approach entails assigning a mode hierarchy for each street on a project-by-project basis. To explain, this approach relies on considering various factors, such as land use context, street typology, and overall project goals, in making decisions before the design development phase. Particularly, the assignment of street typologies facilitates the determination of the suitable mode hierarchy on a project-by-project basis (Chicago Metropolitan Agency for Planning et al., 2015).

2.8. Primary Design Elements of Complete Streets

Table 2. 1 - Complete Street design elements. Source: Institute for Transportation and Development Policy (2013) ; Kost and Nohn (2011); Chicago Metropolitan Agency for Planning et al. (2015); City of Memphis complete streets plan (2020)

Complete Street Design Elements				Design considerations
Ways	Pedestrians	Multi-utility zone		Dedicated spaces for street vendors, street furniture, trees, trash bins and bus shelters.
		Pedestrian zone		This zone offers a continuous path for pedestrians and should be devoid of any obstructions.
		frontage zone		It serves as an intermediate zone between building edge and the pedestrian zone.
	Bicyclists	Bike lane	High-speed road	Bike lanes should be provided on only one side of streets of one-way direction.
			Low speed streets	Shared lane markings indicate the utilization of the roadway by cyclists.
		Bike-Sharing		_
		Bike parking		Bike racks should be placed near to public transportation stations and stops

Complete Street Design Elements			Design considerations
Ways	Transit	Bus stops	If sidewalk ≥ 4.5 m: Bus stop is placed at curb edge, to ensure continuous movement of pedestrians. If sidewalk < 4.5 m: Bus stop is positioned adjacent to the wall in order to ensure an adequate space in the front for pedestrians.
		Bus shelters	The installation of transit shelters is essential to ensure the comfort of passengers during their waiting periods.
	Motor vehicles	Reduced Speed limit	–
		Narrowing of carriageway	Narrowing of the carriageway can contribute to reducing the speeds of vehicles.
Crossings design	Marked crosswalks		The sidewalk curb should be sloped down to reach the carriageway level.
	Signals		–
	Raised crossings		The raised crossings should be provided at intersections

Complete Street Design Elements		Design considerations
Crossings design	Midblock crossings	The mid-block crossings should be placed at fixed intervals.
	Reduce turning radius	it is crucial to calculate the appropriate radius of corners, taking into account the type of vehicles anticipated to use the intersection.
	Curb extensions	The curb extensions are advisable for streets with on-street parking. However, they can also be utilized in areas without on-street parking, where the curb extensions should span the full width of the dropped or added travel lane.
Services-related infrastructure	Shade and Landscaping	The suitable spacing between trees should be determined based on the trees' canopy size and shape to ensure continuous shading.
	Streetlights	For streets that are up to 12 meters wide, a single row of light posts is typically adequate. However, on wider streets, it is possible to mount dual lights on a single central light post.
	Furniture	In areas with higher commercial activity and bus stops, there is a greater demand for the installation of a sufficient number of street furniture.

Complete Street Design Elements			Design considerations
Services-related infrastructure	Signage		–
	Disabled Facilities	Ramps	–
		Tactile pavers	Tactile pavers are essential for creating warning strips in proximity to all areas on the sidewalks that involve conflicting uses, such as property entrances and intersections.
Additional Facilities	On-street parking		–
	Street vending		Dedicated spaces for street vendors should be situated in the multi-utility zone to ensure the continuity of pedestrians' movement.

2.9. Assessment process of Complete Streets

In evaluating various aspects of complete streets, professionals and researchers have suggested different methods that are classified into two distinct groups. The first set of methods focuses on assessing the operational performance of a facility, specifically how effectively it serves the existing demand. The widely used measure for performance measures is level of service (LOS), which characterizes a facility's capacity to accommodate the movement demands of users. However, in certain planning situations, these operation-oriented methods may not be suitable as they overly prioritize mobility and demand. Although such focus is

substantial for identifying capacity improvements within a community, even so, planners often need to assess the quality of a facility regardless of its demand. The second set of assessment methods is more concerned with the extent and quality of provisions, instead of focusing on demand. These provision-oriented methods involve conducting an audit of the built environment; in other words, it involves creating an inventory rating of the available design features. However, a drawback of many provision-oriented methods is their concentration on a single mode of transportation, typically walking or cycling. In addition, most audits fail to consider contextual factors; hence, a poor score is constantly regarded as poor, even if the community's vision for that particular street does not necessitate additional or improved provisions and design (Kingsbury et al., 2011).

Although Complete Streets are intended to provide safe access for all street users, the type and scope of services available to street users vary depending on the street context. Ultimately, the most adaptable metrics should acknowledge different levels of performance by a street and be flexible enough to evaluate a wide range of potential street designs. However, assigning weights to different functions of the street would be challenging. Most of the existing Complete Street policy and literature primarily focuses on qualitative objectives, the impact of Complete Streets projects before and after implementation, and diverse elements of Complete Street design. Even so, limited attention has been given to the quantitative evaluation of the adequacy of current and proposed street designs. It is important to note that there is no comprehensive framework for evaluating the "completeness" of a street, which is the extent to which a Complete Street fulfils its intended functions. Integration of a quantitative assessment framework for Complete Streets would enhance current design techniques, enabling a thorough analysis of quantitative trade-offs and design priorities in street design (Hui et al., 2018).

2.10. Conclusion

Briefly, the complete street policy is an influential alternative to car-centric development as it is designed to align with the specific characteristics of the local environment, taking into account the various street activities, patterns of pedestrian movement, adjacent land uses, and the requirements of the community members (Institute for Transportation and Development Policy, 2020). Regarding the assessment techniques employed for evaluating Complete Streets, this research utilizes the provision-oriented approach in subsequent chapters. Furthermore, in the upcoming chapter, seven international case studies are analyzed by comparing their transformed street elements to the benchmark of complete street elements.

International case studies: Transforming to Complete Streets

3.1. Global Adoption of Complete Streets

In numerous cities around the world, automobiles have assumed a dominant role in transportation, infrastructure, and land use policies. Nonetheless, there is a growing global trend towards embracing the concept of complete streets, which has gained significant momentum and popularity. The United States has been at the forefront of this movement, with over 1,600 Complete Streets policies already enacted (Smart Growth America, n.d.; Al-Mosaind, 2018). In the United States, some cities have passed legislation to enforce complete street policies, while others have implemented them through executive orders, internal policies, non-binding resolutions, or by incorporating complete street principles into their transportation plans (Al-Mosaind, 2018).

Figure 3. 1 - Complete Street Policy adoption in the US in the year 2000. Source: Smart Growth America

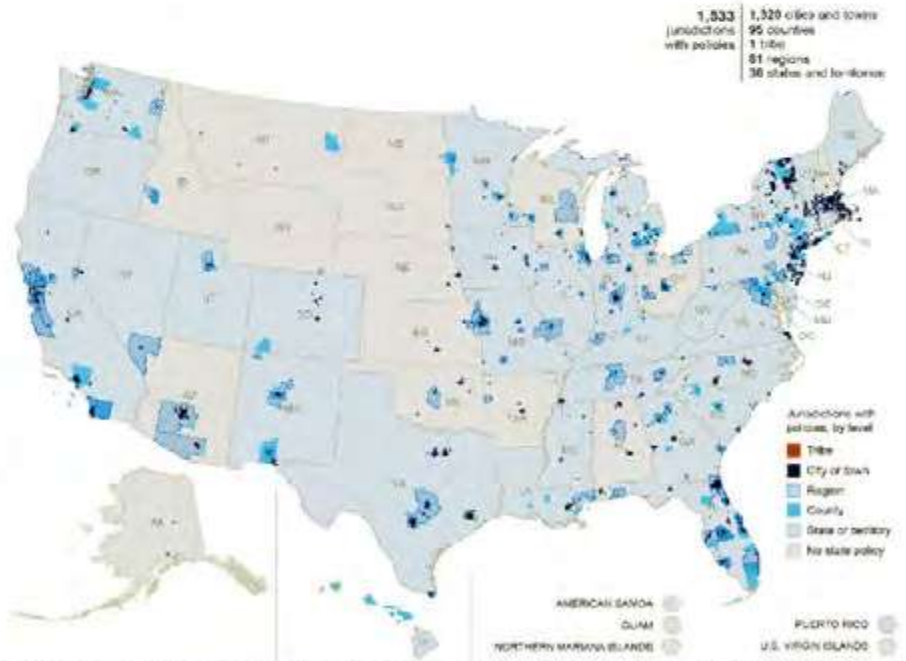


Figure 3. 2 - Complete Street Policy adoption in the US in the year 2021. Source: Smart Growth America

3.2. Selection Methodology of international case studies

Clearly, the Complete Street policy is almost implemented in the United States. However, some developing countries have intended to transform their street network from car-oriented development into Complete Streets. Unfortunately, by exploring international cases that offer comparable levels of economic development and street conditions as that of Cairo, limited cases were found. For further details, the following criteria were applied while selecting the suitable case studies:

1. Case studies that applied complete street policy.
2. Case studies in developing countries that share similarities with Egypt in terms of urban, social, cultural, and economic aspects.
3. Case studies in the last 5-10 years.
4. Case studies which are located at a mixed-use street

Upon searching for convenient case studies with relevance to the selecting criteria, seven international case studies were found (as shown in Figure 3.1). To explain, three case studies were explored in India, one case study in Mexico, and three case studies in Brazil. It is worth noting that these case studies are located in different cities. Subsequently, these case studies are reviewed in detail.

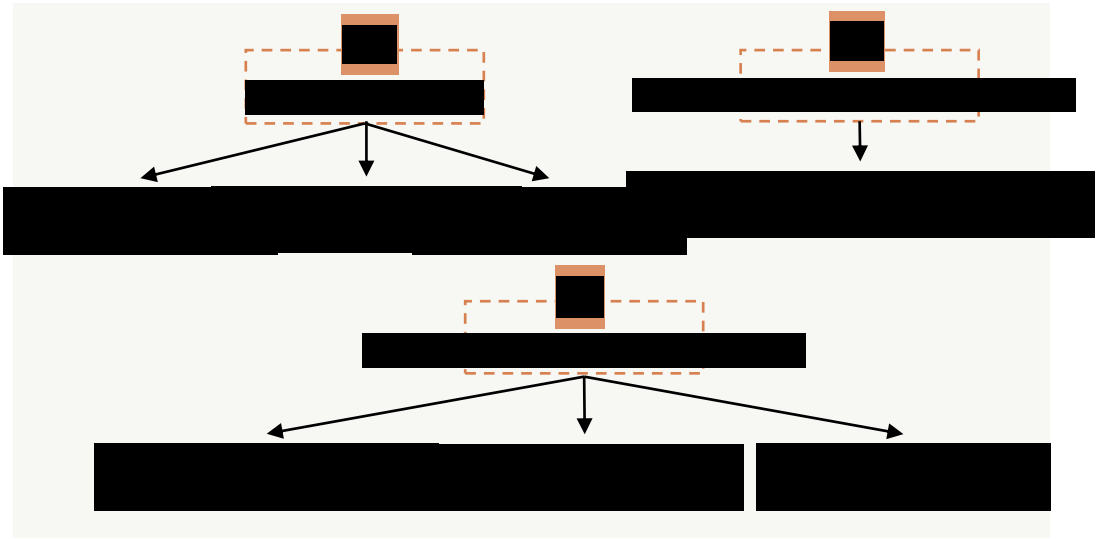


Figure 3. 3 - Selected international case studies. Source: Author

3.3. Case study 1: Second Avenue, Besant Nagar, Chennai, India

3.3.1. Background

The Chennai Corporation has initiated efforts to convert its roads into complete streets, considering the needs of all users. Approximately 150 km of Complete Streets have been designed and implemented in the city. Since 2014, Chennai has been striving to establish a large network of well-connected and integrated streets that prioritize comfortable pedestrian movement. Initially, the focus was on redesigning 26 streets to include wide and continuous footpaths. Among these transformed streets, the Second Avenue, situated in the neighborhood of Besant Nagar in Chennai (as shown in Figure 3.1) (Institute for Transportation and Development Policy, 2019).

Figure 3. 4 - Location of Second Avenue in Besant Nagar, Chennai, India.

3.3.2. Street Dimensions

Table 3. 1 – Street Dimensions of Second Avenue. Source: Author

Street dimensions (m)	Street length	Right of way	Carriageway width	Sidewalk width
	500	25-30	11-12	4

3.3.3. Triggers

One of the most significant triggers on Second Avenue was obstructed and uneven sidewalks. For instance, trees, utility boxes, and bus stops hindered pedestrian movement, in addition to parking cars encroachments on the street edges. Consequently, pedestrians were forced to walk along the carriageway, resulting in potential conflicts with high-speed traffic (Institute for Transportation and Development Policy, 2019; Institute for Transportation and Development Policy, 2015).

3.3.4. Interventions

1. The space previously occupied by parking was streamlined to reclaim a wider and uninterrupted sidewalk for providing safe movement for pedestrians.
2. Raised crossings were introduced to enhance accessibility.
3. Exclusive areas were allocated for bike parking bays and bus shelters, catering to the specific needs of cyclists and public transport users.
4. New bollards were installed to enhance safety measures and provide protection for pedestrians and cyclists

Figure 3. 5 - Before-and-after photographs of the transformation of Second Avenue. Source: Institute for Transportation and Development Policy.

3.4. Case study 2: Pondy Bazaar, Theyagaraya Nagar, Chennai, India

3.4.1. Background

Chennai aimed to enhance the infrastructure for pedestrians and cyclists to support active modes of transportation. Therefore, the city has effectively chosen a commercial shopping street in the centre of Chennai; to be transformed into a complete street (Centre for Liveable Cities and Temasek Foundation, 2022). To emphasize, this transformation prioritizes the needs of people over vehicles and introduces new ways of experiencing space (Soni, 2019). It is worth mentioning that the transformation of Pondy Bazaar was part of Chennai's broader effort to redesign its street network, similar to the previous case study of Second Avenue.

Figure 3. 6 - Location of Pondy Bazaar in T. Nagar, Chennai, India. Source: Author

3.4.2. Street Dimensions

Table 3. 2 - Street Dimensions of Pondy Bazaar. Source: Author

Street dimensions (m)	Street length	Right of way	Carriageway width	Sidewalk width
	700	27-30	6	10

3.4.3. Triggers

According to a traffic, study carried out in 2016, it was observed that approximately 5,000 individuals walk through Pondy Bazaar during peak hours of the day. Even so, the sidewalks were narrow compared to the wide road width. Despite being heavily crowded by retailers and shoppers, it lacked basic measures to ensure the safety and convenience of pedestrians. For instance, numerous issues were identified, including damaged sidewalks, blocking of pedestrian paths by greenery and street utilities, inadequate pedestrian crossings, a lack of public amenities, and encroachment of parking cars (C40 Cities, 2021).

3.4.4. Interventions

1. Expanded and inclusive pedestrian paths.
2. The sidewalk has been redesigned to accommodate wheelchair users and to prevent vehicles from sidewalks intrusion by installing bollards.
3. Addition of seating clusters to enhance convenience for pedestrians.
4. Energy-efficient lighting fixtures were installed to improve visibility and enhance the overall aesthetic of the plaza.
5. Approximately 60 new trees have been planted along the plaza, with planter boxes placed near seating clusters to increase greenery at eye level.
6. Smart Bike cycle sharing stations have been placed at three locations along the Pedestrian Plaza, encouraging the use of non-motorized transportation.
7. Battery-operated feeder vehicles are provided within the Pondy Bazaar section of the Pedestrian Plaza, catering to the needs of the elderly and individuals with disabilities.

Figure 3. 7 - Before-and-after street section of the transformation of Pondy Bazaar. Source: Institute for Transportation and Development Policy.

Figure 3. 8 - Before-and-after photographs of the transformation of Pondy Bazaar. Source: Institute for Transportation and Development Policy.

3.5. Case study 3: DP road, Pune, India

3.5.1. Background

Under the Pune Streets Program, the local government is redesigning 100 kilometers of streets. Additionally, the city has adopted the Smart City Complete Streets Project, which prioritizes walking and cycling by developing plans for

cycling throughout the city. These programs in Pune are achieving several objectives concerned with complete streets. To clarify, they pursued enhancing safety for all road users, improving mobility for all citizens, and creating city-wide networks of Complete Streets.

Figure 3. 9 - Location of DP Road in Andh, Pune, India. Source: Author

3.5.2. Street Dimensions

Table 3. 3 - Street Dimensions of DP road. Source: Author

Street dimensions (m)	Street length	Right of way	Carriageway width	Sidewalk width
	520	24-30	12	6

3.5.3. Triggers

With the rise in the volume of vehicles on the streets, Pune recognized the necessity for sustainable transportation modes. In addition to undertaking efforts to enhance public transportation, the city has also been actively pursuing measures to create streets that prioritize the needs and well-being of pedestrians and cyclists. (Institute for Transportation and Development Policy, 2019).

3.5.4. Interventions

1. Expanded sidewalks on both street sides.
2. Applying measures of accessibility.
3. The addition of a bike lane and bike racks.
4. New dedicated parking spaces were provided.
5. Raised crossings were added to enhance accessibility.
6. Safety bollards were placed to block out two-wheelers.
7. Incorporating several existing trees that were randomly positioned on the street segment within the new design.
8. New benches, stone seatings around trees, trash bins and signages were placed throughout the sidewalk.
9. Traffic calming measures were applied.

Figure 3. 10 - Before-and-after photographs of the transformation of DP Road. Source: Institute for Transportation and Development Policy.

3.6. Case study 4: Avenida 16 de Septiembre, Histórico de la Ciudad, Mexico

Avenue 16 de Septiembre is situated in the city's Historic Centre, it underwent a recent redesign to prioritize pedestrians, cyclists, and motorists alike. Despite being classified as a pedestrian priority street, it effectively functions as a complete street. Through the implementation of advanced traffic-calming measures, the street now encourages shared usage by all modes of transportation, including pedestrians, cyclists, and vehicles. Significantly, Avenue 16 de Septiembre serves as a noteworthy example of designing streets that prioritize the needs of people over cars. As a result, Mexico City has received acclaim for its remarkable revitalization of the Historic Centre. (Institute for Transportation and Development Policy, 2014; Avenida 16 De Septiembre, Mexico City, Mexico, 2019; Complete Streets, Streets for Everyone, 2016).

Figure 3. 11 - Location of 16 de Septiembre, Centro Histórico de la Cdad. de México. Source: Author

3.6.1. Street Dimensions

Table 3. 4 - Street Dimensions of 16 de Septiembre street. Source: Author

Street dimensions (m)	Street length	Right of way	Carriageway width	Sidewalk width
	700	14-15	4	4.5

3.6.2. Triggers

Mexico City took steps to enhance non-motorized transportation as part of its efforts to improve road safety, encourage equitable allocation of space, and foster economic development. The city aimed to implement traffic calming measures to create safer road conditions for vulnerable groups such as children, individuals with disabilities, and the elderly. The increased pedestrian activity benefits local businesses, also, the provision of ample pedestrian space signifies inclusivity and demonstrates that the city is accessible to all people, not solely those using cars (Institute for Transportation and Development Policy, 2014).

3.6.3. Interventions

1. Sidewalks were widened by reducing the carriageway width.
2. Traffic calming measures were applied by reducing vehicles' speed, to provide a safe and comfortable street for pedestrians and cyclists.
3. Adding bollards on the two sides of street to enhance pedestrians' accessibility.
4. The addition of amenities such as (landscaping, benches) enhanced public engagement and improved quality of life.

Figure 3. 12 - Before-and-after photographs of the transformation of 16 de Septiembre street. Source: Institute for Transportation and Development Policy.

3.7. Case study 5: Rua Miguel Calmon, Salvador, Brazil

The selection of Rua Miguel Calmon for the complete street pilot project in Salvador was based on several factors. One key consideration was its strategic position at the core of the Comércio district, recognized as the country's first organized business district and situated within the polygon of the Traditional Historic Center of Salvador. Furthermore, Rua Miguel Calmon holds significant economic significance and serves as a hub of bustling activity, attracting a multitude of individuals seeking various services and engaging in local activities. Consequently, the municipality aimed to achieve a balanced distribution of road space that prioritizes safety, comfort, and sustainability across all modes of transportation, with particular emphasis on pedestrians, cyclists, and the overall environment (Paula Santos et al., 2021).

Figure 3. 13 - Location of Rua Miguel Calmon, Salvador, Brazil. Source: Author

3.7.1. Street Dimensions

Table 3. 5 -Street dimensions of Rua Miguel Calmon street. Source: Author

Street dimensions (m)	Street length	Right of way	Carriageway width	Sidewalk width
	1100	20-24	12-13	3.5

3.7.2. Triggers

The initial phase of the urban project involved conducting a comprehensive diagnosis to identify and evaluate the primary issues within the area. This involved conducting a detailed analysis along the street to gain a deeper understanding of the challenges faced. The diagnosis revealed several difficulties related to pedestrian circulation, including poor paving, the absence of accessibility ramps, inadequate crosswalks, and a lack of traffic lights to ensure safe crossing. Additionally, poorly positioned poles and signs created physical barriers. Furthermore, other problematic aspects in the region were identified, such as disorganized parking spaces, areas prone to flooding, and insufficient public lighting conditions (Paula Santos et al., 2021).

3.7.3. Interventions

1. A cycle lane was established with the inclusion of reflective studs and granite block separators. The separators were strategically positioned between the existing parking spaces and the sidewalk, serving as a protective barrier for cyclists.
2. Reducing carriageway width and widening specific parts of sidewalks.
3. The implementation of ramps, tactile paving, pedestrian crossings, and raised crossings to ensure compliance with universal accessibility standards.
4. Redesign of sidewalk and installing new pavement.

Figure 3. 14 - Before-and-after photographs of the transformation of Rua Miguel Calmon street. Source: Paula Santos et al. (2021).

5. Placement of new public furniture throughout the street such as benches and trash bins.
6. To ensure shade and enhance thermal comfort, a total of ninety new trees were planted.
7. Designated parking areas were established along the road to accommodate service vehicles, including taxis, app-based transportation services, and ambulances.
8. LED lamps were installed on public lighting posts to improve energy efficiency.

3.8. Case study 6: Rua Voluntários Da Pátria, Curitiba, Brazil

In 2018, Rua Voluntários da Pátria, located in the central area of Curitiba, was chosen as one of the revitalization axes under the Rosto da Cidade Program. Additionally, it was designated to become the city's first complete street. The Rosto da Cidade Program is an initiative by the municipal government aimed at redefining and enhancing the traditional centre of Curitiba, intending to attract tourists and promote commercial and recreational activities. The transformation of Rua Voluntários da Pátria aimed to improve the quality of the public space, prioritize pedestrian movement, enhance local accessibility, upgrade public lighting infrastructure, and optimize road drainage systems. (Paula Santos et al., 2021).

Figure 3. 15 - Rua Voluntários Da Pátria, Curitiba, Brazil. Source: Author

3.8.1. Street Dimensions

Table 3. 6 - Street dimensions of Rua Voluntários Da Pátria street. Source: Author

Street dimensions (m)	Street length	Right of way	Carriageway width	Sidewalk width
	650	15-20	4	3.8

3.8.2. Triggers

The street is characterized by buildings in the building alignment, with several commercial establishments. Nevertheless, the sidewalks on Rua Voluntários da Pátria were narrow for the intense flow of pedestrians which made circulation difficult. Also, the pavement was already deformed by the constant maintenance works. For these reasons, the revitalization of the street was a demand of the local merchants to increase in the circulation and permanence of people in public spaces and the improvement of conditions of accessibility (Paula Santos et al., 2021).

3.8.3. Interventions

1. The sidewalk was expanded by removing the parking lane.
2. New paving was installed on the sidewalks, with a focus on restoring the original patterns and designs.
3. To enhance pedestrian safety, a new LED lighting system was implemented throughout the street.
4. Raised crossing was introduced to provide safe pedestrian crossings.
5. Living spaces were established through the installation of specially designed benches, the placement of garbage bins, and the planting of trees.

Figure 3. 16 - Before-and-after photographs of the transformation of Rua Voluntários Da Pátria street. Source: Paula Santos et al. (2021).

3.9. Case study 7: Rua João Alfredo Street, Porto Alegre, Cidade Baixa, Brazil

Porto Alegre is one of the 20 cities involved in a nationwide initiative known as the Complete Streets Program, which is led by WRI Brasil in collaboration with the National Front of Mayors. In April 2019, Porto Alegre partnered with WRI Brasil to execute the initial phase of a tactical urbanism project that transformed a significant intersection along the bustling João Alfredo Street, situated in the central Cidade Baixa neighborhood (Batista et al., 2020). The primary objective of this "complete streets" pilot project was to revitalize the area by prioritizing pedestrian movement, facilitating their circulation, as well as establishing connections between the Cidade Baixa neighborhood, the city's Waterfront, and the Historic District (Bonini and Kruse, 2021).

Figure 3. 17 – Location of Rua João Alfredo Street, Porto Alegre, Cidade Baixa, Brazil. Source: Author

3.1.1. Street Dimensions

Table 3. 7 - Street dimensions of Rua João Alfredo Street. Source: Author

Street dimensions (m)	Street length	Right of way	Carriageway width	Sidewalk width
	650	16-18	7.5	3.5

3.1.2. Triggers

João Alfredo Street, located in the bustling Cidade Baixa neighborhood of Porto Alegre, is recognized for its vibrant nightlife, featuring numerous clubs and entertainment venues. However, during daytime hours, the street experiences a significant decline in activity, primarily due to unsafe road conditions, inadequate infrastructure for pedestrians and cyclists, and limited commercial presence. Recognizing these challenges, the municipality of Porto Alegre selected João Alfredo Street as a pilot location for a tactical urbanism intervention aimed at transforming it into a "complete streets" model. (Batista et al., 2019)

3.1.3. Interventions

1. The addition of curb extensions has contributed to slowing traffic speeds and reducing the crossing distance for pedestrians.
2. Placement of bollards which act as protective barriers for pedestrians
3. New benches were provided throughout the street.

Figure 3. 18 - Before-and-after photographs of the transformation of Rua João Alfredo Street. Source: Batista et al. (2020)

3.10. Evaluation of international case studies in accordance with Complete Street Policy

An evaluation was conducted (as shown in Table 3.8) to examine the most applicable street design elements that are significantly applied in the seven international case studies. Also, to conclude the characteristics of the transformed streets, in order to utilize them while formulating the criteria for selecting streets in the case study of Khedival Cairo (Chapter 5).

3.11. Conclusion

By evaluating the seven international case studies under the Complete Street policy, it was found that 75% (18 out of 24 street elements) of Complete Street elements are achieved in the international case studies. To clarify, the non-achieved Complete Street are relatively limited, including bike parking, bike sharing, bus shelters, and street vending. Moreover, according to the literature, it was not clear if the frontage zone is considered within the sidewalks of case studies or not. Apart from this, it was concluded that thirteen street elements are significantly implemented in the seven case studies, such as sidewalk zoning, shading trees, streetlights, street furniture, ramps, bollards, shared bike lane markings, traffic signals, signages, raised crossings, curb extensions, narrowing of carriageways, and on-street parking.

Table 3. 8 - Evaluation of Evaluation of international case studies in accordance with Complete Street Policy.
Source: Author

Complete Street Design Elements				Case studies						
				Second Avenue	Pondy Bazaar	DP Road	Avenida 16 de Septiembre	Rua Miguel Calmon	Rua Voluntários Da Pátria	João Alfredo Street
Ways	Pedestrians	1. Multi-utility zone		✓	✓	✓	✓	✓	✓	
		2. Pedestrian zone		✓	✓	✓	✓	✓	✓	
		3. Frontage zone		–	–	–	–	–	–	–
	Bicyclists	4. Bike lane	High-speed road							
			Low-speed road			✓	✓	✓		✓
		5. Bike-Sharing			✓					
		6. Bike parking		✓		✓				✓

Complete Street Design Elements			Case studies						
			Second Avenue	Pondy Bazaar	DP Road	Avenida 16 de Septiembre	Rua Miguel Calmon	Rua Voluntários Da Pátria	João Alfredo Street
Ways	Transit	7. Bus shelters	✓						
	Motor vehicles	8. Reduced Speed limit				✓	✓		✓
		9. Narrowing of carriageway	✓	✓	✓	✓	✓	✓	✓
Crossing road	10. Marked crosswalks						✓	✓	✓
	11. Signals		✓		✓		✓	✓	
	12. Raised crossings		✓		✓	No need		No need	
	13. Midblock crossings								
	14. Curb extensions								

Complete Street Design Elements			Case studies						
			Second Avenue	Pondy Bazaar	DP Road	Avenida 16 de Septiembre	Rua Miguel Calmon	Rua Voluntários Da Pátria	João Alfredo Street
Services-related infrastructure	Shade and Landscaping	15. Trees	✓	✓	✓	✓	✓		
	Lighting	16. Streetlights	✓	✓	✓	✓	✓	✓	✓
	Furniture	17. Benches		✓	✓	✓	✓	✓	✓
		18. Trash bins			✓	✓	✓	✓	✓
	19. Signage		✓		✓		✓	✓	
	Disabled Facilities	20. Ramps		✓		No Need		No Need	✓
		21. Tactile pavers						✓	

Complete Street Design Elements		Case studies						
		Second Avenue	Pondy Bazaar	DP Road	Avenida 16 de Septiembre	Rua Miguel Calmon	Rua Voluntários Da Pátria	João Alfredo Street
Additional facilities	22. Safety Bollards	✓	✓	✓	✓			✓
	23. On-street parking	✓	✓	✓		✓	✓	
	24. Street vending			✓				

Egyptian Street planning & design official guidelines and codes

At the country level, there are four prepared guidelines for regulating street design processes; these guidelines are reviewed according to their significance. First, The Egyptian Code for Urban and Rural Streets Works (NERC) is the main reference for road engineers in the street design process in Egypt. This guideline was set by the Ministry of Housing, Utilities and Urban Communities (MHUUC) in 1998. The second guideline is the Detailed Plans Preparation Manual (DPPM) prepared by the coordination between MHUUC represented by the General Authority for Urban Planning (GOPP) and the United Nations Human Settlements Program (UN-Habitat) in 2018. The third authorized guideline is Road Elements Coordination Standards Manual (RESM) prepared by the Housing & Building National Research Center (HBRC), subordinated by MHUUC. Lastly, National Organization for Urban Harmony (NOUH) issued six heuristic guidelines for different urban elements. In the following sections each guideline will be reviewed in detail. Then, there will be a comparison between the Egyptian street design guidelines (in accordance with street design elements) and the complete street design elements. This comparison will be carried out in order to examine the gaps in these guidelines. Also, to deduce to what extent they could be adapted with complete streets policy.

4.1. The Egyptian Code for Urban and Rural Streets Works (NERC)

It is worth noting that any street design project should by law refer back to this code. This code is consisting of ten parts, whereas the third part of the engineering design of roads is only discussed because it is within the scope of the main research (HBRC, 1998).

The engineering design part is subdivided into six chapters as follows:

4.1.1. Chapter I: Highway classification

In light of the type and volume of traffic used for each road, the network can be functionally divided into rural and urban roads. Even so, the research will review only the urban roads part as the rural roads are out of the scope of the research (HBRC, 1998).

4.1.2. Chapter II: Design control and criteria

The guideline illustrated the dimensions and minimum turning radii of the designed vehicle. Concerning pedestrians, the space required for a pedestrian is determined based on the level of service for traffic and the density of pedestrians. To achieve safety on the road, speed limit should be applied in densely populated areas, such as industrial humping and roughening of the road surface. Furthermore, environmental and economic considerations were discussed (HBRC, 1998).

4.1.3. Chapter III: Design elements

In the third chapter, the design elements of the road were represented in the driving eyesight distance, horizontal alignment of roads, and vertical alignment of roads (HBRC, 1998).

4.1.4. Chapter IV: Cross section elements:

The urban road cross-section includes a set of the following elements:

4.1.4.1. Traffic lanes width

It was pointed out that the width of the traffic lane greatly affects the width of the road and the safety and comfort of road users (HBRC, 1998).

4.1.4.2. Cross slopes

It was mentioned that cross slopes provide an effective way for surface water drainage. Also, these slopes manage the gathered water on roads with low longitudinal grades (HBRC, 1998).

4.1.4.3. Sidewalks

Sidewalks are an essential component of urban road cross-section. The widths of sidewalks are determined according to pedestrians' volume. Table 4.1 gives this data. It is preferable to use the largest possible width for pedestrian movement, especially in commercial areas. (HBRC, 1998).

Table 4. 1 - Minimum sidewalk width. Source: The Egyptian Code for Urban and Rural Streets Works

Road typology	Freeways	Highways	Main roads	Local roads
Sidewalk width (m)	2.5	2.5	1.5	1.5

4.1.4.4. Medians

The guide explained the main purposes of the medians, where medians aim to separate opposing lanes of traffic, and to provide an adequate width for U-TURN lanes. The width of the median is related to road typology (HBRC, 1998).

4.1.4.5. Bike lanes

According to the guide, bike lane can be classified into three grades as follows:

The first degree: bike lane is completely separated from the vehicles' lane. It may be designated for the use of bicycles only, or for bicycles and pedestrians together.
The second degree: bike lane occupies part of vehicles' lane; separated by a longitudinal road marking or with a separating curb.
The third degree: bike lane shares part of the vehicles' lane; identified by traffic signs only.

4.1.4.6.Pedestrian crossing paths

They are mainly allocated in the intersection areas. It was given that the width of the pedestrian crossing depends on the shape of the intersection and the density of pedestrian traffic. Moreover, traffic signs and light signals should be used to secure pedestrian crossings. In all cases, the width of the pedestrian crossing must not be less than 2.50 meters (HBRC, 1998).

4.1.4.7. Curbs

Different types of curbs are discussed, the most relevant type to the research topic is the sidewalk curbs, with a length of fifty centimetres. The sidewalk curbs are used at road level at points of connection between sidewalks and medians (HBRC, 1998).

4.1.4.8.Traffic barriers

In urban roads, traffic barriers are placed on the central islands to protect pedestrians and land uses from vehicles drifting (HBRC, 1998).

4.1.4.9.Drainage channels and side slopes

Drainage channels are placed on both sides of the roads and in medians to drain rainwater. The least inclination of drainage channels' sides is 1:3 (HBRC, 1998).

4.1.4.10. Bus stops

The length of the bus stops on both sides of the roads depends on the number of buses used for the stop. It's preferable to provide a length of 15 meters for one bus and a width of 3.60 meters. Figure 4.1 shows the dimensions of bus stops for one bus or two buses (HBRC, 1998)

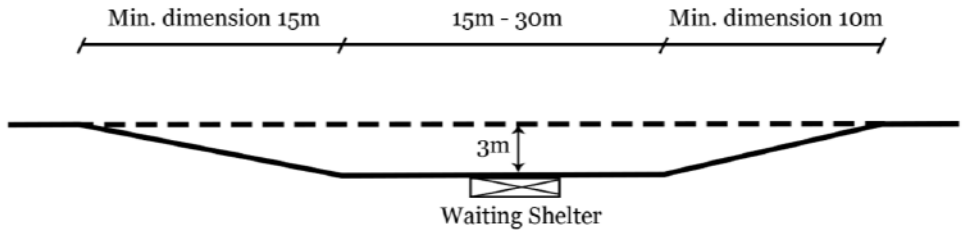


Figure 4. 1 - Bus stops. Source: The Egyptian Code for Urban and Rural Streets Works

4.1.4.11. Curb parking

The dimensions of car parking on both sides of the road are according to the vehicle inclination angle, as well as to the type of vehicles (HBRC, 1998).

4.1.4.12. Right-of-way

It must be adequate to accommodate the final planning of the road, including the central island, landscaping areas, sidewalks, services, and parking lots. The right of way is determined in accordance with the Public Roads Law (HBRC, 1998).

4.1.5. Chapter V: AT-Grade Intersections

As a matter of fact, the chapter mainly discussed the intersections design from the perspective of motorized automobiles. However, there are some small sections which mentioned the addition of a pedestrian refugee to protect pedestrians and reduce the crossing distance (HBRC, 1998).

Chapter VI: Intersections at different levels and signal-free intersections:

Again, chapter six discussed the intersections design from the perspective of motorized automobiles (HBRC, 1998).

4.2. Detailed plan preparation Manual by GOPP (DPPM)

As Law No. 119 of 2008 stipulates the need to prepare detailed plans for the preparation process of cities by transforming strategic plans into reality. In fact, the General department of planning and urban development (GDPUD) should follow the practices of this manual in the preparation process of detailed plans (Law no.118, 2008). The manual consists of ten chapters; the third chapter is the one related to the research topic (GOPP, 2018). This guide is developed based on The Egyptian Code for Urban and Rural Streets Works (NERC). Significantly, both manuals have similar aspects; however, the Detailed plan preparation Manual is developed up to a point. Consequently, the following sections will show the main similarities, differences and additions in chapter three.

4.2.1. Chapter III: Design and implementation of road and transport networks

Firstly, roads can be classified according to the number of lanes into two basic types, two-lane roads and multi-lane roads. Also, the roads are classified according to the function into four grades, each of which has a specific function and has engineering design characteristics (GOPP, 2018).

Similarities & differences: it should be noted that there are some direct similarities to the NERC. For example, the indicative values of sidewalk design, medians design, and bus stops design are identical in both manuals. Even so, there are some differences in particular sections. To explain, the width of pedestrian crossings should not be less than four meters. In addition, in the parking lots section, the dimensions differ according to the parking space, as shown in table 4.2. Furthermore, the manual stated the definition and uses of bike lanes, however, it did not mention the different grades of bike paths (GOPP, 2018).

Table 4. 2 - Dimensions of bus parking lots according to parking spaces. Source: Detailed plan preparation Manual

Parking spaces	Dimensions of bus parking lots (m)
Residential or Administrative buildings	2.3 * 5.0
Mixed-use buildings	2.4 * 5.0
Shopping centres	2.5 * 5.0
Special needs places	3.6 * 12.5

Additions: Indeed, there are some additions that are not totally mentioned in the NERC. To clarify, the manual reviewed the different uses of road markings, where road markings determine stop lines for vehicles at intersections, pedestrian crossing lines, and parking lines. (GOPP, 2018). Moreover, the manual stated the importance of adding medians in separating traffic directions (GOPP, 2018).

4.3. Road Elements Coordination Standards Manual (RESM)

The manual was prepared based on the request and recommendations of the Ministerial Committee in 2004 and Governor's Council in 2005. This guide was set to overcome the issues in the other two guides; however, it is only considered as an indicative guide (HBRC, 2006).The Road Elements Coordination Standards Manual is subdivided into six chapters as follows:

4.3.1. Chapter I: Introduction

The manual started by discussing highway classification as the other two guides.

4.3.2. Chapter II: Road design standards

The following sections will review the main similarities, differences and additions respectively; to avoid duplication of information (HBRC, 2006).

Similarities: In the curbs section, the types and dimensions in the RESM are notably similar to the types and dimensions of curbs in NERC (HBRC, 2006).

Differences: The width of sidewalks is related to pedestrians' volume and roads classification too. Table 4.3 shows the width of the sidewalks required according to the volume of pedestrians. In general, it is preferable to use the largest possible width for pedestrian traffic, especially in commercial areas (HBRC, 2006).

Table 4. 3 - The widths of sidewalks according to pedestrians' volume. Source: Road Elements Coordination Standards Manual

Category	Minimum sidewalk width(m)
Low (Less than 30 pedestrian/minute)	3
Intermediate (from 31 to 80 pedestrian/minute)	4
High (from 81 to 120 pedestrian/minute)	5
Heavy (More than 120 pedestrian/minute)	6

Additions: As for pedestrian crossings, the manual added some illustrations of the crossing design ideas which urges safety of pedestrians and cyclists as shown in Figure 4.2 and Figure 4.3. As discussed in NERC, bike paths are classified into three grades. In addition to this, the RESM added the criteria of selecting the grade of bike paths. To explain, the selection is based on traffic volume, street width, number of intersections, density of parking spaces, and sidewalk condition. Apart from this, the guide state the types of bus station planning. In this section, the manual illustrates in detail the design considerations of traffic signs, indicating the traffic signs placement and installation. As well, it also demonstrates the design considerations of road advertisements (HBRC, 2006).

Figure 4. 3- A model of a raised floors. Source: Road Elements Coordination Standards Manual

Figure 4. 2 - A model of midblock crossing. Source: Road Elements Coordination Standards Manual

In the light of achieving pedestrian safety, the manual emphasizes the value of traffic-calming systems to slow down vehicles speeds near intersections. There are several types of traffic-calming systems, as speed humps and fake turnover (small square) as shown in Figure 4.4. Also, the manual discussed pedestrian paths which should be obligatory in places with high pedestrian density, where they must not be less than two meters wide. It is also preferable to separate between the vehicles lane and pedestrian paths by using green areas with a width of not less than one meter, in order to reduce the chances of pedestrians mixing with cars. Moreover, lighting elements are discussed, where the minimum height of the lighting pole can be estimated by knowing the required lighting intensity and the type of distribution of this intensity (short, medium, long) as shown in table 4.4. (HBRC, 2006).

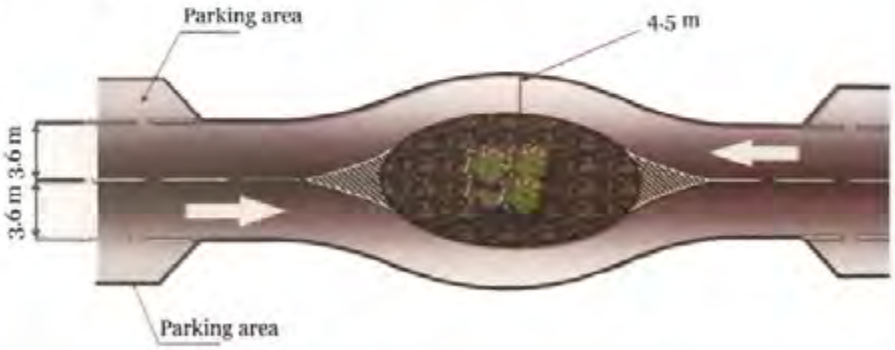


Figure 4. 4 - A model of a fake turnover (small square) for traffic-calming. Source: Road Elements Coordination Standards Manual

Table 4. 4 - The distance between lighting poles in accordance with the distribution type of lighting intensity. Source: Road Elements Coordination Standards Manual

Distribution type of lighting intensity	Distance between lighting poles
Short distribution	4.5 times the height of the lighting pole
Medium distribution	7.5 times the height of the lighting pole
Long distribution	12 times the height of the lighting pole

4.3.3. Chapter III: Site coordination, landscaping and planting

In this chapter, the manual clarified different types of plants, such as: trees, shrubs, climbers, and ground covers. Moreover, the manual reviewed a list of relevant plants, in respect of plants height, water rationing, growth rate, salinity tolerance, leaves colours, flowers colours, flowering season, and fertilization (HBRC, 2006).

4.3.4. Chapter IV: Facilities for disabled people

Generally, countries civilization is measured by the level of concern for handicapped; by considering designing services that facilitate their movement. The manual appealed to the necessity of setting technical standards; the mentioned standards include ramps, wheelchairs' parking spaces, sidewalks, balustrades and barriers. Moreover, wheelchairs' parking spaces should be designated in all public and private parking spaces that are easily accessible. In the case of the sidewalks, the manual listed some regulations for executing easily accessible sidewalks that are free from any obstructions and protrusions. Last but not least, balustrades and barriers help the handicapped to ease their mobility, where the height of the handrail shall not be less than (85 cm) and not more than (100 cm) above ground level (HBRC, 2006).

4.3.5. Chapter V: Application levels and homogeneous sectors

Homogeneous urban sectors are defined as areas of historical value or residential neighborhoods or industrial areas or deteriorated areas. Additionally, several elements must be considered while upgrading historical areas, such as: street widths, pedestrian paths, sidewalk materials, curbs materials, curbs level, commercial shops, lighting, signage, and street advertisements. The manual pointed out to Downtown Cairo as it is one of the areas of historical value, also, it is the central area for business and commerce (HBRC, 2006).

4.3.6. Chapter VI: Executive procedures and application

At last, this chapter consists of a list of the legal legislations that were issued regarding public road works (HBRC, 2006).

4.4. NOUH heuristic guides

The Egyptian building law mandates the establishment of heuristic guidelines for twelve urban elements by the National Organization for Urban Harmony (NOUH). However, since 2010, only six heuristic guides have been issued by the national institution. These include guides for city centres, signs and advertisements, historic sites and buildings, open spaces and green areas, nature reserves, and quality assurance. This research focuses on reviewing the first two guides. Although the guidance for streets and sidewalks is not issued yet. Nevertheless, this research includes a review of this particular guidance due to its relevance to the research scope (Badawi and Galal Ahmed, 2017; El Sharnouby, 2018)

4.4.1. Organizing city centres guidance

The guidance provides an overview of city centres, emphasizing their historical significance as vibrant hubs offering diverse services. It highlights the significance of open spaces and streets that serve as connecting links between the city centre and other areas. Furthermore, the guidance recommends that parking areas should be situated underground for optimal land use. Additionally,

pedestrian paths are advised to be secure and shaded, with a minimum width of 2 meters (Badawi and Galal Ahmed, 2017).

4.4.2. Organizing signs and advertisement guidance

This guidance addresses the various factors associated with road signs, to mitigate visual pollution and minimize obstacles to accessibility. The guidance categorizes the diverse types of signs. Moreover, it establishes regulations governing the specific characteristics of each type, including dimensions, colours, and materials (Badawi and Galal Ahmed, 2017).

4.4.3. Streets and sidewalks guidance

The guidance document provides a comprehensive framework for defining and regulating various types of streets, encompassing standards such as permissible speed limits, width specifications, parking zone locations, and dimensions. Furthermore, the guidance divides the sidewalk into three distinct zones. The first zone, situated adjacent to buildings, is designated for leisurely walking and window shopping. Its width ranges from 0.4 m to 1.5 m, depending on minimum density. The second zone is solely intended for walking and prohibits any additional activities or obstructions. It must have a minimum width of 1.5 meters and a maximum width of 6 meters. The third zone, located adjacent to the road, is designated for planting, lighting columns, signage, and seating. This zone requires a minimum width of 0.45 meters and a maximum width of 1.5 meters. Consequently, the sidewalk width varies between 2 meters and 9 meters, depending on factors such as pedestrian density, specific activities, necessary furniture, and planting requirements. Additionally, the guidance outlines specifications for planting and furniture installations (Badawi and Galal Ahmed, 2017).

4.5. Evaluating the adaptation of national guides with complete street policy

Following the discussion of the four guidelines, an evaluation was conducted (as shown in Table 4.5) to explore the gaps in these guidelines. Also, to understand to what extent they are compatible with complete street policy.

4.6. Conclusion

By assessing the four guides, it was determined that the assessment scales in the Egyptian Code for Urban and Rural Streets Works (NERC) and the Detailed Plan Preparation Manual by GOPP (DPPM) exhibit a high degree of similarity. However, both guides lack consideration for sidewalk zones, basic street elements (e.g., Street lights, shading trees, seatings, benches), and the majority of pedestrian crossing techniques. Secondly, by evaluating the Road Elements Coordination Standards Manual (RESM), it was found the RESM overcomes some of the issues in the other two guides. For example, the RESM partially considers pedestrian crossing techniques, pedestrian paths and basic street elements. Lastly, it was concluded that the heuristic guides provided by the National Organization for Urban Harmony (NOUH) significantly encompass all sidewalk zones and most of the basic street elements. However, it should be noted that these guides exclusively focus on sidewalk design and signage guidance. Consequently, they do not cover pedestrian crossing techniques or other street facilities such as bike lanes, safety bollards, and ramps.

Table 4. 5 - Evaluation of the national guides with accordance to complete street policy. Source: Author

Street Characteristics				Complete Streets (Dimensions)	Egyptian guidelines and codes			
					ECSW	DPPM	RESM	NOUH
1	Pedestrians	Multi-utility zone		Min. 1m - Max. 2.5	●	●	●	●
2		Pedestrian zone		Min. 2.5m - Max. 4m	●	●	●	●
		Frontage zone		Min.1.5m - Max. 3m	●	●	●	●
3	Bicyclists	Bike lane	High speed road	1.5 m -2 m	●	●	●	●
4			Low speed road	-	●	●	●	●
5		Bike sharing		-	●	●	●	●
6		Bike parking		Area: 1 m x 2 m	●	●	●	●
7	Transit	Bus shelters		-	●	●	●	●
8	Marked crosswalks			2.5 m- 5m	●	●	●	●
9	Traffic signals			-	●	●	●	●
10	Raised crossings			2 m - 4 m	●	●	●	●

Street Characteristics		Complete Streets (Dimensions)	Egyptian guidelines and codes			
			ECSW	DPPM	RESM	NOUH
11	Midblock crossings	Min: 3 m	●	●	●	●
12	Curb extensions	-	●	●	●	●
13	Trees	Interval: 5-10 m	●	●	●	●
14	Streetlights	10-12	●	●	●	●
		Interval: 3*Height	●	●	●	●
15	Benches	-	●	●	●	●
16	Trash bins	Interval: 20 m	●	●	●	●
17	Signage	-	●	●	●	●
18	Ramps	1.2 m x 1.2 m	●	●	●	●
19	Tactile pavers	-	●	●	●	●
20	Safety Bollards	Height: 0.9-1.2 m	●	●	●	●
		Interval: 0.815-1.5	●	●	●	●
21	On-street parking	Width: 2.5 m	●	●	●	●
22	Fixed spaces for street vending	-	●	●	●	●

Key: ● Exist, within range ● Exist, No range/out of range ● Not existing

Case study: Khedival Cairo

This chapter reviews an orientation about Khedival Cairo context, providing details about its prominent location as a central business district. The first section discusses the reasons for implementing the complete street policy in Khedival Cairo, where there are seven reasons acknowledging the prerogative of Khedival Cairo as a suitable region for the case study. Subsequently, the selection methodology of the convenient streets in Khedival Cairo is determined. It starts by extracting the streets' characteristics of the international case studies. Following by the final selection criteria of Khedival Cairo Streets.

5.1. Reasons to implement complete streets in Khedival Cairo

5.1.1. Borders of Khedival Cairo

Khedivial Cairo serves as the central area within Downtown Cairo (A. Shalaby and T. Omar, 2022). Encompassing an approximate area of six square kilometers on the eastern bank of the Nile, it is surrounded by contemporary neighborhoods of Greater Cairo in all directions. Notably, it shares borders with historic Cairo to

the east, the Nile to the west, Ramsis Square to the north, and the Garden City area to the south. Khedivial Cairo is consisting of five districts: El-Azbakeya, Abdin, Kasr El-Nil, El-Mosky, and a section of El-Sayda Zeineb (Ibrahim et al., 2021).

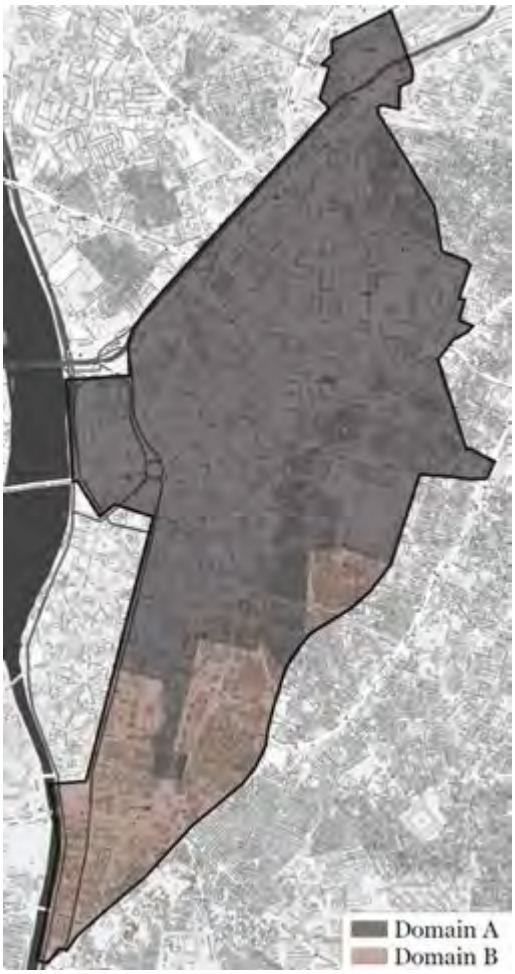


Figure 5. 1 - Khedival Cairo Region. Data: Ministry of Culture and NOUH (2022). Source: Author

5.1.2. Location of Khedival Cairo

In academic literature, the Central Business District (CBD) is defined as the central hub of a city, encompassing its commercial, office, retail, and cultural activities. It serves as a central location for transportation networks. This area is typically distinguished by a dense concentration of retail and office buildings. Additionally known as a central activity district, it represents the commercial and geographical core of a city and is often referred to as "downtown" or "city center" (Eldeen, 2013). The Khedivial downtown area in twenty-first century Cairo clearly aligns with ontological city planning theories. These theories propose that the city center should be strategically situated at a geographically central location, serving as the economic and activity hub of the city (Eldeen, 2013). For a century, Khedivial Cairo has served as the political, financial, and commercial center of Egypt (Embaby, 2015). It encompasses the central business district situated amidst Cairo's prominent squares, namely Ramses, Ataba, Abdulmonem Ryad, Abdeen, and El Tahrir. This district is widely recognized as the most densely populated area in Cairo (Ghoneem, 2013). Moreover, Khedivial Cairo holds significant prominence as one of Egypt's foremost commercial regions (Khalil et al., 2017). It has emerged as the primary business hub and a highly prosperous area, particularly following the relocation of the commercial and economic center from Moski and Clot Bey Streets to downtown. This transition has transformed streets like Fouad I (currently known as 26 July Street), Adly, Sherif Basha, Abd El-Khalek Tharwat, Emad El-Deen, Kasr El-Nil, and several others into the city's most distinguished streets (Hawas, 2022).

5.1.3. Urban value

Khedivial Cairo was meticulously planned and designed by French architects commissioned by Khedive Ismail, who emphasized the significance of European-style urban planning in Cairo. The architectural vision included the incorporation of broad, linear gridded streets, geometric harmony, and modern European architectural styles (A. Shalaby and T. Omar, 2022). The distinctive feature of this area is its wide streets intersecting in a network pattern, with major streets

leading to spacious squares adorned with statues of notable figures (Ibrahim et al., 2021). Spanning 700 acres, Khedivial Cairo is often regarded as an open museum due to its unique architectural and urban characteristics, further enhanced by its extensive Nile frontage (Khalil et al., 2017; Hawas, 2022). Notably, the National Organization for Urban Harmony (NOUH) officially designated the area as a heritage district and named it "Khedivial Cairo" (A. Shalaby and T. Omar, 2022; Hawas, 2022).

To provide additional insights, Khedivial Cairo is distinguished by its well-designed pedestrian paths that seamlessly integrate with the main and secondary road networks. This can be observed through the presence of wide sidewalks constructed in accordance with appropriate technical specifications, such as using basalt stone pavers. In certain areas, the sidewalks are covered by arcades, such as along Muhammed Ali and Clot Bey Streets, as well as in the Behler passageway. These paths, intersecting with the buildings, form an integral part of the urban fabric, facilitating the establishment of commercial activities and shopping lanes, leading to the presence of numerous small shops and entertainment venues like cafes. Furthermore, these paths are designed to ensure proper ventilation and shading, encouraging pedestrian movement while maintaining a human-scale environment that safeguards pedestrians from the hazards associated with streets and automobiles (Hawas, 2022).

5.1.4. Functional & Cultural values

During the late 19th century, Khedivial Cairo held the position of being the cultural and political center of Cairo (Imam et al., 2020). It encompassed the most prosperous activities and areas of international significance, while secondary and fewer desirable activities were directed towards the outskirts (Ibrahim et al., 2021). The cultural significance of Khedivial Cairo is exemplified by its notable buildings, including the Egyptian Museum, Abdeen Palace and Museum, Ramses Railway Station, Saad Zaghloul Mausoleum, Islamic Art Museum, Supreme Court, Post Museum, historically significant squares, and the

People's Assembly Museum (Parliament). Additionally, there are various cultural landmarks within the area, such as Emad Al Dine Street, known for its theaters and cinemas, Opera Square, as well as cultural centers like the French, Indian, and Japanese Cultural Centers, Arab League, Cairo Writers and Painters Atelier (Atelier du Caire), and numerous art galleries (Khalil et al., 2017). Particularly, Downtown Cairo is recognized as an appealing destination for visitors to explore and enjoy a wide range of cultural and entertainment venues, including window shopping, cinemas, cabarets, and simply strolling through the streets (Abdelaal, 2021).

It is important to acknowledge that the 2011 revolution served as an inspiration for various initiatives aimed at undertaking long-term projects in Downtown Cairo. In response, a multitude of urban activists emerged, seizing opportunities for cultural and artistic production. Furthermore, the revolution yielded significant outcomes in the realm of film, music, theater, dance performances, visual art, and photography. Notably, Mahatat for Contemporary Art, an initiative focused on community art projects in public spaces, conducted two artistic interventions in Lazoughli Square within the Mounira neighborhood. Additionally, independent cinemas like Zawya and Cimatheque were established, showcasing alternative films, documentaries, and experimental works from around the world. In summary, Downtown Cairo represents a highly contested area due to its symbolic significance rooted in its urban history and diverse cultural fabric (Abdelaal, 2021).

Figure 5. 2 - Cultural buildings in Khedival Cairo. Data: Ibrahim et al (2021); Fahmy (2014). Source: Author

5.1.5. Existing public transportation network

Ensuring effective public transportation involves establishing connectivity between public spaces in the city center and other areas, with a particular emphasis on integrating the underground train system (Metro)(Ghoneem, 2013). According to Pueboobpaphan et al. (2022), the determination of a station's location and its service coverage area relies on establishing the appropriate walking distance that is acceptable for individuals for accessing public transit. Transit-oriented development planners commonly adopt an acceptable walking distance of 800 meters (equivalent to a 10-minute walking duration). Furthermore, empirical evidence from various cities reveals varying mean walking distances to metro stations: 320 meters in Bangkok, 590 meters in Delhi,

and 1500 meters in Munich. Previous research has consistently demonstrated that the walking distance to transit stations varies depending on the location, generally being longer in areas situated outside the central business district (CBD) compared to those within it. Additionally, sociodemographic factors such as gender, age, vehicle ownership, and household size have been identified as potential influencers on walking distance (Pueboobpaphan et al., 2022). In the case of Khedival Cairo, it is surrounded by eight metro stations, where each metro station has a service coverage of 1000 m (as shown in Figure 5.3). Furthermore, Figure 5.4 shows the transit trips passing by Khedival Cairo, and the locations of terminals as well. It should be noted that transportation means include CTA, minibuses and microbuses.

Figure 5. 3 - Metro Stations in Khedival Cairo. Source: Fahmy (2014)

Figure 5. 4 - Public transportation trips and public terminals in khedival Cairo. Data: TFC (2022). Source: Author

5.1.6. Khedive Cairo revitalization strategy

The ongoing project led by the National Organization for Urban Harmony (NOUH), known as the "Restoring the Civilized Face of Khedivial Cairo," serves as a promising model for rejuvenating the area and preserving its distinctive character. Additionally, the project aims to explore the potential of repurposing the administrative buildings in Khedivial Cairo, as numerous government agencies are planning for relocation to the New Administrative Capital, currently under construction east of the city. The outcome of this recent development and its impact on Khedivial Cairo's future is yet to be determined (Hawas, 2022). In fact, the initiative to relocate governmental buildings to a new city was first undertaken by Egyptian President Sadat, who established Sadat City in the late 1970s with intentions of shifting the central administration from Cairo to that city. However, Sadat's sudden passing halted these plans. In present times, Egypt has identified a new administrative capital project, which commenced in 2015 and has gained significant prominence. At the heart of this new administrative capital lies a district known as Residential District Five, commonly referred to as "the new Garden City." The designers involved in the project are carefully integrating the distinct architectural features of Khedivial Cairo and the renowned Garden City district in old Cairo (Abouelmagd and Ahmed, 2021).

Furthermore, the revitalization strategy for Khedivial Cairo emerged as part of the Cairo 2050 Development Plan (Ibrahim et al., 2021). In line with this plan, the General Organization for Physical Planning (GOPP) initiated an international competition in collaboration with the National Organization for Urban Harmony (NOUH) and the Cairo Governorate in 2010. The competition sought proposals for the revitalization of Khedivial Cairo, with the winning entry being submitted by Associated Consultants Egypt (ACE), led by Dr. Sahar Attia, an architect, urban planner, and the Head of Cairo University's Architecture Department. Dr. Attia's winning proposal was intended to be integrated into the Cairo 2050 vision and entailed a comprehensive urban transformation of downtown Cairo. The proposal included the pedestrianization of numerous streets, the introduction of

green spaces and plazas at strategic locations, and the establishment of more pedestrian connections to the left bank of the Nile. A key aspect of the proposal was to enhance mobility within downtown by implementing pedestrian-only streets, and tram systems, and redirecting some vehicular traffic along the Nile Corniche through a tunnel, thus creating a public space between downtown and the Nile. However, these plans were formulated before the 2011 revolution, which paused all ongoing initiatives (Awatta, 2015).

The events at Tahrir Square brought social-spatial justice issues to the forefront, leading to renewed attention on the revitalization plans for Khedivial Cairo (Attia, 2013). Consequently, in late 2014, the executive committee, under the leadership of the Governor, announced the initiation of a comprehensive development project to revive Khedivial Cairo. This revitalization effort was regarded as a national project due to the involvement of multiple ministries and government entities, each contributing their expertise, and the diverse sources of funding. In line with the goal of preserving the city's identity, a crucial part of the revitalization process involved the conservation of historical structures that contribute to the city's image. Accordingly, the main focus of Khedivial Cairo's revitalization was to enhance urban spaces, including squares, sidewalks, and pedestrian paths, while simultaneously conserving the facades of heritage buildings (A. Shalaby and T. Omar, 2022).

At the urban level, several streets underwent pedestrianization, such as Al-Alfy Street, Al-Shawarby Street, Al.Sharefeen Street, and Saraya Al.Azbakia Street, as part of the revitalization process (A. Shalaby and T. Omar, 2022). These efforts aimed to create a pedestrian-friendly city center by banning vehicular traffic and providing a safer environment for people to enjoy entertainment activities, including fast food outlets, restaurants, cafes, and cabarets that aligned with the new character of the streets. However, it is important to note that the focus was primarily on physical improvements, such as paving, basic street furniture installation, and building frontage clean-up, rather than comprehensive social

upgrading. The approach taken during this period was more experimental, lacking a well-studied strategy regarding traffic, urban design, and activities. Additionally, stakeholders were not totally involved in the decision-making process (Ashour and Braker, 2020).

Figure 5. 5 - Pedestrianized streets in Khedival Cairo. Data: Fahmy (2014); Cluster mapping initiative (2015). Source: Author

5.1.7. Other initiatives

In 2016, Cairo Governorate, with the support of the Drosos Foundation and technical assistance and supervision from the Institute for Transportation and Development Policy and the United Nations Human Settlements Programme, introduced Egypt's first public bike-sharing system (UN-Habitat, 2022; Institute for Transportation and Development Policy, 2022). This initiative strategically places bike-share stations near metro stations, bus terminals, and public spaces, aiming to enhance accessibility and encourage multi-modal transportation (Institute for Transportation and Development Policy, 2022). The implementation of this project occurs in multiple phases, with the initial phase consisting of 250 bikes and 25 stations in downtown Cairo and nearby areas (UN-Habitat, 2022). Recently, the Cairo governorate initiated the renovation of the existing 26 bike-sharing stations in downtown Cairo, Zamalek, and Garden City, starting with the installation of 26 new stations and 250 bicycles in downtown Cairo. Further plans include expanding the system to a total of 45 stations and 500 bicycles throughout the capital in the coming months. The revamp aims to meet international standards and technical specifications following a comprehensive evaluation that revealed unsatisfactory conditions of the existing stations and bikes (Cairo Scene, 2023).

Figure 5. 6 - Cairo Bike Project in Downtown. Source: Official Facebook Page of Cairo governorate

5.2. Streets selection criteria methodology

As mentioned in Chapter 3, one of the purposes of studying international case studies is to understand the attributes of transformed streets in international cases. Moreover, it aims to establish convenient criteria for selecting suitable streets in Cairo. For this reason, fundamental street characteristics of the international case studies were collected, including street length, right of way, sidewalk width and carriageway width (as shown in Table 5.1). These street characteristics served as the basis for developing criteria that encompassed the potential ranges of the street attributes.

5.2.1. Criteria of selecting streets:

1. The selected streets should be mixed-use streets.
2. The selected streets are not pedestrianized streets.
3. The scale of the area under study within streets should be within the range of 500 to 1100 meters length.
4. Regarding the right of way (ROW), the selected streets should range between 15 and 30 meters. For further details, the carriageway width should extend between 4 and 13 meters in total. While the sidewalks should cover a pedestrian path of width ranges between 2 and 3.5 meters.

Table 5. 1 - Street characteristics of the international case studies. Source: Author

Street Characteristics		International Case Studies						
		Avenida 16 de Septiembre	Rua Voluntários Da Pátria	João Alfredo Street	Rua Miguel Calmon	Aundh DP Road	Second Avenue	Pondy Bazaar
Context		Historic Center of the city	Center of the city	Neighbour-hood	Historic Center of the city	Neighbour-hood	Neighbour-hood	Commercial core of district centre
Land use type		Mixed-use street	Mixed-use street	Mixed-use street	Mixed-use street	Mixed-use street	Mixed-use street	Commercial street
Street length (m)		700 m	650 m	650	1100 m	520 m Segment	500m	700 m Segment
Right of way (m)		14-15	15-20	16-18	20-24	24-30	25-30	27-30
Sidewalk width	Muti-utility zone (m)	1.5	1.8	1.5	1.5	2.5	2	-
	Pedestrian zone (m)	3	2	2	2	3.5	2	3
Carriageway width (m)		4	4	7.5	12-13	6m on each side	11-12	6.5
Direction of travel		One-way	One-way	Two-way	One-way	Two-way	Two-way	One-way

5.2.2. Selection methodology

Based on the established criteria, a comprehensive exploration of all possible streets was conducted, leading to the selection of seven streets for further analysis. Among these, five streets were located in the Downtown area, while the remaining two streets were situated in the El-Monira district as shown in Table 5.2. It is important to note that numerous streets were excluded from consideration due to the presence of obstacles on the sidewalks, such as trees, streetlights, and other facilities. For instance, a significant segment of Mohamed Farid Street possessed an adequately wide sidewalk, however, the placement of street trees and streetlights hinder pedestrian movement, as illustrated in Figure 5.7. Furthermore, Al-Falki Street, Magles El-Shaab Street, and El-Sheikh Rihan were excluded as large segments include extensive institutional/ governmental uses.

Figure 5. 7 - Blocking of the sidewalk in Mohammed Farid Street. Source: Author

Table 5. 2 - The list of selected Streets in Khedival Cairo. Source: Author

Selected Streets	Street Characteristics				
	Street length (m)	Right of way (m)	Sidewalk width		Carriage-way width (m)
			Muti-utility zone (m)	Pedestrian zone (m)	
Kasr El-Nil Street	800m segment	18-20	0.8-1.6	1.6-2	12
Talaat Harb Street	1000 m	19-22	08-1.6	1.6-2	10.5-12
Adly Street	550 m	20-25	0.9-2.1	1.5-2.7	12-13
Abd El-Khalek Tharwat Street	600 m segment	20-24	1.2	1.6-2	12-13
Sherif Basha Street	620 m segment	20-24	0.8-1.2	1.6-2	12-13
Mohammed Ezz Al-Arab Street	800 m	18-20	0.6-0.9	1.5-2	12-13
El-Sheikh Ali Youssef Street	730 m	16-18	0.9	1.5-2	12

Figure 5. 8 - Selected Streets in Downtown area. Source: Author

It is worth mentioning that a specific segment of Kasr El-Nil Street was excluded (between Meret Basha to Talaat Harb Square) as streetlights and trees were obstructing pedestrian movement as shown in Figure 5.9.

Figure 5. 9 - Excluded Street segment in Kasr El-Nil Street due to sidewalk blocking. Source: Author

Figure 5. 10 - Selected Streets in El-Monira District. Source: Author

5.3. Conclusion

Generally speaking, Khedival Cairo has been identified as an appropriate area for implementing the complete street policy. As previously discussed, this region possesses various advantageous factors, including its strategic location, well-established public transportation network, and ongoing revitalization strategy. Moreover, the seven streets have been specifically chosen for their substantial potential to be transformed into complete streets, comparatively with other streets. The subsequent chapter will analyze these seven streets in accordance with the street elements of the complete street policy. It's worth mentioning that the research focuses on the street segments, excluding intersections.

Findings and Analysis

Based on established criteria for complete streets, an empirical assessment was conducted to evaluate the selected streets in Khedival Cairo. The study aimed to assess the level of completeness of the selected streets. It is important to emphasize that the analysis of streets encompassed three distinct stages. First of all, check the achievement/non-achievement of complete street elements. Then, numerical values, such as dimensions and spacings, were analyzed. Subsequently, the visual aspects of the streets were studied, suggesting specific recommendations by referring to complete street policy. Recommendations are provided to address the non-achieved street elements. At last, a questionnaire was conducted for validating initial results, where the purpose of the questionnaire is to understand the level of satisfaction of street visitors and to conclude the lacked street elements from the users' perspective.

6.1. Case study methodology

6.1.1. Data collection approach

The case study was built on both primary and secondary data collection methods. To demonstrate, the case study went through 3 steps, where in the first step, there was a field visit to check the existence of the complete street elements by mainly using observation method. Then, the second step was foremost collecting the quantitative data of street elements' measurements by using two methods. For instance, the first method is a measuring mobile application which is based on augmented reality (ARular app), where the margin of error is equal to ±1 cm. Another method is counting sidewalk tiles (knowing the dimensions of the floor tile), which was used for verifying the numbers determined from the measuring mobile application. In addition to collecting qualitative data to further analyze street elements, to compare them to the benchmark of complete street policy. In the same way, qualitative data were collected by mapping the locations of street elements and by taking photos as much as possible to capture different street elements, as well as different types of street encroachments. Generally, both step one and step two took five days of fieldwork, where the fieldwork was conducted at three different times of day in all seven streets. Accordingly, the data were collected in the morning from 9 am to 12 pm, in the afternoon from 2 pm to 5 pm, and in the evening from 7 pm to 9 pm. Regarding step 3, it is considered a validation process for the conclusion of step 1 and step 2. To clarify, a questionnaire was conducted to understand the level of satisfaction of street users, and the deficiencies in the exiting street design elements according to the users' experience. The following section is focused on step 1 and step 2.

6.1.2. Data analysis approach

After verifying the existent street elements in all seven streets in step 1, data were visualized in a form of a table, to deduce the data to be measured in step 2. Given that step 1 identified the achieved and non-achieved street elements, thus, the protocol for collecting data for the achieved elements were classified as following:

Quantitative collected data:

1. Curb height
2. Spacing of streetlights
3. Spacing of trash bins
4. Spacing of trees
5. Dimensions of Accessibility ramps
6. Width of cycle lane
7. Height of bollards
8. Spacing of bollards

Qualitative collected data:

1. Uniformity & Continuity of pedestrian zone
2. Distribution of shading trees
3. Distribution of street lighting
4. Distribution of street furniture
5. Location of accessibility ramps and tactile pavers.
6. Location and type of street encroachments
7. Locations of curb extension & on-street parking
8. Efficiency of bike lanes and bike parking
9. Locations of traffic signals
10. Location of bus stops and shelters

After collecting the previously mentioned points in step 2, data were analyzed through a visualization analysis for the qualitative data as well as a numerical analysis for the quantitative one. Each street was analyzed compared to the benchmark of complete street policy. The output analysis will be the following:

1. Numerical comparison between complete street elements' dimensions and selected streets' dimensions.
2. Visual analysis for the location/type/availability of street elements.
3. Recommendations for non-achieved street elements based on complete street policy.

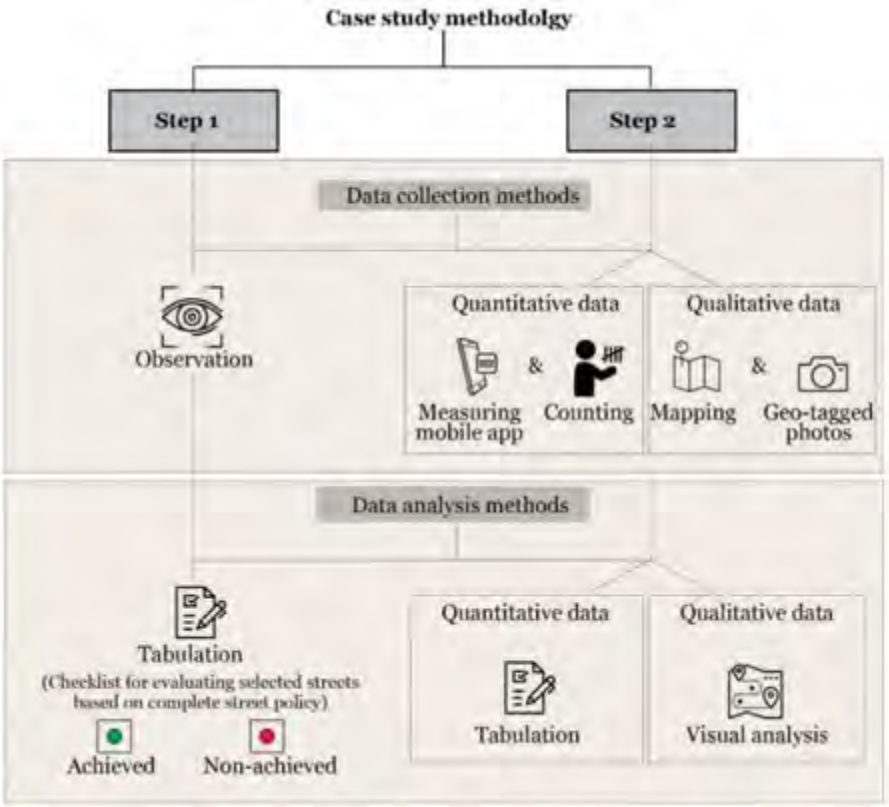


Figure 6. 1 - Case study methodology. Source: Author

6.2. Field visit results

6.2.1. Step 1: Checklist evaluation of the selected streets based on complete street policy

By comparing to the complete street policy, the field visit showed that seven elements out of twenty-two have already been achieved in all streets. More specifically, the other fifteen elements are classified into nine nearly achieved elements in most of the cases and six remaining elements that are not achieved at all (as shown in table in table 6.1). Consequently, the next section is divided into two categories: the achieved elements and the non-achieved elements. To clarify, the achieved points are analyzed in accordance with the benchmark of complete street policy. Whereas the research suggested a number of recommendations for the non-achieved elements in the selected streets in Khedival Cairo.

Table 6. 1 - Checklist evaluation of the selected streets based on complete street policy (Step 1). Source: Author

Street Characteristics				Selected streets in Khedival Cairo						
				Kasr El-Nil	Talaat Harb	Abd Elkhalek Tharwat	Adly	Sherif Basha	Mohammed Ez El-Arab	El Shaikh Ali Youssef
1	Pedestrians	Multi-utility zone		🟢	🟢	🟢	🟢	🟢	🟢	🟢
2		Pedestrian zone		🟢	🟢	🟢	🟢	🟢	🟢	🟢
3		Frontage zone		🔴	🔴	🔴	🔴	🔴	🔴	🔴
4	Bicyclists	Bike lane	High speed road	🔴	🔴	🔴	🔴	🔴	🔴	🔴
5			Low speed road	🟢	🟢	🔴	🔴	🔴	🔴	🔴
6		Bike sharing		🔴	🔴	🔴	🔴	🔴	🔴	🔴
7		Bike parking		🟢	🟢	🟢	🔴	🟢	🔴	🔴
8	Transit	Bus shelters		🔴	🔴	🔴	🔴	🟢	🟢	🔴
9	Marked crosswalks			🔴	🔴	🔴	🔴	🔴	🔴	🔴
10	Traffic signals			🟢	🟢	🟢	🟢	🟢	🟢	🟢

	Street Characteristics	Selected streets in Khedival Cairo						
		Kasr El-Nil	Talaat Harb	Abd Elkhalek Tharwat	Adly	Sherif Basha	Mohammed Ez El-Arab	El Shaikh Ali Youssef
11	Raised crossings	🔴	🔴	🔴	🔴	🔴	🔴	🔴
12	Curb extensions	🔴	🔴	🔴	🟢	🔴	🔴	🔴
13	Shade and Landscaping	🟢	🟢	🟢	🟢	🟢	🟢	🟢
14	Streetlights	🟢	🟢	🟢	🟢	🟢	🟢	🟢
15	Benches	🔴	🟢	🔴	🔴	🔴	🔴	🔴
16	Trash bins	🟢	🟢	🟢	🟢	🟢	🟢	🟢
17	Signage	🟢	🟢	🟢	🟢	🟢	🟢	🟢
18	Ramps	🟢	🟢	🟢	🟢	🔴	🟢	🔴
19	Tactile pavers	🟢	🟢	🟢	🔴	🟢	🔴	🔴
20	Safety Bollards	🟢	🟢	🔴	🟢	🟢	🟢	🟢
21	On-street parking	🔴	🔴	🟢	🟢	🟢	🟢	🟢
22	Fixed spaces for street vending	🔴	🔴	🔴	🔴	🔴	🔴	🔴
	Total scores	12	13	11	11	12	11	8

Key: 🟢 Achieved 🔴 Non-achieved

Table 6. 2 - Assessment of achieved street elements (numerical analysis of step 2).
Source: Author

Street Elements	Complete street policy			Selected streets						
	Min.	Avrg.	Max.	Kasr El-Nil	Talaat Harb	Abd Elkhalek Tharwat	Adly	Sherif Basha	Mohammed Ez El-Arab	El Sheikh Ali Youssef
Curb Height	0.1	0.15	0.17	0.35	0.1-0.3	0.17	0.18	0.12	0.17-0.35	0.25-0.3
Spacing of streetlights	30	-	36	24-26	30-33	18-28	24-27	22-27	19-24	20-22
Spacing of trash bins	-	20	-	25-30 (wherever exist)	10-40 (wherever exist)	20-45	15-45	7-40	20-90	scattered intervals
Spacing of trees	5		10	4-13.5	3.5-40	6-16	5-7	4-22	2.4-20	4-16
Dimensions of ramps (W*L)	-	1.2*1.2	-	1.2*1.3	1.2*1.2	Width: 1.5	0.7*2	-	1*1.4	-
Width of cycle lane	1.5	2	-	1.7	2	-	-	-	-	-
Spacing of bollards	0.815	1	1.5	0.85	0 .9	-	1.2	1.4-2	1	1.5
Height of bollards	0.9	-	1.2	1	1	-	0.65-0.7	1.2	0.65	0.8

Key: Within range | Out of range | Intermediate | Not exist

6.2.2. Step 2: Assessment of achieved street elements

6.2.2.1. Numerical analysis

After determining the protocol of the quantitative data, the following elements were measured in the seven selected streets in order to identify if any of the results (measurements) are below the accepted level (as shown in table 6.2).

- Curb height

According to complete street policy, curbs with a height of no more than 0.15 m are most commonly used (Institute for Transportation and Development Policy, 2013; City of Memphis complete streets plan, 2020), as high curb heights hinder footpath accessibility (Kost and Nohn, 2011). On the other hand, it was obvious that most streets have higher curb height; except for Sherif Basha Street. In addition, the curb height in Talaat Harb Street keeps changing from 0.1 cm to 0.3 cm (as shown in figure 6.2).

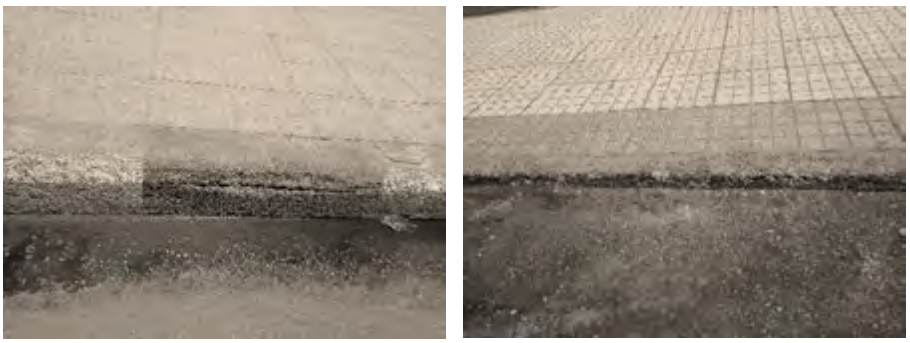


Figure 6. 2 - Curb height in Talaat Harb Street. Source: Author

- Spacing of streetlights

It was concluded from different references for complete street design that the spacing of streetlights is calculated based on streetlight height. By measuring the height of streetlights in the selected street, it was concluded that spacing should range from 30 to 36 m (Kost and Nohn, 2011; Institute for Transportation and Development Policy and UN-Habitat, 2022). Unexpectedly, most of selected streets have spacings less that the required spacing, only spacing of streetlights in Talaat Harb Street range between 30 and 33 m.

- Spacing of trash bins

According to complete street policy, on streets with high pedestrian volume and commercial activity, trash bins should be placed at regular 20 m intervals (Kost and Nohn, 2011; Institute for Transportation and Development Policy and UN-Habitat, 2022). Despite this fact, it was noted in the field visit that most selected streets have spacious spacing intervals that exceed mostly the identified range. For instance, around four streets out of seven have spacing intervals that reach 40 m.

- Spacing of trees

Without a doubt, the spacing between trees is determined based on canopy size for a continuous shade. However, the standard interval ranges between 5 and 10 m between trees (Institute for Transportation and Development Policy and UN-Habitat, 2021; Institute for Transportation and Development Policy and UN-Habitat, 2022). In the selected streets, it is worth mentioning that trees are not distributed at equal intervals, thus, each street has a minimum and maximum spacing within the range. For this reason, it was concluded that the trees' spacing in two out of seven streets lie totally within the range. In the rest of the seven streets, the minimum spacing lies within the range, while the maximum spacing lies out of range.

- Dimensions of ramps

For ensuring accessibility for wheelchair users and assistive devices, a curb ramp should be 1.2 m wide 1.2 m depth (as shown in figure 6.3) (Chicago Metropolitan Agency for Planning et al., 2015). It was observed that five streets only out of seven have accessibility ramps. More specifically, Kasr El Nil Street, Talaat Harb Street and Abd El Khalek Tharwat Street are the only three streets which achieve adequate dimensions for the ramps. While Adly Street and Mohammed Ezz El Arab Street have unsuitable dimensions for the ramps.

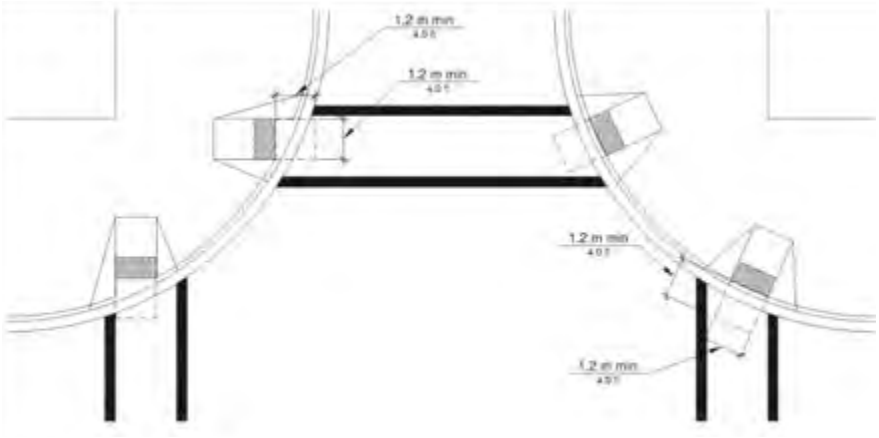


Figure 6. 3 - Proposed accessibility guidelines for curb ramp. Source: Chicago Metropolitan Agency for Planning.

- Width of cycle lane

Considering the clear width of the cycle lane, it should be 1.5 m at a minimum; however, a 2 m width is more encouraged for one-way movement. The clear width is the width free from obstructions like utility poles (Kost and Nohn, 2011; City of Memphis complete streets plan, 2020; Institute for Transportation and Development Policy and UN-Habitat, 2022). Notably, bike lanes are existing only in both Kasr El-Nil Street and Talaat Harb Street (as shown in figure 6.4 and figure 6.5 respectively. In addition, both streets have a proper cycle lane width.

Figure 6. 4 - Bike Lane in Kasr El-Nil Street. Source: Author

Figure 6. 5 - Bike Lane in Talaat Harb Street. Source: Author

- Spacing of bollards

According to different references, bollards define pedestrian spaces and prevent vehicles from crossing. A minimum spacing of 0.815 m is required for wheelchair passage; normally 1 m to 1.2 m is preferred (Kost and Nohn, 2011; Institute for Transportation and Development Policy and UN-Habitat, 2021; Institute for Transportation and Development Policy and UN-Habitat, 2022). Indeed, most of the selected streets have safety bollards except for Abd El Khalek Tharwat Street. In particular, five out of seven streets are achieving adequate spacing of bollards.

- Height of bollards

Similarly, Bollards should have a height which ranges from 0.9 m to 1.2 m (City of Memphis complete streets plan, 2020; Institute for Transportation and Development Policy and UN-Habitat, 2021). It was observed that Kasr El-Nil Street, Talaat Harb Street and Sherif Basha Street are the only three streets which achieve adequate height for bollards.

6.2.2.2. Visual analysis

Qualitative data collection involved the use of mapping reality and geotagged photos in all seven streets, as described in the methodology. The primary objective of this section is to comprehensively evaluate the selected streets by analyzing various aspects such as distribution, location, quality, and type of facilities. Visual analysis is illustrated distinctly, beginning with a review of the benchmark of complete street policy and then assessing the condition of each street individually. Furthermore, after each point of analysis, there is a section dedicated to inferences and recommendations regarding the overall condition of the selected streets (if exist). It is worth noting that, for ease of data collection and analysis, six out of the nine points required dividing the streets into smaller segments. For example, Kasr El-Nil Street is divided into three segments, Talaat Harb Street into four segments, and the rest of the streets into two segments.

- Uniformity & Continuity of pedestrian zone

Benchmark of complete street policy: The pedestrian zone should provide continuous walking space of 2 m wide; free of any obstructions that hinder pedestrian movement. To clarify, placing of trees, streetlights and utility on the pedestrian zone may push pedestrians to use the carriageway (Kost and Nohn, 2011; Institute for Transportation and Development Policy, 2013).

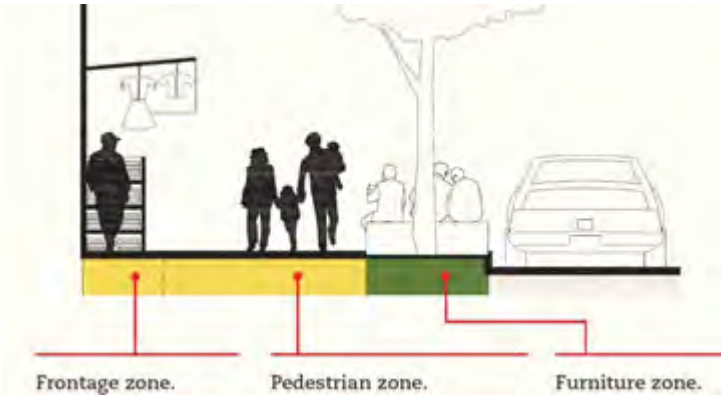


Figure 6. 6 - Sidewalk zoning design. Source: Institute for Transportation and Development Policy.

Kasr El-Nil Street: As obvious in (figure 6.7), street furniture and streetlights are entirely placed within the furniture zone, leaving adequate space for pedestrians. Moreover, the pedestrian zone in Kasr El-Nil Street is almost 2 m wide; nevertheless, in some segments, the pedestrian zone reaches 1.6 m.

Figure 6. 7 - Pedestrian zone in Kasr El-Nil Street. Source: Author

Talaat Harb Street: Likewise, pedestrian zone in Talaat Harb Street is defined, clear of any obstructions. Also, the pedestrian zone in Talaat Harb Street ranges between 1.6 m and 2 m (as shown in figure 6.8)

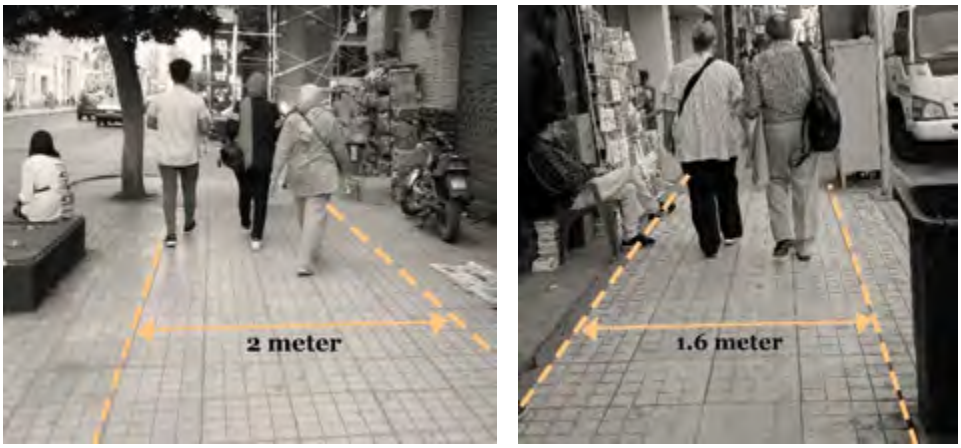


Figure 6. 8 - Pedestrian zone in Talaat Harb Street. Source: Author

Abd El-Khalek Tharwat Street: It was observed that trees in some segments were not on the same tree line, consequently, pedestrians' zone was varying between 1.6 m and 2 m (as shown in figure 6.9).

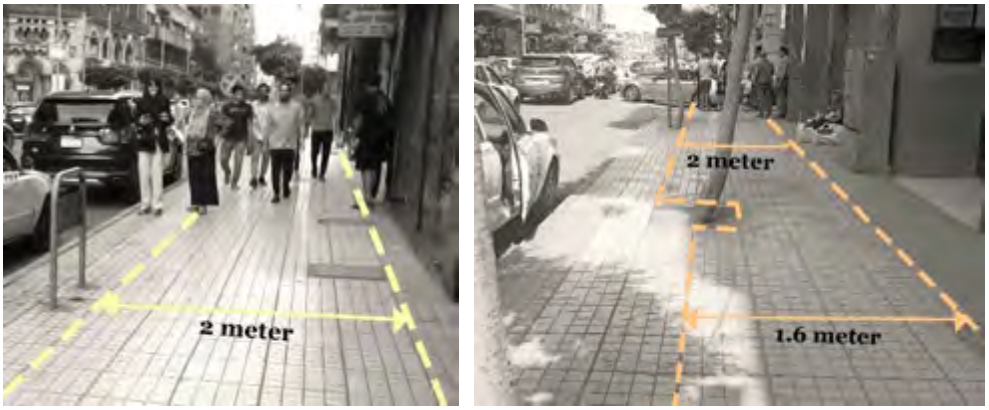


Figure 6. 9 - Pedestrian zone in Abd El Khalek Tharwat Street. Source: Author

Adly Street: In the case of Adly Street, the pedestrian zone on the right side of the street is almost clear of any obstructions, with a width range between 1.5 m and 1.8 m. On the left side, there is a curb extension for on-street parking; thus, the width of the pedestrian zone ranges between 1.2 m and 2.7 m.

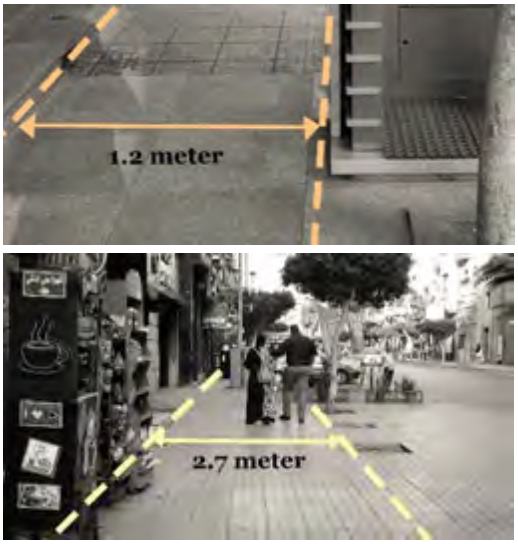


Figure 6. 10 - Curb extension in left side of Adly Street. Source: Author

Figure 6. 11 - Pedestrian zone of right side in Adly Street. Source: Author

Sherif Basha Street: The pedestrian zone in Sherif Basha Street is nearly similar to the one in Talaat Harb Street, where it is a clear space for pedestrian movement, free of street obstructions. Moreover, the pedestrian zone ranges between 1.6 m and 2 m (as shown in figure 6.12)

Figure 6. 12 - Pedestrian zone in Sherif Basha Street. Source: Author

Mohammed Ezz El Arab Street: The sidewalk of Mohammed Ezz El Arab Street is wide enough to provide a continuous space for pedestrian movement. To clarify, the pedestrian zone is a defined space, where it ranges between 1.8 m and 2 m in width.

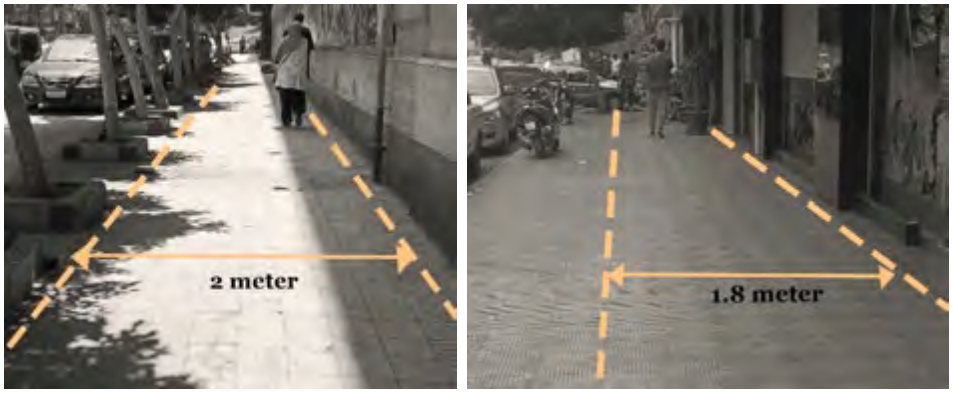


Figure 6. 13 - Pedestrian zone in Mohammed Ezz Al Arab Street. Source: Author

El-Sheikh Ali Youssef Street: In this case, the land uses differ along the street; hence, affecting the sidewalk width. To clarify, in the first part of the street, there are different uses as a public park, educational institutions and a school. While the other part of the street includes several medical supplies shops; these shops make encroachments on the sidewalk by placing the goods in front of their shops. Moreover, in some segments of the street, the trees and utilities are placed in the center of the sidewalk, leaving a narrow space for pedestrian movements (as shown in Figure 6.14).

Figure 6. 14 - Pedestrian zone in El Sheikh Ali Youssef. Source: Author

Inferences & Recommendations: Concerning uniformity and continuity of the pedestrian zone in the selected streets, it was concluded that Kasr El-Nil Street, Talaat Harb Street, Sherif Basha Street and Mohammed Ezz Al Arab Street are almost providing an adequate space for pedestrians. Conversely, sidewalks in some segments in Abd El Khalek Tharwat Street, Adly Street and El Sheikh Ali Youssef Street are narrow due to the unalignment of trees, street furniture and utilities. Yet, pedestrians are forced to walk along the carriageway. According to the literature, the minimum width of the pedestrian zone is 1.8 m to accommodate two wheelchairs beside each other. Regarding studied international case studies, all seven cases had taken actions towards sidewalks inaccessibility by widening sidewalks and narrowing the carriageway. Correspondingly, the narrow sidewalks should be widened; particularly, adding 1.8 m extension to the sidewalk, by narrowing the carriageway.

- Distribution of shading trees

Benchmark of complete street policy: Trees play a practical role, especially, if planted in proper distances to provide continuous shade for pedestrians, cyclists and vendors (Kost and Nohn, 2011; Institute for Transportation and Development Policy and UN-Habitat, 2022). According to City of Memphis complete streets plan (2020), the medium-sized tree has a canopy ranging between 1.5 m to 2 m. In addition, large-sized tree has a canopy ranging between 2 m to 3 m.

Kasr El-Nil Street: As mentioned in Step 2, Kasr El-Nil Street is one of those streets that has minimum tree spacing which lies within the range and a maximum tree spacing which lies out of range. Also, the trees in Kasr El-Nil Street are medium-sized trees, on the hand, they do not provide complete shading (as shown in figure 6.15). Moreover, figure 6.16 shows that the continuity of shading trees is on average, as some segments lack trees.

Figure 6. 16 - Trees' canopy size in Kasr El-Nil Street. Source: Author

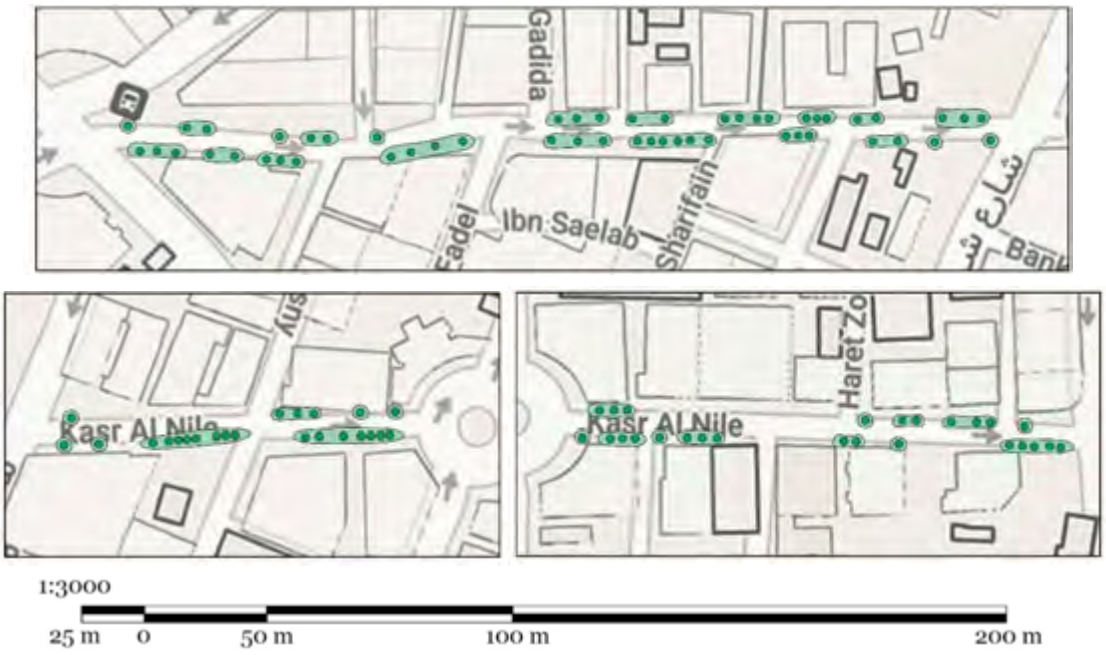


Figure 6. 15 - Trees distribution in Kasr El-Nil Street. Source: Author

Talaat Harb Street: It was observed that the trees grouping is randomly planted. By analysing the following photo in Figure 6.17 and maps in Figure 6.18 respectively, it was found that the street is almost not shaded. To demonstrate, the number of planted trees is too few to provide the proper shading in accordance with street length.

Figure 6. 17 - Trees' canopy size in Talaat Harb Street. Source: Author

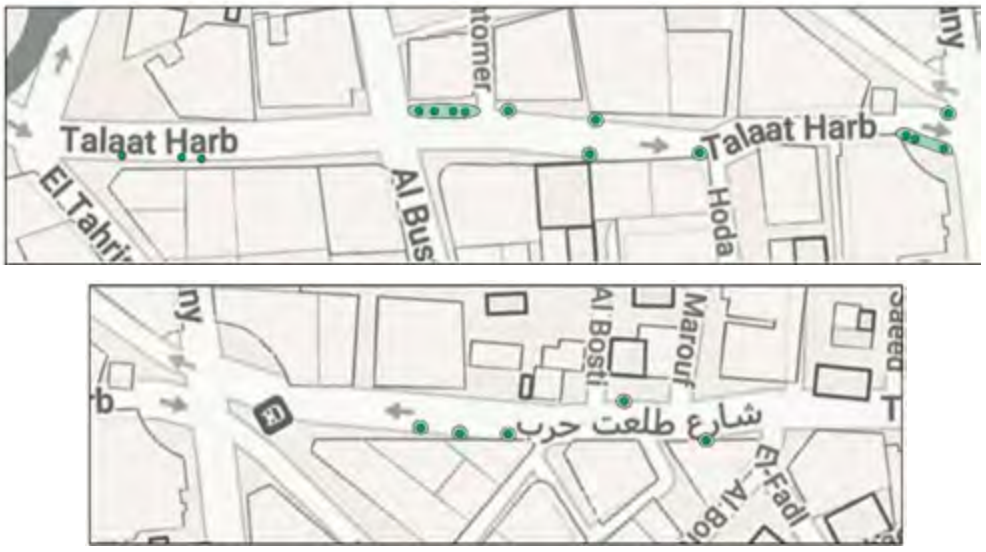


Figure 6. 18 - Trees distribution in Talaat Harb Street. Source: Author

Abd El-Khalek Tharwat Street: The trees in Abd El-Khalek Tharwat Street are not planted continually. As observed, some segments are continuously shaded, others have a few numbers of randomly planted trees. What's more, the right side of the street segment extended between Sherif Basha Street and Talaat Harb Street is totally unshaded (as shown in figure 6.19).

Figure 6. 19 - Trees' canopy size in Abd El-Khalek Tharwat Street. Source: Author

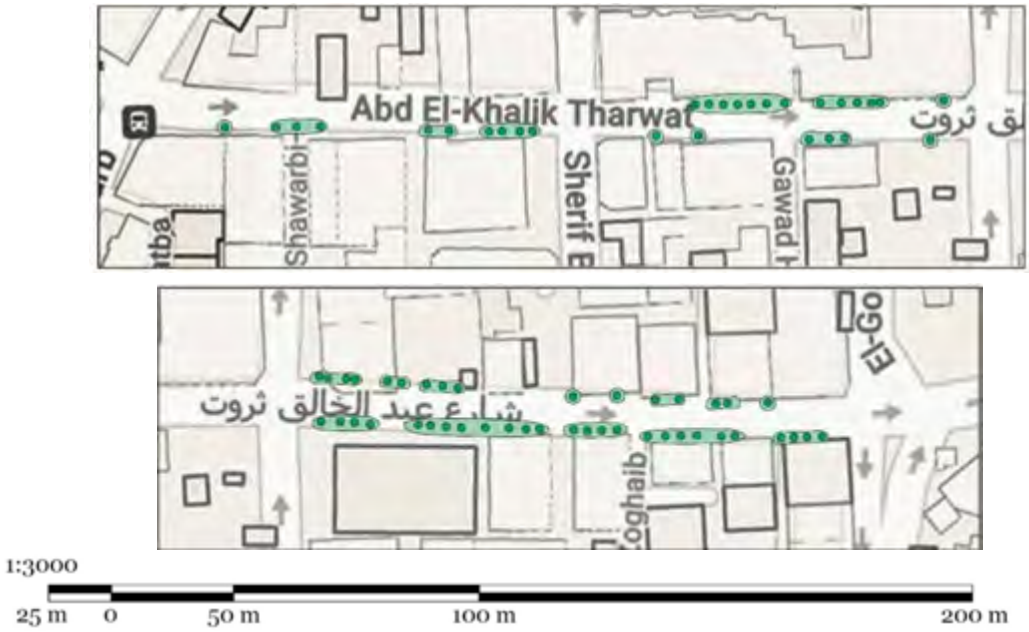


Figure 6. 20 - Trees distribution in Abd El-Khalek Tharwat Street. Source: Author

Adly Street: Results of Step 2 show that the spacing of trees in Adly Street seems to be adequate, however, trees are not regularly distributed in the whole street. For instance, most segments - such as the one extended between Mohammed Farid Street and Sherif Basha Street - are greatly shaded. While there are other segments - such as the one extended between Sherif Basha Street and Talaat Harb Street - are significantly unshaded continually (as shown in figure 6.21).

Figure 6. 21 -Trees' canopy size in Adly Street. Source: Author

Figure 6. 22 - Trees distribution in Adly Street. Source: Author

Sherif Basha Street: Unlike Adly Street, Sherif Basha Street is one of those streets that has minimum tree spacing which lies within the range and a maximum tree spacing which lies out of range. Nevertheless, by mapping trees' locations it was found that most segments have continuous tree groupings, except for limited areas.

Figure 6. 23 - Trees' canopy size in Sherif Basha Street. Source: Author

Figure 6. 24 - Trees distribution in Sherif Basha Street. Source: Author

Mohammed Ezz El Arab Street: As noticeable in Figure 6.25, the right side of the street, as you walk from El Nasereya Street to Qasr El Eyni Street, is unshaded to a great extent. Conversely, on the left side of the street, the trees are highly planted continuously. Although, in some segments, the tree spacing lies out of the recommended range.

Figure 6. 25 - Trees' canopy size in Mohammed Ezz Al-Arab Street. Source: Author

Figure 6. 27 - Trees distribution in Mohammed Ezz Al-Arab Street- Source: Author

El-Sheikh Ali Youssef Street: By mapping trees' locations in El Sheikh Ali Youssef Street, it was noted that trees are not planted regularly in all segments. To explain, in some segments, trees are planted continuously, while in others, trees are planted in a scattered way. For instance, in the first part of the street extended between Nasereya Street to Mansour Street, the trees are too few to provide sufficient shading. Regarding trees' canopy size, it was observed that El Sheikh Ali Youssef Street has large-sized trees, as a result, areas with proper tree spacing are quite shaded (as shown in figure 6.27).

Figure 6. 26 - Trees' canopy size in El Sheikh Ali Youssef Street. Source: Author

Figure 6. 28 - Trees distribution in El Sheikh Ali Youssef Street. Source: Author

Inferences & Recommendations: Overall, the trees' canopy in most of the streets is medium-sized, except for El Sheikh Ali Youssef Street. According to City of Memphis complete streets plan (2020), adequate space of no less than 1.5 m wide is necessary for accommodating a typical medium-sized street tree. Therefore, the medium-sized canopy is the most suitable for the selected streets by reference to streets characteristics mentioned in Chapter 5. Equally important, trees contribute to the comfort of street users by providing a pleasant environment for walking, cycling, and gathering (Kost and Nohn, 2011). Based on the findings, it was determined that six out of seven streets consisted of both shaded and unshaded segments, so, planting new trees is significantly recommended in areas lacking full continuous shade. In case of Talaat Harb Street, it is the least shaded street, almost all segments are lacking trees. Consequently, it is recommended to revitalize Talaat Harb Street by considering planting suitable trees in the whole street to enhance street shading. It is important to mention that Talaat Harb Street is a popular street in downtown; so, enhancing users' comfort is necessary, especially in the summer season.

- Distribution of street poles

Benchmark of complete street policy: Motor vehicle drivers, cyclists, and pedestrians can navigate securely when street lighting is effectively designed. Effective street lighting plays a substantial role, particularly in areas of potential conflict such as intersections. To calculate the illumination zone, the recommended spacing between two light poles is approximately three times the height of the lighting fixture. However, it is important to note that there are other factors affecting streetlights distribution as lux. Furthermore, for single-carriageways, both single-sided and staggered lighting systems are generally considered adequate. (Kost and Nohn, 2011; Institute for Transportation and Development Policy and UN-Habitat, 2022).

Figure 6. 31 - Spacing between light poles. Source: Institute for Transportation and Development Policy/UN-HABITAT

Figure 6. 30 - Single-sided lighting system. Source: Taylor Gong, zgsm-china

Figure 6. 29 - Staggered lighting system. Source: Taylor Gong, zgsm-china

As a rule, streetlights provide illumination within an elliptical area. Accordingly, the following maps illustrate the illumination zone of existing street poles. Additionally, the photos show the illumination quality of streetlights at night, where yellow circles represent illuminated light poles and red circles represent unilluminated light poles.

Kasr El-Nil Street: By comparing the following maps to step 2 results, it was found that street poles are intensely overlapping, where numerous street poles are inefficient. Evidently, through the site visit, it was observed that much of street poles were not illuminated.

Figure 6. 32 - Illumination quality of streetlights in Kasr El-Nil Street. Source: Author

Figure 6. 33 - Distribution of street poles in Kasr El-Nil Street. Source: Author

Talaat Harb Street: As mentioned in Step 2, Talaat Harb Street is the only street which achieves adequate spacing between light poles; where the spacing lies within the recommended range. However, Figure 6.35 shows that some of the illumination zones are overlapping to large extent. Also, it was obvious that some street poles are illuminated at night, while others are switched off (as shown in Figure 6.34).

Figure 6. 34 - Illumination quality of streetlights in Talaat Harb Street. Source: Author

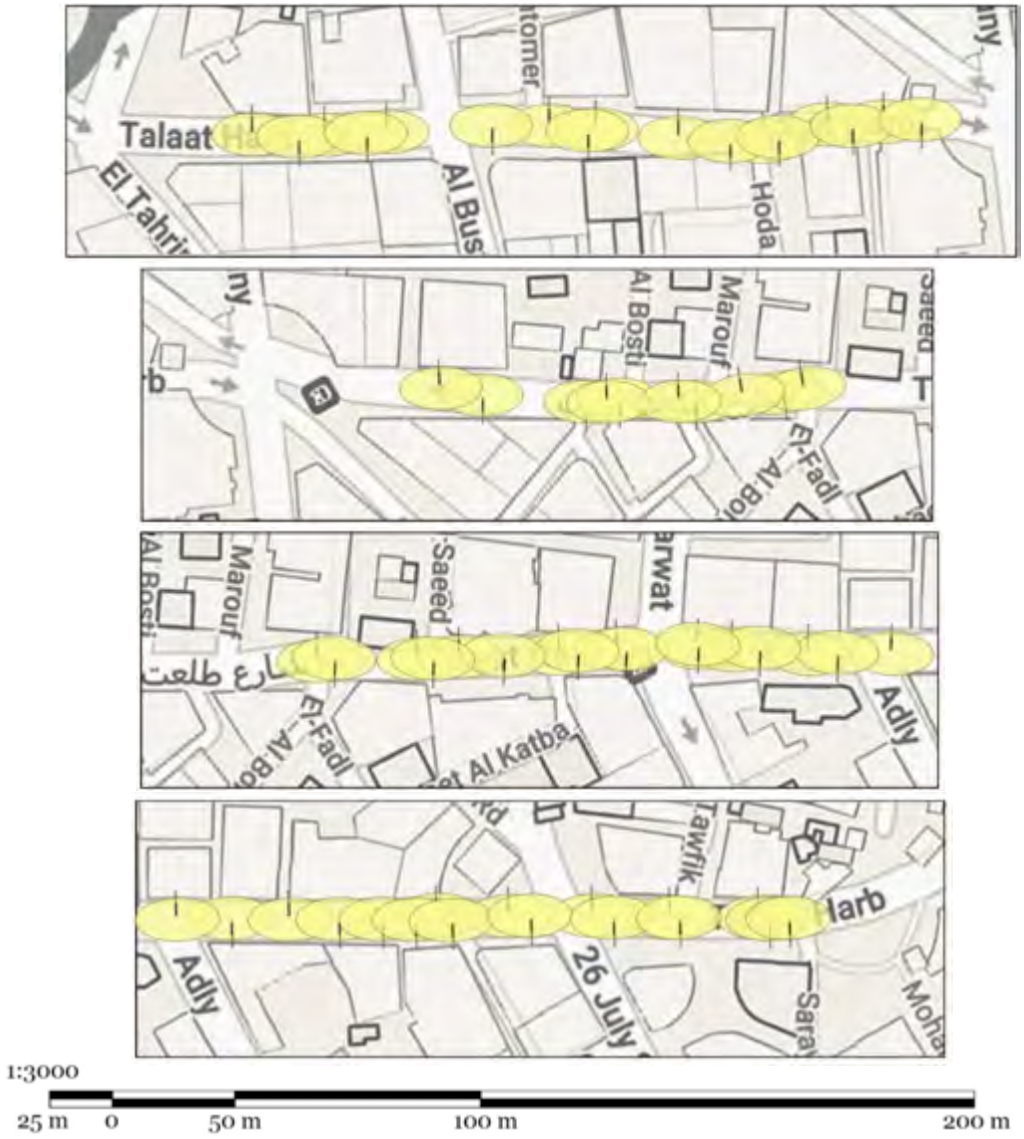


Figure 6. 35 - Distribution of street poles in Talaat Harb Street. Source: Author

Abd El-Khalek Tharwat Street: Despite the streetlight spacing in Abd El-Khalek Tharwat Street being narrow, however, the distribution of street poles is a single-sided lighting system. Consequently, the illumination zones are reasonably overlapping (as shown in figure 6.37).

Figure 6. 36 - Illumination quality of streetlights in Abd El-Khlalek Tharwat Street. Source: Author

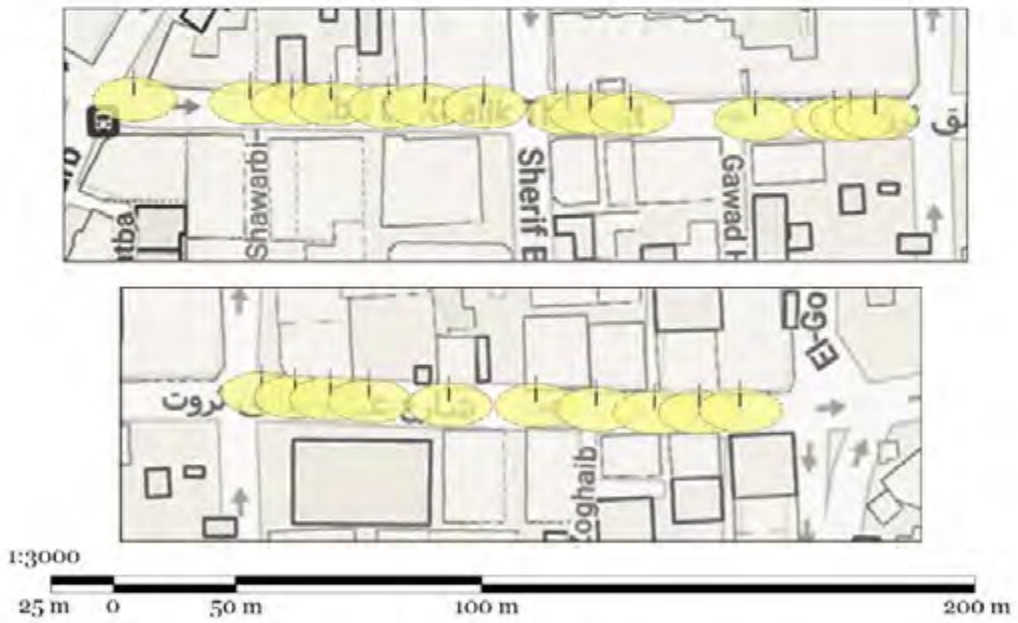


Figure 6. 37 - Distribution of street poles in Abd El-Khalek Tharwat Street. Source: Author

Adly Street: Contrary to Abd El-Khalek Tharwat Street, the distribution of street poles is almost staggered in Adly Street. Furthermore, in the segment extended between Talaat Harb Street and Mohammed Farid Street, street poles are intensely overlapping. Conversely, the other segment extended between Mohammed Farid Street and El-Gomhoreya Street, where street poles are slightly overlapping. Figure 6.38 shows that street poles are almost illuminated along the street, except for the intersections.

Figure 6. 38 - Illumination quality of streetlights in Adly Street. Source: Author

Figure 6. 39 - Distribution of street poles in Adly Street. Source: Author

Sherif Basha Street: It was concluded in Step 2 that the spacing of streetlights exceeds the recommended longitudinal dimension. Thus, in both segments, the street poles are intensely overlapping (as shown in Figure 6.41). Although the staggered distribution of street poles can be applied in single carriageways, even so, in this case, a single row of street poles would be sufficient to effectively lighten the street. Through field visits, it was noticed that the street is generally illuminated, except for a few numbers of unilluminated street poles.

Figure 6. 40 - Illumination quality of streetlights in Sherif Basha Street. Source: Author

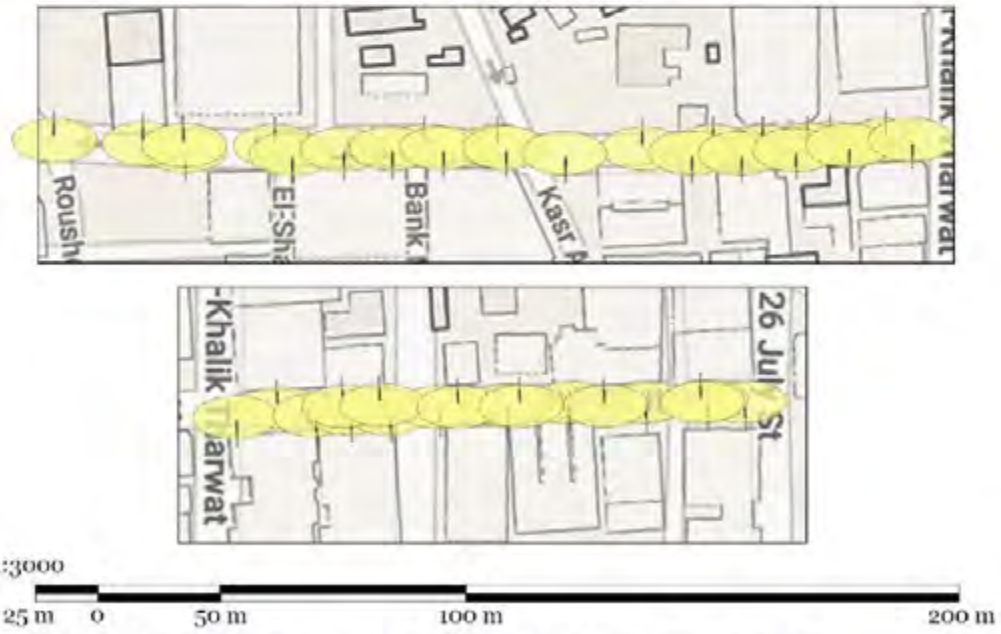


Figure 6. 41 - Distribution of street poles in Sherif Basha Street. Source: Author

Mohammed Ezz El Arab Street: Based on the analysis of Step 2, it was deduced that the distance between street poles is narrower than the recommended dimension. At the same time, the mapping of streetlights revealed that there is overlapping of illumination zones, particularly at intersections, whereas the spacing of streetlights appears to be reasonable in other sections of the street. In addition to that, the distribution of street poles is considered a single-sided lighting system. Apart from that, Figure 6.42 photographs demonstrate that the streetlights were not illuminated, despite the time being around 8 pm.

Figure 6. 42 - Illumination quality of streetlights in Mohammed Ezz El-Arab Street. Source: Author

Figure 6. 43 - Distribution of street poles in Mohammed Ezz El-Arab Street. Source: Author

El-Sheikh Ali Youssef Street: Unlike Mohammed Ezz El-Arab Street, El-Sheikh Ali Youssef Street exhibits a significant overlap of the illumination zones. Additionally, it is important to acknowledge that the distribution of street poles in the initial segment between Mohammed Ezz Al-Arab Street and Ismail Seri Street is staggered, while the subsequent segment between Ismail Seri Street and Ibrahim Basha Street features a single-sided distribution. Furthermore, Figure 6.44 illustrates that certain streetlights were illuminated while others were not. Notably, these photographs were taken around 8 pm.

Figure 6. 44 - Illumination quality of streetlights in El-Sheikh Ali Youssef Street.
Source: Author

Figure 6. 45 - Distribution of street poles in El-Sheikh Ali Youssef Street. Source: Author

Inferences & Recommendations: Concerning the distribution of street poles, it was concluded that the illumination zones in 5 out of 7 streets (Kasr El-Nil Street, Talaat Harb, Adly Street, Sherif Basha Street, El-Sheikh Ali Youssef Street) are intensely overlapping. Contrary to the longitudinal dimension between street poles in Abd El-Khalek Tharwat Street and Mohammed Ezz Al-Arab Street, where the illumination zones are almost reasonably overlapping. According to Kost and Nohn (2011), illumination zones should be slightly overlapping to cover the whole area (as shown in Figure 6.46). Also, carriageways that are up to 12 meters wide can be adequately illuminated with a single row of streetlights (Institute for Transportation and Development Policy and UN-Habitat, 2022).
Given that the carriageways in all seven streets are mainly 12 meters wide, consequently, streets could be illuminated by a single row of streetlights to ensure the efficiency of street lighting. Moreover, a staggered lighting system could be efficiently used if street poles are distributed in a continuous adequate spacing. Possibly, it is not easy to remove excessive streetlights, therefore, the alternative solution to minimize electricity consumption and maximize functionality is unilluminating intensely overlapped streetlights. In fact, not all streetlights in the selected streets are illuminated as discussed before, however, the researcher could not reach the reason behind the un illumination of some street poles; it could be for maximizing the efficiency of streetlights, and maybe not.

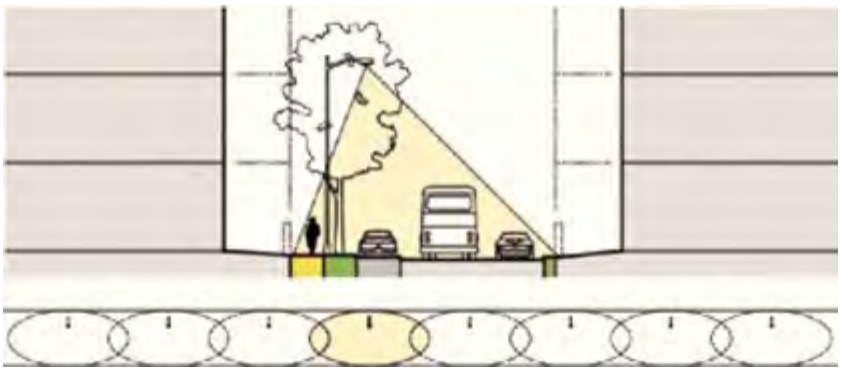


Figure 6. 46 - Distribution of street poles. Source: Kost and Nohn (2011)

- Distribution of street furniture

Benchmark of complete street policy: Street furniture plays a crucial role in providing seating areas for people to rest, which should be strategically placed in shaded areas. Furthermore, street furniture encompasses essential infrastructure such as trash cans, particularly in areas with high pedestrian traffic and commercial activity. As previously mentioned, it is recommended to distribute trash bins at regular intervals along these streets (Kost and Nohn, 2011; Institute for Transportation and Development Policy and UN-Habitat, 2022).

In general, it was observed that selected streets have several models and sizes of trash bins.

Figure 6. 47 - Models of available trash bins. Source: Author

Kasr El-Nil Street: It was observed that Kasr El-Nil Street lack a sufficient number of trash bins. Specifically, it is recommended to have an average of forty trash bins for proper distribution along the street. However, around seven trash bins were found along the selected street segments. Available trash bins are placed within a close range as well. Also, the street segment extended between Sherif Basha Street and Mostafa Kamel Square lacks trash bins. Apart from this, the street lacks seating areas.

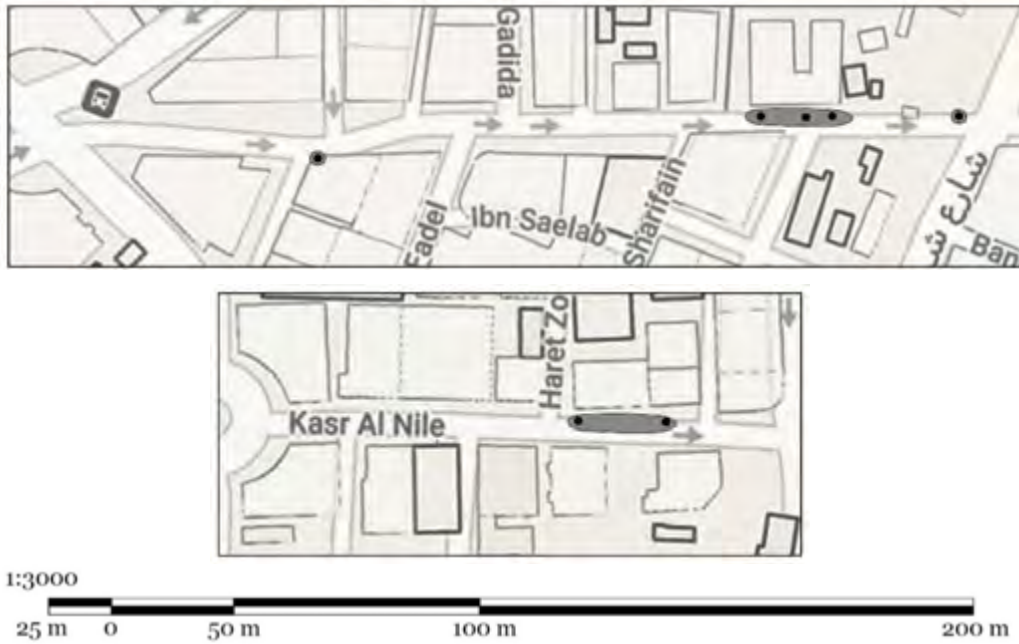


Figure 6. 48 - Distribution of trash bins along Kasr El-Nil Street. Source: Author

Talaat Harb Street: Generally, Talaat Harb Street provide more trash bins compared to Kasr El-Nil Street. In Particular, around twenty-two trash bins were found along the whole street. In addition, it was observed that trash bins are installed in regular intervals to some extent in the two segments extended between Talaat Harb Square and Adly Street. While the other two segments have a few numbers of scattered trash bins (as shown in Figure 6.48). It is worth mentioning that Talaat Harb Street is the only one providing seating areas, where several benches are allocated near Tahrir Square.

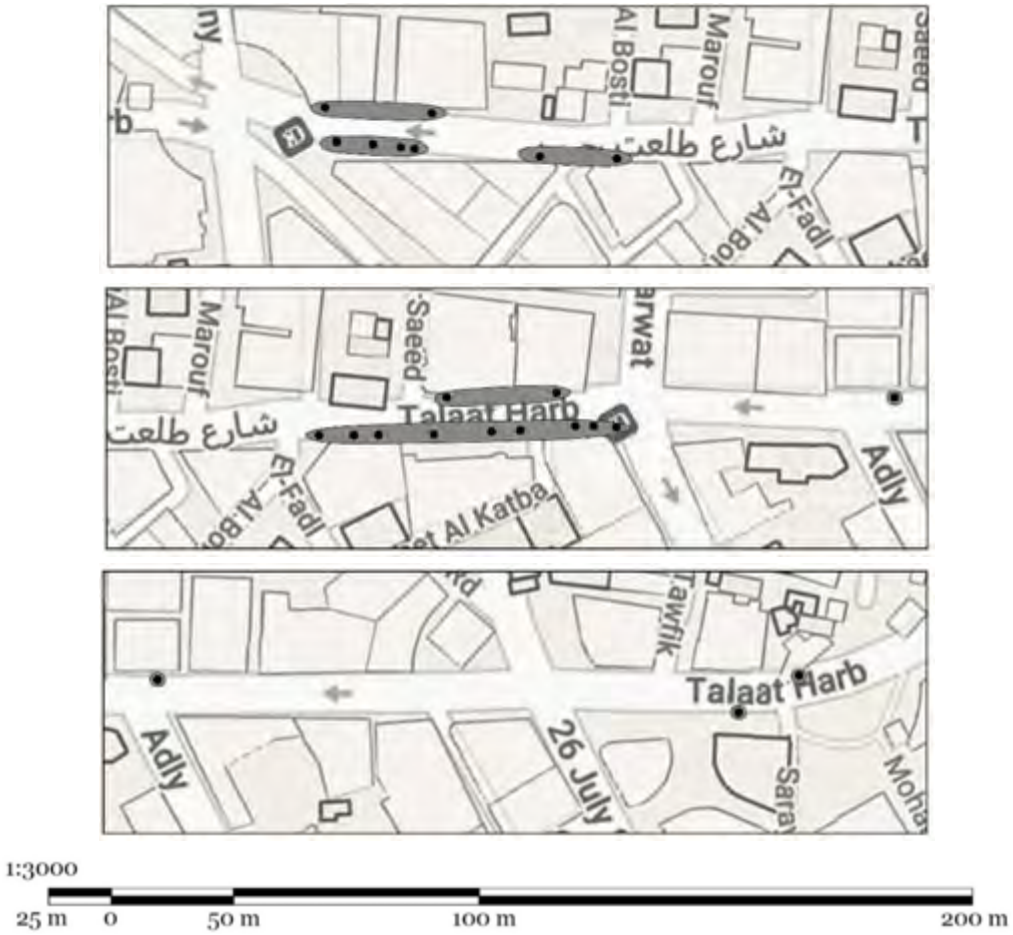


Figure 6. 49 - Distribution of Benches and trash bins along Talaat Harb Street. Source: Author

Adly Street: By observation, around eighteen trash bins were mapped along the street, whilst it is recommended to provide around twenty-seven trash bins. In spite, the spacing between trash bins ranges between fifteen and forty-five meters. However, Figure 6.49 shows that trash bins are distributed along the street; not placed nearby each other as Kasr El-Nil Street.

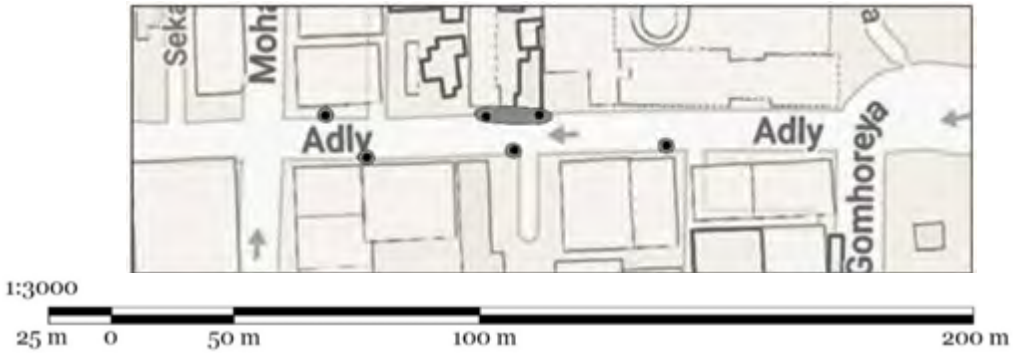


Figure 6. 50 - Distribution of trash bins along Adly Street. Source: Author

Abd El-Khalek Tharwat Street: The spacing between trash bins varies from twenty to forty-five meters. To achieve proper distribution along the street, it is recommended to have an average of thirty trash bins. However, a total of approximately nineteen trash bins were installed along the street, indicating a significantly lower quantity compared to the recommended amount. Furthermore, it is worth noting that trash bins are installed along the majority of the street, except for the right side of the street segment extended between Mohammed Farid and El-Gomhoreya Street.

Figure 6. 51 - Distribution of trash bins along Abd El-Khalek Tharwat Street. Source: Author

Sherif Basha Street: Remarkably, the selected segments of Sherif Basha Street have exceeded the required number of trash bins. While the entire selected segments typically necessitate approximately thirty-one trash bins, the installation has reached around forty bins. Nevertheless, the spacing between trash bins ranges between seven and forty meters as discussed in Step 2. Figure 6.52 visually illustrates that the placement of the installed trash bins does not follow a consistent pattern or regular intervals.

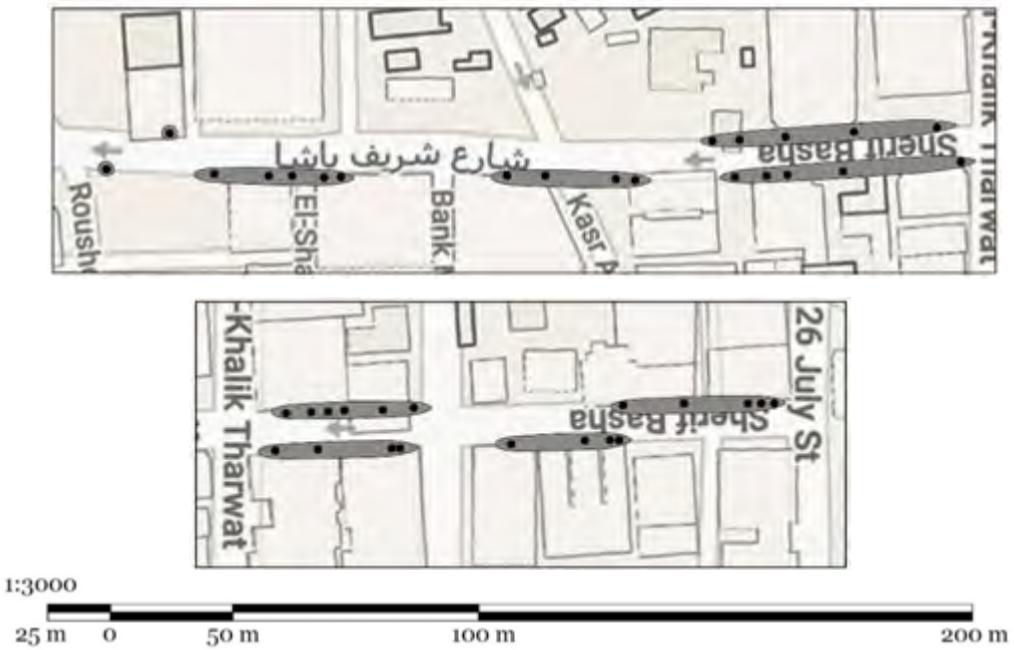


Figure 6. 52 - Distribution of trash bins along Sherif Basha Street. Source: Author

Mohammed Ezz Al-Arab Street: The quantity of trash bins installed along the street falls significantly short of the recommended amount. Specifically, the observed number of installed trash bins is only eleven, rather than the recommended number of forty trash bins. Moreover, the placement of the installed trash bins does not follow a regular interval pattern.

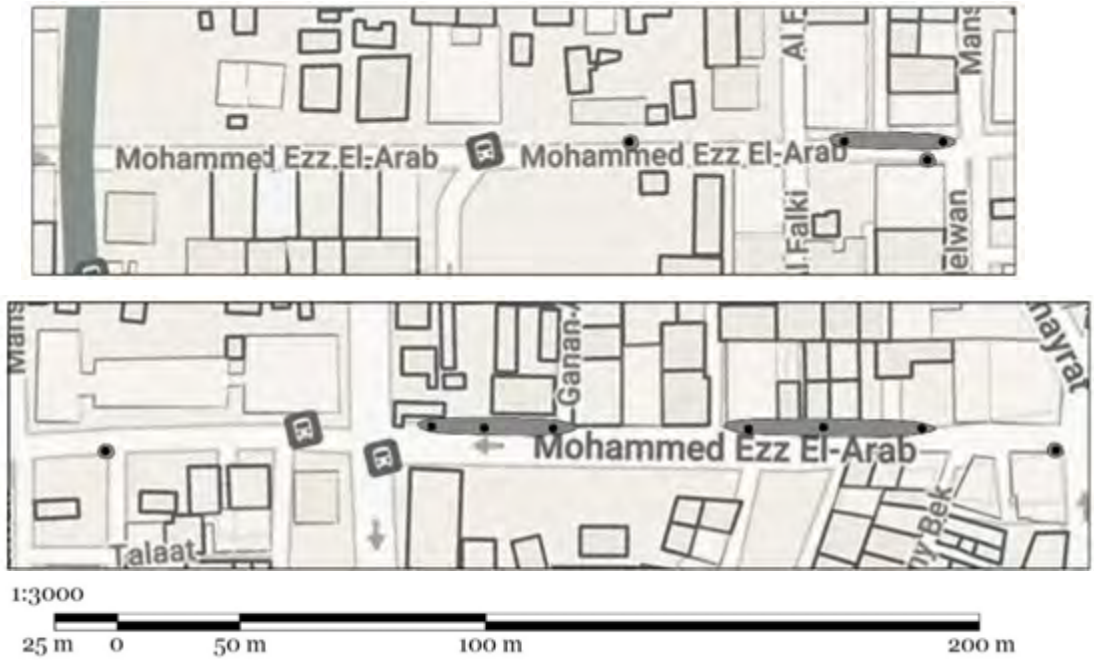


Figure 6. 53 - Distribution of trash bins along Mohammed Ezz Al-Arab Street. Source: Author

El-Sheikh Ali Youssef Street: A limited number of trash bins are distributed along the street; only approximately four trash bins were observed during the mapping process. As a result, numerous segments of the street are devoid of trash bins.

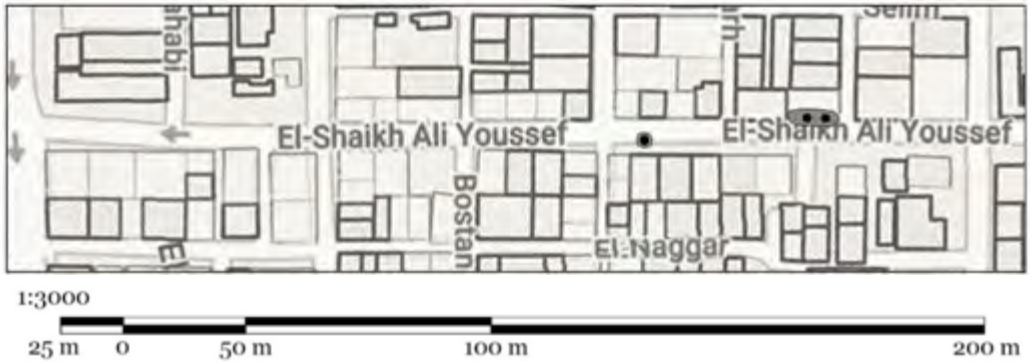


Figure 6. 54 - Distribution of trash bins along El-Sheikh Ali Youssef Street. Source: Author

Inferences & Recommendations: In general, it is deduced that Sherif Basha Street has an adequate number of installed trash bins. However, these bins are distributed irregularly, leaving certain areas of the street without coverage. To address this, it is recommended to redistribute the existing trash bins, ensuring they are placed at consistent intervals. Moreover, three of the selected streets (Talaat Harb, Adly Street, and Abd El-Khalek Tharwat Street) do not achieve the required number of trash bins. Although the existing bins along these streets are distributed regularly to some extent, additional trash bins should be installed to achieve proper distribution. Furthermore, the other three streets (Kasr El-Nil Street, Mohammed Ezz El Arab Street, and El-Sheikh Ali Youssef Street) exhibit a notably low quantity of trash bins. Thus, it is advisable to reconsider the installation of an adequate number of trash bins while distributing them evenly along the streets. Apart from this, it was concluded that all selected streets lack public benches, except for the unshaded benches in Talaat Harb Street. According to the City of Memphis complete streets plan (2020), seating areas serve as a crucial component of the walking environment that offers individuals comfortable spaces for various activities such as resting, eating and socializing. It is also important to position seating areas beneath trees or other shaded regions, accompanied by appropriate nearby lighting.

- Location of accessibility ramps and tactile pavers.

Benchmark of complete street policy: When designing pedestrian facilities, it is crucial to consider the needs of individuals with disabilities or limited mobility. One significant aspect of roadway design is the inclusion of accessible curb ramps. These ramps are specifically designed to facilitate the access of individuals using wheelchairs and other assistive devices. To ensure safety and convenience, it is essential to incorporate level landings at both the top and bottom of the ramp, providing sufficient space for wheelchair turning and maneuvering. Additionally, tactile pavers featuring truncated domes should be appropriately positioned to alert individuals with visual impairments to their proximity to vehicle travel lanes and the transition from pedestrian zones to areas designated for motor vehicle traffic (Chicago Metropolitan Agency for Planning et al., 2015).

Regarding the following maps, it is important to clarify that blue triangles represent ramps, while the four attached dots represent tactile pavers. Also, missing ramps are represented in red circles. It is worth mentioning that various types of ramps were observed, as depicted in Figure 6.55, illustrating three ramp designs.

Figure 6. 55 - Types of ramps. Source: Author

Kasr El-Nil Street: By walking through Kasr El-Nil Street, type 1 was predominantly observed at the starting and ending point of the street. While type 2 was commonly provided along street segments where the entire curb is gradually sloped to reach street level. Through field visits, ramps were observed

at most of the street curbs and intersections. However, there are some missing ramps as shown in Figure 6.56. The mapping of tactile pavers indicated that Kasr El-Nil Street only features a single tactile strip within the segment extending from Mostafa Kamel Square to El-Gomhoreya Street. Also, in some cases, tactile strips were featured in the center of ramps.

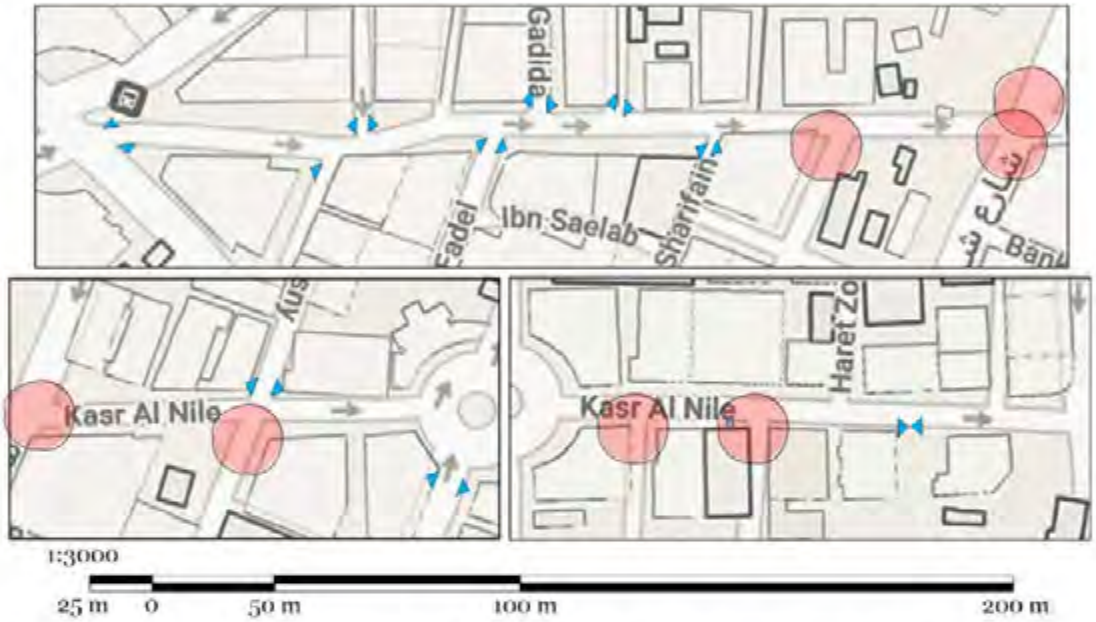
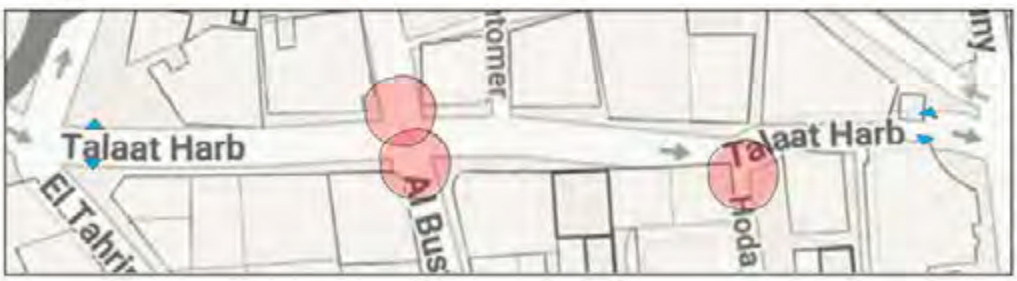


Figure 6. 56 - Locations of ramps and tactile pavers in Kasr El-Nil Street. Source: Author

Talaat Harb Street: Similarly, ramp type 1 was mainly observed at the starting and ending point of the street. While ramp type 2 was frequently provided along street segments. As shown in Figure 6.57, numerous intersections lack accessible ramps, unlike Kasr El-Nil Streets. In addition, no tactile pavers were observed during the field visits.



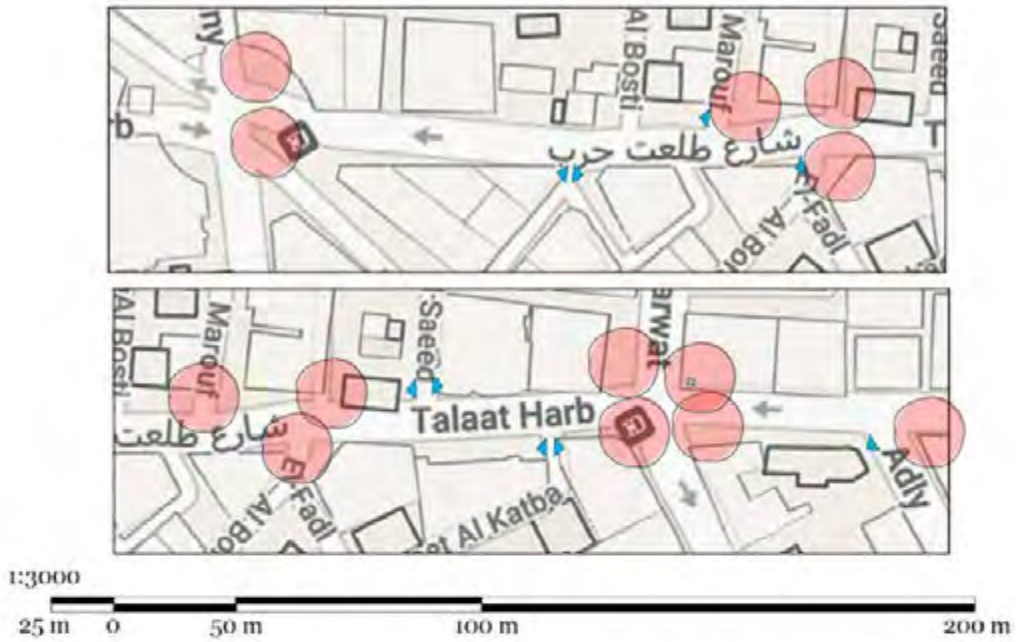


Figure 6. 57 - Locations of ramps and tactile pavers in Talaat Harb Street. Source: Author

Adly Street: Adly Street primarily features ramps of type 2, characterized by sloped curbs that facilitate access to the street level. However, observations revealed instances where the slope does not completely reach the street level or is obstructed by street facilities, as illustrated in Figure 6.58. Consequently, these ramps are not suitable for use by the handicapped. Furthermore, the street lacks the provision of tactile pavers.

Figure 6. 58 - Examples of unsuitable ramps for the handicapped. Source: Author

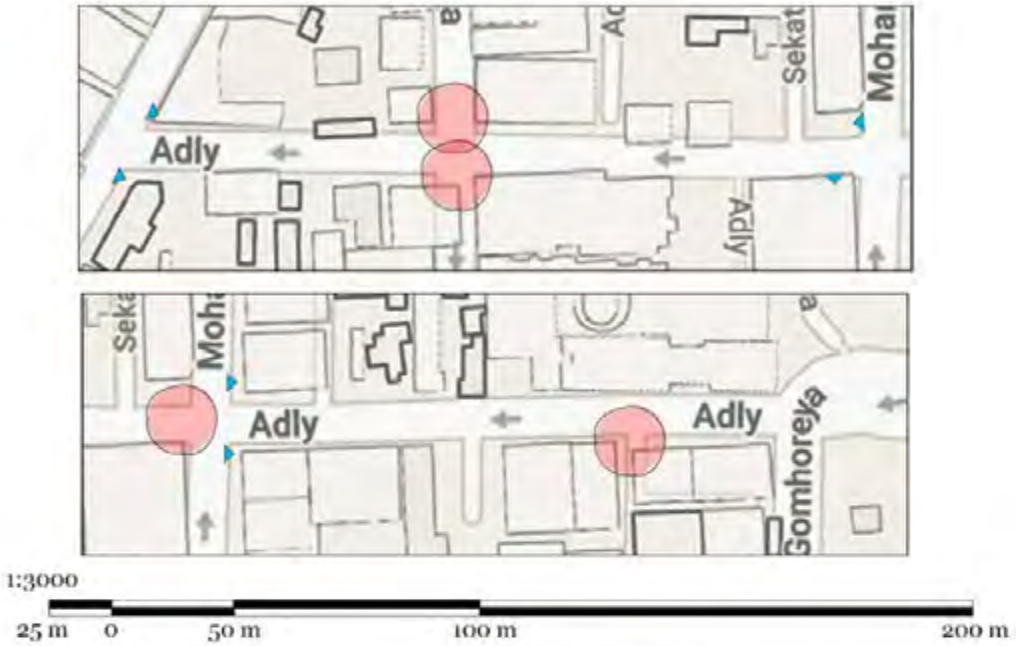


Figure 6. 59 Locations of ramps and tactile pavers in Adly Street. Source: Author

Abd El-Khalek Tharwat Street: Limited ramps were mapped during the field visits, where only three ramps were observed along the whole street as shown in Figure 6.61. Apart from this, there was one tactile strip throughout the street as shown in Figure 6.60.

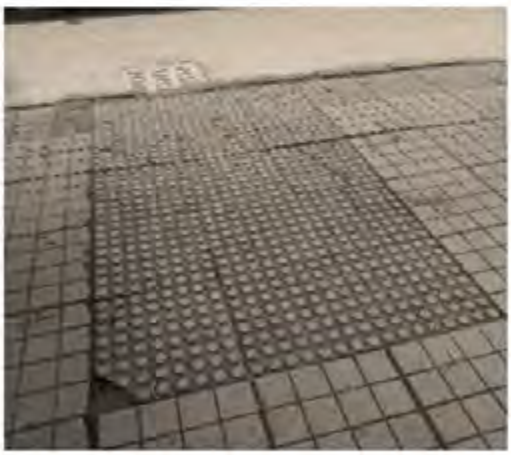


Figure 6. 60 - Photo of tactile strip in Abd El-Khalek Tharwat Street. Source: Author

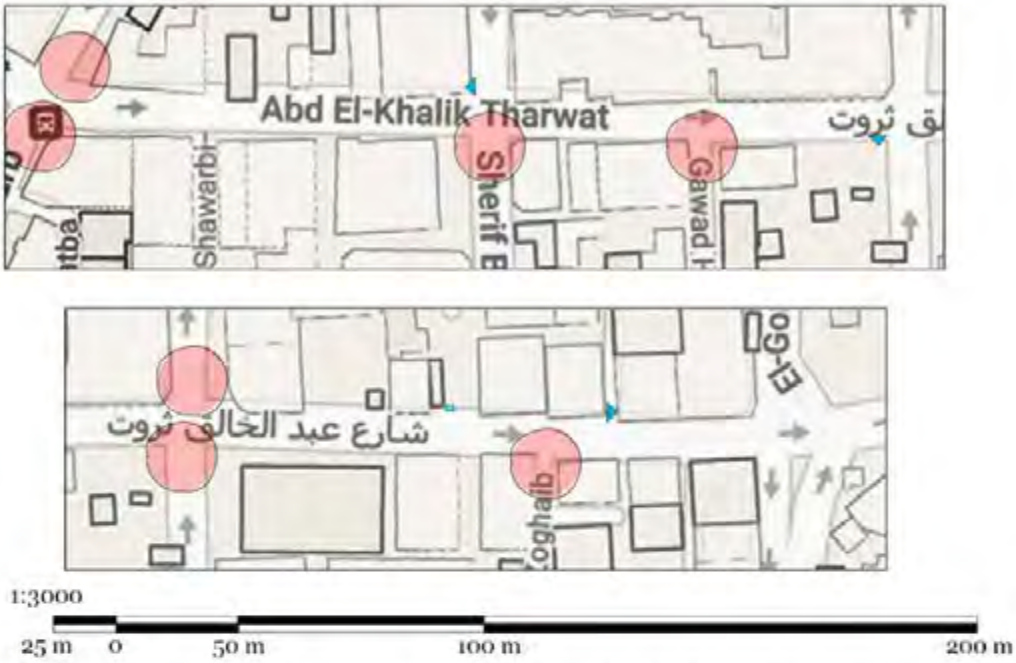


Figure 6. 61 - Locations of ramps and tactile pavers in Abd El-Khalek Tharwat Street. Source: Author

Mohammed Ezz Al-Arab: In Case of Mohammed Ezz Al-Arab Street, there were only two ramps. firstly, in the right photo of Figure 6.62, the entire sidewalk is sloped down to the same level of the carriageway. However, it may result in waterlogging at property entrances; instead, it is recommended to provide the ramp within the furniture zone (Institute for Transportation and Development Policy, 2013). While the second ramp is located in the entrance of the CIB bank.

Figure 6. 62 - Photos of the ramps located in Mohammed Ezz Al-Arab Street. Source: Author

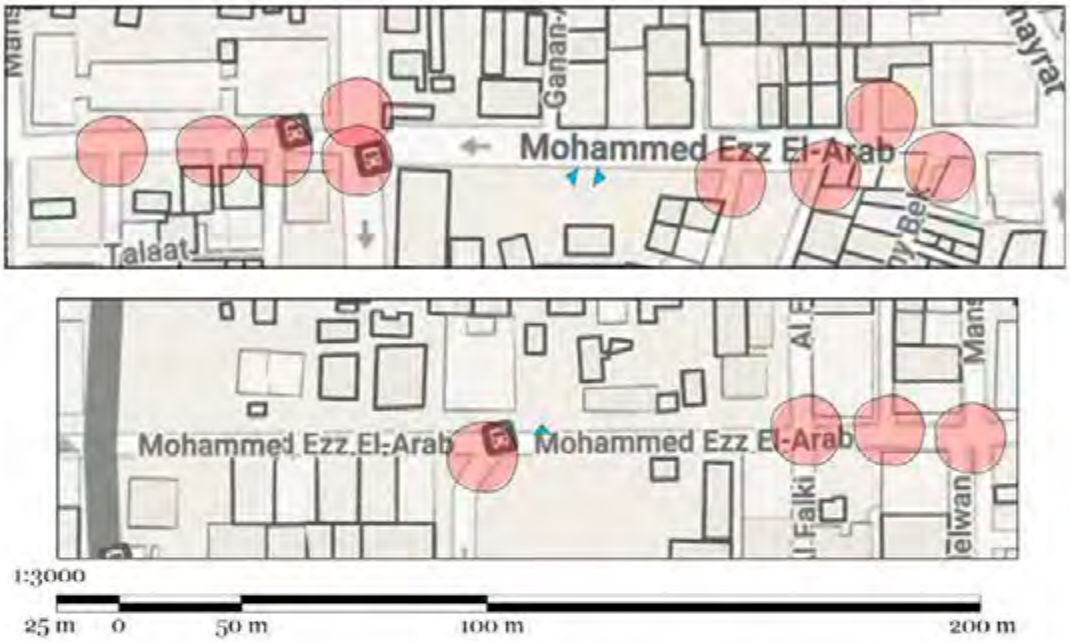


Figure 6. 63 - Locations of ramps and tactile pavers in Mohammed Ezz Al-Arab Street.
Source: Author

Inferences & Recommendations: In summary, among the seven streets assessed, five of them have ramps and tactile pavers, where both Sherif Basha Street and El-Sheikh Ali Youssef Street do not provide ramps or tactile pavers. Although most streets fall short of achieving fully accessible paths, it is evident that Kasr El-Nil Street, Talaat Harb Street, and Adly Street have more ramps and tactile pavers compared to the other streets. Specifically, Abd El-Khalek Tharwat Street and Mohammed Ezz Al-Arab Street have limited provision of ramps and tactile pavers. In fact, a sidewalk lacking curb ramps are impractical for individuals using wheelchairs and poses challenges for parents with strollers and travellers with suitcases (American Planning Association, 2010). Hence, it is crucial to ensure the provision of curb ramps and tactile pavers across all streets to enhance accessibility for individuals with disabilities and those with visual impairments.

- Location and type of street encroachments

Benchmark of complete street policy: In many cases, street designs prioritize motorized vehicles, with streets often planned from the centreline outward. As a result, poorly designed sidewalks are susceptible to encroachment by parked vehicles, street vendors, and shops. In the absence of well-designed and adequately sized sidewalks, pedestrians become forced to use the carriageway for walking. Despite this, street vending plays a significant role in providing goods and services to diverse population groups. Therefore, with proper planning, street vending can be integrated into the streetscape without disrupting other functions. Another point is, parking is a flexible street element that should only be allocated where sufficient space exists within the right-of-way, after ensuring the provisions of pedestrian facilities. In addition, curb extensions between parking areas provide space for street furniture and vending. Unfortunately, in some cases, sidewalks and cycle tracks are transformed into parking areas for cars and motorcycles. Thus, physical barriers or enforcement measures should be placed to prevent such encroachments. (Kost and Nohn, 2011; Institute for Transportation and Development Policy, 2013).

Kasr El-Nil Street: Many forms of sidewalk encroachments were observed in Kasr El-Nil Street during the field visits. For instance, there are street vending, shops, and banks encroachments. To demonstrate, street vending is most common throughout the street segment extended between Talaat Harb Square and Sherif Basha Street, where most street vendors occupy the furniture zone, while others occupy part of the pedestrian zone. Moreover, there is an ATM occupying the sidewalk in the street segment extended between Sherif Basha Street and Gawad Hosny Street.

Figure 6. 64 - Street encroachment in Kasr El-Nil Street. Source: Author

Talaat Harb Street: In Talaat Harb Street, three forms of encroachments were observed, which are street vending, shop expansions, and motorcycle intrusions. While a limited number of street vending encroachments were observed in several street segments, a significant concentration of street vendors was found in the street segment stretching from Adly Street to El-Tawfekeya (Orabi) Square. Additionally, motorcycle encroachments were frequently mapped along the street.

Figure 6. 65 - Street encroachment in Talaat Harb Street. Source: Author

Adly Street: Motorcycle parking on sidewalks is the most observed encroachment in Adly Street, especially in the street segment extended between Talaat Harb Street and Mohammed Farid Street. Additionally, a substantial portion of the sidewalk is occupied by the Cairo Security Sector, forcing pedestrians to walk on the carriageway. Moreover, a discontinuity in the sidewalk arises due to a

demolished building alongside the street segment stretching from Mohammed Farid Street to El-Gomhoreya Street. Apart from this, encroachment by street vendors and shops were observed along Adly Street; particularly in the street segment stretching from Mohammed Farid Street to El-Gomhoreya Street.

Figure 6. 66 - Street encroachment in Adly Street. Source: Author

Abd El-Khalek Tharwat Street: Likewise, there were numerous motorcycle encroachments throughout Abd El-Khalek Tharwat Street. Furthermore, street vendors were frequently observed occupying the street, particularly in the segment that extends from Talaat Harb Street to Mohammed Farid Street.

Figure 6. 67 - Street encroachment in Abd El-Khalek Tharwat Street. Source: Author

Sherif Basha Street: Upon mapping the encroachments in Sherif Basha Street, it was observed that street vendors were the most prevalent encroachment along the entire street. Additionally, numerous instances of encroachments by shops and motorcycles were found, particularly in the segment extending from Abd El-Khalek Tharwat Street to 26 July Street.

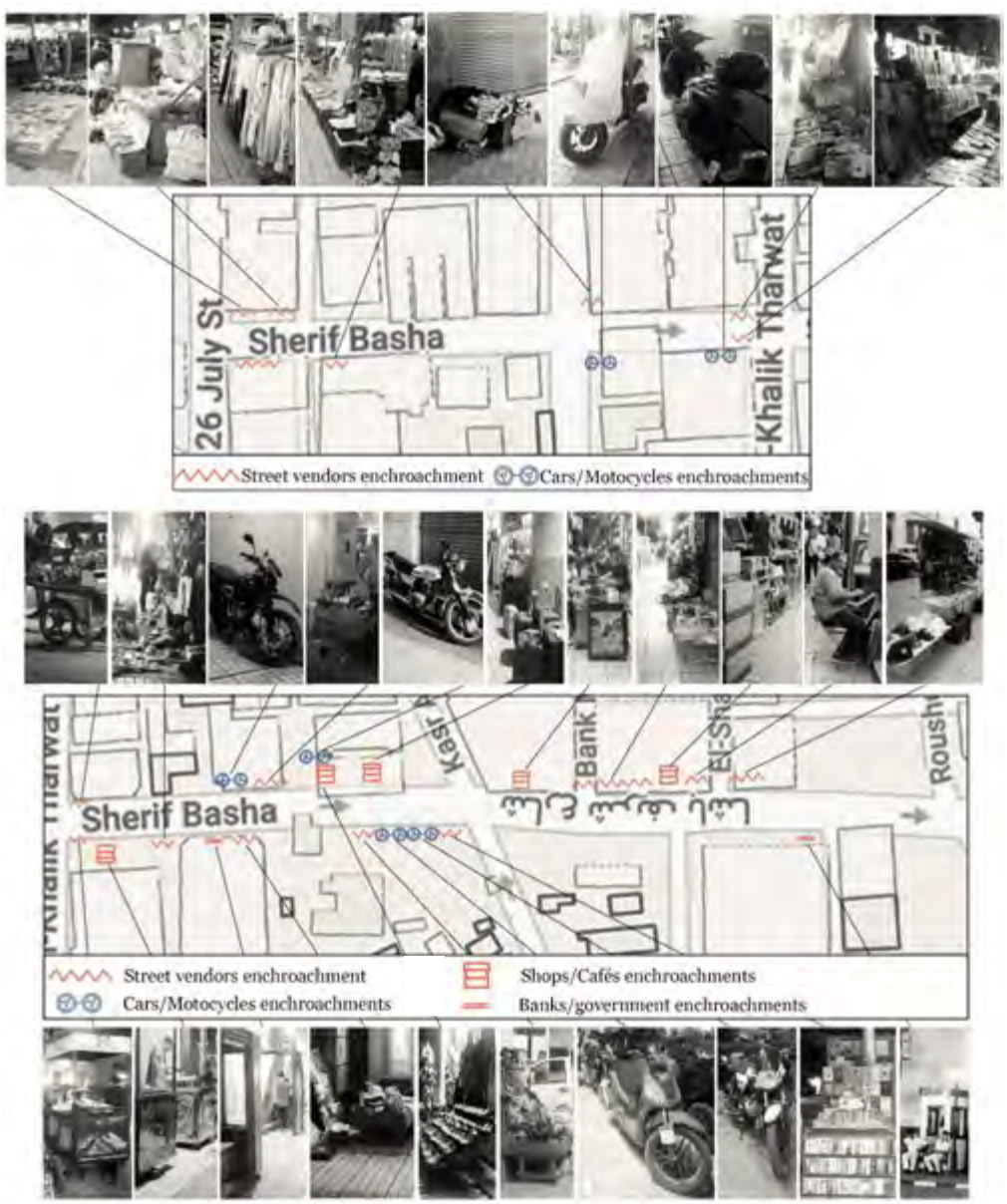


Figure 6. 68 - Street encroachment in Sherif Basha Street. Source: Author

Mohammed Ezz El Arab Street: Mohammed Ezz Al-Arab Street exhibited a considerable number of encroachments by shops. Furthermore, street vendors were frequently observed occupying the sidewalks, particularly in the street segment between Khayrat Street and Mansour Street. On the other hand, instances of motorcycles parking and bank encroachments were infrequently observed.

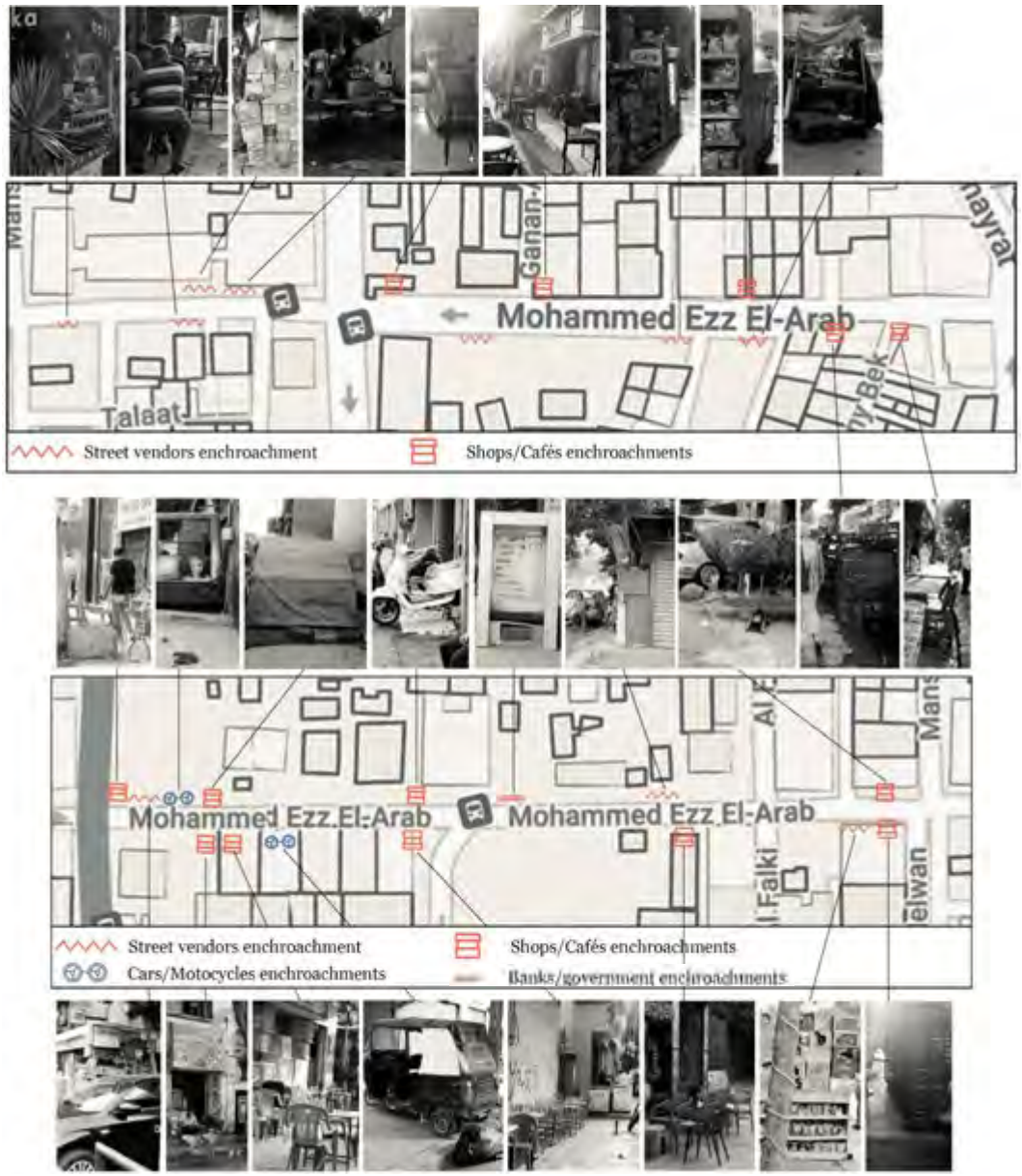


Figure 6. 69 - Street encroachment in Mohammed Ezz Al-Arab Street. Source: Author

El-Sheikh Ali Youssef Street: As discussed before, the street functions differ along the street, affecting the type of street encroachments. For instance, in the first segment between Mohammed Ezz Al-Arab and Ismail Seri Street, a moderate number of street vendors were observed. On the hand, a significant number of medical supply shop encroachments are occupying the sidewalks in the street segment from Ismail Seri Street to Ali Ibrahim Basha Street.

Figure 6. 70 - Street encroachment in El-Sheikh Ali Youssef Street. Source: Author

Inferences & Recommendations: Briefly, Sidewalk encroachments differ in downtown area from El-Monira district. To demonstrate, in Downtown area, street vendors and motorcycles parking are the most frequent encroachments, particularly in Adly Street, Abd El-Khalek Tharwat Street, Sherif Basha Street, and part of Talaat Harb Street. While in El-Monira District, shops encroachments are significantly found in both streets. Accordingly, recommendations are suggested according to the three main types of encroachments.

1. Street vending

According to literature, street vending offers convenient access to affordable goods and services for a diverse range of individuals. Furthermore, properly designed areas for street vending offer citizens secure and respectable spaces for engaging in trade activities. It is crucial to establish improved and "formal" vending areas, particularly along major streets and near public transportation hubs. Such well-planned vending areas have the potential to create livelier urban spaces, foster social oversight, and enhance public safety. Despite the availability of sufficient space for both formal and informal vending, the existing street design often fails to accommodate street vendors. One possible solution is to allocate dedicated vending spaces within curb extensions or the furniture zone, ensuring clear pathways for pedestrian movement. Furthermore, it is important to consider the preferences of street vendors, as they are often attracted to shaded locations or near bus stops, where their presence is visible to passersby (Kost and Nohn, 2011; Institute for Transportation and Development Policy, 2013)

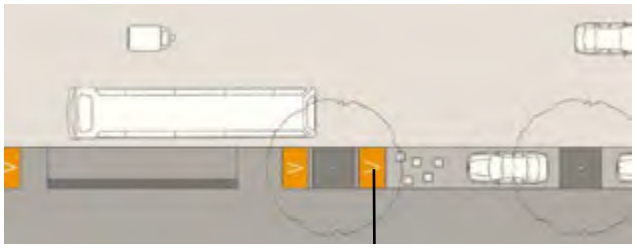


Figure 6. 71 - Recommendation for accommodating dedicated vending spaces within furniture zone. Source: Institute for Transportation and Development Policy (2013)

2. Motorcycles parking on sidewalks: Despite Adly Street has on-site parking, however, motorcycles encroachments were observed on sidewalks. Unless physical barriers or law enforcement measures are implemented, sidewalks and cycle tracks will often become parking areas for cars and motorcycles.

Figure 6. 72 - Motorcycle encroachment on Adly Street. Source: Author

3. Shops encroachments: According to American Planning Association (2010), the frontage zone, located adjacent to the building, should occupy a minimum width of 1 meter (Institute for Transportation and Development Policy, 2013). This area allows property owners to display their goods while maintaining a clear and unobstructed walking zone. Likewise, generally shop owners, especially in El-Sheikh Ali Youssef Street, have the right to display their items. Nevertheless, concerning the current sidewalk width, pedestrians are not having adequate space for walking due to displayed goods. Therefore, the sidewalks should be widened to accommodate both functions. Otherwise, if street widening is not feasible, another approach to ensure an uninterrupted and unobstructed pathway for pedestrians is to restrict shop owners from displaying their items.

Figure 6. 73 - Frontage zone. Source: Institute for Transportation and Development Policy (2013)

- Locations of curb extension & on-street parking

Benchmark of complete street policy: Curb extensions effectively decrease the overall crossing distance and enhance visibility. They provide pedestrians with improved sightlines of approaching traffic, while also ensuring that waiting pedestrians are more easily noticed by drivers. Furthermore, curb extensions effectively slow down right-turning vehicles by reducing the curvature of the curb. As a result, they are typically recommended for streets that accommodate on-street parking (American Planning Association, 2010).

Adly Street: Upon field visits, it was noted that curb extensions are exclusively present in Adly Street. Similarly, on-site parking is exclusively allowed on Adly Street.

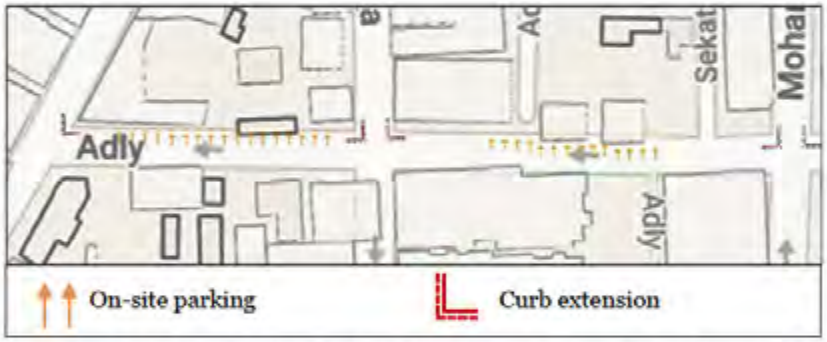


Figure 6. 74 - Mapping of curb extensions and on-site parking in Adly Street. Source: Author

Figure 6. 75 - Photos of curb extension and on-site parking in Adly Street. Source: Author

- Efficiency of bike lanes and bike parking

Benchmark of complete street policy: Well-designed cycle tracks offer uninterrupted movement for cyclists. They should be physically segregated from the primary carriageway to ensure a comfortable and safe cycling experience. In addition to being shielded from potential obstructions such as parked vehicles, pedestrians, and street vendors. Also, bike lanes should be elevated to sidewalk level, allowing for stormwater runoff (Kost and Nohn, 2011). Based on the literature, the optimal options for bike parking on sidewalks are inverted U or ring designs. These designs offer maximum locking space and can be utilized individually or clustered together. Sidewalk bike racks are ideally positioned within the frontage or furniture zones to ensure convenient and appropriate placement (City of Memphis complete streets plan, 2020).

Bike lanes in Kasr El-Nil Street & Talaat Harb Street: Separated bike lanes are only found in Kasr El-Nil Street and Talaat Harb Street. During field visits, numerous encroachments were observed on bike lanes, particularly, motorcycles encroachments (as shown in Figure 6.76 & Figure 6.77).

Figure 6. 77 - Bike Lane encroachment in Kasr El-Nil Street. Source: Author

Figure 6. 76 - Bike Lane encroachment in Talaat Harb Street. Source: Author

Bike racks in Downtown area: Bike racks were identified in four streets: Kasr El-Nil Street, Talaat Harb Street, Abd El-Khalek Tharwat Street, and Sherif Basha Street. It is worth noting that bike lanes are implemented in two out of these four streets. The bike racks were situated at various locations along each street.

Figure 6. 78 - Photos of bike racks in Kasr Al-Nil Street. Source: Author

Figure 6. 79 - Photos of bike racks in Talaat Harb Street. Source: Author

Figure 6. 80 - Photos of bike racks in Abd El-Khalek Tharwat Street. Source: Author

Figure 6. 81 - Photos of bike racks in Sherif Basha Street. Source: Author

Inferences: According to the literature, the existing bike lanes have two problems; firstly, dirt and stormwater are collected as it is located at the lowest point of the street cross-section. Secondly, the bike lanes are not separated probably from the carriageway, where bike lanes are utilized as a travel lane for motorized two-wheelers (Kost and Nohn, 2011). Instead, a single bollard should be installed at the center of the cycle track, acting as a deterrent for car encroachments. To clarify, the spacing between bollards is set at 1.2 meters. As mentioned before, bike lanes should be elevated to sidewalk level, allowing for stormwater runoff and preventing motorcycles from encroaching on bike lanes. In addition to adding a buffer area of width 0.15 m to physically separate bike lanes from carriageways (Institute for Transportation and Development Policy and UN-Habitat, 2022). Furthermore, marked shared lanes could be added to the rest of the selected streets. To explain, marked shared lanes are an economical solution suitable in areas such as central business districts where on-street parking is present. This treatment is most effective in situations where cross streets and traffic signals are closely spaced, and vehicle speeds rarely exceed 20 mph. The purpose of marking shared lanes is to effectively notify drivers about the presence of bicyclists (City of Memphis complete streets plan, 2020). In fact, cyclists were observed on multiple streets as shown in figure 6.83.

Figure 6. 82 - Marked shared lane. Source: City of Memphis complete streets

Figure 6. 83 - Photos of a bicyclists in Abd El-Khalek Tharwat Street, Sherif Basha Street and El-Sheikh Ali Youssef Streets, respectively. Source: Author

- Locations of traffic signals

Downtown area: The provided map indicates that the majority of intersections in the selected streets are supported by traffic signals.

Figure 6. 84 - Locations of traffic signals in Downtown area. Source: Author

El-Monira District: Upon site visits, only one traffic signal was mapped in the intersection between Mohammed Ezz Al-Arab Street and El-Kasr Al-Ainy Street.

Figure 6. 85 - Locations of traffic signals in El-Monira district. Source: Author

- Location of bus stops and shelters

Benchmark of complete street policy: Well-designed bus stops ensure a secure and pleasant waiting environment for passengers. They are conveniently situated near street crossings, allowing for easy access. Importantly, they do not impede pedestrian paths or cycle tracks (Kost and Nohn, 2011). Bus shelters should be carefully constructed to provide complete protection from unfavorable weather conditions, ensuring the comfort of waiting passengers (City of Memphis complete streets plan, 2020).

Downtown area: Based on data obtained from Transport for Cairo (TFC), there are several transportation routes operated by CTA that cover sections of Talaat Harb Street, Kasr El-Nil Street, and Abd El-Khalek Tharwat Street, as depicted in Figure 6.86. Additionally, the marked stops on the map indicate the anticipated locations where passengers typically wait for buses. However, it should be noted that the mapped bus shelter is situated at a considerable distance from the expected bus stops.

Figure 6. 86 - Bus trips and Bus stops in Downtown Area. Source: Author. Data: Transport for Cairo (TFC) (2022)

El-Monira District: Similarly, the provided map displays the bus routes along both streets, operated by various bus types including CTA, minibuses, and microbuses. Transport for Cairo (TFC) data indicate the primary bus stops, are predominantly positioned at intersections. However, it is worth noting that the current bus shelters are not situated at the exact expected bus stops where passengers typically wait.

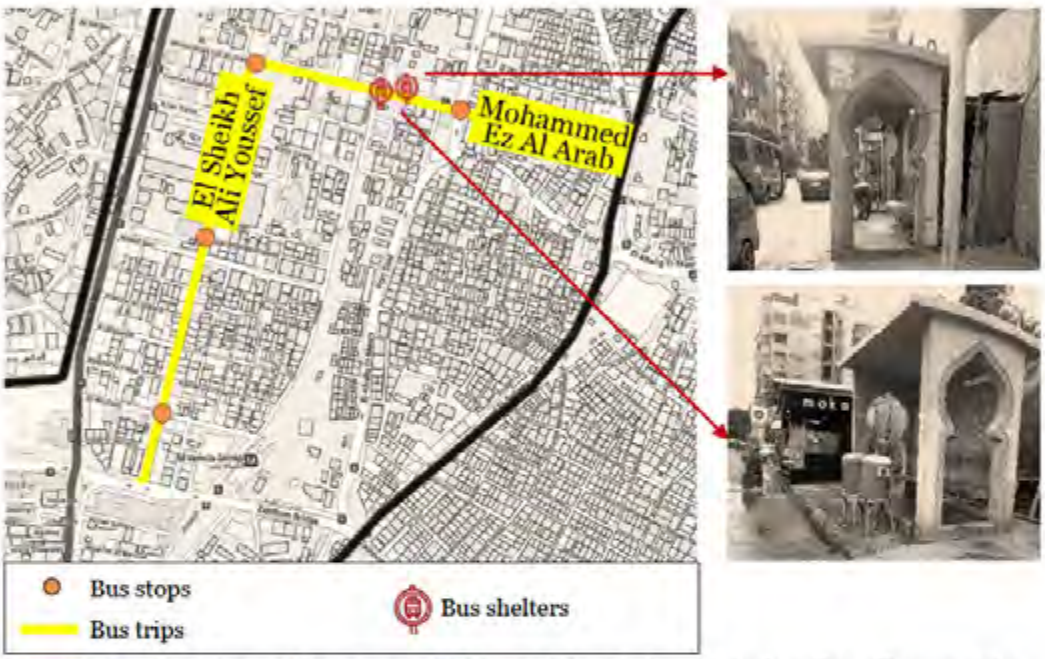


Figure 6. 87 - Bus trips and Bus stops in El-Monira District. Source: Author. Data: Transport for Cairo (TFC) (2022)

Inferences: To conclude, bus shelters in both the Downtown area and El-Monira district are situated far from where buses actually stop. According to the literature, the placement of bus shelters should prioritize the continuity of footpaths and cycle tracks, where it should not limit the pedestrian way (Kost and Nohn, 2011; City of Memphis complete streets plan, 2020). Nevertheless, the bus shelters on Mohammed Ezz Al-Arab Street are entirely obstructing the sidewalk, forcing pedestrians to walk through the carriageway. For this reason, the sidewalk should be widened to provide pedestrians with a continuous path.

6.2.3. Recommendations for non-achieved street elements

Based on the checklist evaluation of international case studies discussed in chapter 3, the highlighted street elements are the most relevant features among the seven international cases. As a result, Subsequently, upon comparing them to the unimplemented street elements in the selected streets of Khedival Cairo, it was observed that raised crossings are one of the applicable street elements that are currently lacking. The subsequent section will review the design considerations associated with raised crossing.

Raised crossing: Pedestrian crossings are typically identified using painted zebra markings, guiding pedestrians to appropriate crossing areas and alerting drivers to anticipate pedestrian crossings at those specific points. The effectiveness of marked crosswalks in ensuring safety has been the subject of considerable debate. For instance, in many urban areas, drivers do not adhere to the painted markings, thereby diminishing the safety advantages offered by such crossings. Conversely, raised pedestrian crossings effectively encourage motorists to reduce their speed, thus enhancing pedestrian convenience. To explain, raised crosswalks should be constructed at the same level as the adjacent sidewalk and include ramps to accommodate motor vehicles. Additionally, their width should be equal to or greater than that of the adjoining sidewalk, with a minimum width of 2 meters. Undoubtedly, it is essential to implement raised crosswalks at all intersections to enable pedestrians to safely and conveniently cross busy streets.

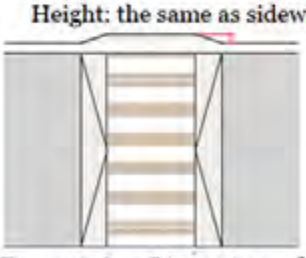


Figure 6. 89 - Dimensions of raised crossing (Layout & Section). Source: ITDP (2022)

Figure 6. 88 - Example of implemented raised crossing in India. Source: ITDP (2013)

6.3. Conclusion of step 1 & step 2

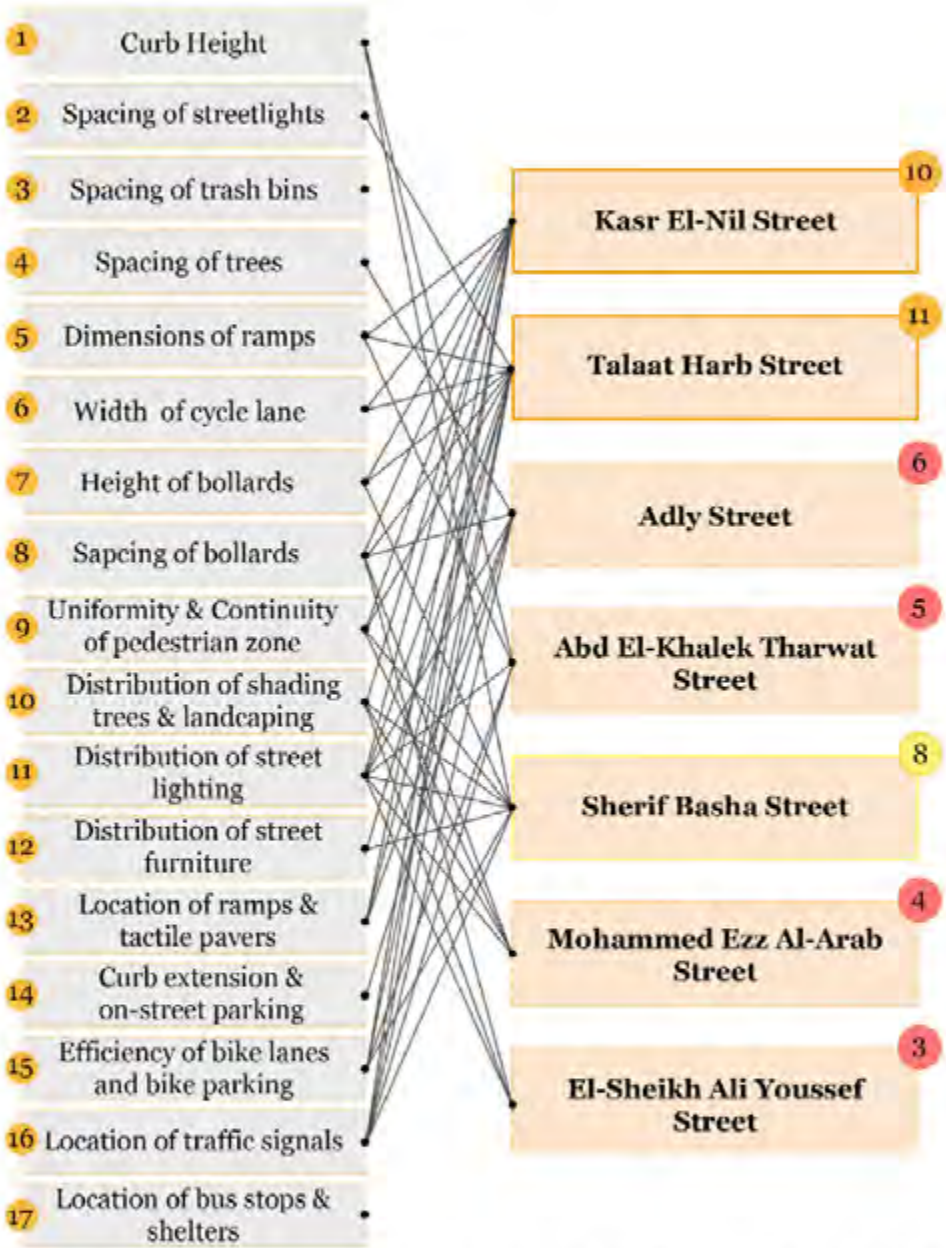


Figure 6. 90 - Concluding assessment of selected street in Khedival Cairo. Source: Author

In light of the analysis and findings outlined in the empirical study, a comprehensive evaluation of streets was conducted to assess their level of accomplishment of complete street elements (as shown in Figure 6.90). It was determined that Talaat Harb Street exhibits the highest level of complete street elements among other examined streets, followed by Kasr El-Nil Street and Sherif Basha Street, ranking second and third, respectively. In contrast, Adly Street, Abd El-Khalek Tharwat Street, Mohammed Ezz Al-Arab Street, and El-Sheikh Ali Youssef Streets achieve a gradual decrease in the fulfillment of studied complete street elements, achieving less than half of the identified criteria. It is worth mentioning that none of the chosen streets have successfully met the recommended standards for the spacing of trash bins, nor have they adequately provided bus shelters at designated bus stops.

6.4. Step 3: The questionnaire

6.4.1. Methodology

The questionnaire collected information about the selected seven streets. The purpose of the questionnaire is to understand the level of satisfaction of street visitors and to conclude the lacked street elements from the users' perspective. It is worth noting that each street was assessed individually, where the respondents were initially asked if they have ever visited the street. To explain, if they answered "yes", they would be directed to assess the street. If they answered "no", they would be directed to the subsequent street. The questionnaire was conducted in both English and Arabic languages. It consists of four main sections as follows:

1- A general background concerning their gender, age, frequency of visiting the street, and the most used means of transportation for reaching the street.

2- A set of questions about their level of satisfaction with various street elements such as walking experience, efficiency of street lighting, availability of trash bins, quality of bike lane, the safety of crossing street, sidewalk shading, accessibility of ramps, availability of green areas, availability of parking lots, and occupancy of street vendors.

3- Thirdly, identify the most engaging/most annoying street activities throughout a list of choices.
4- Lastly, the author provided several photos of transformed complete streets of the international case studies (discussed in Chapter 3), to inquire about the deficiencies existing in the streets compared to the provided photos.

6.4.2. Sample size

The questionnaire's sample size was determined using an online sample size calculator (Raosoft). This tool required inputting the expected number of street users during the entire day, along with the desired confidence level and the acceptable margin of error, in order to derive the appropriate sample size. The information about the expected number of street users during the day (16 hours) was calculated based on data retrieved from the Road Elements Coordination Standards Manual. It reports that the expected high pedestrian volume per minute ranges from 81 to 120 pedestrian/minute. Therefore, the suitable sample size should be an average of 383 respondents for each street. Unfortunately, the actual number of respondents is total 61, indicating a margin of error of 13%. Additionally, this number changes according to the number of respondents in each street. Nevertheless, the validation process for assessing street elements through the questionnaire was merely a miniature of the comprehensive assessment required for the entire framework developed in this research. In other words, the questionnaire is just a validation step for the field assessing results, thus the actual sample size was accepted.

6.4.3. Results

Initially, participants were inquired about their previous visits to the various streets. As depicted in Figure 6.91, the percentages of visits showed a gradual decline from Kasr El-Nil Street to El-sheikh Ali Yousef Street. Furthermore, based on the outcomes of Step 1 and Step 2, it was evident that Kasr El-Nil Street and Talaat Har Street achieve the highest level of complete street elements

among other examined streets. compared to the other surveyed streets. Consequently, for validation purposes, the questionnaire exclusively presented the outcomes for these two streets, as they received the highest number of responses among all the streets under examination.

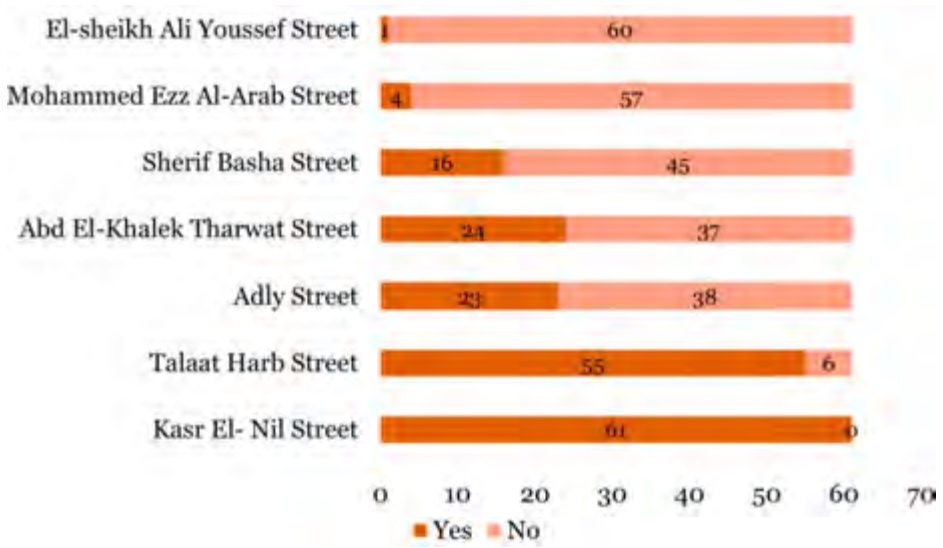


Figure 6. 91 - Number of respondents visited each street. Source: Author

Generally, the demographic characteristics of participants showed that percentages of males and females are nearly similar, also, the majority of participants are of age group from 18 to 30 years old (as shown in Figure 6.92 & Figure 6.93). This pie chart indicates that the response rate among younger age groups surpasses that of their older ones, possibly owing to the questionnaire's online dissemination. Evidently, younger generations exhibit greater familiarity and proficiency towards technology compared to older generations.

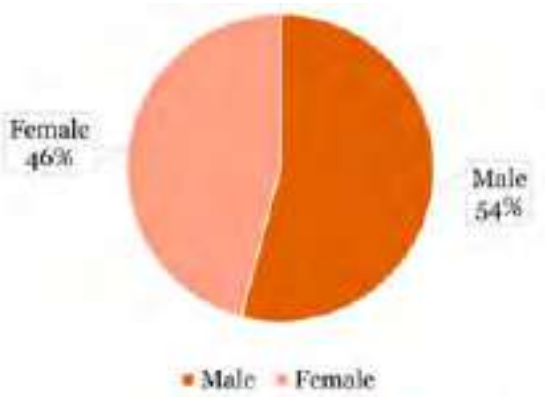


Figure 6. 92 - Categorization of participants per gender. Source: Author

Concerning the frequency of visits to the two streets, the pie chart depicted in Figure 6.94 reveals that approximately 33% of the participants visit these streets six to eleven times annually. Moreover, an equivalent proportion, also comprising 30% of the respondents, visit the streets one to five times per month. However, a notable percentage, comprising 28% of the participants, rarely visit the streets. On the other hand, the majority, accounting for two-thirds of the participants, show a high frequency of visits to the streets. Furthermore, the limited frequency of street visits does not necessarily negate the participants' ability to recall street features.

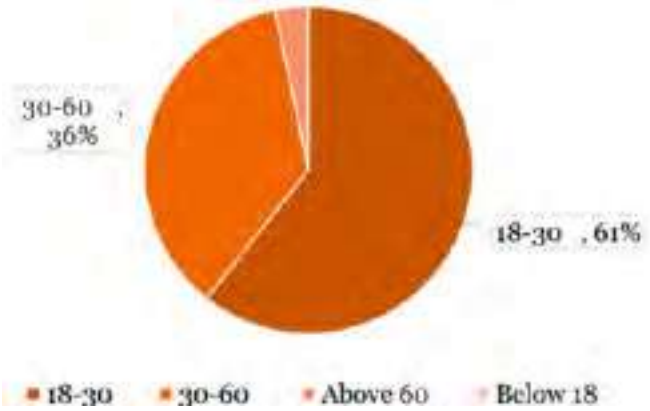


Figure 6. 93 - Categorization of participants per age. Source: Author

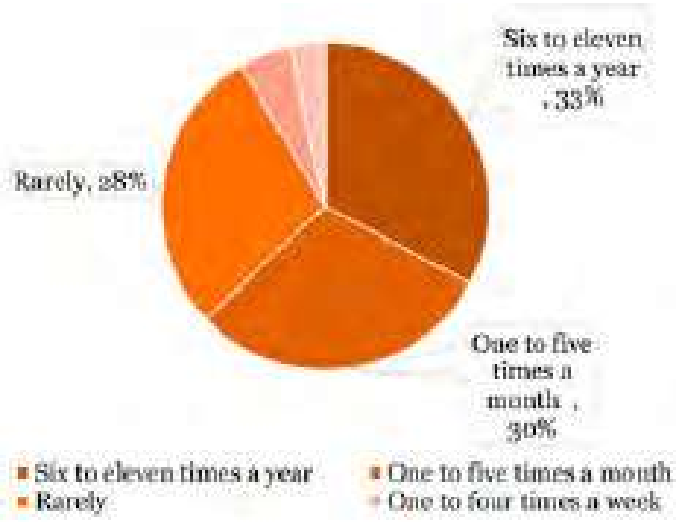


Figure 6. 94 - Frequency of visiting the two streets. Source: Author

Apart from this, the last question in this part concerns the most used means of transportation for reaching the streets. Figure 6.95 indicates that the majority of participants use public transportation means for reaching Kasr El-Nil and Talaat Hard Street.

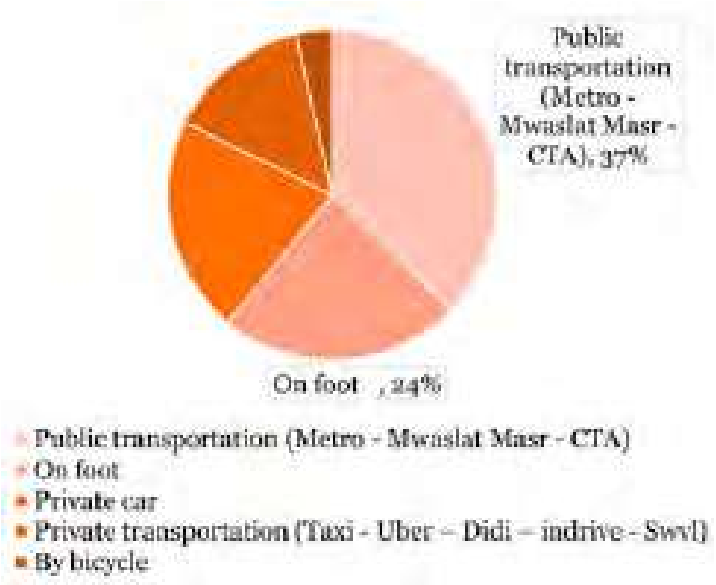


Figure 6. 95 - The most used means of transportation. Source: Author

Another great percentage of participants (24%) reach the street by walking. Limited participants use the bike, about 4% of total responses. The following section shows the questionnaire results of Talaat Harb Street and Kasr El-Nil Street separately.

Talaat Harb Street

As mentioned previously, there was a set of eleven questions examining users' satisfaction level with street elements. The results were collected through a radar chart, in order to form a comparison between street elements and deduce a broad conclusion on the existing shortages. The results showed that the majority of answers were ranging between satisfied/neutral/totally unsatisfied as shown in Figure 6.96. For further details, the majority of participants are satisfied with the overall walking experience on Talaat Harb Street. While a major number of participants have a neutral satisfaction level regarding sidewalk shading, efficiency of street lighting, availability of trash bins, quality of bike lane, and the safety of crossing the street. On the contrary, a majority of participants are totally unsatisfied with the availability of green areas, availability of public seatings,

occupancy of street vendors of sidewalks, accessibility of ramps, and availability of parking lots.

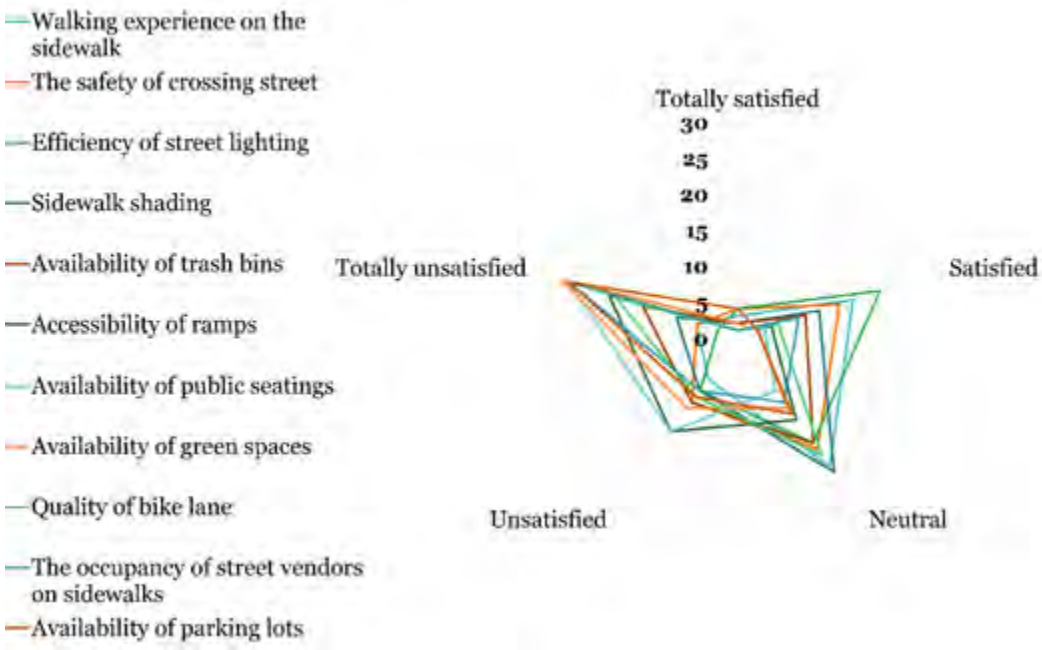


Figure 6. 96 - Users' level of satisfaction with street elements in Talaat Harb Street. Source: Author

Furthermore, the bar charts of Figure 6.97 and 6.98 shows the most engaging activities/ most annoying activities respectively. The majority of participants consider walking and shopping are the most engaging activities in Talaat Harb Street. Also, the majority selected the encroachments of street vendors as the most annoying street activity.

Figure 6. 97 - The most engaging street activities in Talaat Harb Street. Source: Author

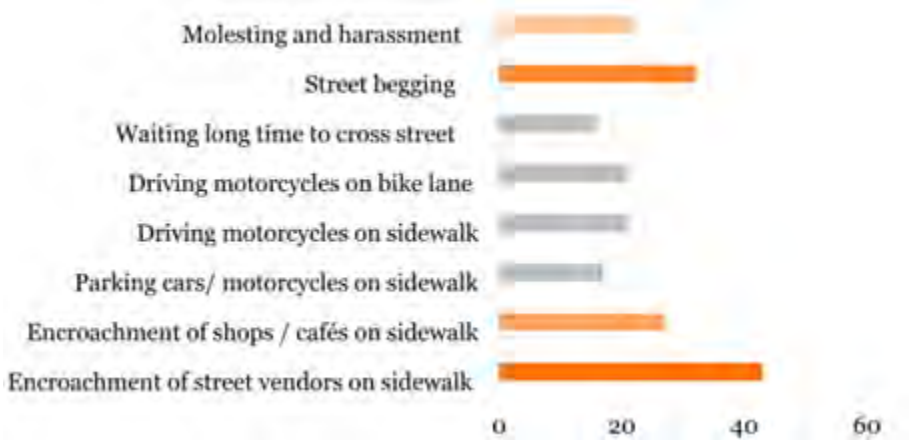


Figure 6. 98 - The most annoying street activities in Talaat Harb Street. Source: Author

The last question was asked about the deficiencies of street elements on Talaat Harb Street, given that several photos of transformed complete streets of the international case studies were provided to assist participants in the selection process. The line chart in Figure 6.99 shows the majority of participants selected green spaces, followed by public benches, trash bins, and accessibility ramps in a successive manner.

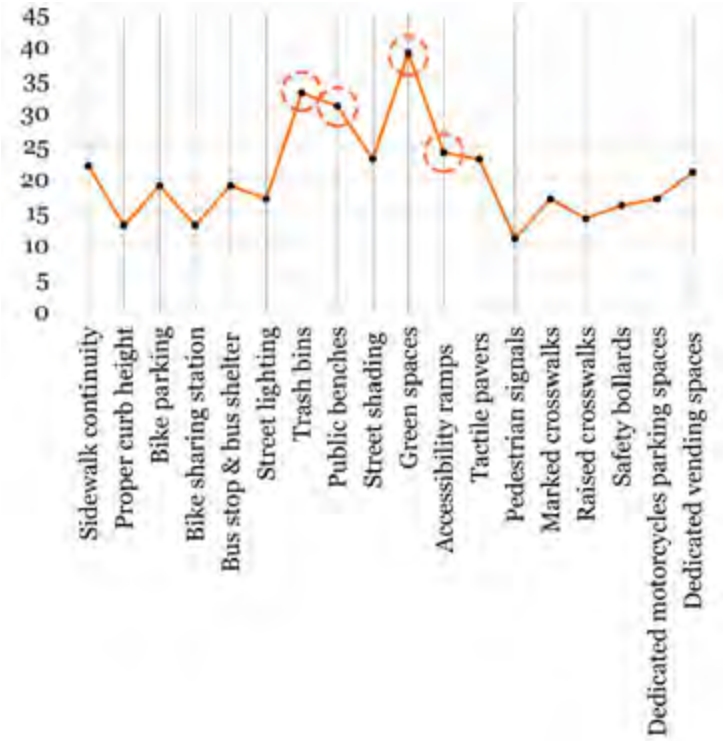


Figure 6. 99 - The deficiencies in the street element of Talaat Harb Street. Source: Author

Kasr El-Nil Street

By the same token, the following radar chart showed that the majority of answers were ranging between neutral and totally unsatisfied as shown in Figure 6.100. To demonstrate, the majority of participants have a neutral satisfaction level regarding the overall walking experience, sidewalk shading, efficiency of street lighting, availability of trash bins, and the safety of crossing the street. Conversely, the majority of participants are totally unsatisfied with the availability of public seatings, the availability of green areas, the accessibility of ramps, the occupancy of street vendors on sidewalks, and the availability of parking lots. It is worth noting that almost half of the participants have a neutral satisfaction level regarding the quality of bike lane, while the other half are totally unsatisfied.

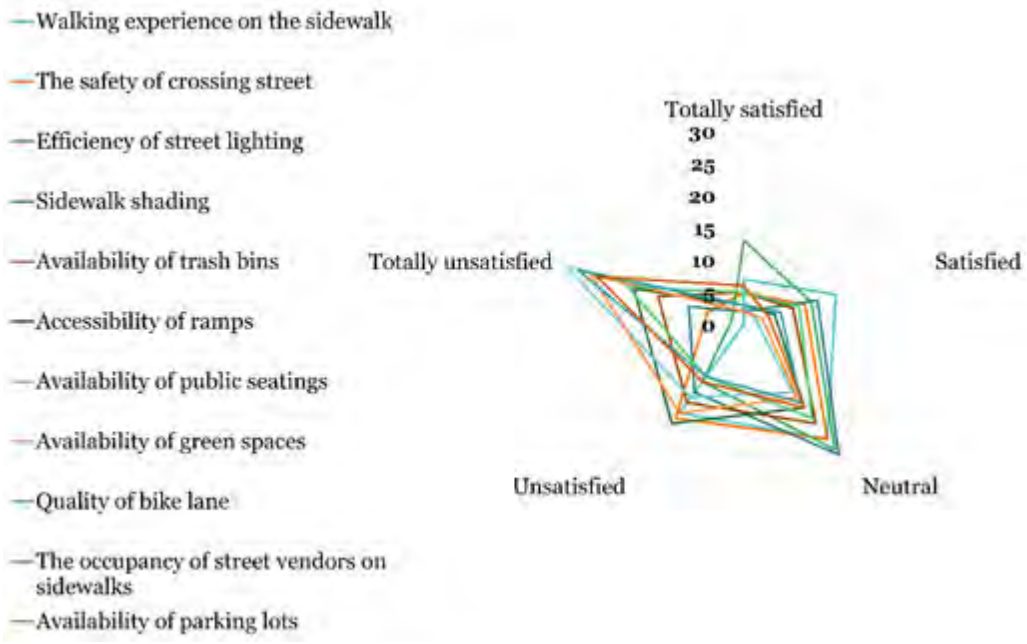


Figure 6. 100 - Users' level of satisfaction with street elements in Kasr El-Nil Street. Source: Author

Additionally, the bar charts of Figure 6.101 and 6.102 shows the most engaging activities/ most annoying activities respectively. The majority of participants consider walking and shopping are the most engaging activities in Kasr El-Nil Street too. Also, the majority selected the encroachments of street vendors as the most annoying street activity, the same as Talaat Harb Street.

Figure 6. 101 - The most engaging street activities in Kasr El-Nil Street. Source: Author

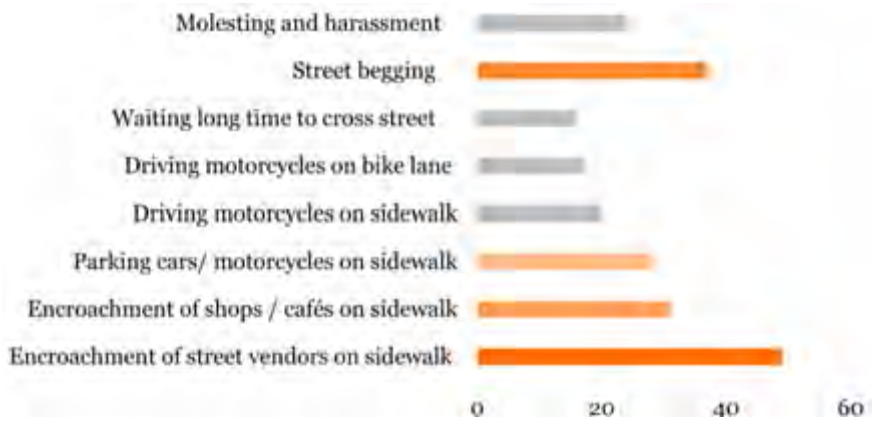


Figure 6. 102 - The most annoying street activities in Kasr El-Nil Street. Source: Author

Regarding the deficiencies of street elements on Kasr El-Nil Street, the line chart in Figure 6.103 shows the majority of participants selected both public benches and green spaces, followed by trash bins, and accessibility ramps in a successive manner.

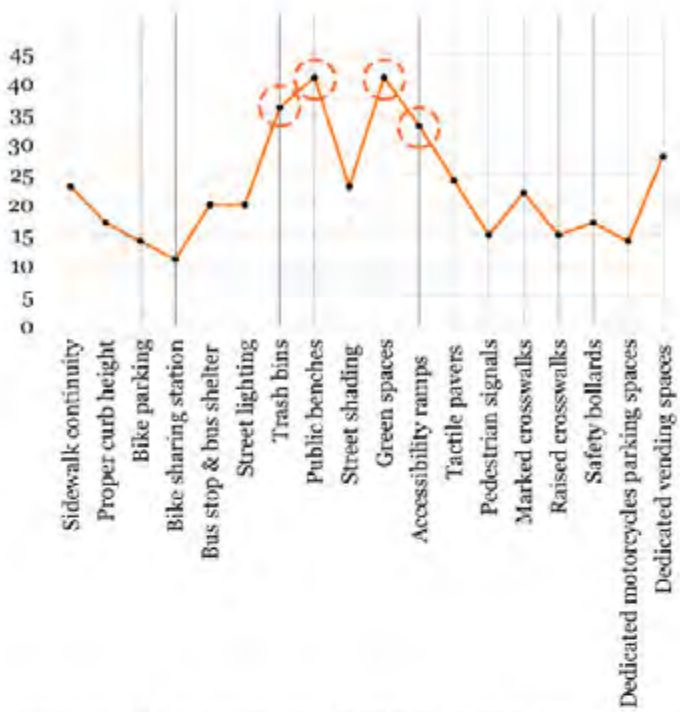


Figure 6. 103 - The deficiencies in the street element of Kasr El-Nil Street. Source: Author

6.5. Final conclusion

By assessing various street elements, there are two main insights regarding the degree of applicability of applying complete street policy on Khedival Cairo Street and the identification of the lacking street elements. Concerning the first mentioned point, Steps one and two showed that the complete street policy is highly applicable in Talaat Harb Street, and Kasr El-Nil Street among other streets, as they achieve approximately 60% and 55% of complete street elements respectively. Furthermore, it was deduced that adequate curb height, continuous shading and landscaping of the street, availability of street furniture (public benches and trash bins), accessibility of ramps, and availability of bus shelters are the most lacking street elements generally in all selected streets. Particularly on Talaat Harb and Kasr El-Nil Streets, it was concluded that continuous shading and landscaping of the street especially in Talaat Harb Street, availability of street furniture (public benches and trash bins), and accessibility of ramps are the most demanded and urgent street elements based on the field visits' analysis and

questionnaire results. Also, the questionnaire showed that the encroachment of street vendors is the most annoying street activity, however, only an average percentage of participants agree on providing dedicated spaces for street vendors. Consequently, the participants might be annoyed by the presence of street vendors in general as they are forced to use the carriageway for walking. Another possibility is that not all participants understand the proposed solution. It is worth mentioning that street vending can be integrated into the streetscape without disrupting other functions, if there is an actual demand.

Discussion & Conclusion

The car-oriented planning approach occurs when a city prioritizes automobile use as the primary means of transportation in decisions related to transportation, infrastructure, and land use. In Greater Cairo Region, considerable financial resources were dedicated to the enhancement and expansion of its road networks. At the same time, limited attention has been directed towards enhancing pedestrian and public transportation infrastructure. Consequently, the prevalence of car-oriented planning has negatively affected the infrastructure of streets and sidewalks, impeding their ability to cater to the needs of pedestrians, cyclists, and users of public transportation. In order to contribute to solving the problem, the research aims to examine the degree of applicability of applying the Complete Street policy on Khedival Cairo streets. The Complete Street policy is the proper solution to reducing dependence on automobiles as it offers guidance in the decision-making and design phases, ensuring that all street users are taken into account during the planning process. This aim was achieved through a deep understanding of the complete street elements, and their possible applications in international case studies. Also, through investigating the gaps in the Egyptian street planning guidelines, and most importantly, assessing the degree of applicability of applying the Complete Street policy on the selected streets in Khedival Cairo.

7.1. The applicable Complete Street design elements

The Evaluation of international case studies in accordance with Complete Street Policy showed that thirteen street elements are implemented in the majority of the seven case studies, which are:

1. Sidewalk zoning (Multi utility zone/Pedestrian zone/Frontage zone)
2. Shading trees
3. Streetlights
4. Street furniture (public benches & trash bins)
5. Ramps
6. Safety bollards
7. Traffic signals
8. Raised crossings
9. Shared bike lane markings
10. Signages
11. Curb extensions
12. Narrowing of carriageways
13. On-street parking

Clearly, the first eight mentioned street elements are basic street amenities that should be implemented to provide safe and comfortable streets. Furthermore, according to the literature, the approach of Complete Streets design advocates for the implementation of narrower vehicle lanes and street widths, whenever feasible and appropriate, to establish a safer street network that accommodates active travel. Wide streets and vehicle lanes, on the other hand, tend to foster higher vehicle speeds, resulting in an elevated likelihood of severe crashes (Chicago Metropolitan Agency for Planning et al., 2015). Nevertheless, the narrowing of carriageways is considered more a solution to wide street lanes rather than a street element. Moreover, curb extensions are advisable for streets with on-street parking.

7.2. The Case of Khedival Cairo

This section shows a comparison between the previous list of the crucial Complete Street elements to the existing and lacking street elements in the selected streets of Khedival Cairo. It was concluded from chapter 6 that the selected streets have a shortage in various basic street elements such as continuous shading and landscaping of the street, availability of street furniture (public benches and trash bins), and accessibility of ramps. Also, it was deduced that selected streets totally lack raised crossings and shared bike lane markings in streets that do not include a separated bike lane. Furthermore, curb extension and on-street parking are only achieved in Adly Street. According to literature, curb extensions are advisable for streets with on-street parking. Additionally, curb extensions create an expansion of sidewalk areas designated for bus shelters, also, they effectively decrease the crossing distance at intersections (City of Memphis complete streets plan, 2020).

7.3. The gaps in Egyptian street planning guidelines

Likewise, by comparing the crucial Complete Street elements to the existing Egyptian street planning guidelines, it was concluded that there are 5 street elements (shared bike lane markings, traffic signals, signages, bollards, and on-street parking) discussed in the majority of guidelines. While there are other 5 crucial street elements (streetlights, street furniture, shading trees, and curb extension) are only discussed in NOUH heuristic guides (not issued). Also, there are two street elements (ramps and raised crossings) are discussed only in the Road Elements Coordination Standards Manual (prepared by the Housing & Building National Research Center). It is worth noting that sidewalk zoning is discussed in both in the Road Elements Coordination Standards Manual and NOUH heuristic guides (in a more detailed manner).

Furthermore, by examining the level of adoption of Egyptian street planning guidelines (excluding NOUH) in Khedival Cairo streets, it was found that 6 of the discussed street elements in the Egyptian street planning guidelines (multi-

utility zone, pedestrian zone, ramps, traffic signals, signages, bollards, on-street parking) are almost achieved in the majority of selected streets. Moreover, the Shared bike lane marking is discussed in most of the Egyptian street planning guidelines, however, it is not totally achieved in the selected streets. Also, some street elements such as streetlights, ramps, and curb extensions are only discussed in the Road Elements Coordination Standards Manual. Even so, the legal validity of this guide is debatable as it is an indicative reference rather than an obligatory requirement in any formal legal documentation. Furthermore, it was noted that the crucial street elements that are not discussed in the Egyptian street planning guidelines as shading trees, and street furniture were not properly achieved in the selected streets. Overall, it was concluded that most street elements that are related to vulnerable street users (pedestrians and cyclists) such as sidewalk zoning, shared bike lane markings, ramps, streetlights, shading trees, and street furniture are not considered in the two main ongoing guides (The Egyptian Code for Urban and Rural Streets Works, Detailed Plans Preparation Manual).

7.1. Recommendations

The overarching goal of the Complete Streets movement is to induce a transformative shift in the approach of transportation agencies and communities towards street projects, aiming to guarantee universal safety, convenience, and accessibility for all individuals (American Planning Association, 2010). Moreover, the realization of Complete Streets involves a notable shift in the effort and responsibility from policymakers to transportation planners and engineers. To successfully execute the Complete Streets approach, a fundamental reevaluation of roadway design principles and factors is imperative to ensure the comprehensive accommodation of all street users. The policy adoption processes across various contexts exhibit a common sequence of stages. These processes are influenced by a variety of dynamic forces such as political support, the local government, financial support, local regulations, and policies. Thus, in order to adopt the Complete Street policy, there are three main steps. Firstly, defining the

existing problems; comprehending the historical context, existing circumstances, and anticipated future conditions of the existing problems establishes a logical foundation for enacting policy change. Once the problems are identified, evidence should be collected to support the need for change such as statistics of traffic accidents, road fatalities, current state of transportation planning, etc. Thirdly, the different interests of stakeholders need to be determined to guarantee a successful adoption of the policy. To clarify, there are numerous stakeholders such as planners, transportation engineers, policymakers, and developers that have different interests and concerns. Successful complete street policies facilitate the collaboration of multiple stakeholders in order to identify shared objectives, enumerate mutual benefits, and cultivate a collective understanding of the transportation needs encompassing all users within a community (Chicago Metropolitan Agency for Planning et al., 2015).

The research has contributed to addressing the first two steps of defining the main problem, as well as collecting evidence and data about the current conditions of street planning in Khedival Cairo. Therefore, the following section proposes recommendations for different stakeholders, calling for action based on the research findings.

Policymakers: Policymakers should update ongoing Egyptian street planning guidelines to include the discussed lacking street elements. Also, the sidewalk guidance should be issued, and forced as an obligatory guide, as it includes most of the Complete Street policy.

Local Government: The local government should provide monitoring of illegal street practices and maintenance of deteriorated street conditions. Moreover, the government should supervise the execution and construction of street amenities.

Urban planners: Urban planners should stick to the local guidelines, as well as work on providing a comfortable and safe street environment for all users.

Developers & Construction companies: Likewise, the developers should follow the local guidelines and the provided plans, taking into account the universal safety, convenience, and accessibility for all individuals

7.2. Research limitations

In Chapter 3, the explored international cases that offer comparable levels of economic development and street conditions as that of Cairo were relatively limited as few developing countries have adopted the Complete Street policy. Moreover, limited literature was found studying the Khedival Cairo context. In addition, the literature review clarified that assigning weights to different functions of the street would be challenging, also, the author did not find an applied assessment model. Thus, the research adopted the proposed protocol in order to assess the street design.

7.3. Concluding remarks

By addressing the first two steps of adopting the Complete Street policy, further research should be directed to investigating the practical procedures of adopting the Complete Street policy in particular or the multi-modal planning approach in general. To emphasize, another dissertation under IUSD, prepared by MSc. Mostafa Khaled, aimed to map the street-shaping policies in Egypt. Consequently, by understanding the current problems, providing evidence about the current state of Khedival Cairo Streets, as well as understanding the current roles of different stakeholders in Egypt, future research should investigate the hindering reasons for adopting such a policy that considers all street users, and provide a feasible plan for adopting the policy.

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Appendix

Questionnaire

Section 1:

1. Gender:
   - Male
   - Female

2. Age:
   - Below 18
   - 18-30
   - 30-60
   - Above 60

3. Have you ever visited “street name”?
   - Yes
   - No

Section 2:

Street name

4. Do you live in “street name”?
   - Yes
   - No

5. How often do you visit “street name”?
   - Daily
   - 1 to 4 times a week
   - 1 to 5 times a month
   - Rarely

6. What is your most used means of transportation to get to “street name”?
   - On foot
   - Public transportation (Metro – CTA – Mwaslat Masr)
   - By Bicycle
   - Private car
   - Private transportation (Taxi - Uber – Didi – indrive - Swvl)

7. What is your level of satisfaction with walking experience on the sidewalk of “street name”?

1	2	3	4	5
Very satisfied راضٍ جدًا	Satisfied راضٍ	Neutral حيادي	Unsatisfied غير راضي	Totally unsatisfied غير راضٍ تمامًا

8. What is your level of satisfaction with the safety of crossing “street name”?

1	2	3	4	5
Very satisfied راضٍ جدًا	Satisfied راضٍ	Neutral حيادي	Unsatisfied غير راضي	Totally unsatisfied غير راضٍ تمامًا

9. What is your level of satisfaction with the efficiency of street lighting at night on “street name”?

1	2	3	4	5
Very satisfied راضٍ جدًا	Satisfied راضٍ	Neutral حيادي	Unsatisfied غير راضي	Totally unsatisfied غير راضٍ تمامًا

10. What is your level of satisfaction with sidewalk shading on “street name”?

1	2	3	4	5
Very satisfied راضٍ جدًا	Satisfied راضٍ	Neutral حيادي	Unsatisfied غير راضي	Totally unsatisfied غير راضٍ تمامًا

11. What is your level of satisfaction with the availability of trash bins on “street name”?

1	2	3	4	5
Very satisfied راضٍ جدًا	Satisfied راضٍ	Neutral حيادي	Unsatisfied غير راضي	Totally unsatisfied غير راضٍ تمامًا

12. What is your level of satisfaction with the accessibility of ramps for the handicapped on “street name”?

1	2	3	4	5
Very satisfied راضٍ جدًا	Satisfied راضٍ	Neutral حيادي	Unsatisfied غير راضي	Totally unsatisfied غير راضٍ تمامًا

13.What is your level of satisfaction with the availability of public seatings/benches on “street name”?

1	2	3	4	5
Very satisfied راضٍ جدًا	Satisfied راضٍ	Neutral حيادي	Unsatisfied غير راضي	Totally unsatisfied غير راضٍ تمامًا

14.What is your level of satisfaction with the availability of green spaces on “street name”?

1	2	3	4	5
Very satisfied راضٍ جدًا	Satisfied راضٍ	Neutral حيادي	Unsatisfied غير راضي	Totally unsatisfied غير راضٍ تمامًا

15.What is your level of satisfaction with the bike lane on “street name”?

1	2	3	4	5
Very satisfied راضٍ جدًا	Satisfied راضٍ	Neutral حيادي	Unsatisfied غير راضي	Totally unsatisfied غير راضٍ تمامًا

16.What is your level of satisfaction with the occupancy of street vendors on sidewalks of “street name”?

1	2	3	4	5
Very satisfied راضٍ جدًا	Satisfied راضٍ	Neutral حيادي	Unsatisfied غير راضي	Totally unsatisfied غير راضٍ تمامًا

17.What is your level of satisfaction with the availability of parking lots on “street name”?

1	2	3	4	5
Very satisfied راضٍ جدًا	Satisfied راضٍ	Neutral حيادي	Unsatisfied غير راضي	Totally unsatisfied غير راضٍ تمامًا

Section 3:

18. Please choose the most three engaging activities on “street name”?
- Walking
- Sitting in public seatings/ outdoor cafés
- Shopping
- Riding bike
- Rollerblading
- Others

19. Please choose the most four annoying activities on “street name”?
- Encroachment of street vendors on sidewalk
- Parking cars/ motorcycles on sidewalk
- Driving motorcycles on sidewalk
- Driving motorcycles on bike lane
- Encroachment of shops / cafés on sidewalk
- Waiting long time to cross street
- Street begging
- Molesting and harassment
- Others

Section 4:

20. In light of the following images: What are the deficiencies in the street elements of “street name”?

- Sidewalk continuity
- Proper curb height
- Streetlighting
- Trash bins
- Street benches
- Street shading
- Green spaces
- Accessibility ramps
- Tactile pavers (used to alert visually impaired people)
- Pedestrian signals
- Marked crosswalks
  Raised crosswalks
- Safety bollards
- Bike lane
- Bike parking
- Bike sharing station
- Bus stop & bus shelter
- Dedicated motorcycles parking spaces
- Dedicated vending spaces
- Others

المستخلص

يواجه سكان القاهرة الكبرى نمواً سريعاً، مما أدى إلى زيادة عدد المركبات وتسبب في ازدحام مروري كبير. قامت الحكومة المصرية بجهود للتخفيف من هذه المشكلة من خلال توسيع شبكة الطرق وفتح طرق جديدة للحد من اختناقات المرور ومعالجة الازدحام. ومع ذلك، فقد تسببت هذه التطورات التي تركز على السيارات في آثار سلبية على بنية الشوارع والأرصفة، مما يعوق راحة وسلامة المشاة وراكبي الدراجات ومستخدمي وسائل النقل العام. وبناءً عليه، من الضروري إنشاء بيئات شوارع تضع أولويات احتياجات الأفراد، مع ضمان سلامتهم و سهولة تنقلهم بدلاً من التركيز فقط على توسيع شبكة الطرق. وفقًا لنطاق الدراسة، تم اختيار القاهرة الخديوية كدراسة حالة لعدة أسباب، حيث تم تخطيطها وتصميمها بعناية، وموقعها المرموق كمنطقة أعمال مركزية، وتوفر شبكة وسائل النقل العام. وبالتالي، يهدف هذا الأطروحة إلى فحص درجة قابلية تطبيق إحدى النهج/السياسات المناسبة لتخطيط الشوارع الموجهة نحو المستخدمين في شوارع القاهرة الخديوية. يتم تحقيق ذلك من خلال هدفين رئيسيين، وهما استكشاف النهج/السياسات المناسبة التي تتناول مشكلة البحث وتطوير نموذج تقييم لقياس درجة قابلية تحويل الشوارع المختارة في القاهرة الخديوية

لتحقيق ذلك، يبدأ الإطار النظري ببناء خلفية نظرية لمراجعة العوامل التصميمية للسياسات/النهج العالمية مثل "Living Streets" و "Non-motorized Transportation" و "Complete Streets". ثم، تحليل البحث العناصر التصميمية للشوارع الأكثر تطبيقًا في سبعة دراسات حالة دولية. وأيضًا لاستنتاج سمات الشوارع المحولة، من أجل الاستفادة منها أثناء صياغة المعايير لاختيار الشوارع في دراسة حالة القاهرة الخديوية. ثم تم استعراض الإرشادات والقوانين المصرية لتخطيط الشوارع للتحقق من الفجوات الموجودة. فيما يتعلق بدراسة الحالة، تم جمع البيانات وتحليلها في ثلاث خطوات. الخطوة الأولى هي تقييم قائمة التحقق من العناصر التصميمية للشوارع الكاملة المحققة/غير المحققة، ثانيًا، تقييم العناصر التصميمية المحققة في الشوارع من خلال البيانات العددية والبصرية. واستنتج أن شارع طلعت حرب وشارع قصر النيل هي الشوارع التي تحقق أكثر العناصر التصميمية للشوارع الكاملة. للتحقق من النتائج، تم إجراء استبيان لفهم مستوى رضا مستخدمي الشوارع. أخيراً، تم تقديم توصيات بشأن العناصرالذي يفتقر إليه شوارع القاهرة الخديوية.

الكلمات الرئيسية: الازدحام المروري، الشوارع التجارية، اعتبارات تصميم الشوارع، الشوارع الكاملة، الأرصفة، معايير اختيار الشوارع، شوارع ملائمة للناس، نموذج تقييم، القاهرة الخديوية

إقرار

هذه الرسالة مقدمة في جامعة عين شمس للحصول على درجة العمران المتكامل والتصميم المستدام . إن العمل الذي تحويه هذه الرسالة قد تم إنجازه بمعرفة الباحث سنة ٢٠٢٣

هذا ويقر الباحث أن العمل المقدم هو خلاصة بحثه الشخصي وأنه قد اتبع الإسلوب العلمي السليم في الإشارة إلى المواد المؤخوذه من المراجع العلمية كل في مكانه في مختلف أجزاء الرسالة..

وهذا إقرار مني بذلك،،،

التوقيع:

الباحث: لورا مدحت جرجس

التاريخ: ٢٠٢٣/٢٢/٠٧

نحو تطوير شوارع ملائمة للناس في القاهرة: البحث في مدى إمكانية تطبيق سياسة شوارع كاملة على شوارع القاهرة الخديوية

مقدمة للحصول على درجة الماجستير في العمران المتكامل والتصميم المستدام

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ختم الإجازة
موافقة مجلس الكلية.../.../...

أجيزت الرسالة بتاريخ: .....
موافقة مجلس الجامعة.../.../...

جامعة عين شمس

نحو تطوير شوارع ملائمة للناس في القاهرة

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على درجة الماجستير في العمران المتكامل والتصميم المستدام رسالة مقدمة للحصول

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