Journal of
Engineering Sciences
Faculty of Engineering
Assiut University
JES
مجلة
العلوم الهندسية
كلية الهندسة
جامعة أسيوط
journal homepage: http://jesaun.journals.ekb.eg

Commercial Streets: A Framework for Creating Livable Environments in Egypt

Received 11 May 2024; Revised 26 July 2024; Accepted 26 July 2024

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Keywords
Livable Commercial Streets, Quality of Life, Urban Design, Placemaking, Street Livability Index

Abstract: The concept of livability has garnered significant attention and has become a focal point in the research and discussions among cities and governments. As the expansion and density of urban areas, the importance of livable streets as fundamental elements of urban design has grown. Livable streets play a crucial role in creating a dynamic and thriving urban environment, driving urban transformation towards improved quality of life and sustainability. One of Egypt's most worked-on agendas is the development of the new improved street network, which has a direct effect on city residents, street users, and most importantly the country's economy. The objective of this paper is to introduce a framework for contemporary and livable commercial streets that can serve as a blueprint for promoting sustainable urban transformation in Egypt. This framework involves the development of categories and indicators to evaluate the livability of streets in contemporary settings. These indicators provide valuable guidance for decision-makers during the planning and design phases. This research adopted a practical framework, a field survey, observations, evaluation, and a questionnaire, as its research methods. To assess the effectiveness of the street livability framework, it will be implemented and tested on two newly developed streets: Prince Mohammed bin Abdelaziz Street (Tahlia Street) in the Olaya District of Riyadh, Saudi Arabia, and Dahshur Link Street in the Greater Cairo Region, Egypt. Through a comparative analysis of these locations, the study aims to derive meaningful conclusions and provide recommendations.

1. Introduction

Livable spaces are characterized by their ability to attract individuals from diverse social backgrounds, cater to various age groups, and foster a range of activities. These spaces are easily accessible and seamlessly connected to the surrounding neighbourhoods. They are inclusive, and welcoming people of all ethnic backgrounds, ages, and genders. Livable spaces serve as democratic platforms, offering areas for both individuals and society to engage and

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https://doi.org/10.21608/jesaun.2024.288746.1334

interact. They incorporate gathering spaces that promote social connections and allow individuals to express their unique identities. Furthermore, livable spaces contribute to the cultural identity of a region, serving as a hub where local communities can thrive and find a sense of belonging [1].

Streets are the lifeblood of cities, one of the most important livable spaces, providing essential spaces for urban activities to flourish. Throughout history, livable streets have been more than just transit or walking paths; they have been vibrant centres of commerce, recreational activities, and social interactions. At the end of the 1950s, two contrasting approaches to street development appeared. The first approach aimed to expand street capacity in response to a growing population and a rising number of vehicles. The focus was on accommodating the increasing demand for vehicular transportation. However, the second approach called for the creation of diverse streets that catered to different modes of public transportation and prioritized pedestrian networks over cars. The focus was on enhancing the multimodal transportation system that offers a range of options to the public [2]. Presently, there is a global shift towards livable streets that meet a variety of needs, which include not only necessities such as food and safety but also aesthetic appeal, cultural significance, and a sense of connection to the community or location. These streets aim to attract individuals to spend more time, which ultimately improves the overall quality of life within public spaces [3], [2]. These livable streets also aim to envision a broader scope, which includes sustainable urban transformation and the restructuring of urban infrastructure, transportation methods, and ways of life.

Egypt is considered one of the main countries expected to contribute 25 million to the increase in the world's urban population between 2014 and 2050 based to the United Nations, this critical situation will lead to an ongoing decline in the quality of life and urban environment. Streets in Egypt constitute approximately 30% of the city's land area [4] and are regarded as an important component of the country's infrastructure, they provide most of the public areas and have a big effect on both the quality of life in neighborhoods and environmental health. Furthermore, high rates of urbanization, intensive urban land use, and neighborhoods gradually taken over by vehicles affect pedestrians' comfort, safety, and physical activities in outdoor living. Recently different studies indicated that Egypt's Co2 emissions increased substantially from (25 to 269.5 million tons) during the past 50 years. According to predictions, Egypt's gas emissions will rise faster than its population by 2030. Egypt's share of world emissions will grow by 50%, therefore reducing traffic congestion must come first in the street development process to reduce gas emissions [5].

Furthermore, the road sector is also considered the backbone of the economy and the most important means of transporting goods and passengers. As a major contributor to trade and an essential mode of transportation. Egypt's road sector was responsible for 97 percent of freight movements, most of which are private, and for more than 55 percent of domestic passenger movements (4.1 million vehicles in 2006/07 with 60 million passengers/day) [6]. As of the end of 2019, Egypt's National Roads Project - implemented in 2014 - has successfully developed 4,500 km of the country's 7,000 km of pledged new roads. An improved road network would support economic development, reduce traffic congestion, and

improve public safety [7]. Streets serve as shared spaces for various individuals, encompassing diverse genders, age groups, and socioeconomic backgrounds, allowing them to participate in social and economic endeavors. [8].

Similar to Greater Cairo, the city of Riyadh in Saudi Arabia, one of the major capitals of the world, has also experienced significant urban expansion. This massive urbanization has resulted in horizontal growth and increased dependence on vehicles for transportation. The urban development area in Riyadh covers an extensive 3,115 square kilometers, with a planned land area of 1,820 square kilometers as of 2017, constituting 58% of the total urban development area. In order to improve livability in Riyadh, the Council of Economic and Development Affairs has devised a plan to achieve Vision 2030. This vision aims to transform Saudi Arabia into a highly livable city by enhancing people's lifestyles and overall quality of life [9]. The city of Riyadh was selected due to its similarities in environment and culture with Cairo, as well as its government's vision to transforming the city into a more livable and sustainable urban center.

As a result, the research study aims to provide a framework (checklist) for contemporary livable commercial streets that can serve as a design blueprint for promoting sustainable urban transformation. This framework involves the development of indicators and sub-indicators to assess the livability of streets in contemporary settings. Its primary purpose is to assist planners and architects in evaluating the appropriateness and enhancing the quality of commercial streets. These indicators also serve as a valuable point of reference for decision-makers during the design and planning phases, offering guidance and informing their decision-making processes. Additionally, the street Livability Framework will be applied and tested in two specific areas: Tahlia Street in the Olaya District of Riyadh, Saudi Arabia, and Dahshur Link Street in Greater Cairo. Through a comparative analysis of these areas, the study aims to derive results and provide recommendations.

Research questions:

- In what ways do livable streets contribute to the attainment of sustainable urban development, and what are the key elements that influence streets' quality in newly established urban areas?
- What are the existing indicators and assessment frameworks that effectively measure street livability, and how can they be utilized to enhance the quality and livability of streets in Egypt?

1.1. Research Problem

The rapid urban growth, increasing population, expansive city development, and the prevalence of vehicles have led to a decline in walking activity, worsened traffic congestion, and heightened carbon dioxide emissions and air pollution. Consequently, streets have become primarily designed for vehicle use, losing their role as liveable spaces. These issues have had a detrimental impact on the quality of urban life, affecting residents, street users, and the overall economy of the country. Prominent cities such as Greater Cairo and Riyadh have been particularly influenced by these challenges. Consequently, the notion of liveability

has gained significant attention and has become a central focus in research and discussions among cities and governments. However, existing studies and assessment tools for evaluating liveability tend to either assess it on a city-wide scale, focus on specific street sections or functions, or concentrate on a singular aspect of liveability. There is a lack of a comprehensive framework for evaluating street liveability, particularly for commercial streets in Egypt.

1.2. Research Objectives

The main purpose of this paper is to propose a comprehensive Framework (Checklist) for contemporary and livable commercial streets that can serve as a blueprint for promoting sustainable urban transformation in the Arab context particularly in Egypt.

1.3. Research Methodology

The research methodology is based on two approaches; Firstly, the analytical approach highlights; livable street definitions, elements, and physical classifications to gather relevant information for developing a framework and identifying suitable indicators. Secondly, a descriptive comparative methodology was adopted in local and regional case studies by using different research tools. The tools vary between a spatial and descriptive analysis of the streets, along with conducting a structured questionnaire with a specific sample of participants. Current research investigates the influence of livable streets on improving the quality of life and assessing their performance in hot climates. Finally, the research proposes a comprehensive Framework (Checklist) that sets design guidelines and indicators for livable commercial streets in Egypt, see figure 1.

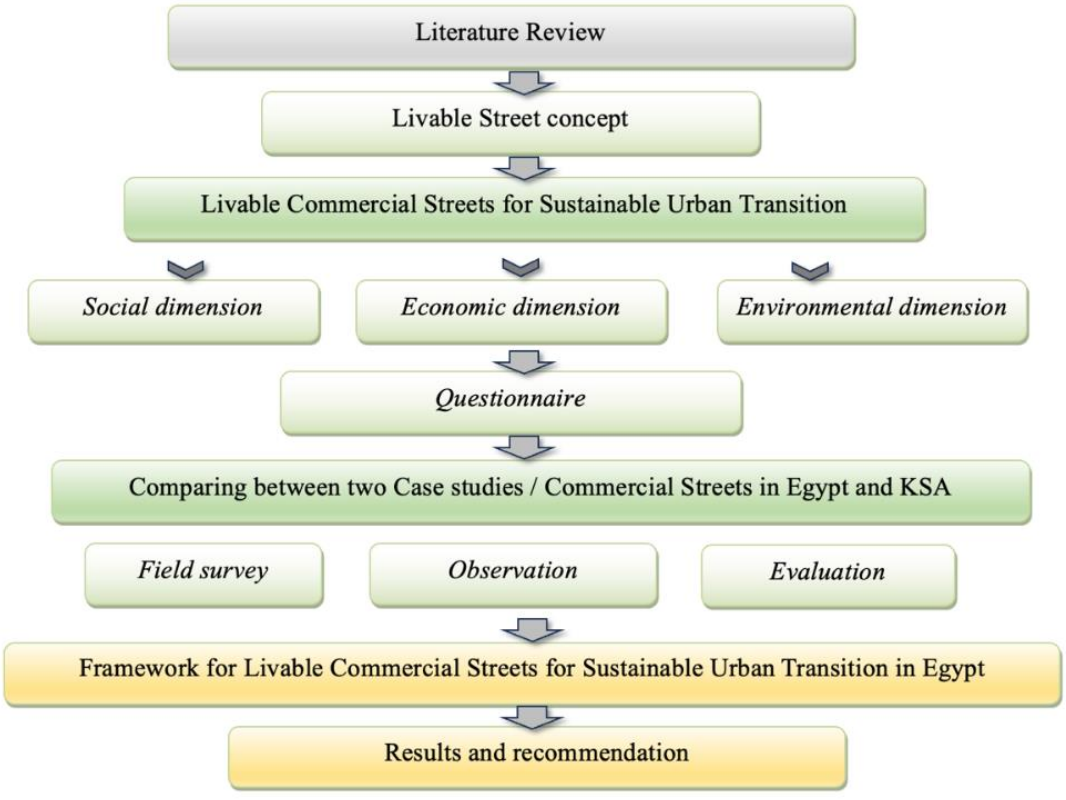

Figure 1: The Research Methodology's outline. (Source: Authors)

2. Literature Review

The term *'Livability'* refers to the level of well-being or Quality of life (QoL) experienced by individuals within a particular physical setting. Different groups with distinct interests focus on various aspects and indicators to evaluate the liveability of a location. Additionally, the perceived environmental and social quality of an area by its residents, employees, customers, and tourists significantly influences its desirability as a place to live. In essence, liveability is a multifaceted concept that can vary across cultures and geographical regions. Generally, liveability is determined by how effectively a place's characteristics can meet the economic, social, and cultural needs of its inhabitants while also promoting their health and overall well-being [10]. Furthermore, the subject of liveability has gained significant attention and has become a focal point for research and discussions among cities and governments. This is primarily due to the continued expansion and densification of urban areas, which puts additional pressure on limited space, resources, and the environment, thereby diminishing cities' ability to maintain a satisfactory quality of life. The concept of liveability first emerged in the 20th century through movements such as New Urbanism, Smart Growth, and Sustainable Urbanism. However, in more recent times, the pursuit of liveable and healthy cities has become a global priority, particularly following the recognition and adoption of the United Nations Sustainable Development Goals [11].

The term *"Quality of life (QoL)"* refers in general to human health and well-being [12], it also refers to the satisfaction of people about the fulfillment of their basic needs and values, it is important to know that the main concept of sustainability & liveability related to the concept of Quality of life. Different reviews and literature have developed models that describe sustainability & liveability as the result of interaction between social, physical and economic factors [13] & [14] & [15]. Thus, achieving both sustainability & liveability leads to achieving quality of life. Streets are the lifeblood of cities, one of the most important liveable spaces, since its inception, urban streets they have served as a means of connecting transportation routes, public spaces, and architectural facades, thereby strengthening urban identities. The movement space created by streets forms the vital link within urban public spaces, ranging from the internal circulation within buildings to the broader scale of entire cities. Streets are the fundamental elements of urban design and, consequently, influence urban life significantly. A city characterized by a lively street life is one that thrives as a viable urban environment, figure 2.

Streets serve a dual purpose as public spaces, where people engage in various activities such as walking, shopping, socializing, and participating in recreational pursuits, all of which contribute to the enjoyment of urban life. The liveability of streets is primarily determined by the effective integration of pedestrian needs, safety, and the movement of vehicles, as well as the thoughtful consideration of land use and the range of activities available [16] & [17].

Authors use different terminologies and keywords in articles to describe the concept of liveability in streets such as "*Livable streets*", "*Innovative streets*", "*Sustainable streets*", "*Digital streets*", and "*Walkable streets*" [18].

According to Appleyard, *"Livable Streets (LS)"* are characterized by a greater emphasis on pedestrians and cyclists compared to conventional urban streets, promoting equal usage by all individuals. However, the concept of liveable streets extends beyond merely providing a safe and pedestrian-friendly atmosphere. It also encompasses the creation of an urban environment that fosters human interaction with the surroundings, facilitating mental, psychological, and physical growth [19], see figure 3.

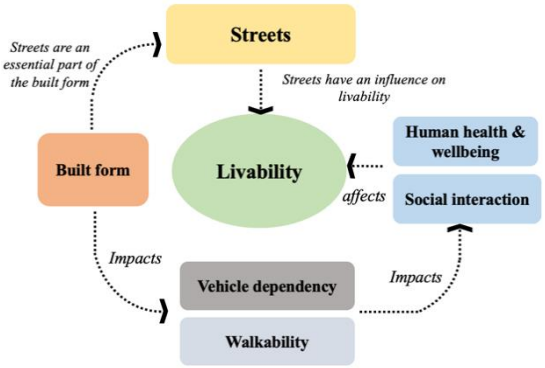

Figure 2: The significance of streets in urban space, (source: Authors)

Figure 3: The main principles of livable streets, (source: Authors from Appleyard, B. 2017)

The pursuit of "Livable Streets" has become a significant global trend and a key focus in research and planning guidelines. Livable streets, also known as liveable or sustainable streets, embody principles of social equity, economic vitality, and environmental sustainability, striving for a fair balance among all street users, including motorists, pedestrians, and cyclists [20]. Livable streets not only have the potential to drive sustainable urban transformation by improving urban efficiency, travel experiences, street infrastructure, and user safety, but they also serve as open public spaces that facilitate social interactions and daily activities [18]. Livable Streets are more essential now than ever before to help us adapt to a new climate reality, especially in the hot climates. Recently, different studies have shown that the implementation of urban green infrastructure in urban planning strategies contributes to reducing the Urban Heat Island effect, and enhances the microclimate, therefore, achieving thermal comfort for users in urban areas.

Meanwhile, sustainable urban transformation aims to optimize and sustainably utilize urban resources. Well-designed and well-maintained liveable streets promote greener modes of transportation and reduce reliance on cars [21] & [22]. To assess and enhance liveability through urban planning, policymakers and city planners worldwide have employed point-based index systems developed by various consulting firms. The goal of improving liveability ratings extends beyond enhancing the well-being and satisfaction of city residents; it also aims to attract new talent and investments while positioning the city favourably in the global competitive landscape. Using these indexing systems as a reference, cities are expanding their urban design guidelines to incorporate liveability considerations in future developments, aiming to enhance the quality of life for their residents and sustainable urban transformation [23]. Also, Livable streets are considered an investment in our community, street design and

public areas can affect the public perception of the community, influence the behavior of residents and visitors, and shape development decisions while also helping to create a sense of place [24].

Cities' liveability is assessed using a variety of global indicators that encompass social, environmental, economic, and civic factors. These indicators offer valuable visions into the quality of life experienced by individuals and provide indications about a city's future liveability. Examples of such indices include The EIU Index, Mercers Index, and Monocle's Quality of Living Survey [25]. However, there is a lack of global indicators specifically focused on evaluating streets' liveability, which represents a significant gap in the current assessment frameworks. Nevertheless, literary studies and various references have made efforts to recognize a specific variety of indicators that gauge the suitability of liveability on the streets. Hence, there is a need to address the existing gap in the literature by presenting a framework that outlines the characteristics of modern and liveable commercial streets. This framework serves as a guiding template for fostering sustainable urban transformation. It encompasses the identification of essential themes and sub-indicators to evaluate the liveability of streets in present-day contexts, drawing insights from existing literature. The framework is structured around three primary dimensions: social, environmental, and economic, with each dimension encompassing a distinct set of indicators.

2.1. Livable Commercial Streets for Sustainable Urban Transition

The various themes associated with the different "functions" that a liveable street can fulfill, as indicated in the research, can be illustrated as follows:

- *The Social dimension:* The street serves as a diverse social space, fostering opportunities for people to gather and interact.
- *The Economic dimension:* The street functions as a marketplace, offering potential for retail trade and various services.
- *The Environmental dimension:* The street acts as an incubator for environmental initiatives, providing opportunities for climate adaptation and other ecosystem services.

In addition to these aspects, the physical environment elements, including technical infrastructure, are integral to each dimension, enhancing the performance of the respective functions.

2.1.1 Social Dimension:

This dimension relates to the social life of the street, as places are not only physical features and spaces, but also have social aspects [2]. The social category of liveable streets combines the design of the physical setting, which provides the appropriate infrastructure to support a strong social and cultural life, with an emphasis on how street occupants use space, the extent to which opportunities exist for individual well-being and encourage a sense of community in addition achieve the notion of placemaking.

2.1.1.1 Place making:

Placemaking plays a crucial role in fostering a sense of belonging and creating a distinct identity for places. Placemaking has evolved to focus on cultural development within urban streets, significantly influencing the creation of a sense of place that reflects the city's character. Establishing a sense of place for liveable streets involves offering a variety of activities, events, and opportunities for conversations and social gatherings [26]. The success of lively entertainment venues often depends on implementing strategies to attract a higher density of people. These venues thrive when people have diverse entertainment options, such as outdoor seating, art, music, food, and opportunities to meet new people. Furthermore, some of these activities can be unique to a specific place, showcasing the surrounding community's culture.

Furthermore, Streets provide an inclusive social environment where occupants can actively and indirectly participate, leading to consistent and ongoing activity. The structure of the street was found to be more influential than social structure in promoting social integration. Livable streets particularly benefit children, who can freely engage in play activities throughout the entire area. Additionally, adults were observed spending extended periods on the streets, responding to the presence of children [27]. Placemaking theory suggested that place creation exceeded the physical dimension and involved other aspects, such as sociability, pedestrian activities, interactions, and comfort [28]. This produced bonds between people and places that then created a sense of place. The overall goal is to design streets that serve as a focal point for the community, facilitating social connections and providing spaces that occupants and visitors are encouraged to utilize. By incorporating elements that promote social communication, gathering, and engagement, liveable streets become catalysts for community cohesion and a sense of belonging.

Street planning should prioritize creating opportunities for maximum social interaction among people. This can be achieved by designing public and congregational spaces, such as wide pavements, benches, playgrounds, and play areas, that encourage people to gather and engage with one another. Additionally, incorporating private spaces and third place, such as cafes and shops, accessible to both residents and visitors, can further foster social interaction. Livable streets should aim to achieve Sociability through attracting diverse groups of citizens, including individuals of different ages, backgrounds, and interests. By catering to the needs of all segments of the community, the street becomes a place where people from various demographics can come together and interact. This diversity contributes to a vibrant and inclusive social environment [29] & [30]. Comfort is an essential need that contributes to the unique character of a place. Incorporating various street furnishing elements like shop awnings, columned walkways, benches, soft landscaping, and rows of trees is part of the placemaking process. These elements aim to achieve climatic comfort by creating a pleasant environment for pedestrians. Additionally, the inclusion of fixed and movable seating options, and awnings and fences along the street edge prioritize physical comfort, taking into consideration the needs of individuals.

2.1.1.2 Safety/ accessibility:

Enhancing accessibility is a key aspect of revitalizing liveable streets [31]. This involves ensuring convenient access to various amenities, such as workplaces, shops, and recreational areas, through different modes of transportation, including public transport, cars, bicycles, and walking. Making street facilities and services easily accessible to all individuals, including pedestrians, diverse users, and people with disabilities, is a priority. To support universal access and public transportation, it is important to have streamlined and clearly defined signs that indicate the purpose of spaces and provide names for different areas. Maps and signage should also be available to show connection points, destinations, pedestrian crossings, intersections, major drop-off points, and parking locations. Consideration should be given to the needs of different users, including footpath networks, access to public transport, freight/delivery, and efficient provision of parking. Clear signage and instructions for entrances should be provided as well [32].

Personal safety and security, physical comfort, a sense of direction, and visually appealing environments are crucial in keeping people engaged on the street. Therefore, a liveable street must incorporate procedures and measures to create a safe environment for street occupants and users, protecting them from traffic hazards, accidents, crime, violence, and unpleasant sensory experiences [33]. Ensuring visual openness without obstructions is important, and lighting plays a significant role in street design, greatly impacting safety and comfort. Adequate lighting, surveillance cameras, and other security measures should be implemented to enhance safety along commercial streets, particularly during evening hours [34].

2.1.1.3 Health and Wellbeing:

The importance of walkability is backed by strong arguments emphasizing the positive impact on people's physical and mental well-being, including exercise opportunities and social interactions in outdoor settings. Promoting walkability and cycling on streets as elements of an active lifestyle not only contributes to healthy living but also helps reduce vehicle emissions. Streets that prioritize non-motorized transport offer various quality-of-life benefits, including increased outdoor activity and a decrease in air pollution, which ultimately lead to improved public health. Recent studies have demonstrated a clear link between the built environment and public health. Research indicates that individuals living in more walkable areas are less likely to be overweight. Additionally, residing in walkable neighbourhoods reduces the reliance on driving, subsequently reducing the contribution to harmful air pollution. Traffic-related air pollution is a significant cause of health issues in many cities, with certain neighbourhoods experiencing the highest rates of asthma hospitalizations. These hazards not only directly threaten people's health but also discourage residents from spending time outdoors. [35] & [36] & [37]

2.1.2 Economic Dimension:

Commercial streets play a crucial role as essential economic hubs, attracting businesses, entrepreneurs, and investors. When these streets prioritize creating pedestrian-friendly environments and fostering a diverse array of retail, dining, and cultural activities, they have

the potential to significantly enhance the economic vitality of a city. Livable commercial streets not only attract more visitors and increase foot traffic but also stimulate local businesses, which in turn generates job opportunities and fosters overall economic growth.

There is a notable connection between the design or operation of streets and the economic prosperity of an area. The underlying idea is that changes in travel patterns, spending patterns, and the attractiveness of the neighbourhood resulting from modifications in the street environment can impact the financial performance of businesses and property owners, particularly in the retail sector. Furthermore, these changes can have indirect effects on factors such as retail rents, office rents, and the overall value of commercial properties. The design of a street can influence the number of potential customers visiting the area and alter their travel frequency or spending patterns, thereby impacting local retail sales. For example, reducing vehicle flow (by eliminating travel lanes) or restricting curb parking may decrease the convenience of arriving by car, potentially reducing the number of customers. Conversely, improving accessibility through alternative modes such as adding bike lanes or bike parking, enhancing bus service and transit connections, widening sidewalks, or improving street crossings can expand the customer base, leading to an increase in potential customers [38], [39]. For a street to be considered liveable, it should possess good connectivity. This entails prioritizing streets as essential components of mobility and accessibility, accompanied by the gradual provision of necessary services. Connectivity refers to the density of connections within the street network and the efficiency of direct links. A well-connected street network consists of numerous intersections, many short links, and minimal cul-de-sacs. As connectivity improves, travel distances decrease, and more route options and travel modes become available (including increased usage of non-motorized and public transport). This allows for more direct travel between destinations, ultimately creating a more accessible and resilient system [40].

Effective urban mobility relies on the connectivity pattern provided by the street, making it a vital asset within any city. The street network plays a crucial role in facilitating the movement of people, goods, and services, making it a highly valued element of urban infrastructure. By enabling access to employment opportunities, commercial areas, services, and various facilities, street networks and mobility patterns enhance the overall accessibility within a city. Furthermore, a well-connected street network brings about several benefits, including the reduction of traffic congestion, commuting time, and reliance on motor vehicles, while also contributing to lower fares and fuel consumption in urban areas. Enhancing street connectivity can have a positive impact on economic productivity and competitiveness by improving the efficiency of the transportation system, leading to reduced traffic congestion and lower commuting costs. This increased efficiency and quicker transportation can, in turn, enhance labor productivity by reducing commuting times and ultimately boosting worker productivity [41].

Livable commercial streets play a crucial role in improving economic competitiveness and benefiting the broader community. These streets offer a wide variety of economic activities that create employment opportunities and attract many visitors. Furthermore, they strive to revitalize communities and cities while providing space for a diverse range of locally owned

and privately operated businesses. By offering a wide range of Mixed-use commercial services and promoting competitive options, these streets foster a dense layout that ensures walkability and encourages economic activity [42]. Additionally, active frontages at ground level contribute to the public realm, either through passive or active engagement.

2.1.3 Environmental Dimension:

The environmental dimension encompasses several aspects, including the provision of natural resources, the ability to handle waste, and fostering a connection between humans and nature. It also involves enhancing local environmental conditions such as cleanliness, noise levels, dust control, and the quality of air and water. Conserving green spaces is another crucial element, as they contribute to clean air and water, while also providing opportunities for families to engage in activities like exercise, play, and relaxation [43].

Streets can deliver environmental advantages both independently and by augmenting the environmental benefits of their surrounding urban areas. They can contribute to the environment through features like street greening and stormwater management. Moreover, streets play a vital role in connecting urban green spaces, granting access to these areas, and serving as corridors to facilitate airflow. These functions aid in purifying the air, mitigating the impact of urban heat islands, and overall improving the local climate [44]. Furthermore, the use of cool pavements that reflect solar radiation can further decrease surface temperatures or cool pavements through evaporation.

2.1.3.1 Green infrastructure

Traffic-related emissions are a significant health issue in urban areas worldwide, with many cities surpassing emission limits. As a result, there is growing interest in the ability of plants to trap particulate pollution. Previous studies have mainly focused on the role of trees in capturing airborne particles. However, research suggests that diverse herbaceous vegetation, characterized by variations in plant height, branching pattern, and leaf traits, can effectively reduce pollution levels near major emission sources [45] & [46] & [47] Additionally, vegetation barriers can serve as protective shields, resulting in decreased pollution levels in nearby regions. Nevertheless, it is important to carefully consider the impact of roadside vegetation on air quality, as trees and dense shrub layers can impede air circulation and potentially worsen local air pollution. Striking a balance between trees and herbaceous vegetation, tailored to specific conditions, is essential [48] & [49] & [50]. Traffic has detrimental effects on the urban environment, including increased heat stress as well. Plants play a crucial role in mitigating these issues by providing shade and facilitating evapotranspiration [51]. Moreover, the positive impact of short vegetation cover in comparison to concrete, asphalt, or bare soil in reducing elevated temperatures. This highlights the effectiveness of both trees and shorter plants in combating the heat island effect and improving the overall microclimate in urban streetscapes [52].

The presence of vegetation can help reduce noise levels through diffusion, which depends on the shape of vegetation barriers. The size of leaves and the branching characteristics of plants impact their ability to absorb sound resonantly. Woody vegetation generally offers greater

noise attenuation compared to grasslands or open fields, and the effectiveness of noise reduction increases with the density and width of woody vegetation belts [53] & [54].

Green streets:

A green street is a sustainable stormwater plan that uses a natural systems approach to manage stormwater, improve water quality, reduce flows, and promote human health to meet regulations and protect resources [55]. Green streets integrate green infrastructure elements such as bioswales, planter boxes and trees into streets, its design involves implementing stormwater management strategies to protect nearby water sources from pollutants and encourage water reuse.

Green Street Elements:

Trees and Vegetation cover: they have a positive impact on the number of pedestrians crossing pedestrian paths and the road network, [56]. According to [57], there is a relationship between walking and road network connectivity and vegetation density. Pedestrian walking distance is influenced by the presence of trees and the green street network. Urban green space is considered one of the most significant aspects of the built environment that affects walking, health, and physical activity. Trees can mitigate the Urban Heat Island (UHI) effect by shading paved surfaces from heat, reducing carbon footprint, intercepting, and holding rain, purifying the weather from dust, and cooling neighborhoods during hot days through the evapotranspiration process [58].

Planter boxes: are urban rain gardens with vertical walls and either open or closed bottoms to absorb or collect runoff from streets, parking lots, and sidewalks.

Bioswales: are channels designed to convey stormwater runoff from one place to another as shown in Figures 4 and 5.

Curb-Cuts are openings created in the curb to allow stormwater to flow into planting areas from streets or parking lots as shown in Figure 6.

Permeable pavements: are paved surfaces that infiltrate, or store rainwater where it falls. They can be made of porous asphalt, pervious concrete, or permeable interlocking pavers.

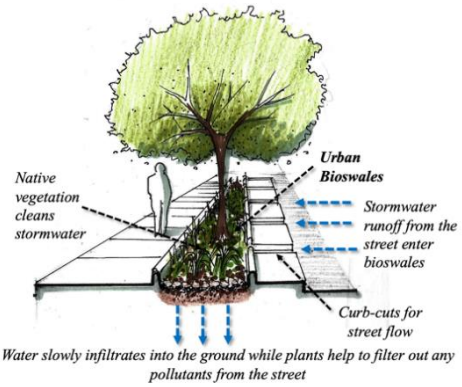

Figure 4: Picture shows how bioswales work (Source: Analysis by Authors)

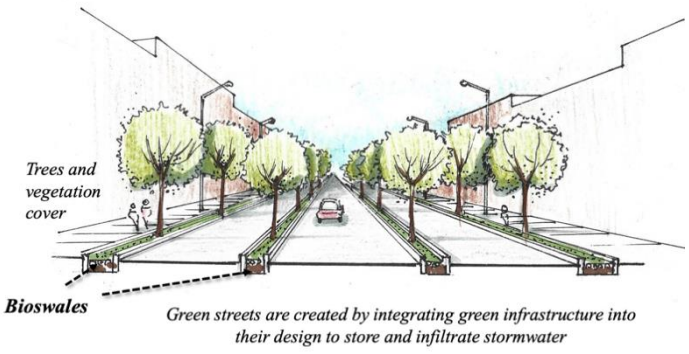

Figure 5: A section in a green street showing the green infrastructure design elements (Source: Analysis by Authors)

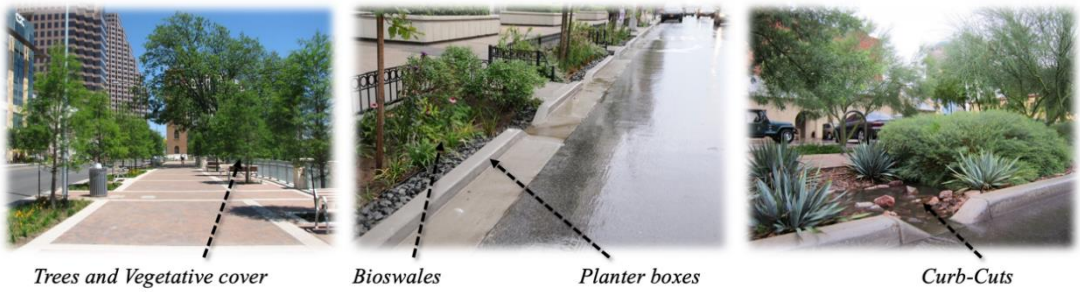

Figure 6: Green Street elements (Source: Analysis by Authors)

2.1.3.2 Cool Streets:

Cools streets are streets designed to cool our cities by reducing the Urban Heat Island (UHI) effect which is caused by the placement of dark impervious materials (such as roads and buildings) that absorb radiant energy from the sun and create high surrounding air temperature. These surfaces create air conditioning demand to cool surfaces that contributes to high electricity needs and increases the total energy demand within the city. Cool streets assist in creating cooler communities for residents within them by reducing air temperatures, improving air quality, generating more comfort for users, and decreasing energy usage [59].

Cool street Elements:

Greenery shading: Greenery cover contributes to reducing the ambient temperature by shading the hardscape and providing cooling evapotranspiration.

Cool pavement: there are different types of cool pavements such as vegetated permeable, reflective slurry seal, conventional, and white toping, all these types contribute to mitigating the ambient air temperature and UHT effect by reflecting solar radiation and evaporating water [60]. Also, providing lower energy consumption and reduced greenhouse gas emissions (through decreasing air conditioning) as shown in Figure 7 and 8.

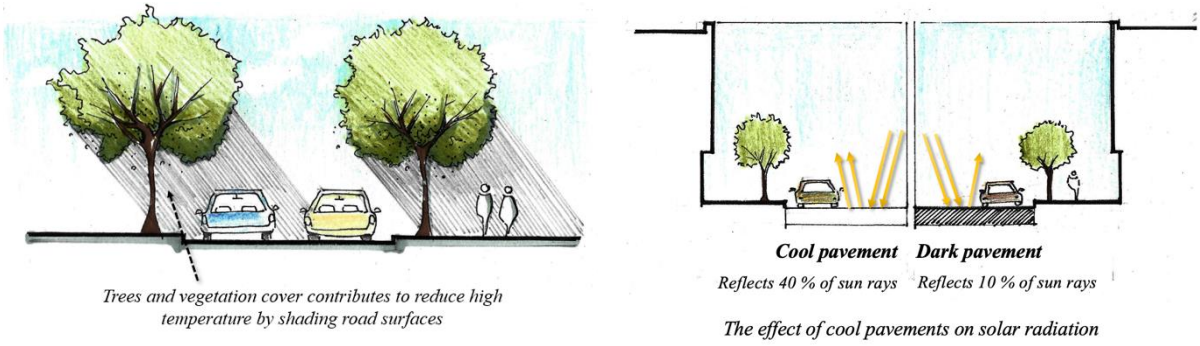

Figure 7: Cool Street elements (Source: Analysis by Authors [61]**)**

According to an experimental study in Riyadh city, KSA, a new technology of Cooling roads has been tested in two different locations, aiming to reduce heat absorbed by roads during the day and released at night, causing high temperatures (reaching 50ºC or more during daytime), increasing in energy consumption and air pollution as shown in Figure 9. [63].

Cool pavements applied are made up of locally produced materials capable of absorbing less solar radiation by reflecting it and reducing the surface temperature. Recently, the Saudi

General Authority for Roads (GAR) tested this technology in the holy sites in Arafat (the pedestrian walkway at Jamarat and around Namirah Mosque). This material proved effective during sunny weather. According to Abdulaziz Al-Otaibi (Roads Saudi General Authority spokesman), "*Data shows that this cooling material helped decrease the temperature of asphalt surfaces by 12 to 15 degrees Celsius, which is equivalent to a 20 percent reduction compared to roads without this material."* [64]. The authority also indicated that cooling pavement technology will be applied in the future in roads, parks, public transportation stations, and pedestrian paths [65].

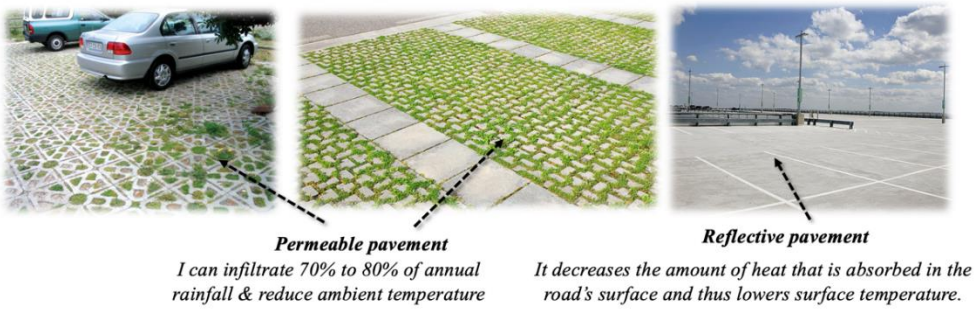

Figure 8: Cooling roads pavements (Source: [62])

Figure 9: Saudi Arabia's implementation of the experiment "Cooling Asphalt Technology"[65]

2.1.4 The Physical Aspects of Livable Streets

The physical aspects of liveable streets include the visible and tangible elements that determine their form, scale, sense of enclosure, and design within the urban environment. These aspects are very essential for understanding how streets function, allow multiple modes of transportation, and contribute to improving street liveability and efficiency in cities.

Street form: The street form refers to the physical configuration and layout within the urban environment. Street forms can be categorized into different types; Straight, Curved, and Irregular streets as shown in Figure 10.

A street intersection is considered the critical point within the street segment where two or more streets intersect or join. They play an important role in urban planning and transportation. The intersection should accommodate all sizes and types of anticipated movement of street users safely and efficiently, including motorized vehicles, pedestrians, and bicyclists. There are four basic forms of street intersections: T-intersection, Cross-intersection (4-legs), Y-intersection, and Roundabout intersection as shown in Figure 11.

Each type is designed based on speed limits, traffic volume, and land-use characteristics of the surrounding areas [66].

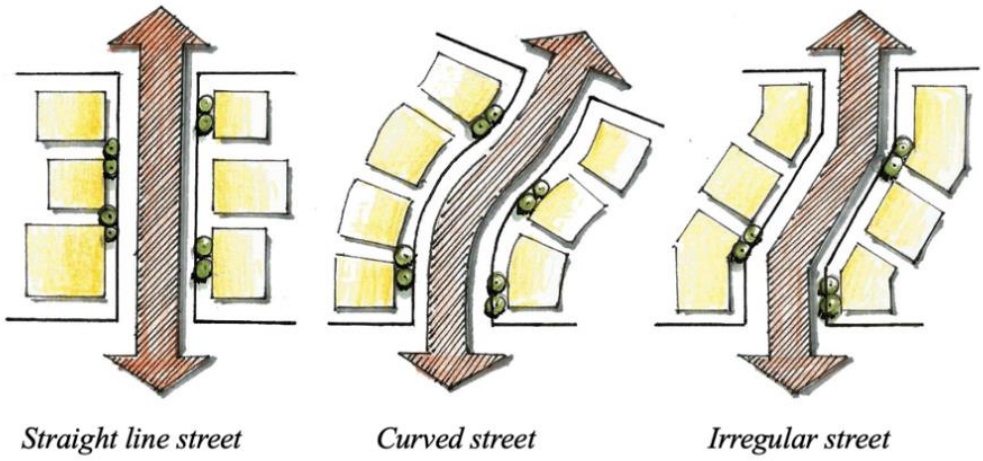

Figure 10: Forms of streets (Source: Authors**)**

Street Scale

Street scale refers to its physical dimension and relative proportion to the surrounding built environment, including the width, height, length, and overall size of the street environment. The street proportion helps frame an occupant's perception of the intensity of the place when they occupy it.

Street Enclosure

It refers to the sense of enclosure created by the surrounding buildings and other elements such as trees and vegetation along the sides of the street, it is about how users feel towards the street. The function and character of the street are justified by the level of the enclosure. The enclosure can be achieved by the ratio between the height to width of the street. In a street with 1:3 ratios, the range of vision gives a weak sense of enclosure. If the ratio is 1:2 the three-dimensional sense of enclosure increases thus providing a good sense of enclosure in a street [67]. A ratio of 1:1 gives a strong sense of enclosure and is considered the minimum for comfortable and liveable streets as shown in Figure 12.

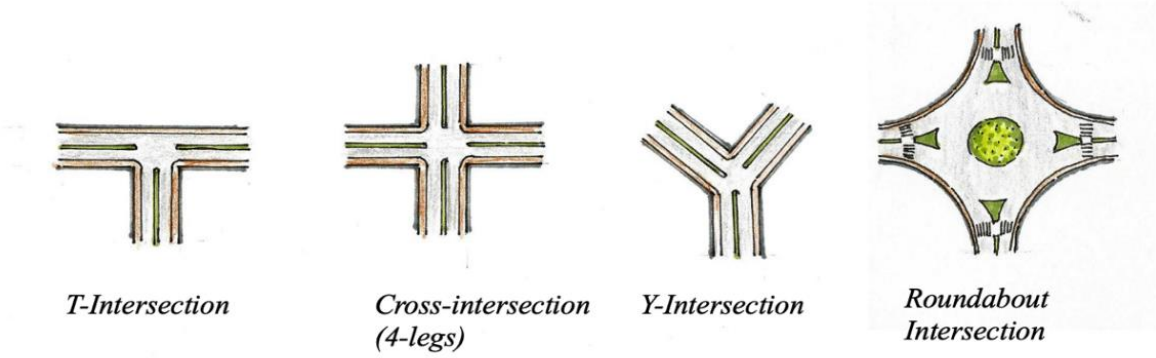

Figure 11: Intersection forms of streets (Source: Authors from [66])

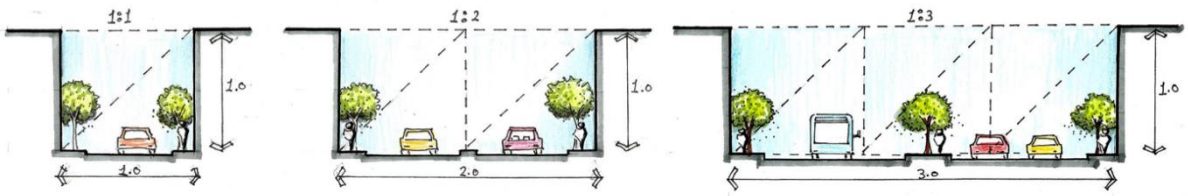

Figure 12: Street height-to-width (H/W) Ratio (Source: Authors **)**

2.1.4.1Livable Streets Zones

Livable streets divide the roadway into different zones to help accommodate all users and create a sense of place. A) Building zone, b) Sidewalk Zone, c) Fixture Zone, d) Green Zone, e) Parking Zone, f) Bicycle Zone, g) Motor Vehicle Zone, and h) Median Zone, as shown in Figure 13.

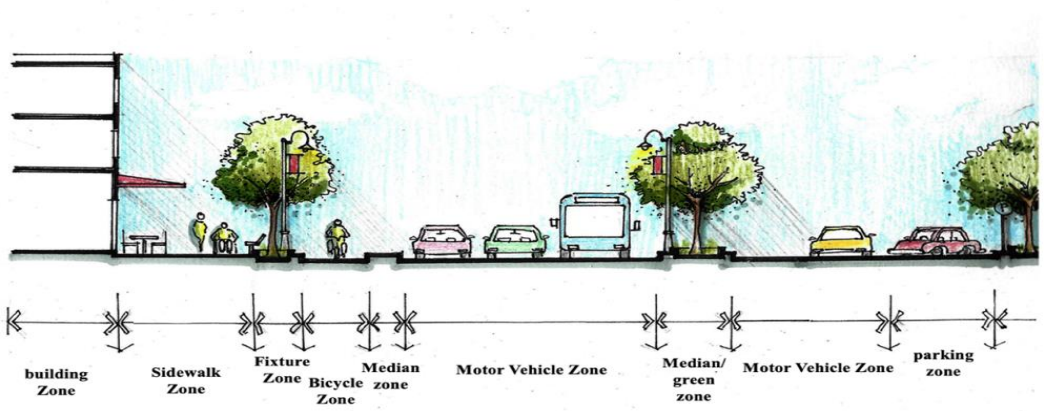

Figure 13: Livable Street Zones (Source: Authors**)**

2.1.4.2 Complete streets:

Complete streets are an approach to planning, designing, operating, and maintaining streets to provide safe access for all users. Pedestrians, cyclists, vehicles, and transit users of all ages and abilities can safely move along and across the street [68]. Design strategies of complete streets provide the highest priority for walking and sustainable transportation. Moreover, reducing vehicular traffic contributes to decreasing gas emissions and pollution, increasing walkability, improving public health, and strengthening urban ecosystems.

Complete Streets include some essential elements as shown in Figure 14, such as; Pedestrian infrastructure (sidewalks, crosswalks including median islands), Public transit accommodation (designed bus stops, bus shelters, accessible transit stops), Bicycle accommodation (bike lanes, bicycle parking), Traffic calming methods, on-street parking, accessible pedestrian signals, curb extension, Street furniture (benches, billboards, trash cans) Smart features (smart street lighting, traffic lights control, speed radars, sensors) [60].

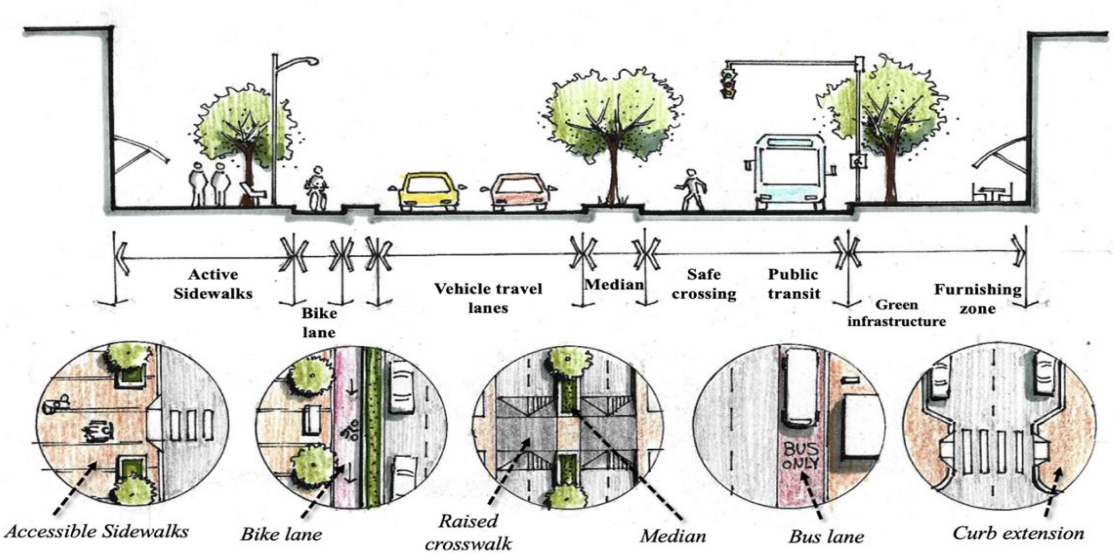

Figure 14: Complete Street Elements (Source: Authors**)**

3. Street Liveability Index and Assessment Themes

To assess liveability in street environments using appropriate indices, Oltean-Dumbrava et al. [69] proposed a method that involves starting with a thorough examination of existing rating systems. By selecting relevant indicators from these systems, they can serve as a foundation for establishing new indicators or improving existing ones to suit specific conditions.

3.1 Existing frameworks for incorporating liveability in academic studies.

The main objective of Säumel et al. [70] was to illustrate the potential of roadside vegetation in creating liveable and healthy urban streets by supporting multiple ecosystem services. In their study, they provide a first synthesis that demonstrates the various ecosystem services which can be delivered by green elements in streetscapes, highlighting their multifunctional capacity. They also emphasize the significance of both planted and naturally occurring herbaceous vegetation, besides trees. Additionally, their findings reveal the existence of trade-offs between certain ecosystem services and the associated risks of disservices. The authors further propose management strategies to complement planning and governance approaches toward improving streetscape liveability, promoting ecosystem services, and mitigating disservices. These options are illustrated in their synthesis, which is divided into four categories.

- Regulation: This point includes regulations related to various aspects such as air quality, air filtration, temperature, carbon sequestration, carbon emission, noise reduction, regulation of water cycling, and water purification. These regulations aim to ensure environmental and health-related standards are met.
- Provisioning: This aspect focuses on the provision of essential resources, including food supply, genetic resources, and groundwater recharge. It highlights the significance of maintaining and supporting these resources for the well-being of communities.

- Habitat: This point emphasizes the significance of creating and preserving habitats. It includes the provision of suitable habitats for various animal and plant species and the establishment of ecological corridors or steppingstones to facilitate their movement and survival.
- Cultural: This aspect encompasses the cultural benefits derived from urban landscapes. It includes psychological, aesthetic, and recreational benefits, but also acknowledges potential disservices such as fear of crime, reduction of permeability, damage to infrastructure, security risks, property values, cultural heritage, educational services, and bioindication's use as a tool for assessment and monitoring.

Elsawy et al. [70] presented a comprehensive set of criteria for evaluating residential streets' liveability. These criteria are divided into four aspects: physical, social, environmental, and economic, each accompanied by a specific range of indicators.

- The physical aspect is further divided into three criteria: comfort and design, accessibility (including safety and street elements such as roadways and sidewalks), and form/scale (considering amenities, street furniture, visual qualities, and access points).
- The social aspect emphasizes livability and includes indicators related to gathering spaces, social interaction, and the activity of the place.
- The environmental aspect focuses on comfort and comprises two indicators: weather conditions and visual excellence.
- Lastly, the economic aspect concentrates on mixed-use and land use indicators of the residential streets.

Abdel-Aziz et al [72] introduced a matrix that establishes a connection between Streetscape Elements, the Basic Principles of Streetscape Design, and the Principles of Urban Livability. This interrelationship facilitated the assessment of the influence of each Digital Streetscape Element on enhancing Livability. The proposed model serves as a preliminary framework for the consideration and evaluation of these elements in public open areas, allowing for flexibility and customization based on individual cases.

Istrate and Chen [73], summarize the factors, qualities, and indicators of the proposed analytical framework to be suitable for liveable streets in the Shanghai context. The framework for evaluating liveable streets in Shanghai city is structured around three main characteristics: physical, functional, and social.

- The physical characteristics encompass humanized street environments and are further divided into three factors: 1. characteristics of buildings and blocks, 2. road and transport characteristics, and 3. the pedestrian environment. Each factor is accompanied by a set of indicators.
- Similarly, the functional characteristics focus on facilities, mixed-uses, local economic activities, and safety. This section is organized into four factors: land uses, services, and facilities; businesses on the streets; business types; and safety from traffic and crime. Each factor is associated with a specific variety of indicators.
- Lastly, the social characteristics pertain to social interaction and a sense of pertinence. This category is divided into three factors: opportunities for interaction, the existence

of people on the street, and the identity and culture of the streets. Each factor is supported by a variety of indicators.

Ali and Baper [26] developed a framework, referred to as a checklist, for evaluating commercial street liveability based on the placemaking's concept. This framework encompassed a wide range of values that encompassed sociability, familiarity, and physical aspects. Each set of indicators yielded a result that corresponded to a specific factor, that, in turn, was connected to one of the three dimensions. By employing this checklist, the researchers assessed the implementation of placemaking activation steps. It was hypothesized that as more placemaking steps were implemented, the commercial street's liveability would increase.

3.2 Street Performance Evaluation Indicators

There are other studies related to street performance evaluation indicators, which evaluate streets in different ways, such as:

- The Walkability Index developed by Frank et al. [74] also considers indicators such as density, service proximity, land use mix, and street connectivity when evaluating the walkability of an area.
- Similarly, the Healthy Development Index (HDI), as described in Health [75], primarily focuses on physical activity. However, the HDI encompasses a wide range of elements, specifically seven built environment elements: density, proximity, land use mix, connectivity, road network and sidewalk characteristics, parking, aesthetics, and human scale. Each of these elements is assessed using a set of measures or indicators.
- As discussed in the study by Asadi-Shekari et al. [76], the Pedestrian Safety Index (PSI) utilizes 24 indicators derived from 20 guidelines developed in different countries. These indicators encompass aspects such as traffic speed, barriers, traffic lanes, pavement, landscaping, and trees. To determine their significance, a coefficient is assigned to each of the 24 indicators. In a related work, the same authors [77] developed a bicycle safety index (BSI) using a similar approach, identifying 11 indicators from 23 guidelines for assessing bicycle safety.
- The Green Road Rating (GRR) system draws inspiration from existing rating systems for buildings such as Leadership in Energy and Environmental Design (LEED), Green Globes, and the Building Research Establishment Environmental Assessment Method (BREEAM). Its purpose is to provide guidelines supporting environmentally friendly practices and technologies in road construction. The GRR system aims to reduce the environmental impact of roads while enhancing their economic and social benefits, as outlined by Park and Ahn [78]. The paper by Park and Ahn [78] reviews various green street rating systems developed in the United States and adapts them to create the GRR specifically for South Korea. The GRR framework is structured around four main goal categories:
  - Green Road Design/Pavement Technologies: This category emphasizes the implementation of advanced green design and pavement technologies to minimize negative environmental impacts and carbon emissions.

- Green Environment: The focus of this category is on minimizing environmental pollution, reducing emissions and pollution levels, creating eco-friendly roads, and establishing strong connections with the community.
- Green Traffic Systems: This category aims to improve safety and energy efficiency for road users through smart road operation while promoting an eco-friendly traffic system.
- Green Resources and Energy: The objective here is to minimize resource consumption through recycling, utilizing renewable energy sources, and reducing unnecessary resource movement.

Overall, the GRR system is designed to guide road construction practices in South Korea towards sustainability and environmental responsibility.

The main concept of liveability can be examined using either objective or subjective measures of the quality of life (QoL). From a methodological perspective, the thematic approach utilizes indicators like infrastructure, accessibility, and transportation to assess liveability. In contrast, the satisfaction approach focuses on residents' subjective perceptions of their own lives, typically through self-reported life satisfaction. It is preferable to employ a combination of both methods. Therefore, once the framework indicators have been recognized, conducting an opinion poll becomes crucial to gauge satisfaction's level and understand street occupants' needs to find out the extent of their satisfaction with street liveability indicators and whether the provision of facilities is a primary or secondary need.

4. Framework for Livable Commercial Streets for Sustainable Urban Transition in Egypt

The theoretical review conducted in this study involved an extensive examination of relevant literature on the concept of liveability and the significance of liveable streets in enhancing commercial streets. This comprehensive review resulted in a deep understanding of the key indicators that contribute to achieving sustainable urban transformation by improving street performance and enhancing the quality and liveability of streets. Based on this, a reference framework was developed, encompassing crucial indicators related to the social, economic, and environmental aspects (Table 1). Subsequently, this framework was applied to evaluate the efficiency of two distinct study areas: a local area in Egypt and a regional area in Saudi Arabia. This evaluation aimed to identify significant findings and generate recommendations based on the results obtained.

Table 1: Framework for Livable Commercial Streets for Sustainable Urban Transition in Egypt. (Proposed by Authors)

ENVIRONMENTAL DIMENSION		**Rating**			
Code	**Indicators**	Good	Neutra	Bad	Not
	Green Infrastructure	3	2	1	0
	SG Street Greenery				
SG1	Field observations indicate that: − The emergence of drought-tolerant and heat-resistant varieties that thrive in the hot climate of Egypt's temperature range.				
SG2	− Having types of plants that consider the aesthetic aspect, such as the desired visual appeal, and incorporating plants with diverse textures, colors, and flowering times to attract interest throughout the year.				
SG3	− Leverage technology by using smart irrigation systems, weather sensors, or mobile applications to efficiently manage and monitor street green spaces.				
	SM/RW Stormwater Management/ Reuse water				
	Field observations indicate that there are any procedures for:				
SM/RW1	− Control the process of water cycling and implement strategies for managing stormwater and reusing water resources.				
SM/RW2	− Manage rainwater by minimizing runoff through the application of water-sensitive urban design and principles of green streetscapes (such as using vegetated curb extensions, utilizing pervious paving for stormwater management, and incorporating drainage systems along the sides for rainwater).				
	AQ Air Quality				
	Field observations indicate that there are any procedures for remove and immobilize pollutants:				
AQ1	− Cultivate diverse plants along roads, incorporating a range of plant species and forms: by Creating a variety of plant groupings with different types and shapes.				
AQ2	− Promote ground-level vegetation between areas affected by traffic-related pollution and persons: Encourage plant growth at the interface where pollution from traffic sources interacts with people.				
AQ3	− Increase the overall surface area covered by plants, for instance, by converting lawns into meadows or allowing natural vegetation to grow along road edges: Enhance the total plant coverage by transforming grassy areas into wildflower meadows or permitting spontaneous plant growth along road boundaries.				
	NI Noise Insulation				
	Field observations indicate that				
NI1	− Presence of noise barriers: Physical barriers such as walls, fences, or soundproof panels along busy roads to block or deflect sound waves away from sensitive areas.				

ENVIRONMENTAL DIMENSION		**Rating**			
Code	**Indicators**	Good	Neutra	Bad	Not
NI2	− Presence of vegetation barriers: Through dense planting of native species of trees and shrubs that absorb and deflect sound waves, creating a natural noise barrier.				
NI3	− The presence of wide sidewalks and green spaces reduce noise levels.				
	Cool Street				
	CP/CR Cool pavement / cool road				
	Field observations indicate that there are any procedures for:				
CP	− Paving materials designed to reflect solar radiation and absorb less heat compared to traditional asphalt or concrete like Lighter-colored pavements or High-albedo pavements				
	S/C Shading/canopies				
	Field observations indicate that there are any procedures for:				
S/C1	− The presence of fixed structures, whether trees or canopies attached to buildings, pergola structures and trellises.				
S/C2	− Temporary or Mobile Solutions: like Umbrellas or parasols and Pop-up tents for events or markets				
	TR/TI Temperature reduction/ Thermal Isolation				
	Field observations indicate that there are any procedures for:				
TR/TI1	− Dynamic awnings and canopies: Utilize sensors to automatically adjust shading based on sun position, temperature, and wind conditions, optimizing cooling and minimizing energy use.				
TR/TI2	− Sensors to collect real-time data on temperature, humidity, and pedestrian activity in different areas to identify heat hotspots and prioritize cooling interventions.				
TR/TI3	− AI-powered solutions: Any smart street furniture that adjusts temperature or air circulation based on individual preferences detected through wearable devices or smartphone apps.				
SOCIAL DIMENSION		**Rating**			
Code	**Indicators**				
	Placemaking	3	2	1	0
	S Sociability				
S1	Field observations indicate that there are any procedures for: − There are cafes, restaurants, and shops with outdoor seating and activities that invite people to linger and socialize.				
S2	− Local activities and Cultural events available in street space or on sidewalks				
S3	− There are comfortable gathering spaces: Incorporate benches, plazas, pocket parks, and outdoor seating areas with shade and greenery to attract people and facilitate conversation.				

ENVIRONMENTAL DIMENSION			Rating			
Code	Indicators		Good	Neutra	Bad	Not
	I/D	*Inclusivity and diversity*				
I/D1	− There are spaces and activities that cater to different ages, abilities, and backgrounds to create a welcoming atmosphere for everyone.					
	SP	*Sens of place*				
SP1	− People's commitment towards the street					
SP2	− Sense of familiarity through tangible and un tangible elements, incorporate landmarks and reference points: Utilize unique buildings, trees, public art installations, facades, or street names as landmarks and reference points					
	Safety/Accessibility					
	ST	*Safe for all travelers*				
	Field observations indicate that there are any procedures					
ST1	− Separate lanes for cars, bicycles, and pedestrians: Dedicated lanes provide safe and dedicated spaces for each user group, minimizing conflicts.					
ST2	− There are crosswalks and intersections: that enhancing accessibility with wider crosswalks, pedestrian islands, and traffic signals with longer crossing times.					
ST3	− Provide security facilities, such as anti-theft and fire alarm systems; closed-circuit television (CCTV) surveillance system.					
	A	*Accessibility*				
A1	− Accessibility for all: Ensure sidewalks, crosswalks, and public transportation are accessible to people with disabilities, including ramps, audible signals, and tactile paving.					
	SF	*Smart features*				
SF1	− Sensors can collect data on traffic flow and pedestrian activity. This real-time information can be used to proactively adjust traffic signals, optimizing traffic flow, prioritize pedestrians at intersections, and prevent congestion that can lead to accidents.					
SF2	− Smart lighting: Adaptive lighting systems which Adjust brightness based on ambient light and pedestrian activity, improve visibility while conserving energy.					
SF3	− Smart parking: which Locate and guide users to accessible parking spaces and reduce stress and frustration for drivers with disabilities.					
	Health/ Wellbeing					
	W/C/AP	*Walkable, cycling, active pedestrians*				
	Field observations indicate that there are any procedures for					
W/C/AP1	− Prioritize pedestrian infrastructure: Wider sidewalks, pedestrian crossings, traffic calming measures, and shared streets encourage walking and cycling, contributing to physical activity, and reducing reliance on cars.					

ENVIRONMENTAL DIMENSION		Rating			
Code	Indicators	Good	Neutra	Bad	Not
W/C/AP2	– Integrating any recreational facilities like basketball courts, skate parks, or community gyms offer accessible spaces for various fitness activities and community engagement.				
W/C/AP3	– Organize community events and activities: Walking groups, bike rides, outdoor fitness classes, or sports tournaments encourage physical activity and social interaction.				
W/C/AP4	– Promote community art and expression: Public art installations, murals, and creative spaces offer artistic expression, encourage positive interactions, and contribute to a vibrant and stimulating environment.				
W/C/AP5	– Organize community events and activities: Festivals, markets, street performances, or social gatherings foster social interaction, combat loneliness, and promote a sense of belonging, contributing to mental well-being.				
ECONOMIC DIMENSION		**Rating**			
Code	**Indicators**				
	Economic Competitiveness	3	2	1	0
A/V	*Attractiveness/ Vibrant*				
	Field observations indicate that there are any procedures for				
A/V1	– The street support innovative business models: through providing incubation spaces, flexible leasing options, and access to resources for startups and entrepreneurs.				
A/V2	– consider innovative solutions like public Wi-Fi.				
A/V3	– Embrace technology: Utilize digital tools for marketing, online ordering, and delivery options to enhance customer convenience and reach new audiences.				
A/V4	– Parking utilization: Monitor parking lot occupancy to understand parking availability and assess its impact on customer convenience and spending.				
ECR/SEB1	*Energy Consumption Reduction and Saving energy bills*				
ECR/SEB1	– Any measures related to sustainable infrastructure, such as solar cells, that reduce energy consumption and save bills.				
	Mixed-use				
LV/FD	*Land-use value & Flexible design*				
	Field observations indicate that there are any procedures				
LV/FD1	– Diversify offerings: Street attracts a variety of businesses appealing to a broader customer base. Through a balanced mix of anchor stores, local boutiques, restaurants, cafes, and service providers.				
LV/FD2	– Availability and flexibility of small spaces and large spaces for rent.				
	Connectivity				
M/TM/P	*Mobility & Transportation moods/ proximity*				

ENVIRONMENTAL DIMENSION		Rating			
Code	**Indicators**	Good	Neutra	Bad	Not
	Field observations indicate that there are any procedures for				
M/TM/P1	– Promote diverse transportation options: Encourage public transport, and micromobility to reduce reliance on cars.				
M/TM/P2	– Proximity of any of the public transport stations (metro station, express bus station, public transport buses).				
M/TM/P3	– There are any bus stops every 400 meters walking distance				
M/TM/P4	– A well-connected street with numerous intersections, many short links, and minimal cul-de-sacs.				

5. Methods and Tools

The study employed a descriptive comparative methodology, utilizing various research tools such as field observation, questionnaires, and evaluations. Case studies were selected from Egypt and the Kingdom of Saudi Arabia for specific reasons. These case studies focused on recently developed commercial streets that shared similarities in hot-arid climatic conditions. They featured areas with amenities for walking, sitting, and resting. The streets comprised mixed-use activities, a diverse range of restaurants and cafes that attracted a wide array of visitors. Additionally, the selected case studies were similar in terms of their length, usage, and noticeable pedestrian density along the sidewalks. The study was conducted through the following stages.

First, Questionnaire:

The questionnaire was based on the following aspects:

- It was directed towards street users and residents.
- The questionnaire was designed to align with the practical framework and encompass the three dimensions utilized in the field survey: environmental, social, and economic indicators.
- The purpose of the questionnaire was to assess the validity of the proposed indicators by the researchers and determine their applicability and compatibility with user needs.

The questionnaire consisted of the following main categories:

- General information: This section included introductory questions regarding the participants' names and ages.
- Environmental indicators: In this section, participants were asked about the significance of green infrastructure and street elements (such as vegetative cover, pavement, shading, and street furniture).

- Social indicators: Participants were inquired about their perception of the street and the community they resided in, including overall satisfaction levels with aspects like sense of place, safety, accessibility, and quality of walking and cycling.
- Economic indicators: This section focused on participants' opinions regarding economic competitiveness, street land use, and the availability of various mobility-related factors.

Second, Field Observation:

Field observation aimed to identify the physical characteristics through the following points:

- Street length and width.
- Activities and land use along the street.
- Frequently used activities and identification of street users (age and gender).
- Assessment of pedestrian movements (including sidewalk width, walkability, safety, and accessibility).
- Observation of crossing facilities and their physical features.
- Recording the availability of seating areas and amenities on the street and near sidewalks.
- Observing shading facilities, such as trees and canopies.
- Identifying the types of trees and shrubs used, suitable for the climate.
- Examination of pavement types.
- Assessment of mobility and connectivity.

Lastly, Evaluation:

The evaluation aimed to assess various liveability indices and test the proposed framework on the selected case studies to determine the effectiveness of street liveability. The framework was divided into three main dimensions: environmental (including green infrastructure and cool streets), social (including placemaking, safety, accessibility, health, and well-being), and economic (including economic competitiveness, mixed-use, and connectivity).

6. Discussion, Findings

6.1 Users Perception of Liveable Streets

Participants were asked whether the application or availability of the indicators proposed in the framework was essential or secondary. A total of 50 participants responded to both streets, ranging in age from 17 to 68 years as shown in Table 2.

Table 2 illustrates sample characteristics.

Sample characteristics					
Participants Number	50				
Age	17-30	31-40	41-50	51-60	> 60
	5	29	6	7	3

Overall, nearly 76% of the street users expressed high levels of satisfaction with the availability of the main indicators and sub-indicators of liveability on the street. However, 24% of the street users pointed out that certain indicators were considered secondary needs. These indicators include:

1- Environmental indicators:
Noise insulation through physical barriers such as walls, fences, or soundproof panels was deemed non-essential. The use of cooling paving materials and temporary or mobile solutions for shading/canopies was also seen as secondary. Utilizing sensors to automatically adjust shading based on sun position, temperature, and wind conditions to optimize cooling and minimize energy use. Sensors that collect real-time data on temperature, humidity, and pedestrian activity. AI-powered solutions, such as smart street furniture that adjusts temperature or air circulation.

2- Social indicators:
Sociability through local activities and cultural events available in the street space or on sidewalks was not considered essential. Smart features like sensors that collect data on traffic flow and pedestrian activity. Public art installations, murals, creative spaces, festivals, markets, and street performances were not seen as crucial for creating a walkable, cycling-friendly, and active pedestrian environment. These were considered secondary needs.

3- Economic indicators:
Attractiveness/vibrancy achieved through embracing technology, such as utilizing digital tools for marketing, online ordering, and delivery options, was also considered a secondary need. The fact that a significant majority of participants recognize the significance and requirement of attaining the indicators on the street indicates a widespread understanding of the importance of creating a liveable environment for the street.

6.2 Analysis of Tahlia Street and Dahshur Street

The study cases were selected according to a list of criteria:

- Geographical location: The selection of streets aimed to represent significant thoroughfares in both Egypt and the Kingdom of Saudi Arabia. Examples include the Dahshur link in the Greater Cairo region and Tahlia Street in Riyadh, which are situated in major urban centers characterized by rapid urban growth and population increase.
- Development age: The chosen streets belong to the category of recently developed commercial streets within the past two decades.
- Function: These contemporary commercial streets are designed to accommodate mixed-use activities, both horizontally and vertically. They exhibit functional diversity with a wide range of activities and services, while also serving as economic hubs that cater to the daily needs of the local population.

- Climatic Conditions: Given the influence of high temperatures in Egypt and Saudi Arabia, careful consideration was given to how these climatic conditions impact street design, outdoor comfort, and the utilization of public spaces.
- Social context: The selection of streets considered the unique social characteristics of Arab regions, including the importance of privacy and cultural norms.
- Scale: The height and width of the streets were chosen based on their suitability and proportionality to one another, ensuring a balanced and appropriate physical scale.

6.2.1 Prince Mohammed bin Abdelaziz Street (Tahlia Street), Riyadh, KSA

Prince Mohammed bin Abdelaziz Street is considered one of the important streets in Riyadh city, locally it is known as "*Tahlia Street*" based on the presence of "The Water Distillation Authority" which is located at the top of the street. In the early 2000s, the street was chosen by the "Riyadh Municipality" to be a paradigm for the new urban commercial street in Riyadh City figure 15. The Riyadh Municipality implemented an ambitious urban campaign program known as "Humanizing the City" aiming at the enhancement of QoL in the city and the conversion of Riyadh into a sustainable city. The rehabilitation work focused on, providing safe sidewalks and increasing their width, adding shading facilities, increasing green spaces, and providing outdoor seating areas [79]. The whole street length is 5 kilometers east to west with a width of 60 meters, and the sidewalk width is 15 meters as shown in Figure 17. The street is divided into four zones; 1) the western section which includes luxurious residential areas. 2) the mid-west section which is a commercial area with furniture stores and cloth retails. 3) the middle section which passes through the heart of Riyadh city were high-rise office buildings. 4) the eastern section which is a commercial metropolitan area with a majority of restaurants and coffee shops [13]. Zone 4 was selected for study because it included most of the design criteria of a liveable commercial street as shown in Figure 16.

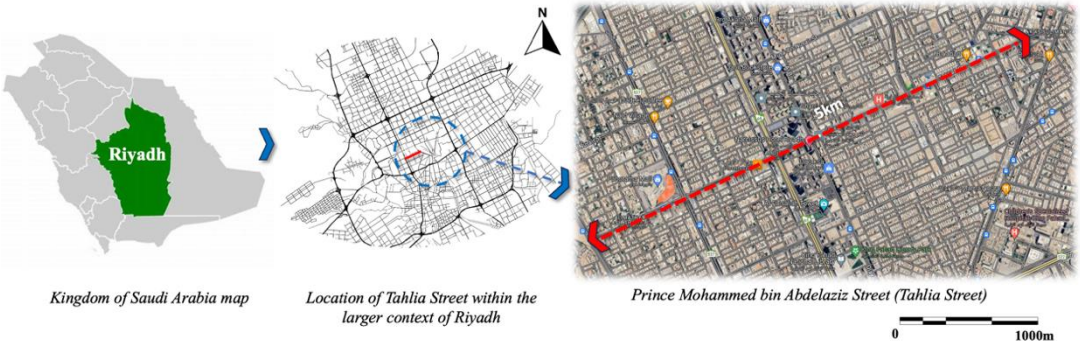

Figure 15: Tahlia Street location (*Source:* https://www.google.com/maps - https://stock.adobe.com**)**

Figure 16: Tahlia Street Land use (Source: Analysis by Authors from *https://www.google.com/maps)*

The physical conditions of the urban environment along "Tahlia Street" are measured through observational assessment by the researchers. The study was conducted by analysing various liveability indices, planning regulations, and guidelines to explore the main urban qualities and characteristics required for achieving a successful liveable commercial street. The street is classified as a commercial street and even all the ground floors of buildings are used for commercial activities which offer several services for street users and residents, also considered a highly active street that provides a lively environment for users. Tahlia Street is a moderate traffic 3-lane street that also follows a grid network, automated traffic lights control the cross-intersection (4 legs), with traffic calming techniques, and wide sidewalks for pedestrians with some greenery areas that improve environmental visual appearance.

The street is designed to allow safe access for all street users including pedestrians, motorists, bicyclists and transportation users of all ages and abilities. Observation of liveability concepts in the street such as the narrow roadway, wide and accessible sidewalks, safe crossing points, and traffic calming methods, contributes to reducing vehicle speeds and giving priority to pedestrians. Trees and vegetation cover planted along sidewalks and medians contribute to enhancing the harsh climate of Riyadh city. However, they are below expectations because the Street contains some trees that do not provide shaded areas. Figure 18 summarizes the descriptive analysis of the physical elements in an intersection of the street.

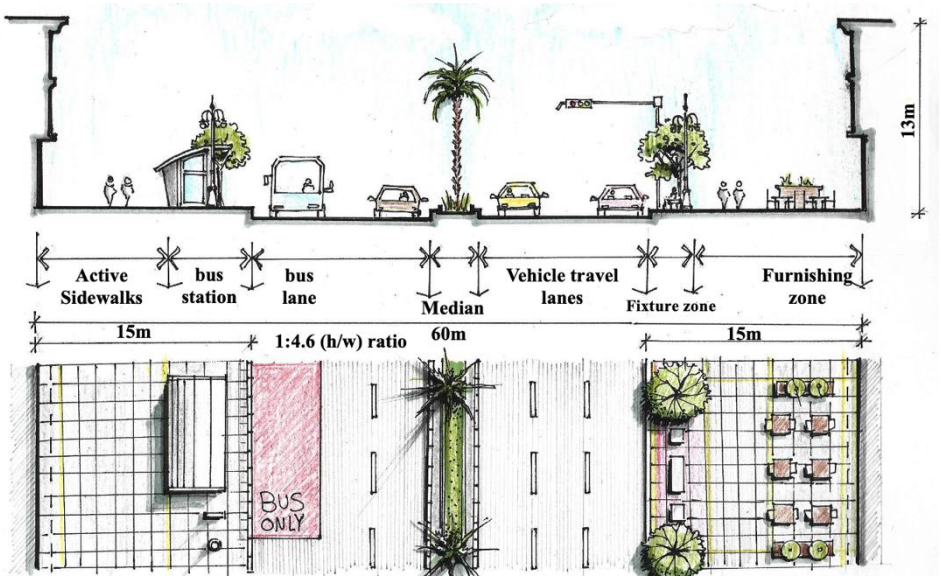

Figure 17: Cross-section through Tahlia Street (Source: Authors)

Figure 18: Analyzing the physical elements in one of the Cross-intersections (4 legs) of Tahlia Street (Source: Authors)

6.2.2 The Obour Street (Dahshur Link), Giza, Egypt

The Obour axis, previously known as Dahshur Link, serves as the dividing line between Sheikh Zayed City in the west and the 6th of October City in the east. It intersects with the Twenty-Sixth of July Corridor and is split into two sections: the northern and southern parts figure 19. These sections encompass residential neighborhoods, a versatile commercial area, and commercial urban zones that feature various dining establishments, cafes, entertainment venues, Padel fields, playgrounds for children, and a recreational pathway. The strategic plan for the new urban communities in western Greater Cairo aims to achieve several objectives. These include linking the two cities through real estate initiatives along the Dahshur Link, enhancing infrastructure and its effectiveness, offering incentives to the private sector, fostering a favorable investment climate, and promoting urban development in desert regions (Minister of Housing's Ministerial Decree number 1064/2018, [80]. The selection of this street was based on its significance in connecting the two cities, particularly emphasizing the northern region. The objective was to assess the feasibility of implementing criteria for designing a vibrant and liveable street. Figure 20 summarizes the descriptive analysis of the physical elements in the street.

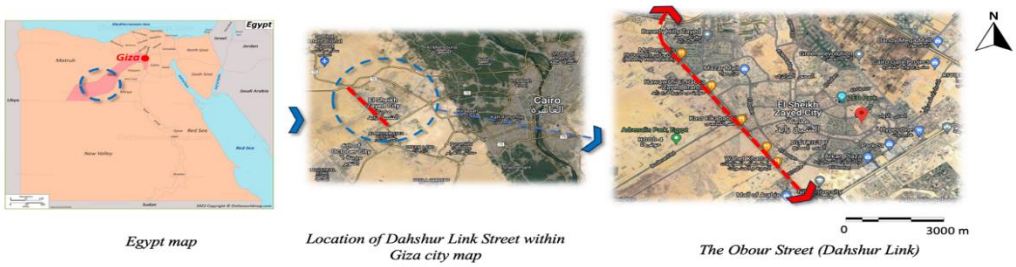

Figure 19: Dahshur Link Street location (Source: *https://www.google.com/maps* - https://ontheworldmap.com)

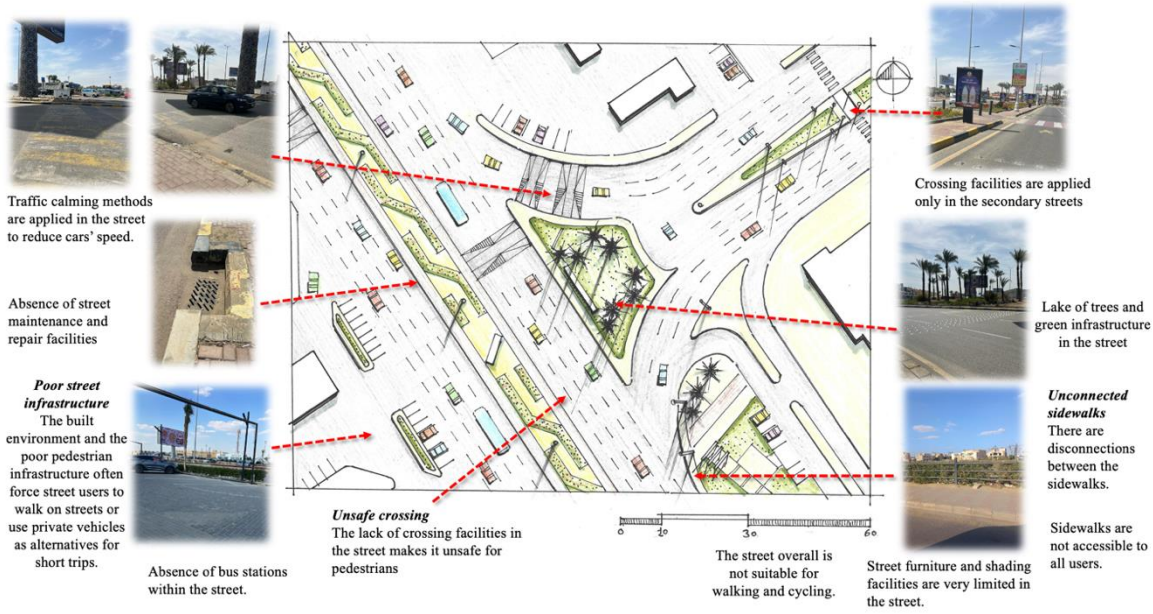

Figure 20: Analysis of the physical elements in one of the T-intersections on the Dahshur links (Source: Authors)

Researchers conducted an observational assessment to measure the physical conditions of the urban environment along the "Obour axis." The study involved analyzing various indicators of liveability, as well as planning regulations and guidelines, to identify the essential qualities and characteristics necessary for a successful and lively commercial street.

Al Obour Street is classified as a commercial street, serving as a hub for various services and catering to both street users and residents. It is known as Dahshur Street and is characterized by high levels of activity, creating a vibrant environment for its users.

Dahshur Street experiences as major arterial, with a speed limit of 80 km per hour and five lanes in each direction. To address speed concerns, traffic calming methods such as speed bumps are in place, along with radar-based speed monitoring devices.

However, unlike Tahlia Street, Dahshur Street was not designed with safe access for all users as a priority. Car traffic takes precedence, and there are no designated safe pedestrian crossings between the two directions. Additionally, traffic lights are absent along the street. The focus has primarily been on providing crossings for internal streets intersecting with Dahshur Street. Nevertheless, there are wide pedestrian sidewalks with some green spaces that improve the environmental visual appearance in every direction. The enhanced

vegetation planted along the sidewalks also contributes to enhancing the harsh climate of the Greater Cairo region.

Despite the good location of Dahshur Link and the presence of diverse uses and activities along the street, it falls short of meeting certain indicators and requirements of a liveable street.

6.3 Evaluating the effectiveness of the street liveability framework.

The street liveability framework was tested on the two streets under study, as shown in Table 3.

Table 3: Evaluation of the proposed framework for both Tahlia Street and Dahshur Street: NE means that the indicators Not exist, 1 means bad, 2 means neutral, and 3 means good. The proposed codes for indicators were used within the evaluation framework to facilitate the evaluation process.

	Livable street indicators	Tahlia Street, Riyadh, KSA				Obour Street, Giza, Egypt			
		Good	Neutral	Bad	NE	Good	Neutral	Bad	NE
		3	2	1	0	3	2	1	0
Green Infrastructure	*Street Greenery (SG)*								
	SG1		✓				✓		
	SG2		✓				✓		
	SG3		✓					✓	
	Stormwater Management/ Reuse water (SM/ RW)								
	SM/RW1			✓					✓
	SM/RW2			✓					✓
	Air Quality (AQ)								
	AQ1	✓					✓		
	AQ2		✓				✓		
	AQ3		✓					✓	
	Noise Insulation (NI)								
	NI1			✓					✓
	NI2		✓				✓		
	NI3	✓					✓		
Cool Street	*Cool Pavement (CP)*								
	CP			✓					✓
	Shading/Canopies (S/C)								
	S/C1			✓			✓		
	S/C2		✓			✓			
	Temperature Reduction/ Thermal Isolation (TR/TI)								
	TR/TI1			✓					✓
	TR/TI2			✓					✓

	Livable street indicators	Tahlia Street, Riyadh, KSA				Obour Street, Giza, Egypt			
		Good	Neutral	Bad	NE	Good	Neutral	Bad	NE
Placemaking	TR/TI3			✓					✓
	Sociability (S)								
	S1	✓				✓			
	S2	✓				✓			
	S3	✓					✓		
	Inclusivity / Diversity (I/D)								
	I/D1	✓				✓			
	Sens of Place (SP)								
	SP1	✓				✓			
	SP2	✓				✓			
Safety/Accessibility	*Safe for all Travellers (ST)*								
	ST1	✓					✓		
	ST2	✓							✓
	ST3	✓					✓		
	Accessibility (A)								
	A1	✓							✓
	Smart features (SF)								
	SF1		✓						✓
	SF2	✓							✓
	SF3	✓						✓	
Health/ wellbeing	*Walkable, Cycling, Active Pedestrians (W/C/AP)*								
	W/C/AP1	✓						✓	
	W/C/AP2			✓		✓			
	W/C/AP3	✓				✓			
	W/C/AP4	✓					✓		
	W/C/AP5	✓					✓		
Econ. competitiveness	*Attractiveness/ Vibrant (A/V)*								
	A/V1	✓				✓			
	A/V2			✓				✓	
	A/V3	✓				✓			
	A/V4			✓				✓	
	Energy Consumption Reduction and Saving Energy Bills (ECR/SEB)								
	ECR/SEB1			✓				✓	

	Livable street indicators	Tahlia Street, Riyadh, KSA				Obour Street, Giza, Egypt			
		Good	Neutral	Bad	NE	Good	Neutral	Bad	NE
Mixed-use	*Land-use value & Flexible design (LV/FD)*								
	LV/FD1	✓				✓			
	LV/FD2	✓				✓			
Connectivity	*Mobility & Transportation Moods/ Proximity (M/TM/P)*								
	M/TM/P1	✓							✓
	M/TM/P2	✓						✓	
	M/TM/P3		✓						✓
	M/TM/P3	✓				✓			

Field observations indicate the absence of certain indicators in Dahshur link. Tahlia Street in Saudi Arabia demonstrates a higher level of implementation of these indicators compared to it, albeit by a slight margin, See Figure (21). These indicators such as:

The first environmental indicators are a lack of control over the water recycling process and the absence of any strategies for managing rainwater and reusing it in buildings. Absence of systems for implementing water-sensitive urban design, including extensions of vegetated sidewalks and integrated drainage systems for rainwater. Absence of paving materials designed to reflect solar radiation and absorb less heat compared to asphalt or traditional concrete. Lack of solutions aimed at reducing temperature, such as the utilization of sensors to collect data, identify hot spots, and prioritize cooling interventions, supported by artificial intelligence. In addition, there are social indicators that are lacking, including the absence of pedestrian crossings and intersections with islands and traffic signals that provide longer crossing times, which significantly impacts the safety of pedestrians. The lack of pedestrian crossings, including ramps, hinders accessibility for individuals with disabilities.

Insufficient implementation of smart features, such as sensors to collect data on traffic flow and pedestrian activity. The absence of smart adaptive lighting systems that adjust brightness based on ambient light and pedestrian activity.

Finally, concerning economic indicators, particularly mobility and transportation, there is an absence of certain elements that are crucial for creating a liveable street. These include the lack of diverse transportation options and an over-reliance on cars as the primary mode of transportation. Consequently, there are no bus stops available.

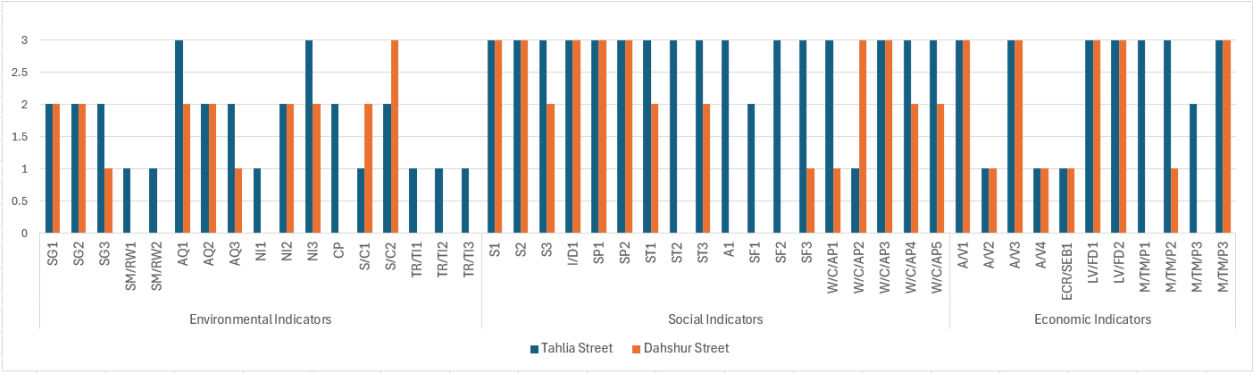

Figure (21) illustrates comparative evaluation of the livable streets index in the two case studies (source: Authors)

7. CONCLUSIONS

The research paper provided an extensive study of the most significant literature and theories focusing on the concept of liveability as a crucial factor in upgrading commercial streets resulting in a comprehensive knowledge base for the most indicators to enhance street's performance and liveability. The paper proposed a framework (checklist) for measuring liveability on commercial streets that can serve as a blueprint for promoting sustainable urban transformation in Egypt. This framework is considered the basis of assessment and design simultaneously, assisting planners and developers in achieving two primary goals: developing existing streets and proposing basic principles for future street design. The framework is divided into three integrated indicators and sub-indicators that correspond to detailed elements and tools of the evaluation.

The framework was applied and evaluated on two different commercial streets in the Kingdom of Saudi Arabia and Egypt, it provided a comprehensive information base that identified the street's most essential strengths in liveability as well as its weaknesses, opening the prospects to find solutions for improving the liveability of both Streets and contributing to upgrading it. The framework could be developed to include multiple streets in the future, making it more comprehensive, the more application of it the more indicators are found. Therefore, the framework represents a starting point for evaluating liveability in different types of streets.

According to the case studies in the research, Tahlia Street is considered more liveable compared to Dahshur Link Street because it includes several physical elements, such as wide sidewalks, safe access for all users, a public transportation network, and traffic calming methods, all these elements give priority to pedestrians, improve quality of life and enhance the urban environment. This indicates the existence of an effective and clear vision for the Kingdom of Saudi Arabia towards sustainable transformation by 2030 and the efforts of the government in all its institutions towards setting action plans and valuable programs to achieve this goal.

The most significant problems in Dahshur Link are observed in the poor pedestrian infrastructure which showed in the lack of safety, greenery, shading areas, disabled facilities,

and connected sidewalks, as, high rates of vehicle accidents, and traffic congestion, additionally, lack of bus stations and waiting areas for pedestrians. Despite the governmental efforts in Egypt to develop roads and infrastructure, there are deficiencies in implementing some of the main indicators and requirements for achieving principles of liveability.

RECOMMENDATION

The research paper concludes by offering various recommendations to planners, policymakers, and local authorities. These recommendations aim to foster pedestrian-friendly urban environments and enhance street performance and liveability, thereby driving urban transformation towards improved quality of life and sustainability.

- It is suggested to embed livable commercial streets in policy and develop design guidelines with accessible tested solutions.
- Policymakers and local authorities should take into consideration all street users' needs considering different ages and abilities in developing streets in the future.
- It is recommended to develop a strategy to enhance the urban pedestrian environment by analyzing the current situation and improving community participation.
- It is proposed to increase shaded areas and tree canopy on sidewalks and medians in the analytical case studies to enhance the microclimate and reduce the Urban Heat Island (UHI) effect, also the plant selection should take into consideration adaptability to the surrounding climate and choosing drought-tolerant species and heat-resistant such as Carpobrotus edulis.
- Increase means of protection against the harsh climate, including arcades and canopies.
- The importance of Controlling vehicles' speed to reduce accidents and increase safety in Dahshur Link by using radars, traffic signs, cameras, and street bumps.
- It is recommended to redesign Dahshur Street to include various kinds of movement to achieve safety for all users such as providing continuous pedestrian sidewalks, and bike lanes. Additionally, enhancing the sense of place by providing adequate spaces for activities to achieve more social interaction.
- Providing street users protection from vehicles in the form of increasing crossing points along Dahshur Link, traffic lights, traffic calming methods, and smart facilities.
- Developing a public transit plan that sustains public transportation stop locations, taxi stops, and shaded waiting areas.

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الشوارع التجارية: إطار عمل لخلق بيئات صالحة للعيش في مصر

لقد حظي مفهوم قابلية العيش باهتمام كبير وأصبح نقطة محورية في الأبحاث والمناقشات بين المدن والحكومات. ومع توسع المناطق الحضرية وكثافتها، زادت أهمية الشوارع الصالحة للعيش كعناصر أساسية للتصميم الحضري. تلعب الشوارع الصالحة للعيش دورًا هاما في خلق بيئة حضرية ديناميكية ومزدهرة، ودفع التحول الحضري نحو تحسين نوعية الحياة والاستدامة. أحد أكثر الأجندات التي يتم العمل عليها في مصر هو تطوير شبكة الشوارع المحسنة الجديدة، والتي لها تأثير مباشر على سكان المدينة ومستخدمي الشوارع والأهم من ذلك اقتصاد البلاد. الهدف من هذه الورقة البحثية هو طرح إطار للشوارع التجارية المعاصرة والصالحة للعيش والتي يمكن أن تكون بمثابة مخطط لتعزيز التحول الحضري المستدام في مصر. يتضمن هذا الإطار تطوير مؤشرات لتقييم قابلية العيش في الشوارع في البيئات المعاصرة. توفر هذه المؤشرات إرشادات قيمة لصناع القرار أثناء مرحلتي التخطيط والتصميم. اعتمد هذا البحث على إطار عملي ومسح ميداني وملاحظات وتقييم واستبيان كأساليب بحثية. لتقييم فعالية إطار قابلية العيش في الشوارع، سيتم تنفيذه واختباره في شارعين تم تطويرهما حديثًا: شارع الأمير محمد بن عبد العزيز (شارع التحلية) في حي العليا بالرياض، المملكة العربية السعودية، وشارع وصلة دهشور في منطقة القاهرة الكبرى، مصر. ومن خلال التحليل المقارن لهذه المواقع، تهدف الدراسة إلى استخلاص النتائج وتقديم توصيات.