Activating the Transportation Potential of Greenways in Saudi Arabia: A Case Study of Jeddah City

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ABSTRACT

Since the early 1970s, auto-centric planning in Saudi Arabia (SA) has led to car-dependent lifestyles, resulting in health and environmental problems. In the past decade, ambitious policies (e.g., The Saudi Vision 2030), urban design manuals, awareness campaigns, city plans and projects have sought to address this problem by transitioning to sustainable urban mobility. Active transportation (AT) via networks of greenways is a dimension of such a transition and is currently being planned and advocated in Saudi cities. However, current walking and bicycling rates for transportation in SA are extremely low. Simultaneously, there is limited research on greenways in SA, and none has explored the influences on their usage as AT corridors (ATCs). An enhanced understanding of such factors is vital because academic journals found minimal effect on AT over the last thirty years from many greenway investments in various regions worldwide. Therefore, this PhD research aimed to explore the activation barriers and strategies of greenways' function as facilitators for AT in SA, using Jeddah city as a case study.

The review and synthesis of existing literature built an understanding of the state of knowledge concerning the planning and usage of AT and greenways in SA. It also explained the events that evolved greenways' forms and functions internationally while chronologically relating to urban and open space planning in Saudi cities. Lastly, it examined where and when greenways would be considered routes for daily commutes using a systematic review of published peer-reviewed journal articles from 1991 until 2021. Due to the multidimensionality of such influences, the case study of Jeddah used mixed research methods (web-based questionnaire, environmental audits, field observations, and interviews with experts and leaders of local walking and bicycling groups). Interpretations and inferences of such an empirical study combined the results of these methods thematically and linked them to existing literature.

Through (I) assessments of the physical environment at the city, neighbourhood, and site levels, (II) examining the preferences, behaviours, and opinions of users and non-users of greenways in Jeddah city, and (III) understanding the underlying causes to existing conditions, this thesis underscored key impediments that must be overcome. These include automobile-centric lifestyles, planning systems, outdoor temperature, social norms, long commuting distances, lack of AT infrastructure, bicycling skills and knowledge, proximity to greenways, and park facilities and amenities. Results also explained that religious and gender norms on women's participation in bicycling can affect social support for policies advocating bicycle usage in Saudi cities and the effectiveness of any proposed greenway network in the future. Informed by the interviewed experts, existing literature, and global best practices, the proposed strategies to address the identified barriers stressed the importance of actions across social, environmental, technological, economic and legal domains. These strategies (e.g., improving stakeholders' participation, integrating with public transit, increasing visibility and awareness, and implementing policies that enable AT) can accelerate the transition towards sustainable transportation in SA.

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GLOSSARY OF TERMS AND ACRONYMS

AT	Active Transportation
SA	Saudi Arabia
LPs	Linear Parks
PNLPs	Perceived Nearest Linear Parks
NDC	Northern Drainage Channel
SUMPs	Sustainable Urban Mobility Plans
PA	Physical Activity
MVPA	Moderate to Vigorous Physical Activity
METs	Metabolic Equivalents
GI	Green Infrastructure
QGIS	Quantum Geographic Information System (software)
SPSS	Statistical Package for the Social Sciences (software)
NMT	Non-motorised Transport
MoMRA	Ministry of Municipal and Rural Affairs
MOT	Ministry of Transport
JWW	Jeddah Waterfront Walkway
QoL	Quality of life
RCRC	Royal Commission for Riyadh City
KAU	King Abdulaziz University
RQ	Research Question
WBQ	Web-based Questionnaire
FOs	Field observations
TOD	Transit-oriented Development
SAPTCO	The Saudi Public Transport Company
ESA	Environmentally Sensitive Areas
EAs	Environmental Audits

CHAPTER ONE

INTRODUCTION

1. Chapter One: Introduction

“The right to have access to every building in the city by private motorcar in an age when everyone possesses such a vehicle is actually the right to destroy the city.” (Mumford, 1963, p.11)

This thesis explores how greenways can be activated to facilitate active transportation (AT), thereby reducing automobile dependence within Saudi cities. This chapter begins with background information about AT, explaining its role in cities’ health, wealth, and sustainability. Next, Section 1.2 states the research problems by explaining the factors impeding AT in Saudi cities because of its automobile-centric planning. Section 1.3 positions greenways as a response to many identified problems in Saudi cities, highlighting their contributions to sustainable transportation. Section 1.4 identifies the gap in the literature and justifies the significance of filling that gap. The following Section (1.5) presents the research objective and questions. Then, Section 1.6 justifies the research study area. Finally, Chapter One concludes in Section 1.7 with an outline of the thesis structure.

1.1. The case for and against active transportation

Active transportation (AT), active travel, non-motorised transport (NMT), or soft mobility are all terms that refer to human-powered means for commuting purposes (e.g., to work, school, shops, or recreational destinations) such as walking, bicycling, and the use of scooters (Petrokofsky and Davis, 2016). These “active” forms of mobility are meant to be used as an alternative to motorised modes of transport.

However, what is considered active? A systematic review that aimed to assess the health benefits of active travel concluded that what distinguishes “active” from “inactive” travel is the amount of exertion, which is affected by terrain, distance, congestion rate, climate, travel speed, body weight, carry-on bag weight, mode of active travel, surface material, age, gender, hormone function, muscle-to-fat ratio, genetics, drugs intake, diet, and more (Ainsworth et al., 2011; Saunders et al., 2013). To gain the associated health benefits of active travel, a sought-after goal of most people, walking or bicycling for 20-30 minutes or more than 3.5 metabolic equivalent task hours per day, is recommended (Ainsworth et al., 2011; Matthews, 2007 as cited in Saunders et al., 2013; WHO, 2020).

What are the associated health benefits of AT? Physical inactivity is among the top non-communicable diseases responsible for most causes of premature death and disability globally (WHO, 2021). Achieving the recommended PA via AT is significantly associated with several health benefits, such as mental health (Kroesen and Vos, 2020), reductions in risk of all mortality causes, hypertension, and Type 2 diabetes (Saunders et al., 2013). However, results are inconclusive regarding obesity (Saunders et al., 2013; Kroesen and Vos, 2020; Zhang et al., 2020). Such uncertain results affirm the multiplicity of AT variables. To conclude, AT has several health benefits; however, with variables such as obesity, the results are inconclusive.

A goal to increase the AT rate offers health, economic, and social benefits. For example, due to an increase of 26.7% and 72.5% in walking and bicycling, respectively, on working days in Barcelona between 2009-2013, Pérez et al. (2017) estimated an average annual monetary benefit of €57,817,000 using the Health Economic Assessment Tool (HEAT) calculations, a tool developed by the WHO. Studies that focused on the social value behind AT found positive associations between social interactions and AT in children and adolescents (Carver et al., 2005, Evenson et al., 2006, Hohepa et al., 2007, McDonald, 2007, Timperio et al., 2006 as cited in Panter et al., 2008). In short, urban development strategies that aim to increase the rate of AT have health, economic, and social benefits.

Several studies have evidenced that increasing the rate of AT contributes to overcoming automobile dependence, which has numerous economic, environmental, social, and health benefits. Among them are (I) the reduction in traffic congestion, (II) saving costs of road infrastructure, (III) consumer savings, (IV) the reduction of chauffeuring burdens (transporting non-drivers), (V) increase in traffic safety, (VI) conserve energy, (VII) minimise environmental pollution, (VIII) vitalise economic development (Litman, 2021; Newman and Kenworthy, 1999, 2015). Using longitudinal panel data from seven European cities, Brand et al. (2021) found that: *"An average person cycling 1 trip/day more and driving 1 trip/day less for 200 days a year would decrease mobility-related lifecycle CO_2 emissions by about 0.5 tonnes of CO2 (tCO2) over a year, representing a sizeable chunk of annual per capita lifecycle CO2 emissions from driving (which e.g. in the UK amount to about 1.4 tCO_2 per person per year)."* (Brand et al. 2021). Therefore, many studies linked the sustainability of cities with overcoming automobile dependence, especially in reducing vehicle kilometres travelled (VKT) per capita.

Physical design and elements of the urban fabric, such as street and block patterns, as well as the arrangements and shapes of buildings, are fundamental determinants of the rate of AT (Carmona et al., 2010; Gehl, 2011). In addition to trip length, Jan Gehl asserted the importance of space quality (Gehl, 2011). Therefore, several studies positively associated several qualities of the built environments with the rate of AT. For example, a literature review conducted by Panter et al. (2008) revealed that high street connectivity, land-use diversity, residential density, and proximity to recreational and commercial land uses are associated with higher rates of AT for children (McDonald, 2007, Mota et al., 2007, Kerr et al., 2006, Frank et al., 2007, Kerr et al., 2007 as cited in Panter et al., 2008). In short, creating compact, diverse, walkable, bikeable, and transit-oriented cities contributes to increasing AT rates and decreasing automobile dependence on daily commutes.

There are numerous benefits of creating built environments that increase the rate of AT and reduce reliance on automotive means of travel. It (I) contributes to the enhancements to the safety, comfort, and aesthetic quality of public places (e.g., streets); (II) increases property values; (III) supports equity objectives by improving non-drivers' accessibility to daily destinations; (IV) save transport costs; (V) preserves natural and semi-natural green spaces; (VI) increase liveability; (VII) reduce sprawl costs; and (VIII) increases security (Litman, 2021; Speck, 2012). For example, between 2008 and 2014, property values of 1747 parcels within 152 m of a 13 km cultural trail in Indianapolis, Indiana, increased by 148%, translating to 1.013 billion USD (Majors and Burow, 2015). These financial returns are substantial, considering the $63 million total cost. This cultural trail is an example documented by the Indiana University Public Policy Institute, linking investments in AT infrastructure to the quality of living enhancements and economic prosperity. Other studies worldwide also calculated the cost-benefit analysis of greenways (Dallat et al., 2013; Hunter et al., 2020; Kang and Cervero, 2009; Manton et al., 2016). Therefore, based on evidence-based research of Worldwide case studies, planning to increase the AT rate (e.g., via greenways) extends beyond mobility since it contributes to cities' health, wealth, and sustainability.

Planning for AT does not come without risks and shortcomings. These include AT infrastructure costs, lower traffic speed, non-drivers' exposure to environmental pollution, slower travel speed, injury, vulnerability to seasonal changes and weather variations, physical effort, convenience, family circumstances, health status, accessibility and continuity of AT facilities, traffic conditions, and safety (Bopp et al., 2018; Dill and Carr, 2003; Litman, 2021). In addition to those factors, several studies reported cyclists' psychological distress related to harassment, victimisation, and discrimination (Basford L et al., 2002; Garrard J et al., 2006, as cited in Bopp et al., 2018), as well as fear of bicycling in traffic (Horton D., 2007, as cited in Bopp et al., 2018). Despite all these issues, the documented benefits considerably outweigh the risks and shortcomings (Hartog et al., 2010; Mueller F et al., 2015, Tainio M et al., 2016, as cited in Kahlmeier et al., 2017).

Many of the previously mentioned risks and shortcomings may be addressed via innovative urban transportation solutions referred to as Micro-mobility. They are shared or owned human-powered or electrically assisted lightweight devices, such as e-bikes and e-scooters, that are meant for short travel distances at speeds less than 30 mph (Dia, 2019, as cited in Abduljabbar et al., 2021). Electric bicycles address challenges related to road gradients, long travel distances, and physical effort, which explains their global adoption, especially in countries with high bicycle share rates, such as China (Fyhri et al., 2017; Simsekoglu and Klöckner, 2019). Although electric bicycles are indeed addressing many of the cycling challenges, they do have their own set of limitations. These limitations include: more serious injuries compared to conventional bicycles due to the higher speeds; security risks (i.e. theft); higher market prices; higher weight; lack of cycling infrastructure; weather conditions; as well as social perceptions that hinder its adoption, such as thinking that electric two-wheelers are meant for people with physical limitations (e.g., elderly) (Simsekoglu and Klöckner 2019). Despite that, these cost-effective, carbon-free, compact, smart, convenient, and efficient modes of micro-mobility are positioned as a better alternative to private automobiles for trips < 2 miles (Abduljabbar et al., 2021).

A closer look at the number of vehicle trips taken at distances of two miles or less in length revealed a considerable opportunity that further strengthened the case for AT. For example, 25% of all trips are less than 1 mile in the UK, and 68% are below 5 miles (Evans et al., 2019). In the US, according to the US Department of Transportation, Federal Highway Administration, and National Household Travel Survey website, 59.44% of all travel day vehicle trips in 2017 were less than 5.5 miles in length[1]. Surprisingly, the same source shows that 35.2% of travel day vehicle trips in 2017 were less than 2.5 miles. Destinations within two miles are certainly bikeable, considering that they will take between 10 to 15 minutes at 10-12 mph in good conditions. Moreover, for most people, any destination beyond two miles would practically require the use of transport means besides walking and bicycling, as evident in the National Travel Survey England 2017 (Avbulimen, 2018). In short, travel behaviour patterns to destinations within two miles and less in both the US and the UK indicate a great potential for AT as a substitute for automobiles.

In summary, ample evidence suggests that AT contributes positively to cities' health, wealth, and sustainability.

1.2. Factors impacting active transportation in Saudi cities

Many people recognise car ownership as a symbol of personal freedom where its users can effortlessly and comfortably travel, on-demand when desired, to any location while being able to carry bags of groceries or luggage (Cervero et al., 2017, 13; Litman, 2009). However, there are various deleterious effects of automobile-dependent cities. Newman and Kenworthy (1999) defined automobile dependence "*as a situation in which a city develops on the assumption that automobile use will predominate so that it is given priority in infrastructure and the form of urban development.*" (p.60). Automobile dependency in cities negatively impacts people and the environment directly (e.g., air and noise pollution), indirectly (e.g., cardiovascular and respiratory disease), and accumulatively (e.g., climate change) (Newman and Kenworthy, 1999, 2015; Carmona et al., 2010). The incremental dependency on the automobile also dramatically fragmented the landscapes of post-industrial cities (the second half of the 20th century), contributed to the loss of the traditional density of cities, and the rise of urban sprawl (Carmona et al., 2010; Speck, 2012). This pattern of urban development was the norm in many cities worldwide during the 20th century (Newman and Kenworthy, 2015). The cities of Saudi Arabia (SA) are among them, a country located in the southwest of Asia and with a population of 34.1 million as of mid-2021 (See Figure 1-1) (The General Authority of Statistics, 2021). Therefore, they are selected as the focus of this PhD research to contribute to overcoming its automobile dependence, using Jeddah as a case study.

[1] To generate the used statistics, select the analysis variable as "*Annual vehicle trips*" and the row variable as "*Trip distance in miles, derived from route geometry returned by Google Maps API, or from reported loop-trip distance*."

Figure 1-1. Map of Saudi Arabia. Jeddah city is in its western region (Map credit: JRC, European Commission).

Has walking and cycling always been rarely used as a mode of transport in Saudi cities? The answer is no. Before the 1930s, many Saudi cities, including Jeddah, were walled, and AT was among the common forms of transportation (Menoret, 2019). In 1970, walking in Jeddah city, for instance, represented 31% of all trips (IBI, 2007, MOMRA, 1980, Municipality of Jeddah, 2006, as cited in Aljoufie et al., 2013). From there, there has been a gradual decline in AT rate.

Major Saudi cities such as Riyadh, Jeddah, and Dammam are all characterised as automobile-dependent cities (Addas, 2015; Aljoufie 2012, 2014a, 2014b, 2016, 2017, 2021; Aljoufie and Tiwari, 2020; Alhajaj, 2014; Helmi 2015; Almahmood et al., 2017; Mandeli, 2011; Sobaihi, 1995). For instance, 96% of all daily trips in Jeddah city depended on private transportation in 2012 (AECOM, 2012, as cited in Aljoufie, 2014b). Even at distances below 1 km, one study in Al Dhahran has shown that people still depend on cars due to multifaceted factors, such as hot outdoor temperatures, poor accessibility to neighbourhood facilities, and inadequate sidewalk designs (Rahman and Nahiduzzaman, 2019). In addition, according to the General Authority for Statistics 2017 Housing Survey, 100% of households own one or more cars: 65% of all Saudi households own a car, 23.3% own two cars, 7.85% own three cars, and the remaining 3.85% have 4 to 8 cars per household (The General Authority for Statistics, 2017). These results are expected since, for example, public transportation within walking distance of ten minutes in Jeddah city is only accessible to 12% of the total population (Arcadis, 2015). Table 1-1 summarises the factors that led to such dependence based on the references cited above. In short, key factors to the low usage of active transportation in Saudi cities resulted from their urban planning, policies, and design, economic support that facilitated car ownership and usage, hot weather, sociocultural aspects, and public perception.

Table 1-1. Factors that led the Saudi cities to become automobile dependent.

Category	**Factors**
Urban policies, planning, and design	Public transportation service coverage and quality are lacking.
	Lack of walking and cycling infrastructure
	Traffic planning and management is inconsiderate of active transportation.
	Sprawled low-density urban development
	Modernistic approaches to city planning (the grid-iron urban pattern that disregards local culture and religion)
	Functionally segregated settlements
	Lack of urban cooling measures
	Addressing the increase in population density was unsuccessful in planning transport infrastructure.
	Lack of vegetation (water scarcity)
	Incompatible urban design solutions to the Saudi natural environment
	Poorly maintained sidewalks
	Available sidewalks are usually hindered by trees, lamp posts, street signage, and illegally parked vehicles.
	The abundance of car parking
	Lack of national urban and landscape design standards that regulated the implementation of AT infrastructure before 2005
	Wide road capacities reserved for automobiles
Economic factors	Highly subsidised fuel prices
	Low automobile registration fees, insurance, and maintenance costs
	Growth of automobile imports and auto-related services since the 1970s
Natural environment	Hot weather
Administrative and legal issues	Delays caused by challenges associated with implementing comprehensive plans that treat automobile dependence (e.g., property expropriation and coordination with the concerned authorities)
Sociocultural aspects	Gender segregation culture
	Social norms
	National costumes (Thoub and Abaya) cover the entire body and are neither suitable nor comfortable for active transportation.
	Drivers’ inconsiderate behaviours towards pedestrians
	Men’s harassment of women in public open spaces
	Sense of insecurity being with or among strangers on public transport
	The use of bicycles does not provide the required privacy for women.
	Cars are comfortable compared to other transportation modes.
	The perception that public transport is meant for blue-collar workers.

Many identified issues in Table 1-1 are common in auto-centric modernist planning and built urban developments worldwide. Transportation systems are one of the main components that shape cities (Newman and Kenworthy, 1999, 2015) and are an essential building block for sustainable development (UN-Habitat, 2013). When streets, “*the most immediate open space for all*” (Walmsley, 1995, p.82), were planned and designed as domains primarily for the use of automobiles, such as in the case of Clarence Perry and Le Corbusier early twentieth century, sidewalks became unwalkable, travel distances became longer, social interactions were reduced, pedestrian and bicycle access was limited, car use was encouraged, and many more problems that affected people's quality of life in many cities around the world, including America and Australia (Carmona et al., 2010; Cervero et al., 2017). The presence of these issues in Saudi cities was partially due to the hasty adoption (because of pressures of rapid urbanisation and population growth) of western planning models, regulations, and design standards without considering the local climate, socioeconomic, and cultural factors (Al-Hathloul and Anis-ur-Rahmaan, 1985; Al-Shahrani, 1992; Hammadi, 1993; Helmi, 2015; Mandeli, 2011; Maneval, 2019; Sobaihi, 1995). In short, cities worldwide share similar consequences of adopting car-centric planning models, and SA is no exception.

However, in contrast to many societies around the world, gender segregation, women's sense of insecurity in public urban spaces, and perception of privacy are all factors of the local Saudi culture (Le Renard, 2008; Maneval, 2019; Meijer, 2010, as cited in Almahmood et al., 2017; Van Geel, 2016). Therefore, they are discussed in greater detail (see Section 2.3).

Another factor worth further emphasis on is the lack of national urban and landscape design standards in Saudi Arabia that regulate the implementation of AT infrastructure before 2005 at the national scale. What further exacerbated this issue is The Ministry of Municipal and Rural Affairs (MoMRA)'s Road Engineering Design Manual, which was published in 2001. While the intention was to "*unify street specifications across all Saudi regions*" (MoMRA, 2001, p.1), their reference to sidewalks was as follows: "*Sidewalks are considered complementary parts in the design of streets within cities. They are hardly necessary for rural areas. Their width must not be less than 1.5 meters and made of smooth, flat, and intact materials.*" Translated from Arabic to English (MoMRA, 2001, p.22). This quote represents half of the information on pedestrian facilities and amenities within a lengthy official document that sets the national design standards for road infrastructure. Furthermore, information about bicycle facilities and amenities is non-existent. Therefore, the lack of urban and landscape design standards at a national scale, specifically before 2005, contributed to the lack of NMT infrastructure, fuelling the dependence on automobiles.

Automobile-centric environments impact AT's safety, comfort, accessibility to daily destinations, and residents' physical activity in SA. A cross-sectional study characterised cycling in Jeddah city as unsafe (Aljoufie, 2017). Regarding AT comfort, air and noise pollution is an outcome of automobile dependence that can partially be considered an indicator of such quality (Peng et al., 2019; Piatkowski and Bopp, 2021). The annual mean concentration of fine particulate matter (PM2.5) in 2021 within urban areas of Saudi Arabia is 63.96 µg/m3 (51.81 – 84.91), which is considerably higher than WHO's recommended 5 µg/m3 threshold, thus negatively impacting residents' respiratory and cardiovascular systems (WHO 2021). On another note, the transport sector is responsible for 19% of Saudi Arabia's CO_2 emissions and other GHG emissions, the third-largest contributor to air pollution (Enerdata, 2020, as cited by Climate Transparency, 2020), of which 85% is attributed to in-land transport (ESCWA, 2009, as cited in MoMRA and UN-Habitat, 2019c). From a global perspective, Saudi Arabia is ranked 29th out of 106 countries as the most polluted (IQAir, 2020). Most of its major cities (e.g., Riyadh, Jeddah, Dammam) are characterised as unhealthy for sensitive groups (e.g., people with asthma) based on WHO 2021 PM2.5 guidelines. In short, automobile dependence in Saudi cities impacts air quality, thus the comfort and safety of using AT modes, suggesting a lack of equity in transport planning.

In terms of noise pollution, case study research in Jeddah (Zytoon, 2016), Al Dammam (Al-Ghonamy and El-Sharkawy, 2008), and Riyadh (Alsaif and Foda, 2015) concluded, based on noise mapping models, that traffic noise levels at daytime, evening, and night-time is higher than the maximum recommended levels established in SA's environmental noise standards. For example, in all those case studies, the recorded noise level in the main streets was >75 dBA, a source of annoyance for the district residents and potential pedestrians and cyclists. Therefore, noise generated from motorised vehicles in Saudi cities is one of the side effects of automobile dependence that affects AT.

Increased travel time and distance is another outcome of Automobile-centric urban policies, planning, and design, which poses a challenge for using AT in Saudi cities. While there is no national data about the number of trips by distance or duration in Saudi cities, several cross-sectional studies revealed that the average trip length is above 5 miles. For instance, the recorded average vehicle trip length in Jeddah city was 8.6 km in 2007 (Aljoufie et al., 2013), and in Riyadh, 32.08 km (Youssef et al., 2021). With the lack of public transit and AT infrastructure in Saudi cities (as cited earlier in this Section), the use of AT is impractical. One study revealed that reducing the walking time by 10% to metro stations increases ridership by 7.2% in Riyadh (Youssef et al., 2021). In short, the sprawling nature of Saudi cities increased travel time and distance; thus, the use of AT necessitates a modal shift to public transport systems, which are yet to be realised.

Another issue related to AT in SA is that its residents are mostly inactive based on the criterion of 150 min or more of physical activity (PA) per week. According to the Saudi General Authority for Statistics, the 2019 Household Sports Practice Survey, 80% of SA's residents are physically inactive. Furthermore, the same source reported that walking is the most practised form of PA by 62% (The General Authority for Statistics, 2019). While the lack of desire and time were the most reported reasons for being physically inactive (36.2% and 40.88%, respectively), 10% of 26000 households mentioned the lack of facilities in neighbourhoods (The General Authority for Statistics, 2019). A systematic review of the factors influencing the prevalence of physical inactivity in SA partially attributed unsupportive urban planning and design for AT and increased travel time and distances (sitting in cars for long hours) as contributors to the sedentary lifestyle (Al-Hazzaa, 2018). For instance, an average morning commute in Riyadh was between 50 to 65 min, which can be doubled if afternoon and evening trips were considered (Kung et al., 2014, as cited in Almahmood et al., 2017). In brief, SA residents do not have time and are uninterested in dedicating 150 min or more to PA per week, and the current built environment does not enable AT (a form of PA); thus, physical inactivity is prevalent.

In summary, since the 1970s, Saudi cities have fostered an automobile-dependent lifestyle, considerably impacting AT and its associated infrastructure. The creation of car-centric planning was not the only factor that led to the limited adoption of walking and cycling as a mode of transport in Saudi cities. Economic support that facilitated car ownership and use, hot climate, sociocultural aspects, administrative and legal issues, and public perception are additional dimensions that also contributed to current conditions (see Table 1-1). Many of those factors are shared with many cities worldwide. However, gender segregation was further discussed among those factors because it is a defining feature of the SA context. Furthermore, one of the downsides of a centralised governing system is the widespread implementation of ill-advised policies, as typified by the lack of national urban and landscape design standards that regulated the implementation of AT infrastructure before 2005. The prioritisation of cars in the planning and design of Saudi cities has direct impacts on AT safety (accidents), comfort (air and noise pollution), accessibility to daily destinations (travel time and distance), and residents' physical activity.

1.3. Greenways as contributors to sustainable transportation[2]

Greenways are key components of AT and green infrastructure; thus, their multifunctionality contributes to many sustainability and quality-of-life agendas (Ahern, 1995; EGWA, 2000; Fábos and Ryan, 2004; Hellmund and Smith, 2006; Lindsey, 2003; Lindsey et al., 2019; Shafer et al., 2000) (see Figure 1-2). The cultural trail in Indianapolis is an example that explains such contributions (see Section 1.1). Therefore, planning to increase the rate of AT (e.g., via greenways) extends beyond mobility since it contributes to the health, wealth, and sustainability of cities.

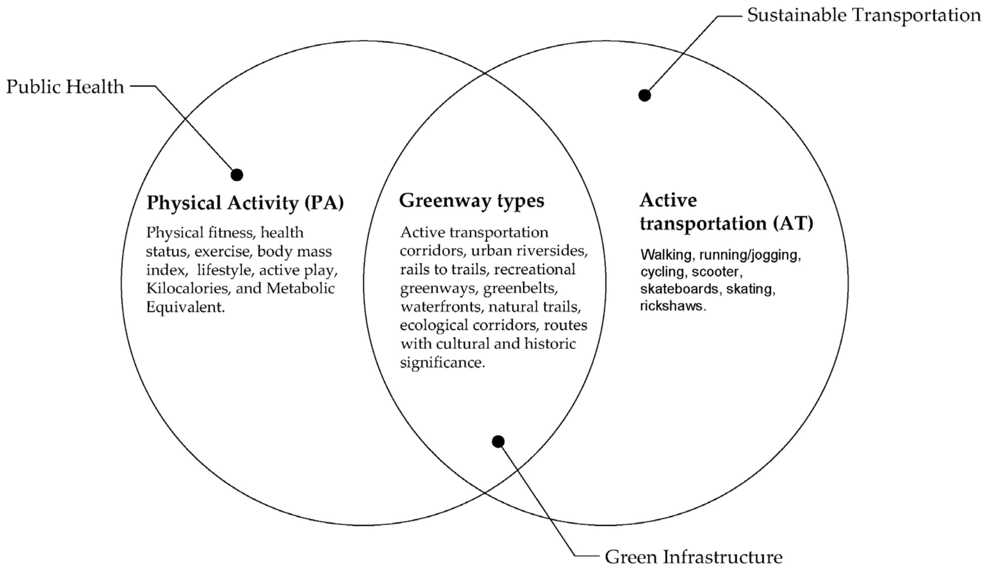


Figure 1-2. Relationship between greenway types, physical activity, and AT.

[2] Most of Section 1.3 was published in Zawawi et al. (2023) as a part of its introduction.

While acknowledging the ecological, cultural, and recreational values of greenways, their transportation value is the focus of this research. Many scholars have asserted the transportation function of greenways in their definitions (see Table 1-2). Maximising the numerous economic, public health, social, and environmental benefits of greenways is contingent upon increasing their usage (Flink, 2020). In other words, high and multifunctional greenway usage contributes to realising sustainable communities. The same principle can also be applied regarding the transportation usage of greenways. Ahern's (2003) greenway theory asserted the transportation benefit of greenways:

"Greenways are often planned and implemented to support alternative forms of transportation, particularly pedestrian and bicycle travel. The benefits of this maybe significant in terms of traffic reduction, reduced air pollutants, and a healthier population." (p.45)

Therefore, the more people rely on those mediums (i.e., greenways) to reach their daily destinations, the fewer cars on the streets, thus, healthier and more sustainable communities.

Table 1-2. Original and contemporary definitions of greenways. The underlined text shows where the transportation function of greenways was emphasised.

Source	**Definitions**
(Little, 1990)	*"… It is any natural or landscaped <u>course for pedestrian or bicycle passage</u>. An open space connector, cultural features, or historic sites with each other and with populated areas. Locally, certain strip or linear parks designated as parkway or greenbelt."*
(EGWA, 2000)	*"Greenways are <u>communication routes reserved exclusively for non-motorised journeys</u>, developed in an integrated manner which enhances both the environment and quality of life of the surrounding area."*
(Searns, 1995)	*"…The word 'way' implies movement, getting from here to there, from point to point. This is the important distinguishing feature of greenways—they are <u>routes of movement-for people</u>, for animals, for seeds, and, often, for water."*
(Shafer et al. 2000)	*"Urban greenway trails … provide places for daily recreation and <u>alternative transportation options</u> while encouraging positive face to face interaction with other people."*
(Horte and Eisenman, 2020)	*"Urban greenways are linear public parks and places that <u>facilitate active travel</u> and recreation in urban areas."*
(Turner, 2006)	*"…my 1996 definition ('a route which is good from an environmental point of view') … retains my support, for the following reasons: … making a <u>contribution to sustainable transport objectives</u> and other public goods."*
(Senes et al., 2017)	*"We know that greenways are multi-user (cyclists, pedestrians, skaters, horseback riders, etc.) and multi-purpose (<u>commuting</u>, leisure and recreation, tourism, physical activity, etc.) trails and they are likely to be influenced by different factors."*
(Lindsey et al., 2008)	*"Greenways are linear open spaces or parks … that shape urban form and <u>connect people with places</u>. Urban greenways are often designed to include multi-use trails that provide opportunities for … <u>transportation."</u>*

Many scholars argue that the ‘by-product’ of movement (the series of spaces that an individual traverses to access a location), regardless of whether initially or frequently, is more important than both the origin or destination of a travel journey to encourage pedestrian movement and support land uses (Hillier, 1996). Therefore, as more people commute via greenways (changing the pattern of movement over time), the more likely it will influence the pattern of land uses, increasing greenways’ accessibility in the process. Hence, well-planned and designed greenways can be seen as a gateway to influencing the land-use patterns that support automobile-dependent lifestyles. In conclusion, planning to increase commuters via greenways influences people’s travel behaviours and enhances the places they traverse.

To enable the transportation function of greenways, many scholars introduced several approaches to integrating them with sustainable urban mobility plans (SUMPs), including public transportation (Flink and Searns, 1993; Hendricks and Catala, 2016; Zawawi et al., 2020; Zawawi et al., 2022b). These integration opportunities stem from the overlapping agendas between greenways and SUMPs, such as enhancing livability and accessibility to live/work/play destinations. As Zawawi et al. (2020) discussed, overcoming automobile dependence via adopting SUMPs provides land reclamation opportunities at multiple levels due to reduced vehicle ownership, parking needs, and road capacity (Zawawi et al., 2020). These reclaimed lands in the form of, for instance, greenways would transform the mono-functional, abandoned, and underperforming city infrastructure into sustainable landscapes for nature and people (Zawawi et al., 2020). Simultaneously, retrofitted streets to include greenways, known as road contraction schemes (Cervero et al., 2017), contribute to (re)building a city’s green infrastructure (Austin, 2014; Hellmund & Smith, 2006), serving as a foundational layer that structure and sustain urban redevelopment (Benedict & McMahon, 2002; Nijhuis et al., 2015; Waldheim, 2016). Examples of such a project type are the Comox-Helmcken Greenway in Vancouver, Canada (Frank et al., 2019, 2021; Ngo et al., 2018), the neighbourhood greenways of Portland, Oregon (Portland Bureau of Transportation, 2021), and the transport greenways of Shenzhen, China (Liu et al., 2020). In brief, as cities reclaim more of their valuable spaces once dedicated to the automobile infrastructure due to their increasing adoption of SUMPs, greenways are posited to advance sustainability and quality of life agendas.

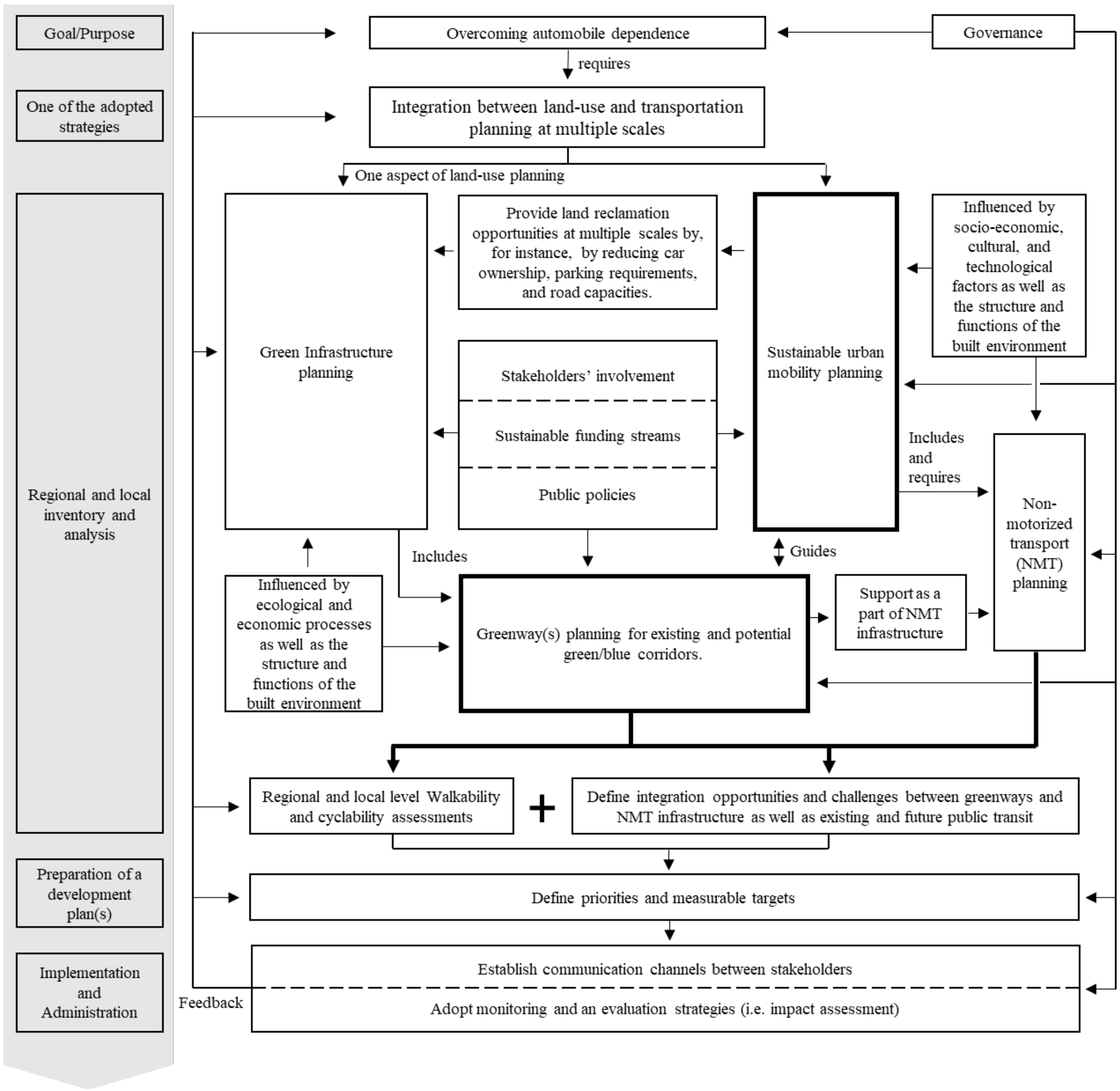


Figure 4-1. An example of an integration process between greenways and sustainable urban mobility plans (Zawawi et al., 2020).

1.4. The research gap and significance

Recent city comprehensive plans and projects (e.g., Riyadh Sports Boulevard) show that road contraction schemes[3] are a clear development direction in SA (AECOM, 2015; RCRC, 2019). The recent update to the definition and types of greenways in SA also affirms their contributions to sustainable transportation (MOMRAH, 2022b) (further discussed in Section 2.4.1). For example, AECOM's green infrastructure plan for Jeddah to 2033 identified greenways as critical to the city's sustainable urban mobility plans (AECOM, 2014). One of AECOM's key recommendations for Jeddah's green infrastructure plan stated, "*Increasing connectivity through the introduction of green streets and greenways is required to promote sustainable travel patterns*" (AECOM, 2014, p.30). Several scholars have demonstrated the value of Jeddah's LPs for physical, social, and recreational activities (Addas & Rishbeth, 2018; Addas, 2015,

[3] They are humanising auto-centric channel-ways via the incorporation of greenways (Cervero et al. 2017).

2022; Addas & Alserayhi, 2020b; Alhajaj, 2014; Almahmood et al., 2018; Al-Mosaind, 2018; Bogis, 2015; Hammadi, 1993; Maghrabi, 2019). However, to date, there has been scant research on the role of greenways as ATCs and the influences on their usage for such purposes. While much is known about greenways and AT in many parts of the world (especially North America and Europe), there has been little research in a Middle Eastern context (see Chapter Three for more information). Therefore, this PhD research helps to fill the gap in knowledge from other geographical and socio-cultural contexts by exploring the influences on the use of greenways as facilitators of AT in Saudi cities.

Simultaneously, there is a need to inform the development of existing greenways and the planning of future ones in SA. Improving pedestrian and bicycle facilities to enable active commuting is a shared goal for all Saudi cities (MOMRA, 2019a). Furthermore, one of Al-Mosaind's (2018) conclusions also reflected such a need, which critiqued how recent projects that retrofitted existing streets in Riyadh to include a walkway lack a transportation dimension. In short, strategies are needed to direct the (re)development of greenways in Saudi cities to extend their contributions to SUMPs.

While most existing literature and urban design manuals in Saudi cities about enabling AT primarily emphasise improvements to pedestrian and bicycle facilities (Addas & Alserayhi, 2020b; Al-Mosaind, 2018; MoMRA, 2019a; The High Commission for the Development of Arriyadh, 2014), they tend to overlook crucial interconnections between sociocultural, personal, economic, and environmental factors influencing AT adoption (see Section 4.4 for more information about those factors). Despite the acknowledged significance of barriers related to the built environment in Saudi cities, an important question arises: can providing physical AT networks alone catalyse a substantial cultural shift towards sustainable travel patterns? This query prompts an exploration beyond conventional boundaries, aiming to deeply understand the complex interplay of diverse factors impeding the adoption of sustainable travel patterns in SA. Therefore, this thesis adopts a holistic approach to exploring the barriers to and strategies for activating greenways as ATCs in Saudi cities (see Section 5.2 for more information). In doing so, this PhD research seeks to make scholarly contributions to diverse disciplines, particularly landscape architecture, transportation studies, and sociology. Addressing this research gap responds directly to Aljoufie's (2017) conclusion regarding the necessity to explore the challenges surrounding bicycle usage in Jeddah and planning for its infrastructure.

1.5. Research objective and questions

The primary objective of this PhD research is to explore the barriers to and strategies for activating greenways' function as facilitators of AT in SA, using Jeddah city as a case study. Therefore, the study enhances understanding the influences on greenways' usage as ATCs. Simultaneously, it informs the development of existing greenways and the planning of future ones. Ultimately, outcomes of this PhD research would accelerate the transition towards sustainable transportation in Saudi cities, which is part of the country's QoL program goals.

To achieve such an objective, the following research questions (RQ) are pursued:

RQ1. What is the state of knowledge concerning the planning and usage of AT and greenways in SA?

RQ2. While relating to the urban and open space planning in Saudi cities, how did the forms and functions of greenways evolve internationally?

RO3. Where, when, and for whom would greenways be considered routes for daily commutes?

RQ4. What are the impediments to activating greenways as facilitators of AT in Jeddah city?

RQ5. While contextualising the barriers identified across the thesis, how can the AT function of greenways in Jeddah city be activated?

Answering RQ1 concerns reviewing the current understanding of the planning and usage of AT and greenways in SA. Doing so provides context about the topic, avoids research duplication, and identifies patterns, gaps in literature, and potential research opportunities. Exploring the planning and usage of greenways included a focus on sociocultural factors since it is, as stated by Almahmood et al. (2017) and Maneval (2019), a differentiating aspect compared to many societies worldwide. The response to RQ1 is in Chapter Two.

Answering RQ2 concerns reviewing greenways' evolution to explain the events that impacted their forms and functions, especially as ATCs. Furthermore, the chronological review relates the international evolution of greenways to urban and open space planning in Saudi cities, which is unprecedented in this field. Doing so could reveal untapped opportunities or lessons to build upon/inform current development directions of greenways in SA. Simultaneously, answering RQ2 identifies the scope of greenways as a spatial type, which is essential when determining what to assess in the Saudi context. The response to RQ2 is in Chapter Three.

Answering RQ3 concerns identifying and analysing the influences on greenways' usage as ATCs internationally via a systematic literature review. The systematic review's outcomes would help build a conceptual framework that illustrates the relationship between various factors and explains how this PhD research would contribute to existing theories. Careful, contextualised consideration of those factors can inform their planning, design, and management of greenways to maximise their potential. Furthermore, it would strengthen the foundation of knowledge about the AT function of greenways, enhance the accessibility of available evidence to decision-makers, and identify knowledge gaps in this field. The response to RQ3 is in Chapter Four.

Answering RQ4 concerns understanding the barriers to activating greenways as facilitators of AT in Jeddah city, which includes examining the physical environments, preferences and opinions of users and non-users. Doing so necessitates using mixed research methods that can effectively capture the complexities of such impediments and how they relate to one another (see Chapter Five for the research methodology). The response to RQ4 is in Chapters Six to Eight.

Answering RQ5 concerns exploring strategies to activate greenways as facilitators of AT in Jeddah city in light of the barriers identified across the thesis. These strategies will result from synthesising research findings and relating them to existing literature and global best practices. Discussing those strategies could be a way to build upon/inform existing practices in planning and managing greenways. The same applies to behavioural change theories that build an understanding of influences on routine travel choices. The response to RQ5 is in Chapter Nine.

1.6. The rationale for selecting Jeddah city as a case study

Problems related to AT and greenways are prevalent in many Saudi cities, and Jeddah is one of them (see Section 1.2). Such a phenomenon was not a coincidence because MOMRA, a central governmental organization, is legally entrusted with Saudi cities' urban planning and regulation (MOMRA and UN-Habitat, 2019a). Municipalities in every Saudi city, including Jeddah, function entirely as the MOMRA's executors. The top-down approach to developing and managing Saudi cities is also reflected in MOMRA's centralized budgetary system. For example, Jeddah is "*reliant on funding allocation from MoMRA, through the sole fiscal resource of annual line item budgeting.*" (MOMRA and UN-Habitat, 2019a, p.32). As a result, Mandeli (2011) found that many Saudi cities share similar open space and urban planning characteristics. Therefore, selecting Jeddah as a case study would offer relevant insights into other Saudi cities.

However, Jeddah's cultural diversity and historical significance as a gateway to Mecca infuse the city with a unique socio-cultural fabric. This diversity impacts how residents use and perceive urban spaces (Addas and Rishbeth, 2018), offering a rich context for studying the intersection of urban planning, cultural practices, and public space usage. Another characteristic of Jeddah city is that it serves as a major commercial hub and is one of the most populous cities in SA (MoMRA and UN-Habitat, 2019a). These conditions present numerous urban challenges (see Sections 1.2 and Chapter Two), making Jeddah an ideal case to explore impediments to and strategies for extending greenways' contributions to sustainable transportation and liveability agendas in Saudi cities.

In addition, substantial urban regeneration and public transportation projects (e.g., Central Jeddah Project and Jeddah Metro Project) are underway in Jeddah city (see Section 2.1.1). One common development trend in Jeddah during the past decade is the implementation of several walkways/LPs (see Section 5.4 for more information). Since the transportation function of greenways is largely influenced by the context in which they exist, this PhD research presents a timely opportunity to inform planning initiatives, especially as Jeddah navigates through a phase of significant urban renewal.

Lastly, practical reasons also played a role in selecting Jeddah as a case study. Data accessibility in Jeddah, owing to the researcher's established connections with local government bodies and communities through his lecturing role at King Abdulaziz University, offers an unparalleled depth of insight. Moreover, selecting a case study other than Jeddah adds considerable financial expenses (e.g., accommodation and travel) and risks due to COVID-19. For these reasons, Jeddah was selected as a case study for this PhD research.

1.7. Research organisation

This thesis has Ten chapters. Chapter One introduced background information about the study and key terms. Moreover, the research problems, primary objective, and questions have been explained, and the significance argued. Chapter two explores the state of existing knowledge about greenways and AT in Saudi cities to identify patterns and gaps in literature and potential research opportunities. Chapter Three builds an understanding of the sequence of events that influenced the evolution of greenways' forms and functions internationally, especially as ATCs. Simultaneously, the chronological review relates such sequence to the urban and open space planning in Saudi cities to explain the areas in which SA's greenways differ from their international counterparts. Doing so could identify unrealised potentials or lessons that improve or guide the ongoing development of greenways in SA.

Chapter Four presents the conceptual framework based on behavioural change theories and models and the systematic review results that identify, evaluate, and synthesise the influences on greenways' usage as ATCs. Simultaneously, the outcomes of such a review would clarify the state of existing literature, identify knowledge gaps, strengthen its knowledge base, and enhance the accessibility of available evidence to decision-makers. Chapter Five presents the research methodology, which is informed by the conclusions of Chapters Two to Four. Furthermore, Chapter Five explains the research design, scope of work, data collection methods, analysis, and synthesis.

Chapter Six is the first of three findings Chapters. It assesses the physical environment at three levels. These are the city, neighbourhood, and site levels to explore the activation barriers of walkways/LPs' function as facilitators of AT in Jeddah city. Chapter Seven serves the same purpose but focuses on residents' opinions and preferences about greenways as routes for daily commutes in Jeddah city using AT modes. Based on the feedback of interviewed experts, Chapter Eight explains the underlying causes of existing conditions regarding Jeddah's greenways. Analysis of experts' feedback also encompasses their recommendations to address many of the identified impediments.

Chapter Nine discusses the research findings to primarily explore strategies to activate Jeddah's greenways as ATCs in light of the identified barriers in the thesis. These strategies are based on the interviewed experts' recommendations, existing literature, and global best practices. The thesis concludes in Chapter Ten with a summary of research findings, contributions to knowledge, limitations, and future research opportunities. Figure 1-3 illustrates the research process, outlining the series of steps discussed in this Section.

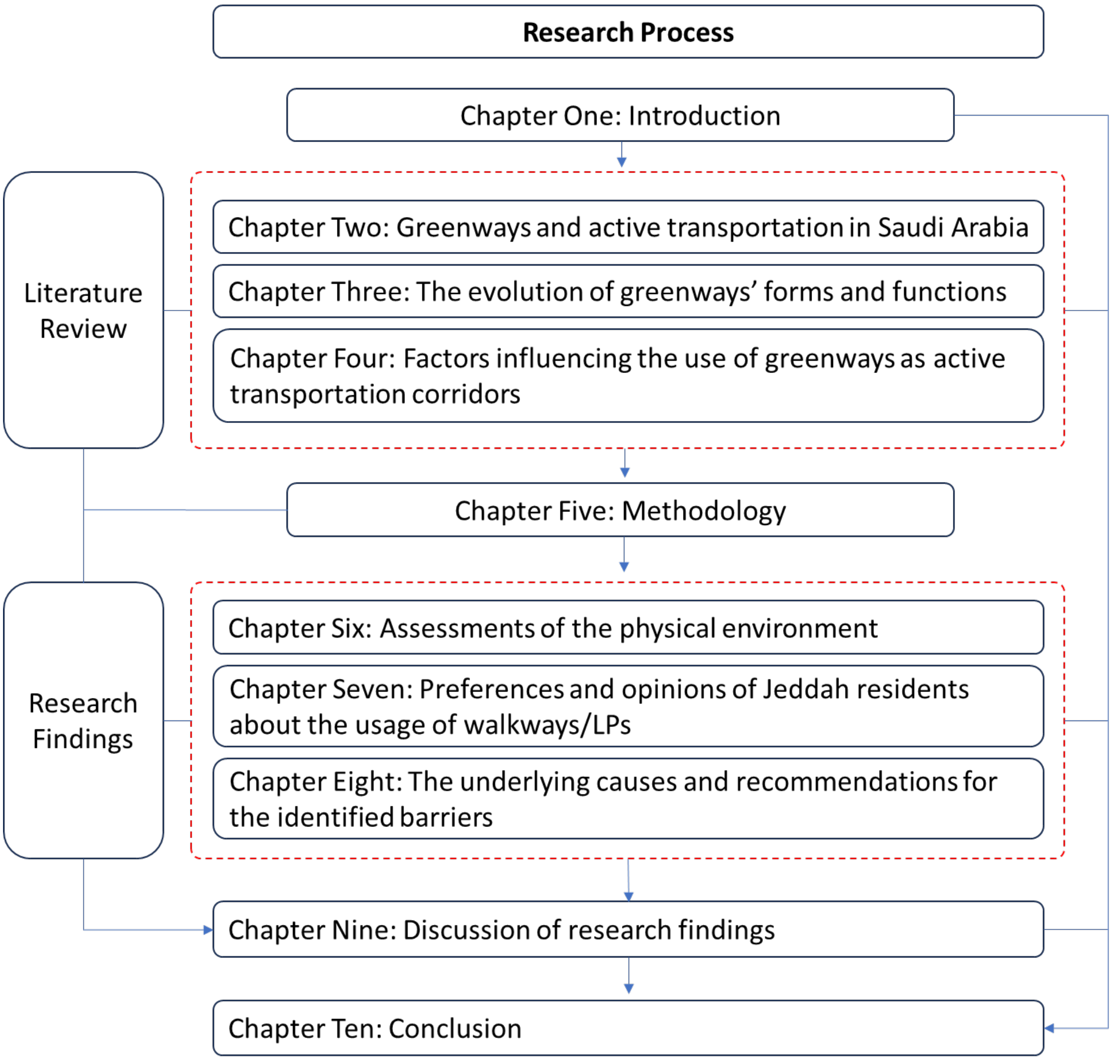


Figure 1-3. The PhD research process.

CHAPTER TWO

GREENWAYS AND ACTIVE TRANSPORTATION IN SAUDI ARABIA

2. Chapter Two: Greenways and Active Transportation in Saudi Arabia

This Chapter aims to review the state of knowledge concerning greenways and AT in SA to identify patterns and gaps in the literature and future research opportunities. In the beginning, Section 2.1 presents an overview of the context of SA, focusing on Jeddah city since it was chosen as a case study for this PhD thesis (see Section 5.4 for more details). The overview encompasses the study area's environmental, demographic, economic, and urban development context.

Section 2.2 explores the current understanding of AT, which continues what has been discussed in Section 1.2[4]. Furthermore, Section 2.2 was divided into three Sections (2.2.1 to 2.2.3) to organise the review of existing literature: factors at the city, neighbourhood, and site levels. Next, since sociocultural influences on the usage of public urban spaces (e.g., greenways) in SA is a differentiating factor compared to many societies worldwide (Almahmood et al., 2017; Maneval, 2019), Section 2.3 focuses on it. Chapter Two closes with Section 2.4, which shifts attention to greenways in SA: their definitions, types, usage, and challenges.

2.1. The context of the study area

SA is the fifth largest country in Asia and the largest in the Arabian Peninsula, with an area of 2.1M km². SA is a country that upholds Islamic law. It is a country located in the southwest of Asia with a population of 34.1M as of mid-2021. Population growth is expected to reach 45M by 2050. The percentage of Saudis and non-Saudis is 63.6% and 36.4%, respectively (General Authority for Statistics, 2021). The same source also noted that the total population is 58.6% male and 43.2% female. However, such a percentage difference is attributed to non-Saudi males (for Saudis only, it is somewhat balanced). Regarding age, 48.1% of the total population is younger than 30 years, and 68% are younger than 40 years as of mid-2021 (General Authority for Statistics, 2021).

One of the strongest demographic trends in SA is the number of women with university-level degrees. Between 1994 and 2017, the number of women with a bachelor's degree increased by 950% (World Bank, 2017a; GaStat, KSA, 2017, as cited in MOMRA and UN-Habitat, 2019c). The employment survey of 1.72M Saudis in 2017 revealed that nearly 30% were Saudi women, which aligns with the Saudi 2030 Vision of localising jobs, increasing women's participation in the labour market, and replacing foreign employees (The General Authority for Statistics, 2017b). However, these trends increased traffic congestion and demand on transport infrastructure, especially after June 2018, when women were permitted to drive automobiles in SA (Al-Tayyar and Al Dabbagh, 2021; Turak, 2019).

The automobile-centric planning of Saudi cities places tremendous financial pressure on residents, especially non-Saudi workers. The average monthly salary for Saudis is 7,372 SAR, and for non-Saudis, it is 2,731 SAR (total surveyed 6.9M) (The

[4] Section 1.2 explained when and why walking and cycling for transportation significantly decreased in Saudi cities. It also explained the impact of automobile-centric environments on AT in SA.

General Authority for Statistics, 2017b). The same source also showed that the monthly average salary disparity was also found between Saudi men (8,388 SAR) and women (4,939 SAR), which is higher for men by 51.7% (total surveyed 1.72M). According to the General Authority for Statistics (2018), the average household monthly expenditure on transportation is 1,532 SAR, which financially pressures low-income individuals/groups who cannot afford a car. For example, 10.5% of households in Jeddah city do not have a car (Jeddah Municipality, 2004, as cited in Aljoufie, 2014b). Therefore, automobile-dependent urban planning of Saudi cities limits equal access to public services and opportunities.

In 2020, people who live in urban areas represented 84.3% of the total SA population, and such a trend is expected to grow (MOMRA and UN-Habitat, 2019c). However, 55% of the total urban population is concentrated in major cities: Riyadh, Jeddah, Makkah, Madinah and Dammam (see Figure 2-1). The urban boundary and population of these cities grew rapidly as a result. A major contributor to urban sprawl is the percentage of vacant lands. For instance, in Jeddah city, it represents 29.5% of Jeddah's built-up area (Moreno and Murguía, 2015). Therefore, urban densification is the planned route to accommodate future population and urbanisation growth within these cities (MOMRA and UN-Habitat, 2019c).

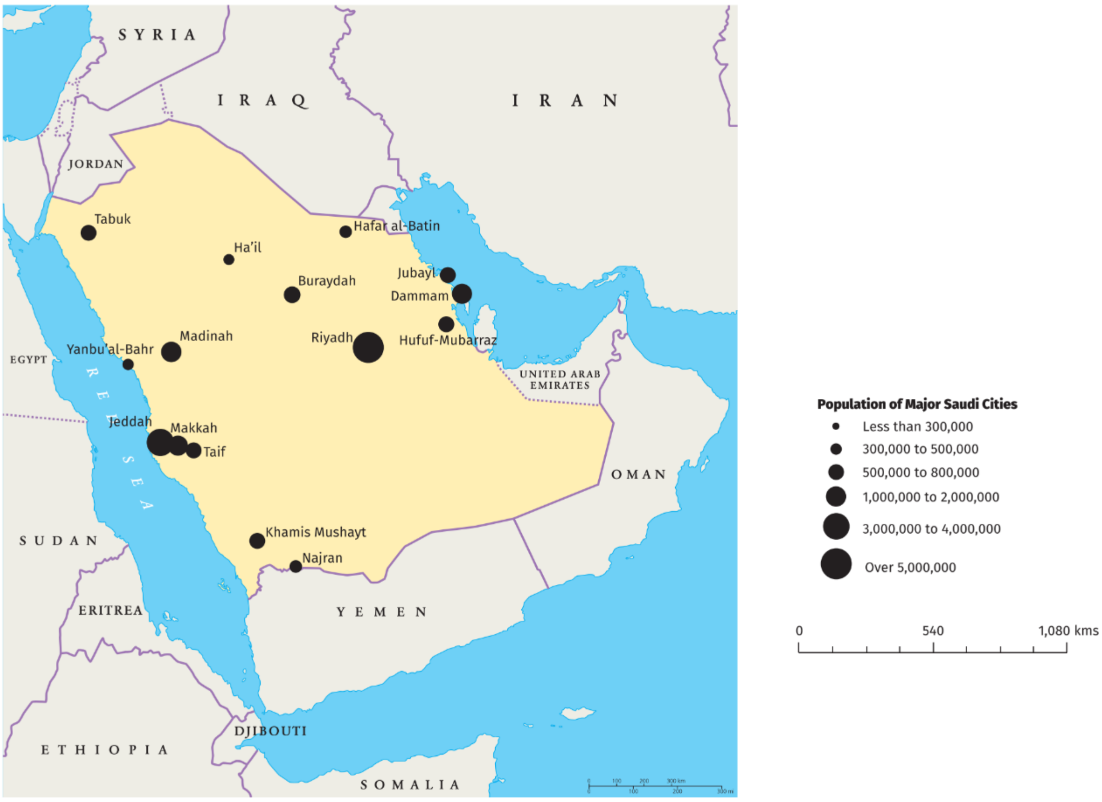


Figure 2-1. Distribution of Saudi Arabia's population (United Nations, 2018a, as cited in MOMRA and UN-Habitat, 2019c).

2.1.1. Jeddah city

Since Jeddah City was selected as a case study (see Section 1.6 for the reasons), this Section overviews Jeddah's environmental, demographic, economic, and urban development context. Jeddah, a tropical hot, arid region located west of Saudi Arabia, is the country's economic and tourism capital (See Figure 2-1). Due to Jeddah's geographical location (21.54°N; 39.7°E), it is a hot, humid climate region (Hegazy and Qurnfulah, 2020). Jeddah's maximum temperature exceeds 32°C from April until November, which is when Gobster et al. (2017) recorded a sharp drop in greenways' usage in Chicago, Illinois. Similarly, Heng and Chow (2019) also found from a study within a large Singapore urban park that acceptable temperatures range between 21.6 and 31.6°C. Furthermore, Jeddah's temperatures typically exceed 35°C, especially during the summer season up to 52°C, a national record-breaking in June 2010 (Almazroui et al., 2012). Nonetheless, low temperatures range from 21°C to 30°C, which explains why outdoor activities in Jeddah peak in the evening (Addas, 2015). The mean annual precipitation level is 51.2 mm (Almazroui et al., 2012). However, in January 2011, the Department of Meteorology at KAU recorded an extreme rainfall event of 111 mm within four hours. As for humidity, from June to November, it mostly exceeds 60% (Hegazy and Qurnfulah, 2020), which is considered uncomfortable (The Engineering ToolBox, 2005). Overall, the weather in Jeddah city, especially during summer, is a considerable challenge.

Jeddah is the second largest city in SA, situated in the centre of the Red Sea's eastern shore, in the Tihamah region of the Hejaz. Its history dates back to 500 BC as a fishing town before Islam (Al-Shahrani, 1992; Abdu et al., 2002; Bagader, 2014; Baesse, 2012). Furthermore, it is the gateway for pilgrimages (2-4 million annually) to the holy Islamic cities of Mecca and Medina (Mandeli, 2011). Pilgrimage travellers (Hajj and Umrah) generate significant demand for consumer products, construction supplies, hotel rooms, and administrative and technical services, greatly enhancing the city's business sector and boosting its overall wealth (MOMRA and UN-Habitat, 2019b).

Nonetheless, Jeddah's economic prosperity is not reliant on accommodating pilgrimage travellers' needs. Jeddah's port connects trade between Europe and the sub-continent of India, which exemplifies the city's global significance (Mandeli, 2011). It also has important industrial hubs for heavy manufacturing, construction materials, and seawater desalination (MOMRA and UN-Habitat, 2019b). Another key attribute to the city's unique position globally and regionally is its rich history and culture. For example, in 2014, UNESCO registered historic Jeddah (Al Balad) as a World Heritage Site, providing it with further tourism opportunities (UNESCO, 2014). Additionally, in the past decade, public funding, government initiatives, and private investment in the city's booming economy dramatically increased Jeddah's pace of urban development. In short, given Jeddah's strategic location and rich culture, its importance is global.

In the 1940s, Jeddah's urban population and urbanisation in Jeddah city grew exponentially. It all began with the discovery of the largest source of petroleum worldwide in SA in March 1938. It was the foundation of SA's prosperity. The wall surrounding the city limits was demolished in 1947 to accommodate such growth (Abdu et al., 2002; Mandeli, 2011). Moreover, the population of Jeddah grew from 30,000 in 1948 (Al-Shahrani, 1992, 70; Sobaihi, 1995; Mandeli, 2011) to 381,000 people in 1970, to 2,560,000 in 2002 (Aljoufie et al., 2013). The substantial population growth was mainly due to the influx of migrants, employment opportunities, and high wages (Abdu et al., 2002).

In 2017, Jeddah's population exceeded 4 million people, with an annual population growth rate of 3.2% (MOMRA and UN-Habitat, 2019a). In addition, 41% of Jeddah's population is younger than 24 years old, and half is under 30 years old (MOMRA and UN-Habitat, 2019a). The gender ratio of male to female is estimated at 1.27, and non-Saudi nationals represent 40% of the total population (MOMRA and UN-Habitat, 2019b).

As for urbanisation, the city expanded from 1.8 km² in 1945 (Abdu et al., 2002) to 188.4 km² in 1970, 407.3 km² in 1993, 541.7 km² in 2007 (Aljoufie et al., 2013). In 2017, Jeddah's urban area was approximately 846.5 km² (MoMRA and UN-Habitat, 2019b) (see Figure 2-2). This was due to the low-density growth pattern that dominated most of the city (50 people per hectare) (Moreno and Murguía, 2015; Sobaihi, 1995). The urban sprawl was caused by (I) unplanned urban extensions from Historic Jeddah, (II) large immigrations, (III) migrants' previous lifestyles, (IV) poor urban planning, (V) vacant lands, (VI) lack of government funds, (VII) the coincide of a sharp rise in housing costs with a decline in earnings, (VIII) Jeddah municipality's weak enforcement of development control, and (IX) the long bureaucratic procedures of a centralised, top-down approach to governance (Abdu et al., 2002; Gadou and Quazi, 2009; Mandeli, 2011; Moreno and Murguía, 2015; Mortada, 2017).

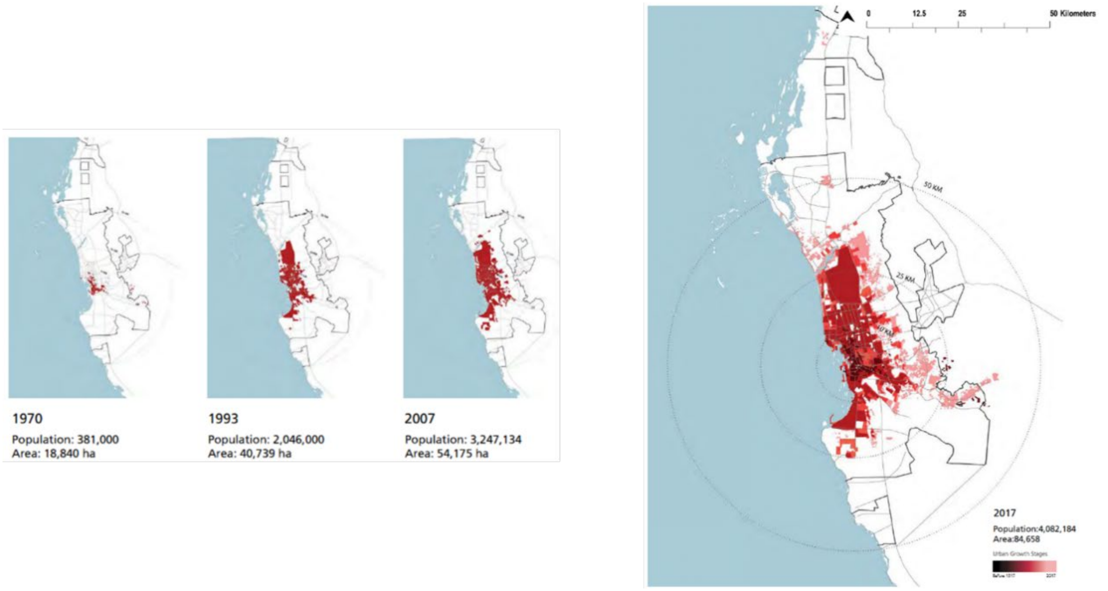


Figure 2-2. Population and urbanisation growth in Jeddah city (adapted from MOMRA and UN-Habitat, 2019a).

The rapid and sprawled urban development affected how people moved throughout the city. As a result, more and more people opted to purchase a motor vehicle as a mode of transport (Aljoufie et al., 2013). Moreover, a space syntax analysis (segment-angular) at a citywide scale identified critical urban challenges, such as the historic core's isolation, absence of a defined city centre, northward shift in urban focus, uneven urban expansion, negative impacts from large undeveloped central sites, and the segregation of rapidly deteriorating unplanned settlements (Karimi et al., 2007; Karimi, 2012). In 2022, Jeddah's urban renewal project (ongoing) partially resulted in the demolition of 18.5 km² of unplanned settlements to improve residents' quality of life (see Figure 2-3) (Radwan, 2022). Urban regeneration of Jeddah city also includes ongoing projects such as Jeddah Central Development (area of 5.7 km²), Jeddah Metro Project, and Jeddah Historical Rejuvenation Project, all of which to achieve the Saudi Vision 2030, especially its quality-of-life program ("Quality of Life Program," 2018). These developments and interventions signify a comprehensive effort to revitalize Jeddah's urban landscape, aligning with the Saudi Vision 2030 goals to enhance the quality of life and address the city's historical and contemporary urban challenges.

Figure 2-3. Part of Jeddah's urban renewal progress (Radwan, 2022).

2.2. Active transportation in Saudi cities

Factors impacting routine active travel choices are multidimensional (Alfonzo, 2005; Panter et al., 2008; Rodríguez et al., 2015; Saelens et al., 2003; Sallis et al., 2006). To organise the review of existing literature, this Section is divided into three parts. Each Section (2.2.1 to 2.2.3) discusses different factors (e.g., public transportation), yet all are linked to one another. Furthermore, many authors linked AT to walkability and bikeability of the built environment at different scales (citywide to site level), which refers to the ability to safely, comfortably, and enjoyably walk or cycle (Speck, 2012; Nielsen and Skov-Petersen, 2018). Overall, the following Sections explore the state of existing literature about AT at each level in SA.

2.2.1. Factors at the city level

At the city level, pedestrian and bicycle infrastructure support but do not replace public transportation. In addition to considering density and mixed-use development, an integrated transportation system is a crucial element in overcoming automobile dependence (Newman and Kenworthy, 1999, 2015). Most major Saudi cities (i.e., Jeddah, Riyadh, Mecca, Medinah, and Dammam) are building their public transportation system (MOMRA and UN-Habitat, 2019c). However, the Metro and BRT Network have yet to begin construction except for Riyadh's bus network, which is planned to begin operation by March of 2023 (Saudi Gazette report, 2023). The same source also stated that Riyadh's Metro is planned to operate by the end of 2023.

All public transportation plans in major Saudi cities follow TOD principles (see ITDP, 2017, for example), strategically linking primary and secondary TOD nodes (MOMRA and UN-Habitat, 2019a, 2019d, 2019e, 2019f, 2019g). Identifying those nodes considered existing conditions and future growth/development plans. Furthermore, as stated in these reports, the development of these areas/nodes includes densification, mixing of land and building uses, offering a variety of housing prices and tenures, and improving bicycle and pedestrian infrastructure (see Figure 2-4). Moreover, the Bus Rapid Transit (BRT) network intersects the TOD nodes but covers additional areas within cities. The last pattern in the reported action plans of The Future Saudi Cities Programme, developed in collaboration between MOMRA and UN-Habitat, is the protection, improvement, and connection of green and blue infrastructure (MOMRA and UN-Habitat, 2019a, 2019d, 2019e, 2019f, 2019g). These green and blue networks are partially planned to promote active travel and enable first-and-last-mile mobility, especially to/from public transit stations/stops. With that in mind, the underlying issues of implementing those transit plans vary considerably due to the differences in the physiographic, biological, planning, cultural, and historical contexts among Saudi cities.

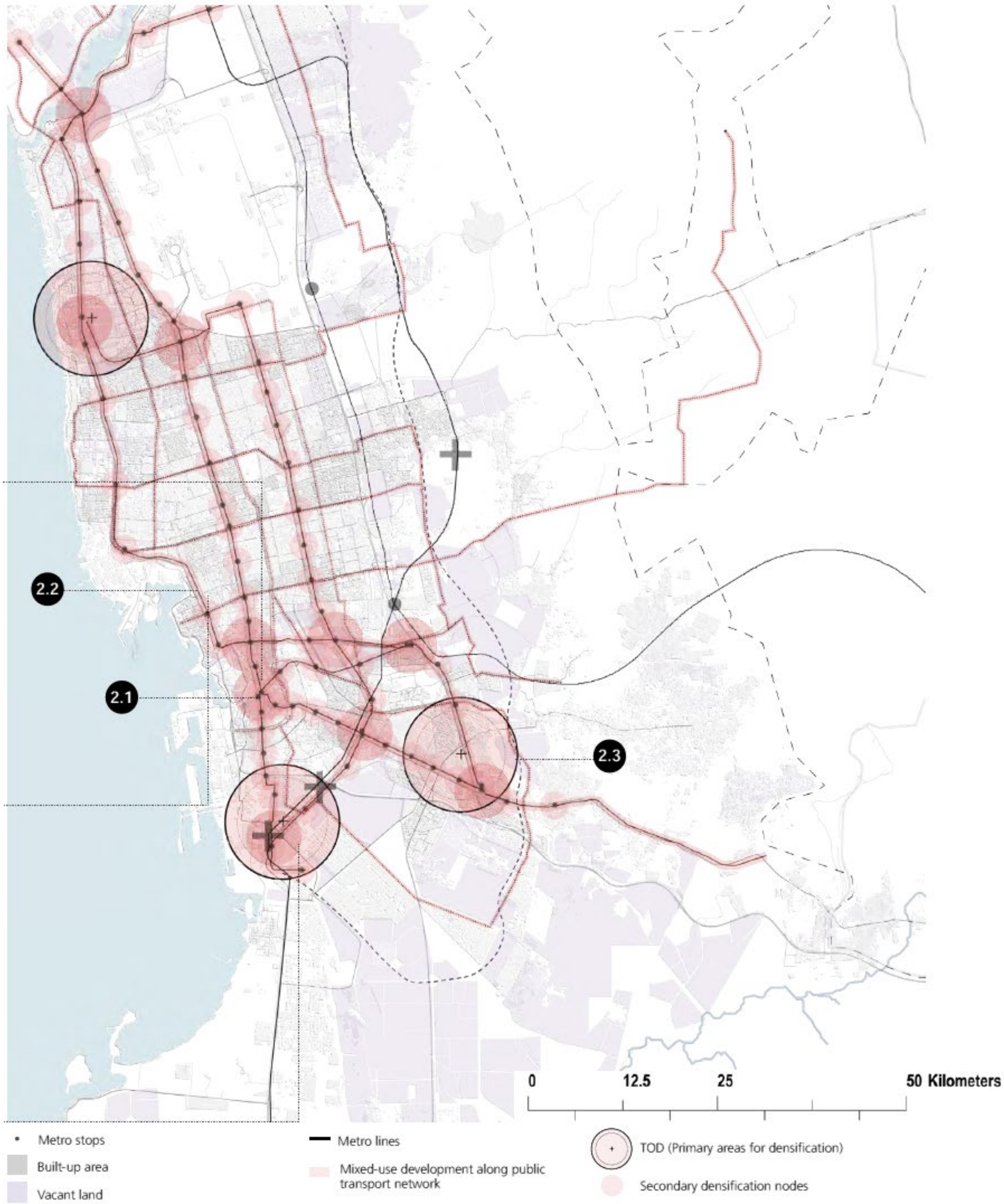


Figure 2-4. This plan illustrates adopting the TOD strategy in Jeddah city (MoMRA and UN-Habitat, 2019a).

Even though there were considerable investments in public transit systems in major Saudi cities ("Towards Saudi Arabia's Sustainable Tomorrow," 2018), these efforts were paralleled by increasing road capacities and building new roads, tunnels, and bridges that induce traffic demand. Jeff Speck (2012) described induced demand as a phenomenon that encourages more drivers, increases vehicle miles travelled, and worsens traffic congestion due to increasing the supply of roadways. For instance, although the redevelopment of King Abdullah Road in Riyadh transforms it into a multimodal freeway, The Royal Commission for Riyadh City also plans to increase its road capacity from 190,000 to 520,000 vehicles/day (RCRC, n.d.). Similar projects are found in Jeddah city but without implementing a rapid mass public transportation system (as of Oct 2023). For example, since 2011, the Jeddah municipality has constructed 29 underpasses, bridges, and tunnels that transformed arterial roads into freeways as measures to relieve the city's traffic congestion (Al-Salmi, 2019). Despite those hefty investments (Billions of dollars), Saudi cities are still suffering from traffic congestion (Gately et al., 2013, OICA, 2017, Alpen Capital Limited, 2016, as cited in MoMRA and UN-Habitat, 2019c; "Towards Saudi Arabia's sustainable tomorrow," 2018). These urban ills have exacerbated the failure to control urban sprawl. For instance, between 2009 and 2021, Jeddah City grew by 20% despite the lack of road and utility infrastructure (Shawly, 2022). In short, the transportation development strategies of several Saudi cities in the past decade have perpetuated their automobile-dependent lifestyle, thus hindering a faster adoption of sustainable transport in the future.

With a focus on Jeddah as a case study, aside from the regional highspeed Railway line that connects Makkah to Madinah with two major stations in Jeddah and one in King Abdullah Economic City (KAEC), Jeddah's public transportation plans are still at the planning stage (Shawly, 2022). Therefore, as of October 2023, Jeddah City still relies on its inaccessible bus network, operated by the service lines of SAPTCO and unregulated coaster buses (Aljoufie, 2014b). In a press release published in 2015 by Arcadis, an Engineering company, public transport in Jeddah city (i.e., buses) is only accessible to 12% of the population within a ten-minute walk (Arcadis, 2015). Furthermore, social exclusion of the existing bus network in Jeddah puts a financial burden on low to medium-income groups, representing 49% of the city's population (Jeddah Municipality, 2004, as cited in Aljoufie, 2014b). Moreover, according to Hassan Shawly (2022),

"The performance of buses did not change and did not constitute any milestone in reducing reliance on private vehicles. Indeed, allowing women to drive for the first time in the Kingdom of Saudi Arabia put more pressure on road network performance and significantly increased car ownership." (p.19)

Therefore, the planned actions to reduce automobile dependence via public transportation in Jeddah city have yet to start, a major walkability barrier at the city level.

The Municipality implemented the densification policy (i.e., increasing the height of existing buildings) from 2007 until 2014, a main element of a TOD, in 75% of residential areas, resulting in adverse social, economic, and environmental impacts (Aljoufie, 2021; Shawly, 2022). For instance, Aljoufie (2021) found via Pearson correlation, paired t-test, and bootstrap for paired samples test a considerable impact on transport infrastructure; specifically, $\cong$ a 20% decrease in road density, 100-133% increase in parking spaces and estimated trip production in three residential districts in Jeddah city. Aljoufie's results show that parked and moving vehicles dominate residential district streets. These highly contested spaces (i.e., streets) leave no room for pedestrian and bicycle infrastructure. Therefore, their provision strategy in Saudi cities, as mentioned in Riyadh's Metro Urban Design and Street Manual, could be considered conservative.

"Future cycling demand is still difficult to estimate. Providing dedicated cycle paths may therefore result in an overprovision for cyclists and loss of space for other functions and activities. It is consequently more appropriate to combine cycle paths with pedestrian walkway, giving most flexibility for the future. Combined paths also allow for future modes of aided personal movement, such as Segways. The typical cyclist in KSA is relatively slow (i.e. heat) and integrates well with pedestrian movements." (The High Commission for the Development of Arriyadh, 2014, p.93)

MOMRA's Built Environment Design Manual and National Urban Design Guidelines contradict such a conservative vision/plan towards bicycle infrastructure. Those manuals require dedicated bicycle lanes for street widths of 20-40m (i.e., collector roads) or wider (MOMRA, 2019a; MOMRAH, 2022a). Therefore, as evidenced by the citywide implementation of the densification policy experience, contextualised planning (i.e., tailored approaches for every district) could prevent unintended consequences despite being resource-intensive.

Densification in parts of Jeddah's residential districts was not strategically integrated with urban plans that promote the mixing of land and building uses and zoning regulations, which are another crucial element of TODs (Aljoufie, 2021; Shawly, 2022). According to Shawly (2022), the above-mentioned urban ills created unattractive environments that discouraged investments in mixed-use real-estate developments within the densified residential districts. Therefore, the fragmented and asynchronous actions towards achieving the TOD goals in Jeddah city caused various deleterious effects.

On another note, in 2015, the UN-Habitat published a report that analysed the street connectivity for 17 Saudi cities, calculating the average share of land used by streets, the length of streets and the number of intersections per 10-hectare sample points (Moreno and Murguía, 2015). The authors semi-randomly selected the sample of locales in an urban area using the Halton sequence of coordinates. Their results showed that Jeddah is among 12 cities with a moderate connectivity index (high is above 80, moderate is 60-80, and low is below 60). Specifically, Jeddah has a good intersection density (100 points), relatively medium values in land allocated to streets (69 points), and poor street density (43 points).

Moreno and Murguía (2015) results were also disaggregated based on seven typologies grouped by residential and non-residential land types. For example, results showed that the street density of atomistic developments in Jeddah city (44 km/km^2) is double those recommended by UN-Habitat (20 km/km^2) (Moreno and Murguía, 2015). The same applies to the intersection density of atomistic areas in Jeddah. Contrastingly, the weighted average of land allocated to streets (19.73%, the recommended minimum is 30%), street density (10.23 km/km^2, recommended minimum is 20 km/km^2), and intersection densities (58.54 #/km2, recommended minimum is 100-140 #/km2) of non-residential areas in Jeddah is below the UN-Habitat recommended values. Even though Moreno and Murguía's (2015) comprehensive and detailed understanding of the physical layout of Saudi cities has several benefits and applications, studying street connectivity to a greenway examines the adjacent neighbourhoods, which include varying relationships and combinations of land uses and residential development patterns. Therefore, a purposive (rather than semi-random) examination of locales may yield different results compared to the citywide analysis, which initiates a much more specific discussion on ways to address those street connectivity barriers.

2.2.2. Factors at the neighbourhood level

At the neighbourhood level, walkability has been a subject of interest to several scholars in SA, especially in the past few years (AlQahtany et al., 2021; AlShareef and Aljoufie, 2020; Alhajaj, 2014; Fatani et al., 2019; Habibullah et al., 2022; Rahman and Nahiduzzaman, 2019). Despite the similarities in their intent, the geographical region, location(s) within the city, methodologies, and examined factors were different; thus, their results and conclusions shared unique insights about the walkability of Saudi neighbourhoods.

Several neighborhoodlike walkability studies stressed the inadequacy of pedestrian infrastructures in their results as a major deterrent to walking in Saudi cities (Alhajaj, 2014; AlQahtany et al., 2021; AlShareef and Aljoufie, 2020; Rahman and Nahiduzzaman, 2019). For example, AlShareef and Aljoufie (2020) found that criteria related to the physical environment were the top five elements that defined a walkable neighbourhood in Jeddah city. All the referenced studies (first sentence) reaffirmed the same conclusion, stressing that sidewalks' availability, safety, and condition were poor and a major barrier affecting residents' willingness to actively commute to daily destinations within neighbourhoods. However, most were based on data collected via questionnaires.

Only three studies quantified the size and extent of those problems via field observations and mapping (Alhajaj, 2014; AlQahtany et al., 2021; Rahman and Nahiduzzaman, 2019). Scholars of all three studies disaggregated their analysis of sidewalk conditions differently. However, only AlQahtany et al. (2021) adopted an assessment framework using the MAPPA (Marchabilité pour les personnes âgées) audit tool, which defined and specified sidewalk safety and comfort variations and measurements. Nonetheless, AlQahtany et al. (2021) omitted important sidewalk safety elements such as curb ramps, suggesting that they primarily concern older people. Such an omission contradicts global standards (e.g., Americans with Disabilities Act 1990 and the Disability Discrimination Act 1995 in the UK) that require the provision of accessible curb ramps (NACTO, 2013). Beneficiaries from their availability also include pedestrians with strollers, a pram for babies, pushers of carts or hand trucks, and anyone riding a scooter, bicycle, roller skates, or skateboard. Thus, future studies using the MAPPA should adapt the version used by AlQahtany et al.

(2021). Aside from the fixed sidewalk elements, driver's behaviours, i.e., parking on the pavement, was an observed pattern that affected sidewalks' usability (Rahman and Nahiduzzaman, 2019). In short, several studies emphasised the importance of addressing issues related to the inadequacy of sidewalks within residential neighbourhoods in Saudi cities. However, none quantified the size and extent of those issues using an assessment framework or environmental auditing tools in regions other than the eastern cities of SA.

Research evidenced that the proximity, accessibility, and density of facilities and amenities in urban areas influence the propensity of walking (Humpel, 2002; Saelens and Handy, 2008; Handy et al., 2002; McCormack et al., 2004, as cited in Rahman and Nahiduzzaman, 2019). Given that SA is a Muslim country, the questionnaire respondents of AlShareef and Aljoufie's (2020) study in Jeddah city showed that mosques are the most important and visited destination because they (mostly men) pray in that location five times a day. For Muslims, mosque prayer also strengthens social relationships (Abu-Ghazzeh, 1997). Furthermore, the Islamic prophet Muhammad (PBUH) mentioned, as narrated by Abu Hurairah[5] (May Allah be pleased with him), that Allah rewards walking to the mosque and that reward increases with further distances (Al-Hajjaj, 2007). Therefore, in a walkability study of Dhahran City's Doha and Dana residential districts, mosques were the closest facilities to every resident (242m) (Rahman and Nahiduzzaman, 2019). However, the same study found, using The Nearest Neighbor Index, that most other community facilities (i.e., schools, supermarkets, grocery stores, banks and ATMs, pharmacies, and hair Salons) were randomly distributed. AlShareef and Aljoufie (2020) study ranked those facilities in importance to motivate walking for transportation. Using the Fuzzy Analytic Hierarchy Process, they found that grocery stores, supermarkets, and pedestrian areas (e.g., walkways) ranked second, third, and fourth (mosques were first). In short, mosques within residential districts in Saudi cities are a primary motivator to walk for transportation multiple times a day.

2.2.3. Factors at the site level

Evaluations at the site level had a high overlap with findings at the neighbourhood level, especially regarding pedestrian infrastructure. Both Kamel (2013) and Parashar and Bnayan (2020) analysed the walkability of public parks via the 5Cs' assessment criteria in the former case (Transport for London, 2005) and the Ewing et al. (2005) protocol for measuring urban design qualities in the latter case. On the one hand, Kamel (2013) found via a descriptive analysis of questionnaire responses that hot air temperature, poor street conditions leading to the park, reckless drivers' behaviours, littering, lack of environmental awareness and sustainability features, inadequacy and the unsuitability of public toilets, lack of shading and seating, absence of public participation in the design and implementation of the Abdullah national park in

[5] As the most prolific hadith narrator in Sunni Islam, Abu Hurayra was one of the companions of the Islamic prophet Muhammad.

Dammam, SA (a waterfront). Based on those outcomes, Kamel (2013) recommended several smart innovations (e.g., wind towers, intelligent shades, public toilets, and more) to enhance walkability within and to the park. However, there is no discussion about their feasibility in Saudi cities from an economic and management perspective. Additionally, Kamel (2013) only had 51 respondents, and most were males, limiting the generalisation and reliability of results. Nonetheless, the feasibility and (economic, environmental, and social) impact of innovative technologies for increasing walkability and bikeability in Saudi cities could be a future research direction.

On the other hand, Parashar and Bnayan's (2020) research analytically compared two looping walkways around two sites: the Prince Sultan University campus and King Abdullah Park in Riyadh. The authors used field observations to collect data, which involved counting users, site features, and materials. However, little was shared about the observation protocol. For instance, information about the time, frequency, duration, location, and type of users' counting method would have been useful to increase the validity of the results. With that in mind, the authors' analysis concluded that greenery and people's presence are primary imageability qualities that attracted users and differentiated both sites. Their walkability score leaned in favour of King Abdullah Park since it had a variety of building characteristics, better enclosure due to the curvilinearity of its path, and better transparency due to the higher number of windows and entries. However, as admitted by the authors, these results did not consider the context of both sites, which may have played a major role in explaining users' behaviours and preferences. Therefore, considering context-related factors such as accessibility in assessing LPs/walkways in SA is important.

Other walkability studies also had important insights (Addas and Alserayhi, 2020b; Alhajaj, 2014; Alhajaj and Daghistani, 2021; Badawi, 2017; Fatani et al., 2019; Shokry and Maksoud, 2015). However, since some were conference papers, they lacked important information, especially about the methodology (Badawi, 2017; Shokry, 2015). Therefore, their studies were not reviewed. Other studies were theoretical, and results were not based on empirical results (Addas and Alserayhi, 2020b; Fatani et al., 2019). Alhajaj and Daghistani's (2021) study focused on walkability inside the King Abdulaziz University Campus in Jeddah City, which is outside the scope of this PhD research. Alhajaj's (2014) PhD thesis was design-based research where the author proposed "*new forms of public open spaces*" for Jeddah city (e.g., greenways) to address the provision of greenspaces, public health, and walkability problems. Evaluation of his proposed urban design scenarios at the street (i.e., Tahlia), neighbourhood (i.e., Mishrifah district), and city level were limited (i.e., listing advantages and disadvantages of different approaches). Simultaneously, Alhajaj's (2014) proposed scenarios implied that problems regarding Jeddah's open spaces could be fixed with good design of the physical environment. If greenways hold the potential to solve urban mobility problems and achieve other ecological and environmental benefits, what is preventing their widespread implementation? Therefore, more interdisciplinary research is needed to build an understanding of the legal, technical, social, financial, and operational challenges of greenways' realisation in Saudi cities.

Despite the growing interest in the walkability of Saudi cities, research about bikeability is limited. Aljoufie (2017) concluded, via a questionnaire and visual assessment guided by AASHTO[6] of ten streets in Jeddah city, that most bicycle facilities are unavailable and inadequate. Furthermore, his questionnaire respondents (n=886, but 81.6% were males) had a positive attitude towards utility cycling but with concerns about practicality (e.g., weather) and safety (e.g., lack of bicycle infrastructure). Even though bicycle infrastructure is a primary component in Jeddah's future transportation plan (AECOM, 2015), research about bicycle usage challenges in Jeddah city is limited (Aljoufie, 2017). Therefore, with cycling becoming a popular physical and recreational activity in Saudi cities (Sports for All Federation, 2020), there are several research gaps about their users' types, behaviours, perceptions, and usage barriers, especially as a transportation mode.

2.3. The influence of sociocultural factors on the usage of public urban spaces

How do the sociocultural factors influence the design characteristics, usage, perception, and regulation of public open spaces in Saudi cities? Sociocultural is "*related to the different groups of people in society and their habits, traditions, and beliefs*" (Cambridge Dictionary, 2023). Sociocultural values, religious beliefs, government regulation, and urban form characteristics are the four dimensions that segregate the usage of public urban spaces in Saudi cities (e.g., walking for transport or leisure) based on gender (Almahmood et al., 2017). They further explained that gender norms and traditions have restricted women's access to urban spaces, leading to the masculinisation of these areas, and young women often choose 'privatised' public spaces like shopping malls and gated communities for walking, especially at night.

Since 1980, the other impact of those sociocultural aspects was on urban development via the duplication of public spaces such as malls, banks, schools, workplaces, university campuses, governmental buildings, and more to limit *ikhtilāṭ* (mix of sexes in spaces or groups) (Le Renard, 2008, 2014, as cited in Maneval, 2019). Such duplication resulted from the influence of conservative Muslim scholars and strict legal segregation between sexes in workplaces and socialising areas since the 1960s, which has been maintained by a discourse on modernisation (Le Renard, 2008; van Geel, 2016). Public parks were also duplicated, like in the case of the Amira women's park in Jeddah city, a fenced park exclusive to women and children (Maghrabi, 2019). The other form of duplication and separation was between bachelor men and families (see Figure 2-5). It was common in public parks and other public places (e.g., restaurants, malls, and more) to have a "families only" sign, where entry is permitted only to women, children, and men accompanied by a relative woman (Maneval, 2019). The interviewed women in Addas (2015), Maghrabi (2019),

[6] The American Association of State Highway and Transportation Officials.

and Maneval (2019) studies mentioned that the spatiotemporal segregation provides them with safety from (verbal, visual, and/or sexual) harassment and comfort/freedom to jog or exercise. Therefore, the religiously and legally influenced spatiotemporal segregation between sexes in SA limited the usage and access capacity of walk spaces for both genders and duplicated public open spaces.

Socially constructed beliefs and perceptions of acceptable behaviours also contributed to the spatiotemporal division of walking spaces between males and females (Almahmood et al., 2017). To uphold what is seen as socially "acceptable" behaviour for women (and men), social norms and beliefs about gender impose behavioural regulations (Morin and Guelke 2007; Rieker and Ali 2008; Le Renard 2013; Whitzman 2013; Jin and Whitson 2014, as cited in Almahmood et al., 2017). Therefore, in addition to women's experiences of harassment in public open spaces, they are socially stigmatised for being in supposedly male-only walking spaces, especially during night hours (Almahmood et al., 2017, Le Renard 2013, as cited in Almahmood et al., 2018). Based on mixed methods, which included semi-structured interviews with planners and workshops with female participants, Almahmood et al. (2018) concluded that: *"Saudi women's use, experience of, and access to public urban space are not only formed with the quality of spatial settings, but are also influenced by the presence of other women, the spatial programming, and the level of control and management of public urban space." (p.19).* The same finding was also shared by several scholars (Addas, 2015; Addas and Rishbeth, 2018; Maghrabi, 2019). Therefore, the (standardised) provision of urban spaces may not be used or experienced as intended due to the multidimensional layers of sociocultural aspects.

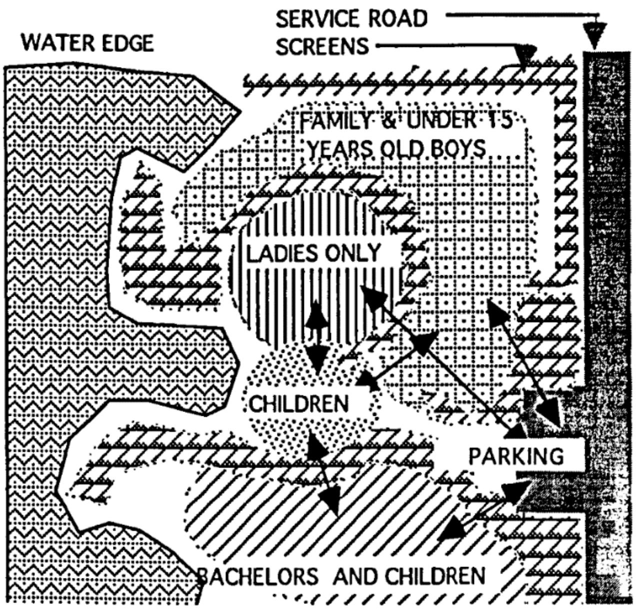


Figure 2-5. One of Talal Hammadi's (1993) design recommendations for Jeddah's Corniche was to address harassment issues, a common design practice that perpetuated gender segregation in outdoor spaces.

Many social reforms were gradually introduced throughout the 2010s, greatly reducing the extent of gender segregation and its perceptual effects. With relevance to AT, the consent of women cycling in 2013 by the religious police (Committee for the Promotion of Virtue and the Prevention of Vice) is an example of such relaxation (Ramdani, 2013). However, despite those mitigations, women's use of bicycles was still restrictive, according to The Guardian news website, since it was limited to recreational purposes within parks and the Corniche, with a male guardian, and while wearing hijab or 'abaya' as locally referenced (Ramdani, 2013). In June 2018, an anti-harassment law was enacted, stipulating hefty fines and imprisonment years ("Anti-Harassment Law," 2018). During the same period, several political and social reforms (spearheaded by Crown Prince Mohammed bin Salman bin Abdulaziz) ended gender segregation in public places (i.e., ended space duplication in most places), allowed women to drive, limited male guardianship, ended the requirement to wear the *abaya* (women's full body garment), and more (Al-Tayyar and Al Dabbagh, 2021; Turak, 2019). Another notable yet significant social reform was stripping the religious police's power to make arrests while upholding Islamic law in 2016 (Bashraheel, 2019). Despite these social reforms, recommendations to segregate men and women are still part of recent literature about public open spaces in Saudi cities. For instance, one of Maghrabi's (2019) main conclusions was to dedicate spaces only for women to encourage the usage of public urban spaces for PA, which reinforces Hammadi's (1993) recommendations. Therefore, individuals/groups who may have found comfort/sense of safety in isolated outdoor public realms resist the cultural shift towards socially inclusive, safe, and resilient public spaces. As demonstrated, the gradual yet considerable social reforms during the past decade are combating harassment and eliminating the laws and enforcers of gender segregation that lasted for half a century.

Simultaneously, cycling for physical activity gained much more momentum during these social reforms. In January 2020, the Sports for All Federation reported that 1.1% of the Saudi population cycle weekly and 32% are women (Sports for All Federation, 2020a). To increase the rate of PA, MOMRA and the Saudi Sports for All Federation (SFA) are collaborating to activate the role of parks, open spaces, and municipal facilities by offering designated spaces for fitness-centric activities (Sports for All Federation, 2020b). In that collaboration, the planning, design, management, and impact assessment are led by SFA, while MOMRA facilitates those goals and processes (Sports for All Federation, 2020b). With that in mind, most of the existing literature, as well as national and local efforts, are focused on physical activity, not transportation. As Aljoufie (2017) found, literature about cycling for transportation in SA lacks more research on barriers and challenges. In short, recent social reforms are rapidly changing the practice of walking and cycling for all purposes except transportation.

Despite these social reforms, the "*internationalisation of architecture*" (Abu-Ghazzeh, 1997) since the 1950s and 1960s in Saudi cities are the result of imported planning models that ignored traditional sociocultural elements of traditional settlements (Al-Hathloul and Anis-ur-Rahmaan, 1985; Al-Hemaidi, 2001). These modern urban forms eliminated semi-public spaces and social interactions, which are unique qualities of traditional settlements (See Figure 2-6) (Al-Shahrani, 1992). Densification policies that permitted additional floors on existing buildings exacerbated those issues, which led many residents to increase the height of walls, thus increasing the gap between public and private spaces (Shawly, 2022). These additional wall heights (which can reach more than 5 meters) isolate dwellers from neighbours, streets, and, in some instances, access to sunlight (See Figure 2-7). The need for privacy is not only culturally and religiously grounded but also for the freedom of the imposed social rules and protection from urban fears or fear of crime (Maneval, 2019).

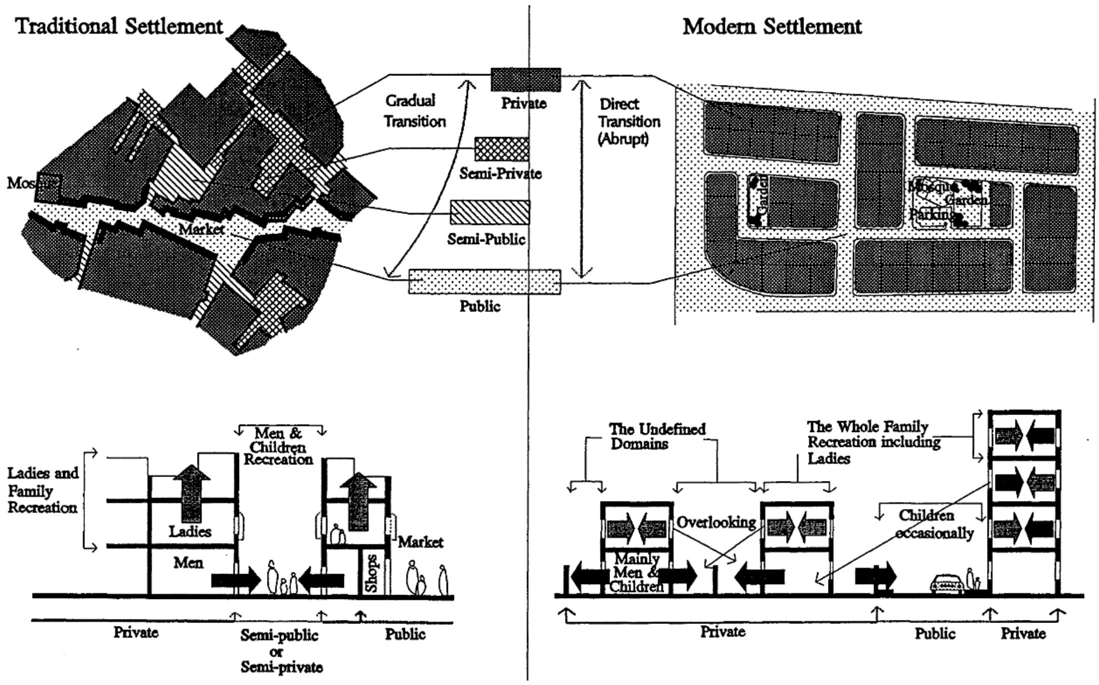


Figure 2-6. Difference between traditional and modern settlements in Saudi cities (Al-Shahrani, 1992).

Figure 2-7. examples of walled residential units in Jeddah city (Shawly, 2022).

Nonetheless, research statistically evidenced that gates' impact on deterring crime is low in the United States (Low, 2003, as cited in Maneval, 2019). No research studied the effect of those housing fortifications on street liveliness in Saudi cities.

Schiller and Kenworthy (2017) argued that causal surveillance through windows and doors facing directly onto the street contributes to pedestrians' sense of safety. Despite such importance, research about neighbourhood walkability in SA did not consider the prevalence of those gated residential units/communities and the impact on daily active commutes. In short, the implemented social reforms in the past decade may have changed or are changing how people live and interact with one another in Saudi cities. However, the inherited modernist architecture that responded to various notions of privacy contributed to the loss of streets as places for people, a challenge for many generations to come.

2.4. Greenways of Saudi Arabia

Previous Sections discussed factors influencing walking and bicycling in Saudi cities. This Section focuses on greenways of SA, their terms, definitions, types, and usage influences. Guiding questions include: Is greenways a term used to describe linear open spaces in SA? Are greenways defined similarly to their international counterparts? What are the greenway types in SA? Why do (or not) the residents of Saudi cities use greenways? How do they use them? What are the research methods used to understand usage behaviours in greenways? What are the underlying causes of existing conditions?

2.4.1. Terms and definitions

In the Saudi context, the word *way* in the term *greenway* is translated in Arabic into Al Masar (المسار الأخضر), as shown in naming the Riyadh Sports Boulevard project ("Riyadh Sports Boulevard," 2019). Several governmental reports, comprehensive plans, and academic studies about public open spaces use the terms greenways and LPs interchangeably, including this PhD research (Addas, 2015; AECOM, 2015; Alhajaj, 2014; Jeddah Municipality et al., 2008; Maghrabi, 2019; MoMRA, 2014, 2019a, 2019b). For example, the streetscape and urban design manual for Jeddah city defined a 'linear park/median' as *"Long greenways that serve as regional connections, related to multimodal nature of boulevards."* (Jeddah Municipality et al., 2008, p. 3.26). This definition highlights linearity, connectivity and multifunctionality as key characteristics of LPs in the Saudi context, which shares international definitions (Ahern, 1995, Lindsey et al., 2008). The same interchangeable use of terms was observed in Jang and Kang's (2015) and Horte and Eisenman's (2020) definition of urban greenways. However, Kullmann (2013) differentiated LPs as places designed to be experienced at a slower pace than greenways since they combine destination and route characteristics. In short, LPs and greenways are used interchangeably in SA (including this PhD research).

The recognition of public sectors involved in the policymaking, planning, implementation, monitoring, and evaluation of greenways as contributors to sustainable transportation in SA is recent. MOMRA's planning standards for city recreational areas do not even recognise LPs as a distinctive public open space type (MOMRA, 2005c). In most cases, recognition of greenways as facilitators of sustainable travel patterns was observed in plans and reports prepared in collaboration with international firms (AECOM, 2015; Jeddah Municipality et al., 2008). However, in 2022, it became valued at the national level, as evident from MOMRA's definition of greenways in the National Public Realm Design Manual:

"Greenways and trails are linear public spaces designed to connect city and district destinations, elevate and strengthen community identity, and support multimodal mobility. Systems of greenways and trails create opportunities for bicycle and pedestrian travel, exercise, and informal recreation." (MOMRA, 2022b, p.152)

The change in how greenways are defined and valued in SA reflects the planning direction communicated in governmental plans and reports (AECOM, 2015, MOMRA and UN-Habitat, 2019b, 2019c, 2019d, 2019e, 2019f, 2019g) (see Section 3.5 for further details).

Despite the recognition of the greenway concept in SA, there are inconsistencies in LP definitions in SA. The terms and definitions offered by Addas and Alserayhi (2020a) for various forms of linear open spaces in Jeddah city reflect existing design and implementation practices. These practices do not consider AT to be a part of their functions. The same applies to MOMRA's (2014) definition of LPs. These inconsistencies also occur at the international, which may prevent a clear exchange of ideas and evidence-based research (see Section 4.3.1 for further details).

Adding to such confusion is how the term "walkway" is used in official capacities to reference LPs and waterfronts, a phenomenon observed on government websites and official news outlets (Jeddah Municipality, n.d.; Saudi Press Agency, 2020). Such ambiguous use of this term suggests that LPs may only be used for walking (for leisure or fitness), which certainly is not the case based on local and national manuals and guidelines (Jeddah Municipality et al., 2008; MoMRA, 2014). A plausible explanation behind the ambiguous use of "walkway" as a term to reference LPs in addition to other forms of linear open spaces is to reinforce the national movement toward active lifestyles ("Quality of Life Program," 2018). Therefore, the evolved understanding of greenways in SA, especially as constituents of sustainable urban mobility systems, departs from past and current design practices. Real-world applications of the recently developed understanding are likely to be part of future greenway projects (e.g., Riyadh's Sports Boulevard).

The inconsistencies in what defines a greenway are also evident globally. When urban greenways replace previous construction in highly urbanised locations, the concept of "green" expands from one of "nature", i.e. vegetation, to include a wider sustainability and livability agenda (Horte & Eisenman, 2020; Turner, 2006). ATCs or transportation-led greenways such as Comox-Helmcken Greenway in Vancouver, Canada (Frank et al., 2019, 2021; Ngo et al., 2018), neighbourhood greenways in Portland, Oregon (Portland Bureau of Transportation, 2015, 2021), and transport greenways of Shenzhen, China (Liu et al., 2020) are examples of a contemporary expression of a greenway, which may lack vegetation in some of their segments. Despite conforming to the intrinsic qualities of a greenway, specifically (I) linearity, (II) linkage, (III) multifunctionality, (IV) consistency with sustainable development goals, and (V) contributions to comprehensive landscape and physical planning (Ahern, 1995), such an evolution in what defines a greenway stretches Fabos (1995) and Little (1990) original typologies in many directions. In the Saudi context, the absence of urban vegetation in various LP segments could cause misinterpreting them as footpaths or walkways, a phenomenon observed in the literature (Addas & Alserayhi, 2020a; Jeddah Municipality, n.d.; Saudi Press Agency, 2020). Therefore, as Jack Ahern concluded in 1995, landscape context can change how greenways are defined. When greenways replace previous construction in highly urbanised locations (like in the case of Jeddah city), the concept of "green" could extend to indicate sustainability and livability agenda.

2.4.2. Types of Linear Public Spaces

Linear public spaces in SA have been classified differently during the past two decades (Addas and Alserayhi, 2020a; AECOM, 2015; Jeddah Municipality et al., 2008; MOMRA, 2014, 2019a; MOMRAH, 2022b). In those classifications, greenways or LPs are a type of linear spaces, and in cases such as MOMRAH (2022b), they are grouped with trails, suggesting that both have highly overlapping characteristics. Furthermore, greenways and trails exist along rights-of-way, which are lands dedicated for transportation (Gardiner et al., 2018), ranging from urbanised to natural settings (MOMRAH, 2022b). The same source indicated that scale variability (neighbourhood to regional scales) and physical separation from streets or automobile traffic (via a barrier or an open space) are key characteristics.

The other main group of linear spaces are promenades. Unlike greenways, the definition of promenade places greater emphasis on recreational, social, and physical activities (no mention of transportation) (MOMRAH, 2022b). Internationally, both categories of linear public spaces (greenways and promenades) are grouped under the umbrella term *greenways* whether in original (e.g., Fabos, 1995; Little, 1990) and contemporary definitions and categories (e.g., Horte and Eisenman, 2020). In short, promenades (e.g., Al Corniche Parks) are not considered greenways in SA, which differs from international classifications.

The concept of linear public spaces in SA extends beyond greenways and promenades. Although unrecognised and unstated officially in MOMRAH (2022b) as part of linear public spaces, historical and religious routes in Saudi cities could be classified as one of its greenway types and a part of its tourism planning. Outside the historic city boundaries, Prophet Mohammed's migration path from Makkah to Madinah in 622 CE exemplifies a historic route with considerable cultural and religious significance to all Muslims worldwide. Scenic or historic routes are one of the traditional greenway typologies (Little, 1990). In 2018, the Ministry of Haj and Omra began an initiative called the Road to Thaniaat Alwadae (الطريق الى ثنيات الوداع) during Al-Haj season, where they guided pilgrims from Makkah to Madina using the same path as Prophet Mohammed (Peace be upon him) for religious tourism (Ministry of Hajj and Umrah, 2019). In 2012, Abdullah H. Alkadi produced a comprehensive digital map of that historic route using GIS and GPS (Alkadi, 2012). Other historic routes in Saudi Arabia include, but are not limited to, the Incense Trade Route and Al Hijaz Railway. Furthermore, the Arabian Trails website documents many of SA's histroric, natural, and cultural trails (Shoaib, 2020).

Another form of linear public space is the main market streets of historic areas within Saudi cities (e.g., Al-Alawi Street in Historic Jeddah). Historical and religious routes are part of a much larger discussion about the evolution of public open spaces in Saudi cities, explored in Chapter Three and related to the international evolution of greenways.

In contrast to historic linear spaces, the Line City's greenway in Neom, SA, is a unique type that aims to connect several urban hubs, a concept like rail trails found in the American and European contexts (Neom, 2021). However, Neom's greenway does not replace existing transport infrastructure. Instead, it is a central component of a progressive urban development approach that has not yet been implemented.

The discussion of linear public space types in SA stresses the need to establish a detailed description of subcategories for greenways and promenades. These descriptions should be unified across all public sectors involved in the planning and managing of linear public spaces in SA. Doing so partially minimises confusion about what is or is not a greenway in the Saudi context. Simultaneously, it would further organise the exchange of ideas and evidence-based research. In brief, Saudi greenways share many forms, functions, and scales found internationally, while culture, history, variable terminology, and natural settings are unique defining characteristics.

2.4.3. Influences on greenways usage in Saudi cities

Examination of the physical characteristics, usage, and users of greenways in Saudi cities was part of several PhD and master theses and journal articles (Addas and Rishbeth, 2018; Addas, 2015, 2022; Addas and Alserayhi, 2020b; Alhajaj, 2014; Almahmood et al., 2018; Al-Mosaind, 2018; Bogis, 2015; Hammadi, 1993; Maghrabi, 2019). All these studies used qualitative data collection methods (e.g., questionnaires, interviews, field observations) to understand users and their usage patterns, behaviours, and barriers. Despite the overlap in their methodologies, each study had unique insights that partially aimed to inform the planning and design of walkways/LPs. However, since most of Jeddah's waterfronts were redeveloped in the past decade (Jeddah Municipality, n.d.), Hammadi's (1993) findings are outdated, specifically regarding Al Corniche's physical characteristics and his respondents' perceptions of it. Nonetheless, even after 30 years, many of Hammadi's results, especially about gender segregation, privacy, lack of open space provision, poor open space design and management, fragmentation, and harassment by male bachelors, are still findings of recent research. These unresolved issues suggest a significant gap between research and practice planning and designing public spaces in Saudi cities.

Many scholars attributed the continuity of the same issues in the past decades to administrative, management, environmental, and financial barriers (Abdu et al., 2002; Alhajaj, 2014; Al-Shahrani, 1992; Fatani et al., 2017; Hammadi, 1993; Mandeli, 2011; Sobahi 1995). For example, the daily water demand to water Jeddah's parks is 1 million cubic meters, and only 25-30% of treated wastewater used to irrigate the green open spaces water is delivered (Aljoufie and Tiwari, 2015). Such water shortage also partly explains the lack of open space provision. For example, in Jeddah city, it is 0.5m² per capita, which is considerably less than the national 4.43 m² per capita target (Addas and Maghrabi, 2020). Furthermore, Khalil (2014) found that access to green spaces within 500 m in Jeddah city is available to less than 30% of its residents without considering the quality and type of that space. Consequently, the insufficient provision and access to public parks in Jeddah city affect its residents' quality of life (Aljoufie and Tiwari, 2015; Mandeli, 2016, as cited in MoMRA and UN-Habitat, 2019c).

Simultaneously, chronological reviews of Jeddah's public open space system concluded that the lack of provision and quality is also attributed to: coordination issues between the concerned authorities, insufficient funds, municipal budget cuts, maintenance problems, negligence of law enforcement, perception of its values (i.e., perception greenspaces solely as beatification elements), and disregard of sociocultural aspects in its planning and design (Abdu et al., 2002; Alhajaj, 2014; Al-Shahrani, 1992; Fatani et al., 2017; Hammadi, 1993; Mandeli, 2011; Sobaihi 1995). In addition, periodic changes of the appointed consultants to develop city plans moved ahead of the update process that could not keep up with rapid population and urban growth, further complicating integration efforts between the concerned authorities locally and regionally (Al-Shahrani, 1992; Hammadi, 1993). Are these issues still relevant today? Do they apply to the planning and management of greenways? Are there challenges specific to greenways in the Saudi context? More research is needed to respond to these questions. In short, factors that led to insufficient quantities and inadequate quality of Jeddah's public open spaces system extend beyond design-related issues.

Many scholars concluded, via field observations and their interviewed participants, that Jeddah's walkways/LPs require improvements to their safety, maintenance, aesthetic qualities, and provision of facilities (Addas, 2015, 2022; Addas and Rishbeth, 2018; Bogis, 2015; Maghrabi, 2019). Each of those studies had a variety of public open space types as case studies except for Bogis (2015), who analysed multiple segments from the Northern Drainage Channel (NDC) or Al Tahlia channel via typical cross-sections of each segment. Nonetheless, due to the absence of an assessment framework in all the studies mentioned above, the size and extent of the design, maintenance, and amenity issues were not reflected/considered. For example, Maghrabi's (2019) field observations flagged accessibility to Al Rawdah walkway via pedestrian crossings as an issue. Does such a problem exist in all the site's access points? Are these issues found in other walkways/LPs? Moreover, factors related to AT, such as the availability of public transit stops, traffic speeds, wayfinding signages, and more, were not considered. Therefore, a systematic and objective evaluation of Jeddah's walkways/LPs with a focus on AT is needed to understand the size and extent of the observed design, maintenance, facilities, and amenities problems.

On-site or intercept interviews/questionnaires with walkway/LP users were one of several scholars' primary data collection methods [7] (Addas, 2015, 2022; Addas and Rishbeth, 2018; Maghrabi, 2019). Despite introducing selection bias, such a method focused on on-site users. No research examined non-users who may share different perceptions and preferences than existing users. Furthermore, in the case of Maghrabi's (2019) PhD research, the number of interviewed users for Al Rawdah and Al Rehab walkways was four and seven, respectively. Findings from those user interviews were triangulated with FOs, interviews with practitioners (n=5), and a focus group meeting to validate and weigh the importance of generated themes/factors influencing women's physical activity in outdoor and indoor spaces. However, while considering the sample size limitations, Maghrabi (2019) did not assess the proximity and walkability to/from walkways/LPs despite it being one of the most influencing factors, as explained by his research participants, to the usage of walkways/LPs. Therefore, examining those factors could be a future research opportunity.

Studies of usage purpose and patterns of walkways/LPs in Jeddah city revealed varying results. Based on Addas and Maghrabi (2020), Addas and Rishbeth (2018), Addas (2015, 2022), and Maghrabi (2019) studies, Jeddah's walkways/LPs are used for various reasons, though mainly for health and mental well-being. Would the identified usage purposes and patterns apply to other walkways/LPs, for instance, in Jeddah city? In addition, none consider AT as a potential usage purpose of walkways/LPs. Simultaneously, the influence of socio-demographic attributes (e.g., gender, age, and more) on usage frequencies and durations was not explored. The same applies to the influence of proximity, mode of transport to access walkways, and other environmental and personal factors. For example, does the mode of transport used to access walkways/LPs relate to participants' usage purpose? Does proximity influence the usage frequency of LPs/walkways? In short, more research is needed to understand the influences on greenways' usage in Jeddah city.

Despite such a gap in the literature on greenways' usage, Addas (2022) examined the influence of seasonal variations on the usage frequencies and durations. Using an intercept questionnaire of 409 participants, he concluded that park visitors tend to use the park weekly in the summer and monthly in the winter, with longer stays in urban parks during the summer season. Explanations, such as school and work holiday dates and personal circumstances, for such results were not explored. Furthermore, the weather varies in the summer and winter months. In other words, results were not based on a specific month or time of the day, necessitating further

[7] Addas and Rishbeth (2018) is a journal article from Addas's (2015) PhD thesis.

research to better understand the variation of usage patterns. Lastly, greenway studies that examined the impacts of seasonal variations on walking and cycling used year-round readings from automated counters, meteorological records, and census data to formulate objective conclusions (Ermagun et al., 2018b; Gobster et al., 2017; Zhao et al., 2019a). No impact assessment methods were performed on the greenways of SA, which is another gap in the literature.

Recent research has shown a positive attitude towards adopting alternative modes of transportation (i.e., public and active transport) when enabled in Jeddah city (Aljoufie, 2017; Badawi and Farag, 2021). Yet, no study examined the activation barriers and strategies of greenways as facilitators of AT in Saudi cities. Therefore, as a case study, empirical research on Jeddah's greenways would contribute to addressing such a gap.

2.5. Chapter two summary

Chapter Two reviewed the state of knowledge regarding greenways and AT in SA to identify patterns and gaps in the literature and future research opportunities. After the overview of SA's context and Jeddah city, the literature review concerning AT revealed that TOD is the adopted planning strategy of major Saudi cities. The translation of those plans into practice lacked alignment and concurrent implementation of TOD elements, which are complex and interdependent. Thus, actions such as the 2007-2014 densification policy in Jeddah city engendered many challenges. Furthermore, the inadequate public transit, poor sidewalks, and influx of women drivers since June 2018 impeded the implementation of TOD, resulting in further investments in automobile-centric systems. Therefore, greenways' integration with public transportation planning and mobility management is needed to activate their AT function.

Scholars who examined neighbourhoods' walkability within Saudi cities concluded that the lack of pedestrian and bicycle infrastructure is a significant barrier. Yet, using an assessment framework to objectively determine the size and extent of its issues is limited. Even though AT rate is minimal in Saudi cities, walking to/from mosques is common, especially considering the religious value behind such practices. Mosques' consistent proximity to every resident within walking distance is enabling such practice. Therefore, linking greenways to neighbourhood centres, where mosques are usually located, is important to build upon current walking practices and gain social support. Simultaneously, research in SA has yet to explore the associated challenges and potential impact of innovative technologies (e.g., e-bicycles). Such a gap is also linked to the need for interdisciplinary research about multidimensional barriers to enabling AT (e.g., via greenways) and the strategies to overcome them.

Design characteristics, usage, perception, and regulation of public open spaces in Saudi cities are influenced by sociocultural factors in Saudi cities. Hence, Section 2.4 discussed the sociocultural theories in Saudi cities while highlighting how the social reforms immediately post-launch of the Saudi Vision 2030 in 2016 changed many of those norms. With that in mind, one could argue that SA is in a cultural shift period where past socially constructed beliefs are disputed. Embracers and resistors of that cultural shift are apparent in the existing literature. Nonetheless, the inherited urban forms and buildings that satisfied various notions of privacy inadvertently contributed to the loss of streets as places for people.

The reviewed research that examined greenways' usage behaviours and influences in Section 2.4.3 identified several gaps in the literature. For example, none considered non-users of greenways who may have unique insights about their preferences and needs. Even though many scholars qualitatively evaluated the physical characteristics and conditions of walkways/LPs, none used assessment frameworks to determine the size and extent of the issues in Jeddah city. Additionally, proximity and walkability to/from walkways/LPs were flagged as a problem, but no studies on it in Jeddah city have been conducted. Also, little attention has been placed on bicyclists and bicycling barriers to/from/within these walkways/LPs despite their growing popularity in Jeddah city. Lastly, considering greenways' recently redefined planning direction in SA, more research is needed to explore the influences on their usage, especially as ATCs.

CHAPTER THREE

THE EVOLUTION OF GREENWAYS' FORMS AND FUNCTIONS

3. Chapter Three: the evolution of greenways' forms and functions

Chapter Three[8] identifies greenways' forms and functions, especially mobility functions, as evidenced through a chronological review of their planning and design in different contexts. Doing so is important because it identifies the scope of greenways as a spatial type. Furthermore, since urban and open space planning in Saudi cities borrowed Western models (Al-Hathloul, 2017; Al-Hathloul and Anis-ur-Rahmaan, 1985; Al-Hemaidi, 2001), the series of key events that shaped and evolved the greenway concept internationally are related to the Saudi Arabian planning context of open spaces. Such a comparison would chronologically explain the strengths and deficiencies of SA's open space system. Simultaneously, doing so could reveal untapped opportunities or lessons to build upon/inform current development directions of greenways in SA.

The chronological review is divided into five periods, based on a synthesis of scholarly work that has defined generations of green way/infrastructure (Benedict and McMahon, 2006; Fábos, 2004; Searns, 1995; Kullmann, 2013; Pourjafar and Moradi, 2015). The five periods are:

- First Generation: the origin of the greenway concept (pre-1900).
- Second Generation: Landscape Architects and Greenway Planning (1900-1950).
- Third Generation: greenways in the wake of the Environmental Movement and Ecological Planning (1950 – 1987).
- Fourth Generation: greenways beyond the attenuation of urbanisation ills (1987 – 2006).
- Fifth Generation: greenways as infrastructure (2006 – present).

Several general observations about this chronology can be made. First, this survey of greenways' evolution is based predominantly on literature originating in the US, Canada, UK, Europe, Australia, and some parts of Asia, reflecting the dominance of literature based in these contexts (see Figure 3-1). Second, none of the periods presented is discrete since there is not a clear moment where one theme stops and another emerges. It is more accurate to suggest that greenway trends, approaches, and technologies have been successively integrated into existing and newly built projects over time. Third, issues related to urbanisation and population growth are a continuing challenge in many parts of the world. Even though each generation had unique events that affected the evolution of greenways, rapid urbanisation and population growth remained constant challenges for greenways. Lastly, mobility is only one of many functions greenways are designed for. Thus, greenways' evolution must be understood as a function of different scales, goals, landscape contexts, and planning strategies (Ahern, 1995). Consequently, this review looks holistically at greenways while highlighting mobility as one important function throughout and relating to the Saudi context of public open space planning.

[8] This chapter is a revised version of published book chapter via IGI Global (Zawawi et al., 2020).

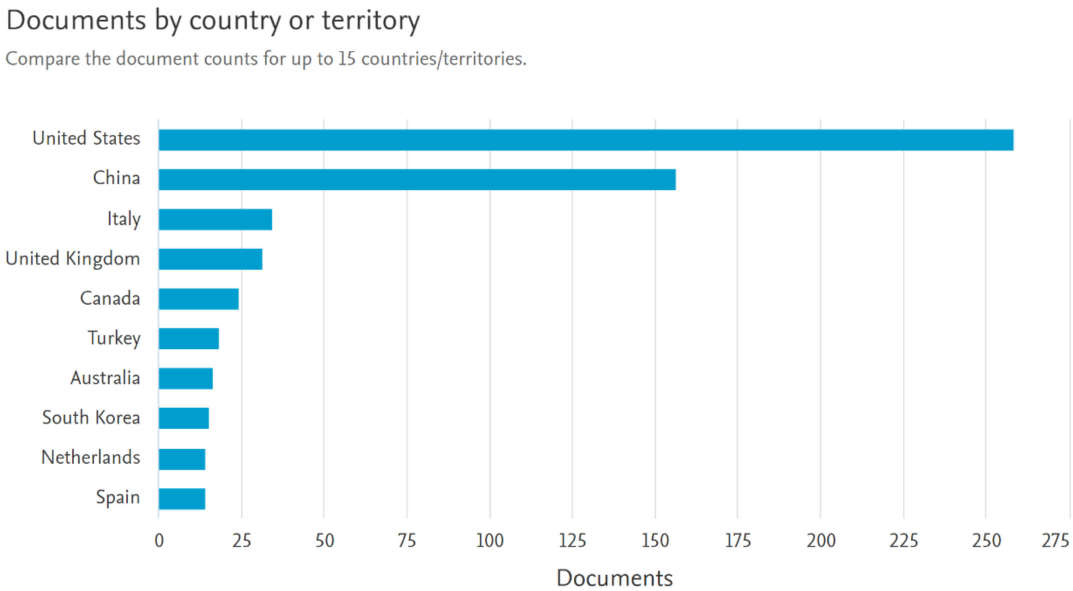


Figure 3-1. Scopus analysis of search results (a total of 706) featuring the term *"greenway"* from 1894 until 2023.

3.1. First Generation: the origin of the greenway concept (pre-1900).

Greenways before the 20th century have been called "Ancestral Greenways" (Ahern, 2003; Searns, 1995). Ancestral greenways are a broad concept, including the formal axes and boulevards of Europe and other parts of the world, reaching back to the ceremonial avenues in Ancient Egypt, the walkways found in highly geometrical Islamic gardens, and the religious ways of Rome (See Figure 3-2) (Turner, 2006). The axes of Versailles and the boulevards of Champs Elysees in Paris, dating circa the 1700s, are examples of what later evolved into the concept of large-scale urban greenways (See Figure 3-3). These ancestral greenways displayed grandeur and connected access ways that manifested beauty, power, and unique scenic values.

Linear forms of open spaces existed in traditional Islamic cities, many of which are in the historic areas in the Saudi cities of today (Al-Shahrani, 1992; Alhajaj, 2014; Fatani et al., 2017; Sobaihi, 1995). These historic cities include but are not limited to At-Turaif District, Historic Hofuf, Ushaiqer Village, Historic Jeddah (Al Balad), Thee Ain Village, and Rijal Almaa Village. Linear open spaces in historical areas have a unique function, scale, and privacy level (Alhajaj, 2014; Al-Shahrani, 1992). Furthermore, such distinct differences (e.g., hierarchies) among linear open spaces of the historic Saudi cities indicate the significant social and cultural roles each level played in the daily life of locals (Hammadi, 1993; Almahmood et al., 2017). Of most resemblance to the ancestral greenways, as described by Flink and Searns (1993), Searns (1995), and Fabos (1995, 2004), are the organically shaped main market streets that link to key destinations and function as public places that facilitate social interactions, trade, recreation, and commuting (See Figure 3-4 and 3-5) (Al-Shahrani, 1992). Compared to the European examples, the main difference is the absence of vegetation due to water scarcity and physical characteristics. In short, the multifunctional main market streets of historic areas within Saudi cities are greenways with historical heritage and cultural values, as Fabos (1995, 2004) typified.

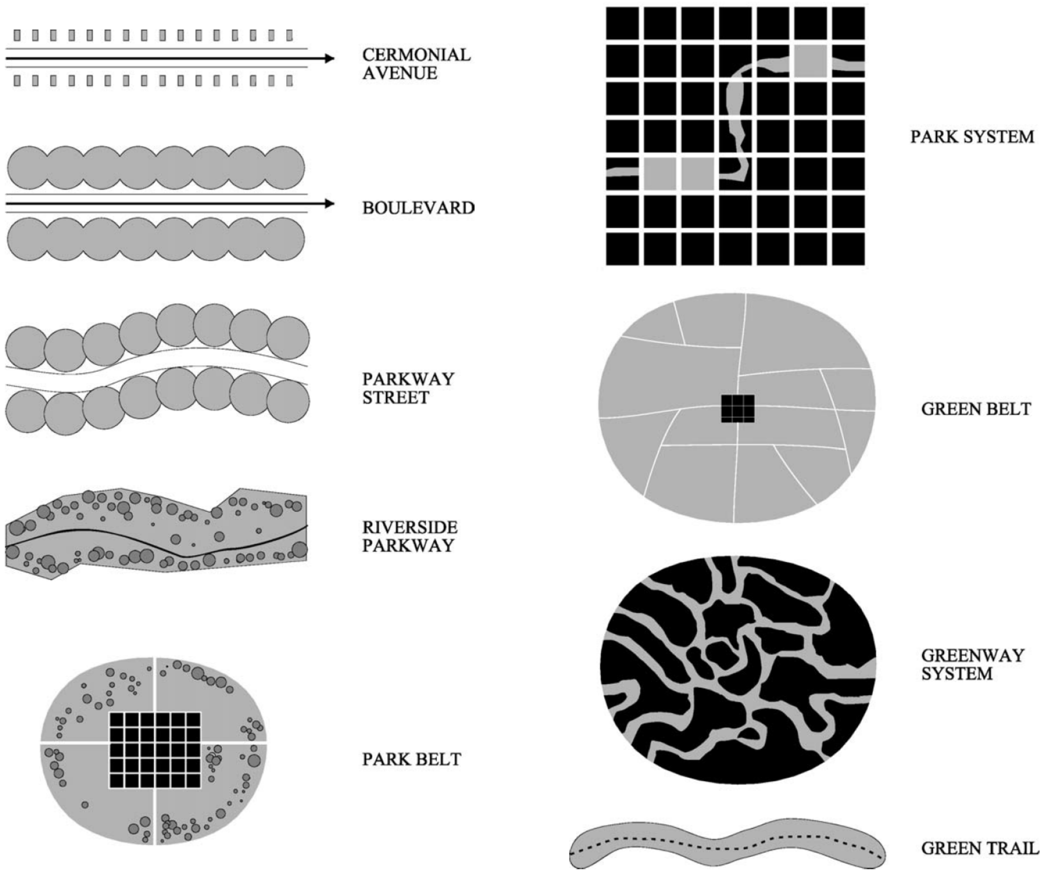


Figure 3-2. Diagrammatic illustrations that describe the various concepts of the Ancestral Greenways (Turner, 2006).

Figure 3-3. Champs Elysees 1860s in Paris, France (Public Domain).

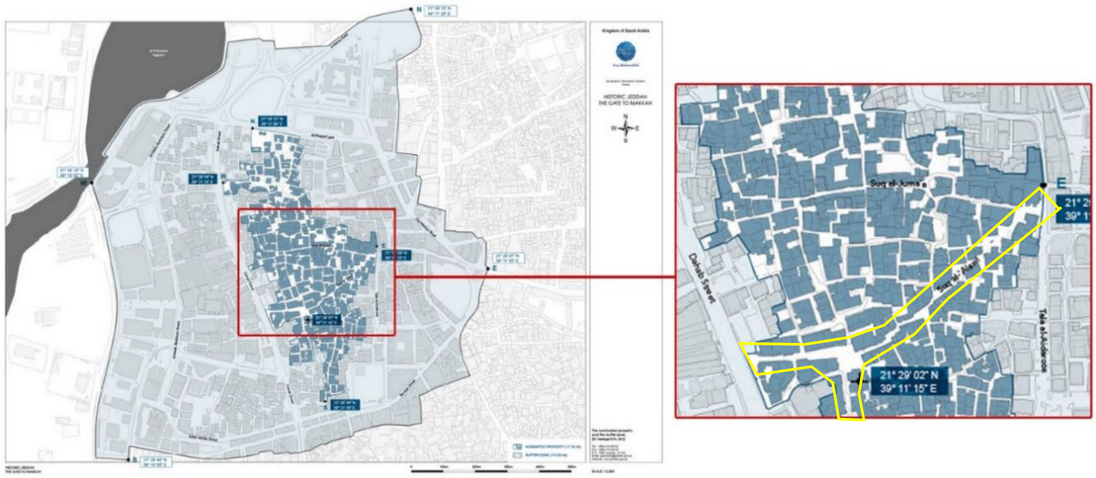


Figure 3-4. Market streets such as 'Suk Alalawi' (yellow boundary) in Historic Jeddah are pedestrian-oriented corridors with many important buildings and commercial activities (UNESCO, 2014).

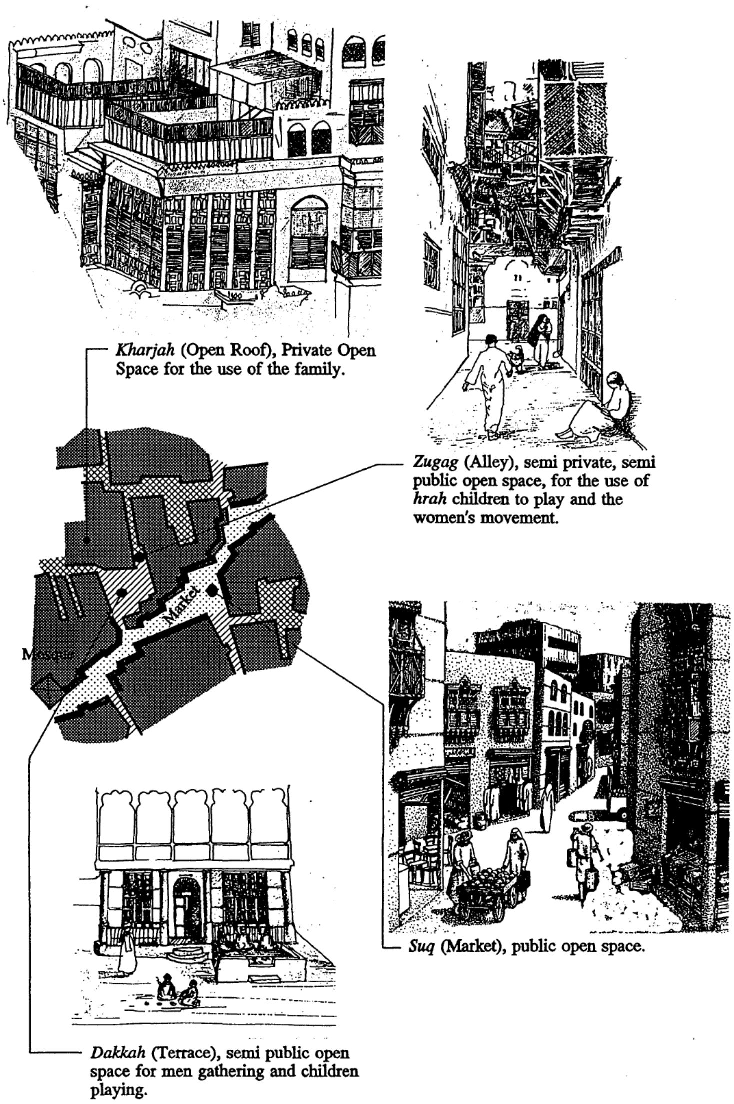


Figure 3-5. The streets' form and hierarchy and associated open spaces in Historic Jeddah (Al-Shahrani 1992). Presented is Suk Alalawi.

During the eighteenth century, greenways and waterways influenced the economic and spatial development of the urban landscape in many European cities. Both in Paris, France, and Campine, Belgium, power provision for mills, workshops, and transport depended on urban canals (Nijhuis and Jauslin, 2015). In the Netherlands, during the same period, the urban landscape's paths and lanes were utilitarian features (Loos and Vliet, 2014). Furthermore, plants were selected based on their usability and growth rate. For instance, in the Netherlands, plants on both paths sides were used to produce wooden shoes. Greenways and waterways during the eighteenth and nineteenth centuries were utilitarian features that affected cities' economic and spatial development.

Moreover, the concept of greenways primarily arose in response to the effects of urbanization caused by the industrial revolution (Searns, 1995; Walmsley, 1995). During this time, marked politically by concerns for public health and social reform initiatives, government authorities and civic leaders began to acknowledge the significance of green spaces in enhancing public health (Fabos, 1995). This recognition led to the creation of public parks and parkways. In the US, Frederick Law Olmsted, the father of the greenway movement, introduced the term ‘parkways’ (Walmsley, 1995). Olmsted’s book, *Public Parks and the Enlargement of Towns*, published in 1870, viewed the planning concept of parkways as a way to shape urban growth and introduce nature to cities. Olmsted’s goal was to permeate and structure urban fabric via parkways and park systems so that no part of town is more than a few minutes away from these spaces. One of his greatest achievements (in addition to Central Park of New York) was the Emerald Necklace, Boston, US (1867), an integrated parkway system that not only preserved natural patches and corridors but also connected with distinctive cultural and historic locations in the city (See Figure 3-6) (Hess, 2006; Walmsley, 1995).

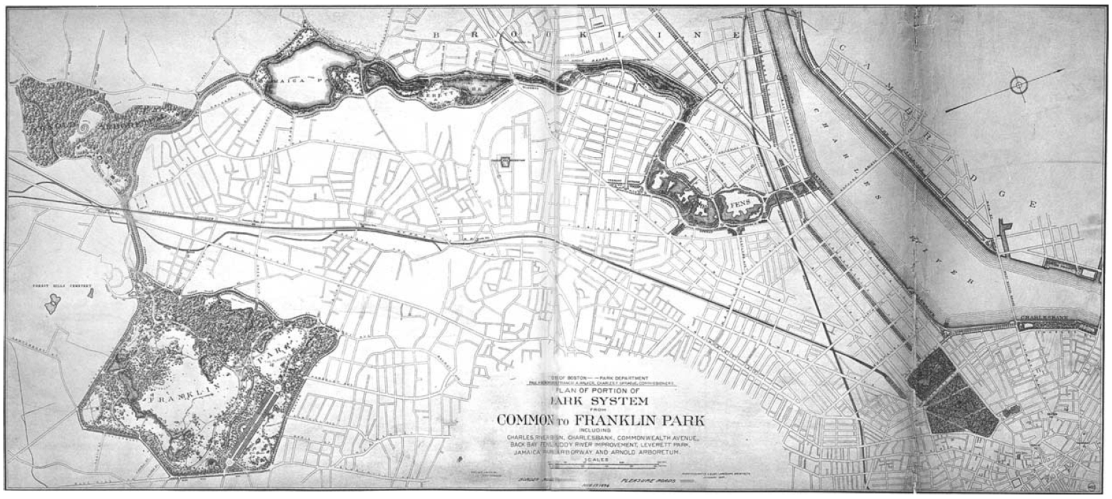


Figure 3-6. Olmsted’s park system in Boston, US, a project known as the Emerald Necklace of 1867, which includes Franklin Park (the large park down the left corner). (Fabos, 1985, p. 131, as cited in Fabos, 2004).

Olmsted, along with the work of Peter Lenne, George E. Kessler, Horace W.S. Cleveland, Charles Eliot, and John C. Loudon (designer of the first British public parks) during the 19th century, were amongst the primary influencers of what became known as greenway planning. One of the notable publications was John C. Loudon's book *Hints for Breathing Places for Metropolis*. He envisioned urban growth being shaped by green belts and open spaces as "breathing zones" for London in 1829 (Turner, 1984). In addition, Olmsted created two types of parkways, Stream Valley Park and Pleasure Drive for Carriages, in the planning of Berkeley, California (Little, 1990). Other key accomplishments are the Minneapolis and Kansas City open space system by Cleveland (former) and Kessler (later) in 1883, as well as the preservation of the Adirondack Park, New York, in 1892 (Zube, 1995). Given the contributions above, it can be inferred that what later became known as "Greenways" was an international movement that shaped many cities worldwide.

In SA, town planning was not introduced until the late 1930s (Al-Hathlou and Anis-ur-Rahmaan, 1985). The modern SA of today was established in 1932 by King Abdulaziz Al-Saud. Before the 1930s, major Saudi cities such as Jeddah and Riyadh were surrounded by fortified walls mainly for protection from Portuguese troops and some bedouins (Bagader, 2014). Their urban fabric primarily addressed climate and sociocultural factors. Consequently, open spaces were intentionally small and only suitable for passive recreation (Al-Shahrani, 1992). Active forms of recreation (e.g., football) happened outside walls to minimise disturbance and nuisance that might bother neighbours.

Furthermore, walking was among the common forms of transportation (Menoret, 2019). In Jeddah city, the Red Sea coast was primarily a port. During special occasions such as Al-Hajj (pilgrimage), ships at the anchorage would sell food, drinks, and merchandise from different parts of the world to visitors. The Red Sea shoreline also acted (until today) as a promenade to the city residents (Hammadi, 1993).

In addition, open spaces lacked vegetation due to water scarcity (Pesce, 1974, as cited in Alhajaj, 2014). Residents during that period harvested water via several methods, including catchment areas (Hofra), cisterns, wells, and canal systems that captured spring water from multiple sources, such as Al-Waziriyah (Habibullah, 2014). Even the establishment of the two desalination plants in 1928 (ordered by King Abdulaziz- the founder of Saudi Arabia) scarcely met the residents' needs for potable water, cleaning, and cooking (Habibullah, 2014). Therefore, in contrast to Western societies, planning and managing open spaces and urban growth had different forms that adapted primarily to climate and sociocultural factors.

In summary, before the invention of the car, ancestral greenways conserved existing landscape features like river floodplains by the planner's proactive actions before introducing new developments in the city (Kullmann, 2013). These existing natural patterns cut into the urban fabric through axes, boulevards, and parkways. The axes and boulevards of Europe and parkways of the US were multifunctional corridors that provided many social, economic, environmental, and social benefits to societies of the 19th century. The most resembling form of the ancestral greenways in SA are the main market streets of historic Saudi cities due to their connectivity, multifunctionality, and historic and cultural values. Before the 1930s, town planning had not been introduced. Therefore, planning concepts that grounded Western cities and their greenways were dissimilar to Saudi historic towns, which mainly adapted to climate, natural resources, and sociocultural factors.

3.2. Second Generation: Landscape Architects and Greenway Planning (1900-1950)

Following the significant influence of 19th-century greenway planning, the early 20th century witnessed several extensions and applications of this concept, particularly in Europe and the US. Key projects and policy changes included:

- The 40-mile Loop in 1903, Portland, the US, planned by Olmsted, continued development by his two sons to become 140 miles (230 km) long, connecting more than thirty city parks. (Little, 1990).
- The Blue Ridge Parkway. The longest linear parkway system (750 km) links 29 Virginia and North Carolina counties in the US (Fabos, 2004; Searns, 1995).
- The establishment of the UK National Parks and Access to the Countryside Act in 1949 created a framework for creating national parks and maintaining natural reserves (Turner, 2006).
- The Open Space Plan for the Commonwealth of Massachusetts 1928 by Charles Eliot II (Searns, 1995).
- San Antonio's Paseo Del Rio (The River Walk) in 1930-41 (Searns, 1995).
- John H. Forshaw and Leslie P. Abercrombie's London Plan of 1943–1944 viewed "parkways" and "park systems" as one of four key aspects in the planning of London County (Turner, 2006).

These projects emphasise the importance of comprehensive greenway planning, including national, regional, and local coordination.

Ebenezer Howard's Garden City model was a comprehensive planning framework with greenways as a main component. Greenways of that framework brought nature to cities, and greenbelts as a method to control urban expansions and protect the rural landscape, creating a buffer between communities, influenced a generation of planners (Zube, 1995). In 1909, Letchworth was built, Howard's first Garden City, which aimed to combine the virtues of town and country living. The success of creating a social, community, and economic model, where the captured annual value of the land is spent on building and maintaining the garden city (Howard, 1902), encouraged the creation of additional new towns in the UK, such as Hampstead Garden Suburb and Wythenshawe. Later, the British New Town Act in 1946 generated multiple additional satellite towns such as Runcorn, Ipswich, and many more. The influence of Ebenezer Howard's Garden City concept was not limited to the UK's new towns but also to the American Greenbelt Towns in the 1920s-30s (Walmsley, 1995). In short, the greenways of this Generation were greatly influenced by the English Garden City Movement in 1898.

At the same time, this Generation introduced pedestrian-oriented greenways that follow humanmade flood channels and other land uses (e.g., Commercial and recreation) in direct response to the rise of the automobile (Searns, 1995). With the increased rate of car ownership, as well as velocity and size, city plans introduced by Clarence Perry and Le Corbusier and many more (influenced by Ludwig Hilberseimer 1885-1968) separated pedestrian and vehicular movement by the introduction of hierarchical transportation systems that corresponded to the traffic volume and function (Carmona et al., 2010). An example of such separation is parkways such as the Bronx River, the first parkway designed specifically for the recreational use of automobiles (Benedict and McMahon, 2006).

Another example is the traffic-free superblock Radburn (1929-1931) by Henry Wright and Clarence Stein (proponents of the Garden City Movement) in New Jersey. Radburn's development pattern had automobiles as the second mode of transport and open spaces as the community structure that enabled the movement of pedestrians and bicyclists to several public amenities (Girling and Kellett, 2005). Nonetheless, the Radburn planning model had several shortcomings, including poor accessibility to public transit, commercial activities, and inter-neighbourhood connectivity (Girling and Kellett, 2005). The separation of pedestrians and automobiles and the departure from the traditional towns undermined streets as the centre of public activities (see Figure 3-7) (Stein, 1951, as cited in Walmsley, 1995).

Figure 3-7. Segregated pedestrian and bicycling corridors from roads in Radburn, New Jersey (Photo Credit: Flickr user: Design for Health, web-link: https://www.flickr.com/photos/designforhealth/6974616023).

The degradation of the quality of life and the loss of indigenous natural and cultural landscapes were key concerns of planners and architects, including Benton MacKaye (originator of the Appalachian Trail), Patrick Geddes, Lewis Mumford, and Stuart Chase. Such landscape changes stemmed from urban sprawl stirred by the development of the automobile industry and infrastructure in metropolitan regions in the early 20th century (Bower, 1963). Thus, the advancement and rise of comprehensive parkway systems in cities between the late 19th century and 1933 (a combination of the Romantic Park and City Beautiful Movements) was a response to many urbanisation ills, which were exacerbated by the steady in-migration to urban areas (Walmsley, 1995). Fundamentally, those movements did not view cities as a representation of industry and economic growth but rather as providing aesthetically improved urban environments for their residents. Enhancing circulation and addressing vehicular traffic congestion were core objectives of the City Beautiful Movement (Hess, 2006). Despite its offering of new streets, boulevards, avenues, and parkways, Lewis Mumford and other critics faulted the movement's superficial or cosmetic solution to urban problems that neglected social, equity, and practicality issues (Hess, 2006). In brief, the aesthetic reconfiguration of urban environments via boulevards, parkways, and more was a key movement that addressed many urban ills.

This Generation acknowledged links between ecology and planning (Mossop, 2006) as manifested in the work of Patrick Geddes, Benton MacKaye, Aldo Leopold, and Lewis Mumford, describing the city as an amalgamation of human and natural processes. This approach is manifested in Walter Burley Griffin's 1911 design for Canberra, Australia, where significant natural environments affected the placement and form of key structures and major axes (Mossop, 2006).

At the same time, however, there was a rise in standardisation and normative thinking, which led to standardised design solutions in the 20th century (Mossop, 2006; van der Velde and de Wit, 2015). An example of such thinking is Clarence Perry's 1929 Neighbourhood Unit, which had a standardised categorisation of open spaces in both scale and functions (Girling and Kellett, 2005). Greenways were "open ways" (as referred to by Benton MacKaye) that traversed settlements and formed connections between the 'standardised' (and fragmented) open spaces (Hellmund and Smith, 2006).

During the second generation, many cities experienced considerable urban migrations (Walmsley, 1995), especially considering the mass production of automobiles via assembly lines starting from 1913 (History.com Editors, 2009). The same applies to SA, specifically in the 1940s after the oil discovery in 1938 (see Section 2.1.1 for more information). Walls that defined the urban growth boundary of those cities were demolished, for instance, in 1947 for Jeddah city (Abdu et al., 2002; Mandeli, 2011). Saudi cities continued to grow, following the traditional Arab-Muslim urban fabric. To manage such growth, town planning began in 1941 via the "Roads and Building Statute", which focused on zoning, right-of-way, planning procedures, and building codes (Al-Hathloul and Anis-ur-Rahmaan, 1985). Then, in 1947, with the assistance of the Arabian-American Oil Company (ARAMCO), the gridiron planning model, produced for Dammam and Al-Khobar, influenced subsequent urban development throughout the 50s, 60s, and 70s in all other Saudi cities (Al-Hathloul, 2017; Al-Hathloul and Anis-ur-Rahmaan, 1985). Many scholars regarded that urban development direction as destructive of the traditional spatial patterns and social functions of the Arab-Muslim settlements (See Figure 3-8) (Alhajaj, 2014; Al-Hemaidi, 2001; Al-Shahrani, 1992; Fatani et al., 2017; Sobaihi, 1995). Therefore, unlike Western societies where planning concepts of parkways or greenways were extended and evolved, open space planning in Saudi cities was disrupted by foreign models that paved the way for automobile usage.

In summary, this Generation is characterised as a period that witnessed suburbanisation enabled by the massive production and ownership of automobiles. This phenomenon (in addition to events such as World Wars, economic depressions, and more) considerably affected human settlements and ecosystems worldwide and, by extension, the form and function of greenways in urban areas. The separation between pedestrian and vehicular movement was a major trend in city planning to accommodate such growth. However, concerns about the quality of life and the natural environments, led by landscape architects, among other allied professions, led to the advancement of comprehensive greenway planning at various scales. SA’s open space planning did not evolve like in the case of Western societies. It was disrupted by foreign planning models that destroyed the Arab-Muslim settlements' traditional spatial patterns and social functions.

Figure 3-8. Spatial qualities that defined Riyadh's traditional Arab-Muslim urban fabric during the 1960s were disrupted via wide roads and large malls (Al-Hemaidi, 2001).

3.3. Third Generation: greenways in the wake of the environmental movement and ecological planning (1950 – 1987)

The environmental movement gained increased political recognition during this Generation as a response to the prevalence of post-WWII environmental negligence (Dukakis, 1996). Rachel Carson's *Silent Spring* in 1962 emphasised the role of ethics in science and advocated for earth stewardship to protect endangered and fragile natural environments (Carson, 2000). During that time, the suburban development rate outpaced most US cities' ability to plan for park systems and protect ecologically vital land (Girling and Kellett, 2005). Saudi cities experienced similar urban growth and urbanisation challenges (Al-Hathloul and Anis-ur-Rahmaan, 1985). Therefore, in 1970, President Nixon established the Environmental Protection Agency (EPA) to address the environmental problems in the US. The SA’s equivalent to North America’s EPA resulted from restructuring the General of Meteorology and the Civil Aviation Authority in 1981.

Even though the ‘automobile city’ began before the Second World War, it accelerated afterwards, enabling cities Worldwide to grow in any direction and at low densities (Newman and Kenworthy, 1999). Such a description matches the haphazard growth of major Saudi cities from the early 50s to the early 70s (Aldalbahi and Walker, 2016; Al-Hathloul and Anis-ur-Rahmaan, 1985; Sobaihi, 1995). Except for the Hijaz

Railway (1900-the 1920s), which was not entirely constructed (Orbaşli and Woodward, 2008), and the Dammam–Riyadh line (inaugurated in 1951 and expanded in 1985) (Briginshaw, 2020), railways in SA played little to no part in the formation and urban growth of its cities before the 1950s. Furthermore, it can be deduced that Saudi cities leapfrogged *The Transit City* (the 1860s-1950s) as Newman and Kenworthy (1999) narrated how evolution in transportation technologies shaped cities around the world, which explains how rail-trails in Saudi cities are not one of its greenway typologies like in the US and Europe. In short, Saudi cities went from being 'walking cities' before the 1930s to 'automobile cities' starting from the 1950s, gradually forgoing urban elements that shaped the Arabic Islamic cities, such as the hierarchies of its open spaces and urban fabric (Al-Shahrani, 1992; Alhajaj, 2014; Fatani et al., 2017; Sobaihi, 1995).

Since the early 1960s, the urban planning of Saudi cities (e.g., Robert Mathew, Johnson-Marshall and partners for Jeddah city as well as Doxiadis Associates in Riyadh city) was reactive to the rapid population and urbanisation growth, focusing on housing, transportation, and infrastructure rather than the quality of life (Abdulmughni et al., 2021; Alhajaj 2014; Al-Hathloul, 2017; Al-Shahrani 1992; Hammadi 1993; Mandeli 2011). Open spaces in the masterplans of major Saudi cities, like Jeddah, during this Generation primarily satisfied Westernised zoning code requirements (Hammadi, 1993). Like the City Beautiful Movement's cosmetic treatment of urbanisation ills, open spaces in Saudi cities disregarded sociocultural and practicality issues and viewed greenspaces as beautification of urban environments (Mandeli, 2011; Alhajaj, 2014; Sobahi, 1995).

Contrastingly, multiple US and UK scholars promoted greenways as a response to environmental problems. Those scholars include but are not limited to Philip H. Lewis Jr., Ian McHarg, Ervin Zube, William H. Whyte, Bill Flourney, and Julius Fabos. Their innovative ecological planning and design methodologies had greenways as a part of their models (Ahern, 1995). It is essential to realise that during the first three generations, there was a dominant perception of "*Man versus Nature*" (Mossop, 2006, p.168): nature being inherently good, while cities are inherently bad. Many works that followed McHargian ideals were anti-urban and assumed that the right design outcomes followed the right process. However, in 1984, two critical publications, Michael Hough's *City Form and Natural Process* and Anne Whiston Spirn's *The Granite Garden,* developed the discourse of integrating ecological planning with city urban development, thereby breaking down the dichotomy between humans and nature.

Concerning greenways, McHarg's "Valley Floor," Lewis's "Environmental Corridors", and Julius Fabos's Metropolitan Landscape Planning Model (METLAND) are prominent examples that preserve the ecological structure of natural systems to inform decisions regarding urban development and economic growth (see Figure 3-9) (Fabos, 2004). Nonetheless, McHarg's work being an influential and significant contribution to the field of ecological planning and design, many authors criticised his exclusion of social and ecological systems in cities and the viewpoint that has led to the creation of "*well-landscaped, automobile-dependent suburbs*", which many view as unsustainable (Farr, 2008). In short, the environmental planning models of this Generation focused on identifying ecologically sensitive corridors (greenways) to guide urban development as a response to the decline of the biotic and abiotic ecosystems.

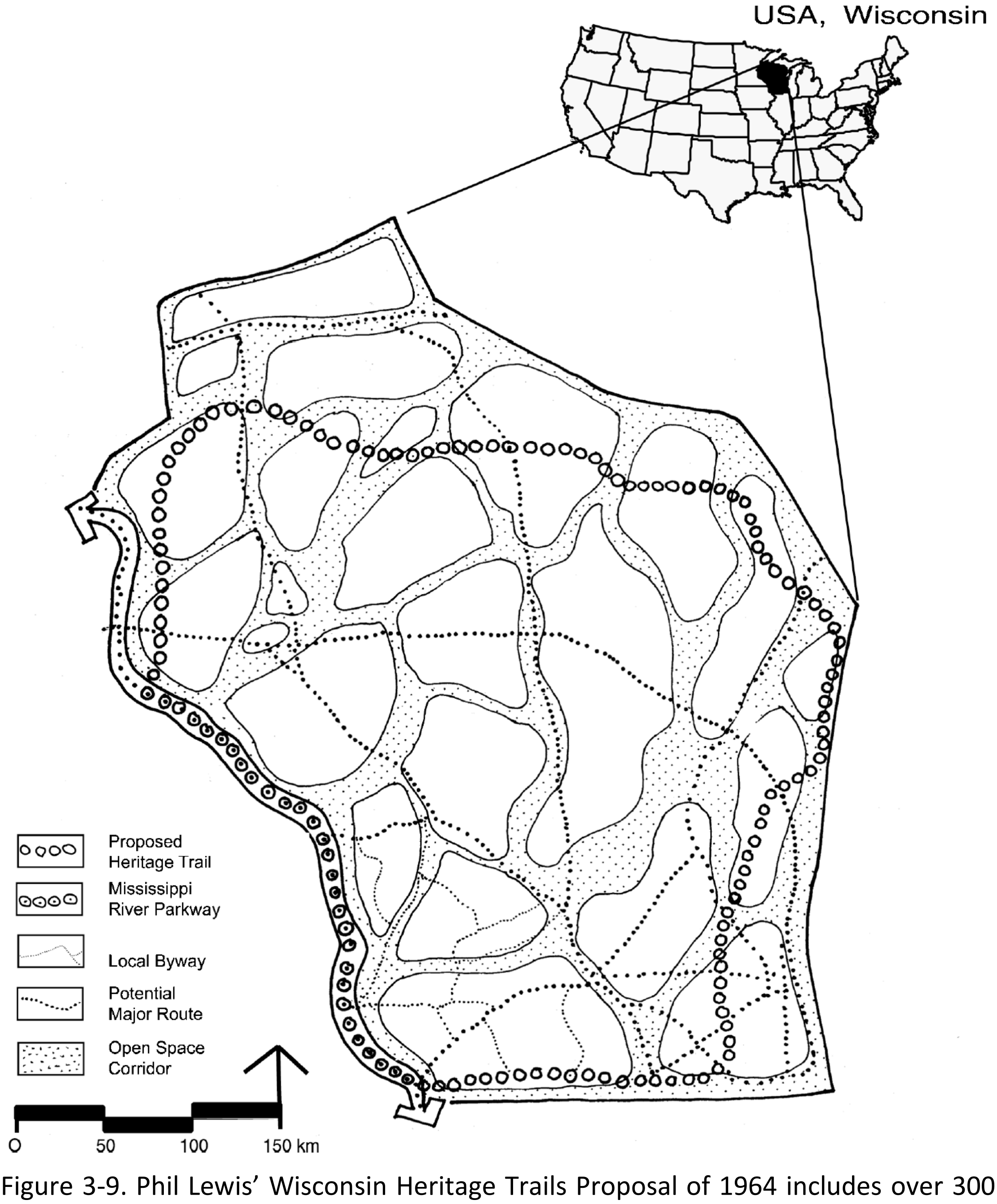


Figure 3-9. Phil Lewis' Wisconsin Heritage Trails Proposal of 1964 includes over 300 Km of environmental corridors (Fabos, 1985 p. 118, as cited in Fabos, 2004).

Since most new urban development occurred on urban fringes during the second half of the 20th century in the form of new towns such as Reston, Virginia and Columbia, Maryland (Girling and Kellett, 2005), a considerable number of planning initiatives (such as Planned Unit Developments [PUDs], Planned Residential Developments [PRDs] and Planned Mixed-Use Developments) were introduced to counteract urban sprawl and enable the preservation of natural landscape features. While these initiatives were facilitated by the works of Clarence Stein, Henry Wright, and others in the Greenbelt towns, they were still mainly low-density and remained automobile-dependent (Beatley, 2000, Table 2.1, p.30, as cited in Walmsley, 2006). greenways were considered in these planning initiatives as the underlying structure that guided development. However, the shortcomings of their urban development plans, being automobile-centric, contributed to the degradation of many ecosystems, and with time, it exacerbated the social, environmental, and economic impacts (Carmona et al., 2010). These defects caused the emergence of new planning initiatives (discussed in the Fourth-Generation Section) that also had greenway planning as a foundational layer to development at multiple scale levels. However, they simultaneously rewrote urban codes to overcome their predecessors' urban planning shortcomings (Walmsley, 2006).

Another iconic scholar of this Generation was William H. Whyte, who is acknowledged as the first to use the term "greenways" in his 1959 monograph, *Securing Open Space for Urban America*, published by the Urban Land Institute (Fabos, 2004). In the 1960s, the term was used to describe linear parks in several parts of the US, and by the mid-1970s, it was first applied in large built projects such as the Platte River Greenway, Denver, Colorado (Searns,1995).

Most of the greenways Olmsted and other scholars created were transportation routes that accommodated horses and carriages in the 19th century. By the second half of the 20th century, these greenways or parkways were also occupied by automobiles that gradually made it difficult for pedestrians, bicyclists, and equestrians to use due to safety, noise, and air pollution (Searns, 1995). As a result, there was an increased demand to create separated trail-oriented (or urban trails or the European's off-street bikeway concept) from automobiles.

Due to the growing interest in the Platte River greenway model (trails along natural corridors) and the abandonment of several city infrastructures in the 1960s and 1970s (referred to as Urban Decay due to suburbanisation post-WWII in the US, UK, and parts of Europe) (Walmsley, 1995), created a greenway movement known as "Rails-To-Trails" or "tow-path movement" (Kullmann, 2013). This movement generated thousands of greenways in the US that connected towns to the countryside. Furthermore, this movement was even supported by President John F. Kennedy in the 1960s due to the growing public awareness about environmental issues, problems with automobiles, public health, and physical inactivity (Searns, 1995). Furthermore, with this growing popularity and the invention of the mountain bike in the early 1980s, the design standards of trails (width, surface materials, and more) were changed. For instance, in the US, the recommended width was increased from 2.4m to 3m, with some trails up to 4.87m (Searns, 1995). Surface materials were also expanded to include compacted soils and crushed stone surfaces. In short, the Rails-To-Trails movement was a significant milestone in the evolution of greenways that influenced people's movements, perceptions, and interactions with nature.

In summary, even though greenways were, in the wake of the political and environmental awareness, the underlying structure of several ecological planning models and urban planning initiatives of new towns, the automobile-centric development models remained, and so did their deleterious effects. Thus, some greenways were created based on planning efforts, while others resulted from regenerating disused city infrastructures, which later became a movement referred to as rails to trails. Greenspaces in SA evolved differently. They were perceived as a means to beautify urban environments. Simultaneously, their planning satisfied Westernised zoning code requirements that disregarded sociocultural and practicality issues. Meaning they were context-insensitive. The series of master plans that were developed since the 1960s for major Saudi cities focused on housing, transportation, and infrastructure primarily to control and respond to the rapid population and urbanisation growth that was partially enabled by automobiles.

3.4. Fourth Generation: greenways beyond the attenuation of urbanisation ills (1987 – 2006)

The US President Ronald Regan's commission on the American Outdoors report in 1987 marked the Fourth Generation of the Greenway movement (1987-2006), which is recognised as a major landmark by scholars of the Greenway movement (Ahern, 2003; Fabos, 1995, 2004; Turner, 2006; Walmsley, 2006). Robert Searns (1995) identified this Generation as the "*multi-objective greenways*" (p.72), where "*ecological linkage, water quality, recreation and education are woven into a multifarious set of performance objectives*." (Kullmann, 2013, p.41).

It can be inferred from the past greenway generations that they were adaptive responses to the issues that gradually manifested from urbanisation, automobile dependency, air and water pollution, lack of public open spaces, accessibility to nature, and many more. Even though the greenways of this Generation served the same causes, the principles of earth stewardship and sustainability were integral components that expanded the purpose of greenways of this Generation (Searns, 1995). Rio Grande Valley State Park (Paseo del Bosque Bike Trail) in Albuquerque, NM, The Boulder Creek Greenway in Boulder, CO, and The Santa Monica Mountains Corridor Project outside Los Angeles, CA are examples of this new iteration of the greenway concept.

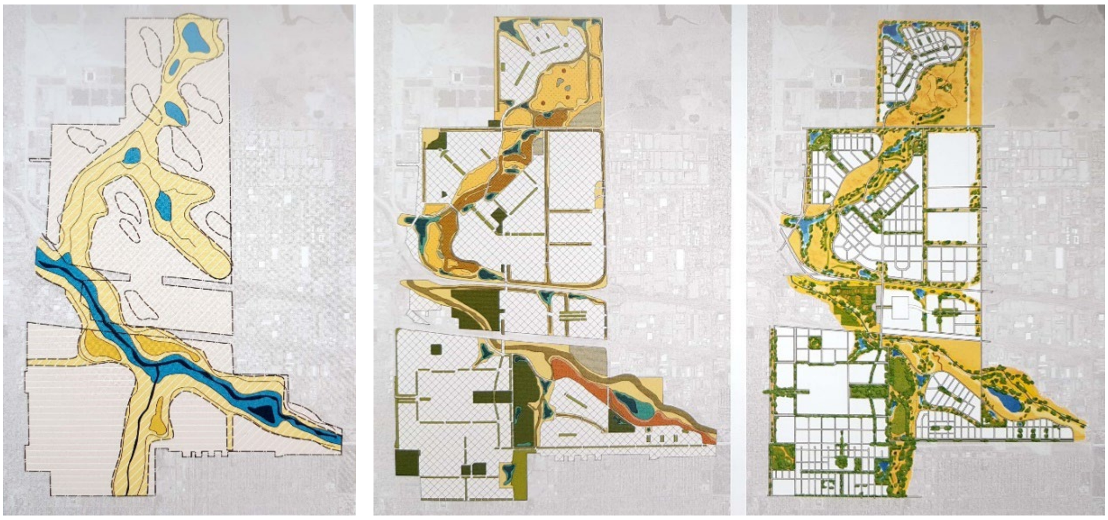
The purpose of greenways was expanded to treat human interventions that deteriorated many environmentally sensitive ecosystems as human settlements and technologies (including the car) accelerated. At the policy level, by the late 1990s in the US. APA enforced urban stormwater management programs, resulting in more cities incorporating greenways in planning strategies (Girling and Kellett, 2005). Ahern (1995) and Searns (1995) presented several arguments in support of greenways, especially regarding the ecological services they provide and environmental protection. However, it is important to note that the direct relationship between ecosystem services and humanmade systems should be based on *"an ecological model of interdependency, instead of an industrial model of segregation."* (Brown, 2014, p.7). In short, the increased integration of greenways with multi-sectoral planning and political strategies evolved its potential to serve the cause of achieving sustainable urban development and environmental protection goals.

The major difference in the planning initiatives of this Generation, such as Green Infrastructure Planning, Smart Growth, New Urbanism, Smart Conservation, Traditional Neighbourhood Development, and Transit-Oriented Development, compared to the previous ones is the integration of their processes with sustainable urban development strategies. The planning process of these initiatives borrowed concepts of earlier generations, for instance, Ian McHarg and Phil Lewis's approach in the 1960s to preserve environmentally sensitive spaces and corridors, as well as Clarence Perry's 1929 Neighbourhood Unit model (Girling and Kellett, 2005). Even though these initiatives redeveloped the concept of city and neighbourhood planning, as well as aided in the rewriting of urban codes, they are all *"different aspects of the greenway movement, expressing its many possibilities, enriching its original concepts, enlarging its credibility—if need be—and emphasising its importance for and relevance to current issues of sustainability and 'green' planning and design."* (Walmsley, 2006, p.252).

Many scholars during this Generation developed greenway planning models that preserve environmentally sensitive areas (ESA) while guiding urban development. Examples of those models are (I) Charles Flink and Robert Searns (1993) and (II) Ndubisi et al. (1995). Both models integrated cultural aspects in the greenway planning process, and such distinction is significant because early planning models of the 19th century and throughout the 20th century overlooked the interrelationship between nature and culture (van der Velde and de Wit, 2015). Even though the conservation schemes shifted from protecting fragmented patches to ensuring overall ecological integrity, it is important to understand that scale:

"is responsible for the dynamic relationship between landscape configuration and function (Carlile et al.,1989), so that neither corridors nor large reserves will work as a stand-alone solution to our wildlife protection problems; an integrative solution based on functional scales of operation may represent a more balanced approach." (Linehan, Grossa and Finnb 1995, p.181)

In densely populated urban areas, greenway planning is a restorative process involving the ecological restoration of existing infrastructures and spaces to provide ecological, social, and economic benefits such as stormwater management (Austin, 2014). In short, greenway planning is a sensible and systematically structured approach that integrates smart conservation and smart growth principles (See Figure 3-10 for example) (Benedict and McMahon, 2002).



A B C

Figure 3-10. An urban redevelopment plan of the closed Stapleton Airport, Denver, Colorado, US, in 1995 (now known as Forest City) by Andropogon Associates, Ltd (Alminana and Franklin, 2016). Maps A to C show the assessed natural drainage and habitat areas that contributed to developing the open space plan and informing the urban redevelopment.

In the US, 80% of the population lived in edge cities (Walmsley, 2006). Therefore, any enhancements towards creating sustainable alternatives were encouraged. Planning approaches like New Urbanism, TND, TOD, transit villages, pedestrian pockets, and Livable Neighbourhood in Australia share similar values and principles. However, they differed primarily in "*the conception of the pedestrian shed: the location of its centroid, and its extent.*" (Duany Plater-Zyberk and Co., 2002, p.3.2). Even though New Urbanist towns (such as Orenco Station in Hillsboro) had a better sense of community and public transit use, they were built next to existing automobile-dependent areas with poor NMT infrastructure. As a result, New Urbanism is "*less effective as the building blocks of a whole and livable city or region.*" (Girling and Kellett, 2005, p.137). In short, New Urbanism, as well as other compact and transit-oriented development models, were a movement that mainly focused on supplanting suburban sprawl with the provision of sustainable and transect-based development.

Greenways are part of New Urbanism's open space typologies that traverse from urban core zones to rural zones (Duany Plater-Zyberk and Co., 2002). Each zone has a specific open space form and function. On the one hand, Green belts were perceived as a corridor separating urbanised areas and may contain recreational and agricultural uses. On the other hand, greenways were not only described as nonmotorised transport routes and corridors that connect the countryside to urban parks within neighbourhoods but also characterised as a landscaping pattern that:

"should be appropriate to the location: naturalistic within the countryside, and formal within the neighborhoods. A greenway should follow a natural trajectory which is transformed to its purpose. Typically, these are riverfronts (riverwalk) or disused tracks (the rails-to-trails)." (Duany Plater-Zyberk and Co., 2002, p.5.1)

The underlying assumption of New Urbanism's transect-based codes is that natural (environmentally sensitive areas) and agricultural open spaces are preferably separated from compact development patterns because they compromise their protection and assume that low-density development will mitigate the loss and fragmentation of natural systems (Girling and Kellett, 2005). Thus, New Urbanism's greenways are multi-purpose LPs that are based on an opportunistic basis to establish ecological, cultural, economic, social, and recreational functions (See Figure 3-11) while leaving 'species-rich spaces', as well as natural and agricultural grounds separated from development as an act of preservation.

Figure 3-11. A 30-acre greenway in Villebois, Wilsonville, Oregon, US, connects the ecological structure while wrapping around the Village Center, providing multiple functions for the community (Google Earth September 17, 2019).

SA had a very contrasting planning direction to its open spaces during this Generation. For instance, in Jeddah, open spaces in the city's master plans (1962-2004) were not a concern or a source of controversy (see Figure 3-12) (Alhajaj, 2014). The update, for example, to Jeddah's fifth master plan (called Albeeah), repurposed lands allocated for open spaces to become residential subdivisions (Alhajaj, 2014). Exacerbating their fragmentation and inadequate provision in SA was MOMRA's policy in 1981, which allocated 33% of all land subdivisions to the combined areas of streets, automobile parking, and open spaces (Sobaihi, 1995). Creating open spaces as leftover fragments in a sea of asphalted streets continued until today (Alhajaj, 2014; Addas, 2020). Research has evidenced that encouraging physical activity (PA) is better than providing a large park (between 1-10 ha) in a neighbourhood instead of small, fragmented ones (Sugiyama et al. 2010 as cited in WHO, 2016). This suggests that the standardised public open space provision strategy (MoMRA, 2005c) is ineffective in achieving one of the QoL program 2020's central goals: encouraging active lifestyles where AT would be a major contributor. Several scholars attributed the poor open space planning and design to the entrusted non-specialists with a limited understanding of landscape architecture and planning fields (Addas, 2020; Alhajaj, 2014; Mandeli, 2011; Sobaihi, 1995). Overall, open space provision and quality deteriorated during this Generation due to poor planning (see Section 2.5 for more details).

Master Plan & Year	1962[1] First Master Plan	1973[1] Second Master Plan	1980[1] Third Master Plan	1986[1] Fourth Master Plan	2004[1] Fifth Master Plan
Consultant	Dr. Makhloof[1]	Robert Matthew, Johnson-Marshall's (RMJM&P)[1]	Sert Jackson International (SJI) / Saudi Consult[1]	Dr. Alsummait[1]	Albeeah Consultants[1]
Master Plan Area	700 km2[1]	800 km2[1]	1000 km2[1]	1875 km2[1]	2400 km2[1]
Proposed Population	1.1 to 2 Million[1]	0.8 to 1.65 Million[1]	1.6 to 2.25 Million[1]	2.2 Million in 1425[1]	4.6 Million in 1450[1]
Title of the open space & total land area	Recreational Areas[1] 7530 Hectare[5]	Recreational Areas & Open Spaces[1] 3770 Hectare[5]	Parks & Recreation[1] 2725 Hectare[5]	Recreational Areas & Farms[1] 5760 Hectare[5]	Recreational & Regional Services[1] 6330 Hectare[5]
Proposed Provision of Open Space	Not Available	10 m2 / per person[2]	11 m2 / per person[3]	33% of the overall land area of a new residential district to be for public use (roads, parking and parks)[4]	

1- Jeddah's Municipality (2013 c).
2- Al-Shahrani (1992) & Hammadi (1993).
3- SJI, cited in Al-Shahrani (1992).
4- MOMRA, cited in Sobaihi (1995).
5- Finding is based on the analysis of the masterplan.

Note: The total land area of recreatioal and regional services in the fifth masterplan not including the six major areas listed above.

Figure 3-12. A study of open spaces in previous master plans for Jeddah City (Alhajaj 2014, p.67).

There are exceptions to open space planning norms, such as the Al Safarat district in Riyadh, completed in 1982 (See Figure 3-13). MoMRA used this exemplary example to illustrate how the hierarchy of open spaces should be linked via transitional spaces, a form of greenways (MoMRA, 2005a; MoMRA, 2005c). The other planned greenway form that existed during the 70s was Al Corniche (or waterfront), like in the case of Jeddah city (see Figure 3-14), which functioned as a port and a recreational destination (Hammadi, 1993). In short, transitional public open spaces and Al Corniche are two notable examples of greenways during the last quarter of the 20th century, though the former type was an isolated case.

Figure 3-13. Al Safarat district in Riyadh is one of SA's exemplary and rare neighbourhood planning models (MoMRA, 2005a).

Figure 3-14. Jeddah North Corniche (or Waterfront) in 2020 (By author).

In summary, greenways' functions in this Generation expanded beyond mitigating the deleterious effects of urbanisation. Stewardship of lands and resources was pivotal in its planning and management process. This new iteration of greenways was accompanied by several sustainable urban developments and political strategies that addressed the shortcomings of past planning initiatives, notably automobile dependency. These planning and political strategies had the multifunctional greenways continue to serve human needs while sustaining ecosystems on a wide scale by implementing perseveration codes and regulations. In contrast, open space planning in SA received little attention. The most notable impact on their planning and design was MOMRA's policy in 1981, which led to it becoming fragmented afterthoughts in land subdivisions.

3.5. Fifth Generation: greenways as infrastructure (2005 – present)

Greenways of this Generation are characterised as integral components of the landscape, (in)forming the infrastructure of urban regions. Since the turn of the 21st century, the landscape has been increasingly recognised as a model and a building block for urbanism and infrastructure (Corner, 2006; Waldheim, 2006, 2016; Mostafavi and Najle, 2003), incrementally identified as a performative medium for urbanisation and the restoration of the post-industrial sites and structures. The landscape provides an armature for regenerating the gradually deteriorating Fordist economy via integrating ecological performance and design culture (Waldheim, 2016). At this time, streets, constituting more than 80% of public places in large urban regions (NACTO, 2016), are increasingly recognised as landscape spaces, with Walmsley noting how they can form "*additional links*" that complete the green infrastructure systems (Walmsley, 1995, p.84). With this in mind, in densely populated urban regions, where limited original ecosystems may remain, substituting a potential replacement ecosystem is an option, especially if it would link or support the remaining natural spaces and corridors (Clewell et al., 2005). Practices to spatially and materially transform conventional single-purpose grey networks into ecological links include using light-coloured porous pavements, continuous tree trenches, stormwater management, rich tree canopies, and ground plantings (Brown, 2014). In short, this era focuses on replacing existing and operational mono-functional structures and streets with parks and ecological connections as primary building blocks of urbanism to achieve this dual ambition of continuous and integrated green infrastructure.

Ever since the turn of the 21st century, the use of landscape and ecological systems as infrastructure has led to the emergence of several discourses of urbanism. Among those are landscape urbanism (Waldheim, 2006, 2016; Mostafavi and Najle, 2003), ecological urbanism (Mostafavi and Doherthy, 2010), infrastructural ecologies (Brown, 2014; Bélanger, 2016; Hung et al., 2013; Brown and Stigge, 2017), urban landscape infrastructures (Farini and Nijhuis, 2013; Nijhuis and Jauslin, 2015), and many more (see Table 3-1). Each of these approaches to urbanism provides a unique perspective concerning the shape of the city and its performance in ecological, social, and economic terms. These concepts advocate moving away from the conventional infrastructural silos to provide public services, especially since they have proved inefficient as a system (Brown, 2014). Furthermore, approaches to urbanism that characterise landscape as infrastructure use ecological and economic processes as formative design tools and integrate natural and anthropogenic systems as well as programs to structure and sustain urban development (Nijhuis et al., 2015). In brief, landscape as infrastructure, a goal-oriented approach, is increasingly perceived as a medium that facilitates the formation and articulation of solutions that address many environmental, economic, and social problems found in many cities worldwide.

Among the urbanism discourses mentioned above, landscape urbanism, while aiming at (re)shaping cities in a way that places *landscape* at the core of its planning, design, and management, when compared to New Urbanism, is "*a more fragmented matrix of discontinuous land uses*" (Mossop, 2006, p.165). The emphasis here is to adapt the multifunctional landscape, rather than architectonic structures, to direct the development of urban areas for the following reasons:

- The landscape is "*uniquely capable of responding to temporal change, transformation, adaptation, and succession*" (Waldheim, 2006, p.39).
- Via the lens of ecology, the scale and scope of factors affecting cities extend beyond the urban boundaries (Mostafavi and Doherthy, 2010).
- Instead of the revenue-driven development, congestion, pollution, and ill social effects produced by the transportation infrastructure and technology of high-density buildings, landscapes exemplified by parks, greenways, street vegetation, and more reduce the urbanisation ills (Corner, 2006).
- The landscape is everchanging and resilient compared to the fixed and definite urban infrastructure (Corner, 2009, as cited in Carmona et al., 2010, p.45).
- Ecological systems have the potential to provide a framework for urban intervention while being autonomous and open-ended (Waldheim, 2016).
- The Generation of landscapes provides the ability to use the ecological processes in design via the natural dynamic flows of energy, nutrients, water, and more (Mossop, 2006).

It can be inferred that many greenway projects of the 21st century are a network of linear landscape forms (re)linked to natural systems at various scales via ecological restorations of underperforming urban infrastructure to safeguard ecosystems' integrity, as well as overcome the current and future challenges to sustainability such as climate change, and automobile dependency.

Table 3-1. Definitions of terms that integrated landscape and ecological systems with urbanism.

Term	Definition
Landscape Urbanism	"*We define urbanism as the experience of, study of, and intervention upon processes and products of urbanisation… the term [landscape urbanism] signifies an understanding of urbanism read through the lens of landscape*" (Waldheim, 2016).
Ecological Urbanism	An approach that "*has the capacity to incorporate the inherent conflictual conditions between ecology and urbanism*" (Mostafavi and Doherty, 2010, p.17).
Infrastructural Ecologies	"*Integrated, holistic approaches to the provision of energy, water, sanitation, and transportation […] based on the simple insight that the critical systems that serve settlements are analogous to the ecological systems that support nature's flora and fauna*" (Brown and Stigge, 2017).
Urban Landscape Infrastructures	"*Armatures for urban development and for facilitating functional, social and ecological interactions. It seeks to redefine infrastructural design as an interdisciplinary design effort to establish a local identity through tangible relationships to a place or region*" (Nijhuis and Jauslin, 2015).

These redefined approaches to urbanism illustrate how 20th-century road-dominant cities could be transformed into resilient landscape-based systems. Many cities worldwide concluded that the nuisance effects of freeways exceed their benefits. The movement from freeways to greenways was seen as a focus transition from fast, uninterrupted, and automobile-oriented mobility to livability. The last quarter of the 20th century has seen multiple freeway demolition projects (Kang and Cervero, 2009): in Portland, Oregon, in 1978, the Harbor Drive freeway was replaced by a 37-acre waterfront park; in San Francisco, the aftermath of the Loma Prieta earthquake in 1989 resulted in the removal (after great resistance) of the city's double-deck Embarcadero freeway along its waterfront in favour of scenic boulevards. Prominent examples of greenways in the 21st century such as Cheonggye elevated highway in Seoul, South Korea; the Madrid Rio project along the Manzanares River in Madrid; Rose Fitzgerald Kennedy Greenway, Boston, Massachusetts, US; Cultural Corridor Chapultepec, Mexico; Hamburg car-free green network in Germany; Donghaochong greenway Project in Guangzhou, China; the Comox Greenway, Vancouver, Canada; Portland's neighbourhood greenways, and many more have extended these processes even further, shifting the prioritizations of streets, the most immediate public space for all, to favour the creation of livable and sustainable places for people via greenways, which has become an international movement.

In SA, the mid-2000s marked a significant turning point for AT planning and design since it witnessed contributions from various governmental sectors in the publication of manuals and standards (MoMRA, 2005a, 2005b, 2019a, 2019b). To build upon the national efforts, municipalities of major Saudi cities published design guidelines that address local challenges and circumstances (Jeddah Municipality et al., 2008; The High Commission for the Development of Arriyadh, 2014). Furthermore, comprehensive plans of major Saudi cities (e.g., Jeddah) also had AT network as an integrated component of its future transport system (AECOM, 2015; Aljoufie, 2014b; MoMRA and UN-Habitat, 2019b). Therefore, after decades of neglect of AT infrastructure (e.g., greenways), the collective multiscale efforts since the mid-2000s gradually began to close the wide gap between international greenway planning practices and in SA (See Table 3-2). Nonetheless, targets that measure the progress of AT are absent from the National Transformation Program 2020 and the Quality-of-life Program implementation plan 2020-2023. Establishing key performance indicators of AT in SA can be a sustainability and livability measure like the UK National Travel Survey and the Active Lives Survey (ALS) (Avbulimen, 2018; Evans et al., 2019).

Table 3-2. A chronological summary of local and national efforts made for AT [9] (Bold text are implemented projects).

Document/initiative name	Date	Author	Scope	Remarks concerning AT and Greenways
Road Engineering Design Manual (Arabic)	2001	MoMRA	National	Info about AT is extremely lacking. No data about cycling and sidewalks are considered complementary elements to roads.
The Humanising the City initiative	Started 2004	Municipality	Riyadh	**Implementation of 61 walkways.**
Al haraka baraka programme	2004/05	King Saud University	Riyadh	One of the hundreds of governmental and citizens-led awareness campaigns about PA.
The Guideline for Space Planning and Treatment in Cities and (Arabic)	2005	MoMRA	National	Linking residential district spaces with a hierarchy of walking and cycling networks, which includes greenways.

[9] This table is not meant to capture all efforts, but rather highlight major documents and initiatives.

The Design Guide for Sidewalks and Median Islands in Roads and Streets (Arabic)	2005	MoMRA	National	The first national manual for pedestrian infrastructure design, though details about bicycle infrastructure are limited.
Establishment of Jeddah development and urban regeneration company	2006	Municipality	Jeddah	While not focused on AT, its urban development projects included the creation of AT infrastructure.
Establishment of Planning and Design for Open Space Areas in Jeddah Municipality	2006	Municipality	Jeddah	Establishment of a comprehensive open space program and facilitate collaboration and partnerships with stakeholders.
Streetscape and Urban Design Manual	2008	Municipality + Int. firms	Jeddah	The redesign of several streets provided streetscape design details and development regulations for AT infrastructure.
The rehabilitation project of Wadi Hanifah	2010 – CMPLT.	Royal Commission	Riyadh	**A project that partially transformed this valley into a recreational destination.**
Establishment of Metro Jeddah Company	2013	Municipality	Jeddah	Implement Jeddah's public transportation program in collaboration with Int. Firms.
Implementation of 24 walkways	2013-20 CMPLT.	Municipality	Jeddah	**Destinations aimed at providing destinations that facilitate physical activities.**
Metro Urban Design and Streetscape Manual	2014	ASandP consult. Firm	Riyadh	Improve Riyadh's road infra. and provide an integrated public transport system.
Jeddah's structure and strategic plans	2005-15	Municipality + Int. Firms.	Jeddah	AT is part of several development strategies, such as TOD and green infrastructure.
National Transformation Program	2016	Saudi Gov. Vision 2030	National	It has important KPIs for all governmental sectors. Green spaces are being measured, though none about AT.
Jeddah waterfront redevelopment project	2017 – CMPLT.	Municipality	Jeddah	**A mega project that partially encouraged walking and cycling for physical activity.**
Quality of life program	2018	Saudi Gov. Vision 2030	National	Enhancing both lifestyle and livability. Its delivery plan for 2020 does not have KPIs for AT. The goal is to make **40%** of SA's residents practice sports and physical activities.
Built Environment Design Manual	2019	MoMRA	National	Greater emphasis on urban design principles and how their elements are related to walking and cycling lanes.
Engineering Design Manual for Roads (Arabic)	2019	MoMRA	National	An update of the 2001 manual has design and technical details about pedestrian facilities, but cycling information is still absent.
Riyadh Sports Boulevard	2019 - ongoing	Riyadh	Riyadh	The first to build a connected greenway network at a city-wide scale partially for AT.

Mostadam Rating System for Communities (by Sustainable Building)	2019	Ministry of Housing	National	Community connectivity (two manuals for existing and new communities). Providing a walkable public realm and bicycle network is an optional credit (not Keystone credits).
Retrofit plans of existing streets to implement new cycling lanes	2020	MoMRA	National	A part of a plan to treat visual pollution in Saudi cities, though aimed at encouraging sports and not as a connected network for AT.
Enforcement of new housing regulations in favour of AT infrastructure.	2020	MoMRA	National	A major turning point that prevents the implementation of new housing projects without AT infrastructure.
Saudi Green initiative	2021	Saudi Gov.	National	Become carbon neutral by 2060 partially via investments in public transport.
National Urban Design Guideline	2022	MoMRA	National	Urban design strategies to retrofit every street size in SA.
Public Realm Design Manual	2022	MoMRA	National	Greenways' contribution to sustainable transportation is recognised in their definition.

During the research and development cycle of AT planning and design at both the national and local levels, various walkways and promenades were implemented in major Saudi cities as destinations that mainly encourage physical, social, and recreational activities (Bin Ayyaf 2015, as cited in Almahmood et al., 2018; Jeddah Municipality, n.d.; Madinah Municipality, 2021; Saudi Press Agency, 2020). Then, the launch of the QoL program in 2018 as a part of the Saudi Vision 2030 gave massive momentum to projects that enhance both lifestyle and livability of Saudi cities ("Quality of Life Program," 2018). Such momentum influenced subsequent efforts, which included the update of road design standards, development of urban design manuals, retrofitting of existing streets to become safe and inclusive, implementation of more walkways nationally, enforcement of new housing regulations, and the organisation of several public awareness campaigns about the benefits of active living (See Table 3-2) (see Section 2.5 for the review of their quality and usage by multiple scholars). These efforts culminate with the Riyadh Sports Boulevard, an unprecedented greenway project (Figure 3-15). Its connectivity to public open spaces and work/education/pleasure destinations is one of its key characteristics that support the realisation of walking and cycling as a mode of transport in Saudi cities (Riyadh Sports Boulevard, 2019).

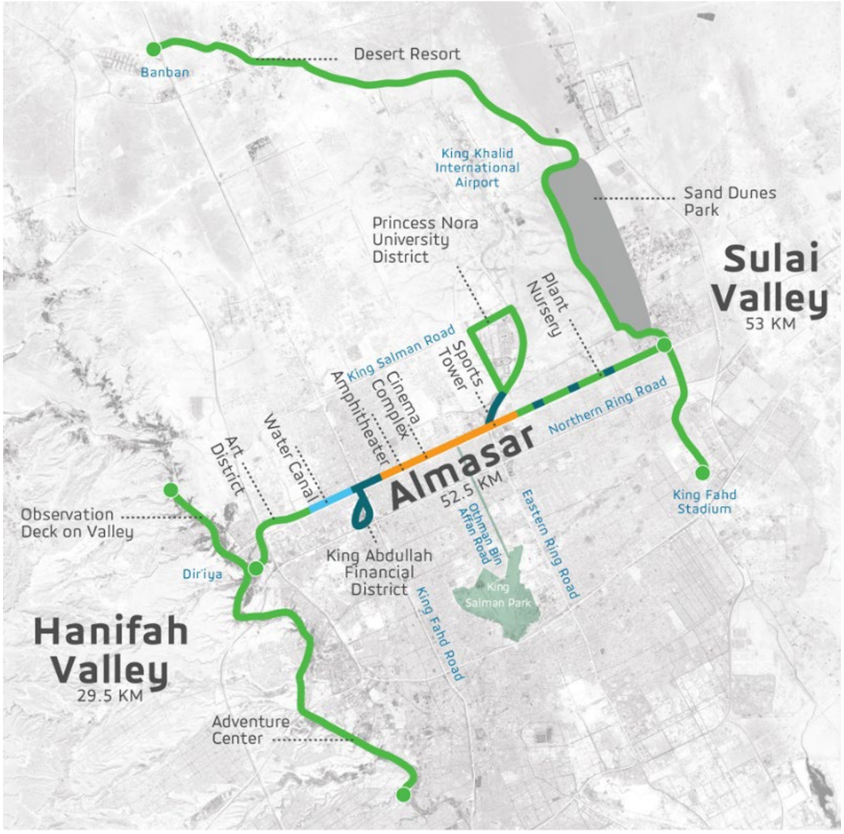


Figure 3-15. Riyadh Sports Boulevard connects Hanifah, Sulai Valley, and many other destinations. Image source: Royal Commission for Riyadh City (RCRC, n.d.).

Despite the proliferation of greenways worldwide, several scholars argued that projects such as the High Line in New York, US, the Promenade Plantée in Paris, France, and the Atlanta BeltLine in the US are drivers of gentrification and economic inequality (e.g., displacement of locals, small businesses, and industry) (Birge-Liberman, 2017; Heathcott, 2013; Larson, 2017; Loughran, 2017; Roy, 2014). Even though the High Line was built based on public funds, its management was outsourced to the Friends of the High Line (Loughran, 2017). Many parts were privatised for the project to be financially sustainable, making it a product of neoliberalism. The Neoliberalization of public spaces is defined as "*a set of policies designed to attract more capital to alleviate cuts in local budgets*" (Dassé, 2019, p.5). As such, the High Line's spatial design, accessibility, and definition of acceptable activities are regulated by these private entities to keep these public spaces as attractive business environments.

The Promenade Plantée was part of a larger plan that regenerated Northern and Eastern Paris over the 1980s and 1990s via targeted investments that shifted property valuations corresponding to a decline in middle-income households (Heathcott, 2013). The Promenade Plantée's conversion into a leisure and consumption space was coupled with the creation of Viaduc des Arts, the Opéra Bastille, and more, which all contributed to the displacement of squatters and small-scale DIY artisanal workshops (Meade 1996, as cited in Heathcott, 2013).

As for the Atlanta BeltLine, Roy (2014) explained, via interviews with the project's planners, steering committee members, study group members, and two local politicians, that the ostensibly inclusive and collaborative planning process is an entrepreneurial agenda that attracts developers and resourceful gentrifiers who could raise Atlanta's tax-base and create more jobs. Gentrification is achieved via bracketing participants based on their socioeconomic status in the planning process, exclusions of less resourceful or disadvantaged ones, and building consensus to avoid conflict and reinforce neoliberal agendas (Roy, 2014). Nonetheless, to reduce the burden of higher property taxes, the Anti-Displacement Tax Fund Program are among the efforts to help eligible homeowners along the Westside Trail of the BeltLine (Palardy et al., 2018). In short, despite the multifunctional benefits of greenways like the High Line, the Promenade Plantée, and the Atlanta BeltLine, inequality, socio-spatial exclusions, and gentrification are products of neoliberal urbanism.

The inequality discourse also extends to greenways connecting communities of different social classes and ethnicities. Harris et al. (2021) study found that neighbourhood stigma affected Caucasians' usage of Chicago's 606 Trail segments that are adjacent to the Latinx community. Consequently, the 606 exacerbated discrimination and catalysed gentrification of stigmatised neighbourhoods (Harris et al., 2021). Nonetheless, unlike New York's High Line, the 606 was created to fulfil underserved communities' transport and greenspace needs (Gobster et al., 2017). Therefore, as Harris et al. (2021) concluded, park programming is needed to mitigate the preconceived assumptions of disorder and celebrate cultural diversity instead.

The neoliberalization of public spaces in SA is also prevalent (Mandeli, 2019). In 2014, the analysis of Jeddah's waterfront showed that 21% and 46% of the Northern Corniche and Obhor Creek Corniche, respectively, were privatised (Alhajaj, 2014). Access to the waterfront in these segments was ticketed, thus socially excluding those who could not afford it. These privileged segments of Al Corniche were maintained, regulated, and surveilled by private entities prioritising business interests (Mandeli, 2019). However, since 2018, many contracts that permitted the complete privatisation of several corniche segments have not been renewed and are currently planned to become public parks (Saudi Press Agency, 2018; Saudi Gazette, 2022). In addition, since 2019, the private sector has created and maintained public parks in exchange for 20% of their total area, a development practice believed to promote community participation, attenuate financial burdens, and increase the quality and quantity of parks (Taleb, 2019). It is also a practice endorsed by several scholars to elevate the declining quality of public parks and address residents' dissatisfactions (Addas and Maghrabi, 2020). The problem with that approach lies in aligning public and private sectors' interests. Devolving the government's responsibility of developing public parks with entrepreneurs can exacerbate inequalities within the public open space system, as experienced in New York, US (Brash, 2017).

In summary, the fifth Generation is a period where landscape and ecological systems are forming as an armature for the regeneration of the disused AND underperforming city infrastructure (e.g., streets). The multi-objective green infrastructure (encompassing greenways) safeguards ecosystems' integrity and overcomes the current and future challenges to sustainability, such as climate change and automobile dependency. In SA, the mid-2000s was a significant turning point where livability received political attention. Partially, it resulted in the implementation of several walkways and linear parks in SA as contributors to enhancing residents' physical activity rate (see Table 3-2). These multiscale efforts are gradually closing the gap between international greenway planning practices and SA's practices (see Figure 3-16). Despite the proliferation of greenways worldwide, gentrification and economic inequality were highlighted as primary challenges. Table 3-3 summarises all the generations of greenways' evolution.

Table 3-3. A table that summarises greenways' global evolution (mostly in English-speaking countries) based on a synthesis of existing literature (By author).

Variables	Before 1900	1900-1950	1950-1987	1987-2005	2005-Present
Generation Title	The Origin of the Greenway Concept	Landscape Architects and Greenway Planning	Greenways in the wake of the Environmental Movement and Ecological Planning	Greenways beyond the attenuation of urbanisation ills	Greenways as infrastructure
Selected Key Thinkers	Peter Lenne, Frederick Law Olmsted, George E. Kessler, Horace W.S. Cleveland, Charles Eliot, John C. Loudon, George Perkins Marsh, and more.	Benton MacKaye, Ebenezer Howard, Patrick Geddes, Aldo Leopold, Lewis Mumford, John and Frederick Jr. Olmsted, Peter J. Lenné, Henry Wright, Horace W.S. Cleveland, George E. Kessler, and more.	Philip H. Lewis Jr., Ian McHarg, Ervin Zube, William H. Whyte, Rachel Carson, Michael Hough, Anne Whiston Spirn, and more.	Robert M. Searns, Charles A. Flink, William L. Flournoy Jr., Paul Cawood Hellmund, Daniel Smith, Diana Balmori, Mark A Benedict, Edward T Mcmahon, Jack Ahern, Tom Turner, Charles E. Little, Frederick R. Steiner, Richard T. Forman, Anthony Walmsley, Julius Fabos, Byron Stigge, Hillary Brown, James Corner, Charles Waldheim, Pierre Belanger, Karl Kullmann, Gary Austin, Robert L. Ryan, István Valánszki, Sándor Jombach, Krisztina Filep-Kovács, Mark S. Lindhult, and more.	
Main Trends, concepts, and events that affected greenways' form, function, as well as planning and design	• Ancestral greenways to reference the axes and boulevards. • The US. Parkways: Stream Valley Park and Pleasure Drive for Carriages. • Utilitarian features that affected the economic and spatial development of cities. • Industrial Revolution and urbanisation. • The axial walkways of Islamic gardens brought unique identity and meaning while providing several functional and aesthetic qualities.	• English Garden City Movement in 1898 • American Greenbelt Towns in 1920-30s • greenways for non-motorised transport, separated from ones made for motor usage. • Suburbanisation and the Automotive Industry. • The link between ecology and planning. • The rise of standardisation and normative thinking. • Landscape architects play a vital role in its evolution.	• Ian McHarg's Valley Floor, and Phil Lewis's Environmental Corridors. • Rails to Trails: results of the abandonment of several city infrastructures in the 1960s and 1970s (and in some cases demolition by natural disasters), referred to as urban decay. • Public health and physical activity issues. • Landscape planning and suitability analysis. • The Environmental Movement due to the prevalence of diseases, as well as air and water pollution post-WWII.	• US President Ronald Regan's Commission on American Outdoors Report in 1987. • Earth stewardship and sustainability. • Referred to as multi-objective greenways • The suburban regions of 78 large cities in developed countries had 85% faster growth patterns than their urban cores. • Integration between smart conservation and smart growth strategies. • Geographic Information System (GIS).	• Landscape as a model and a building block for urbanism and infrastructure. • As part of the urban landscape, Greenways facilitate the establishment of solutions to integrate infrastructure with variable programming that can treat many problems in cities worldwide. • Ecological restorations of underperformin g sites, streets, and structures. • Increased focus on greenway networks instead of signaler corridors within urban regions. • Climate Change.
Consistent greenway characteristics across all generations	• A means to control urban and economic growth. • Preserve natural, cultural, and scenic resources. • Provide recreational grounds. • A medium that supports safe and healthy mobility alternatives. • Link between the city and the countryside, as well as between communities. • Linearity, continuity (to an extent), and connectivity. • Deliver community amenities that induce economic values, such as enhancing the quality of life, increasing nearby property values, and tourism. • Offer ecological services, including stormwater management. • Access to nature or to constructed natural-like landscapes. • Used in conjunction with planning and design initiatives.				
Project Examples	• Boulevard of Champs Elysees in Paris, dating circa the 1700s. • Emerald Necklace, Boston, US.	• The 40-Mile Loop in Portland, US. • The Open Space Plan for the Commonwealth of Massachusetts 1928.	• Wisconsin Heritage Trails Proposal of 1964. • Platte River Greenway, Denver, Colorado.	• The Promenade Plantée. • Villebois Greenway in Wilsonville, Oregon, US. • Fallowfield Loop, Manchester, UK.	• The High Line, New York, US. • Cheonggyecheon River, South Korea. • Madrid Rio along the Manzanares River.
Major Disciplines	Landscape Architects, City Planners, conservationists, historians, philosophers.	Landscape Architects, conservationists, urban planners, ecologists, historians, philosophers.	Landscape Architects, urban planners, urban designers, urban ecologists, biologists.	Landscape Architects, urban planners, urban designers, urban ecologists, botanists/plant ecologists, landscape ecologists, and architects.	

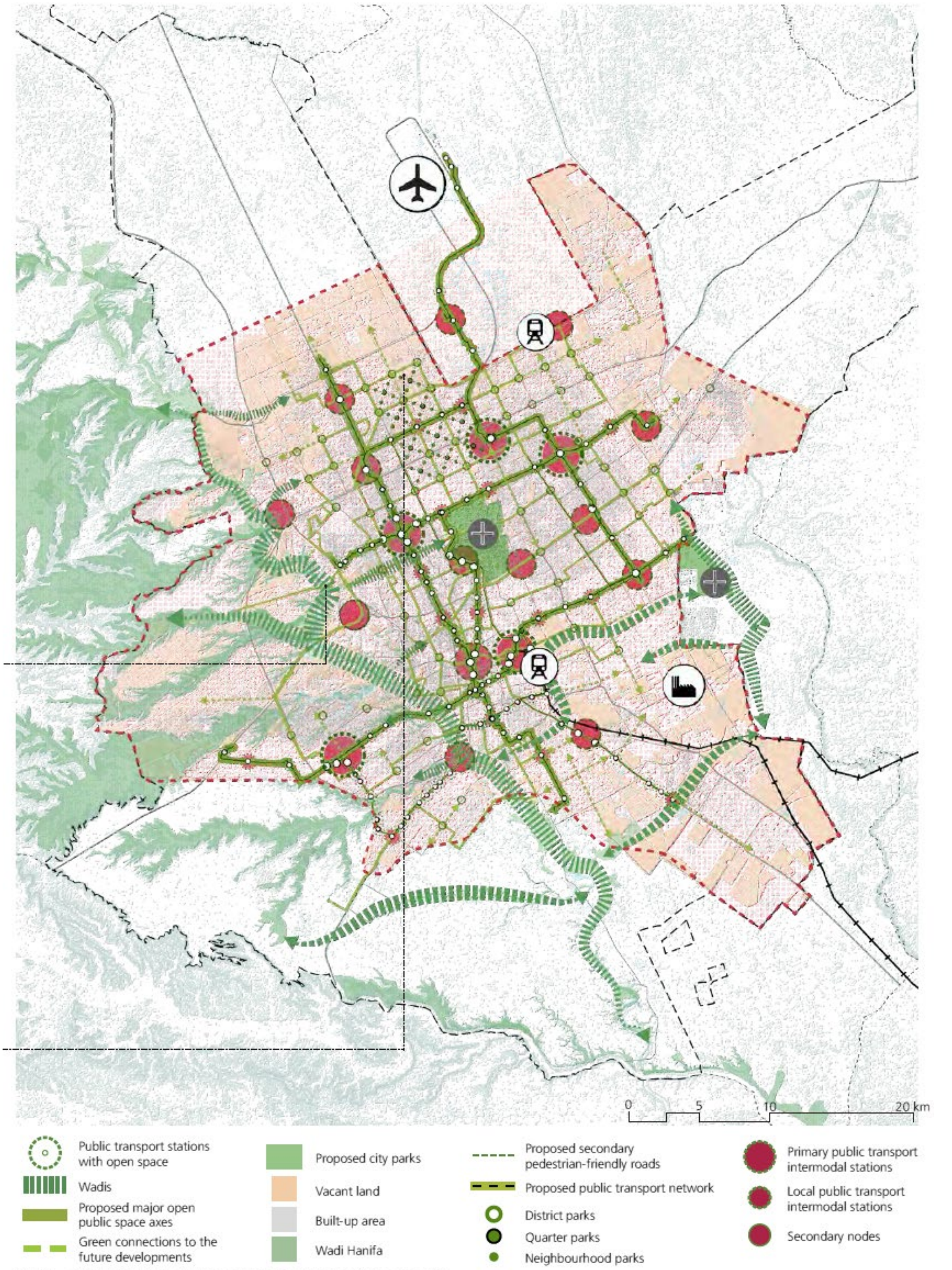


Fig. 51. Action 3: Protect, improve, and re-link green and blue networks

Figure 3-16. Riyadh's future urban development direction shows the integration of greenways with TOD (MOMRA and UN-Habitat, 2019d).

3.6. Chapter three summary

This chapter presented an updated literature review of greenways' evolution while stressing their role as transportation corridors in planning initiatives, policies, and case studies worldwide chronologically (mainly in English-speaking countries). This chronological review of greenways' evolution identified five generations of change, from pre-1900 to date, to provide an understanding of the sequence of events that influenced greenways' form and function, especially as mobility corridors. The review has shown how the concept of greenways has shifted significantly over time in response to technological innovations, the prevalence of automobiles, and other environmental and urban planning imperatives.

This review also related the international evolution of greenways to urban and open space planning in Saudi cities, which is unprecedented in this field. The chronological review identified a greenway planning and design gap between Western societies and SA. Even though implementing Western planning models in SA was inconsiderate of the Arab-Muslim settlements' spatial patterns and social functions, their open space planning was translated superficially (i.e., cosmetic or aesthetic solutions to urban ills). An exception to that conclusion is the mega projects of the past decade, such as the rehabilitation project of Wadi Hanifah, Jeddah Waterfront redevelopment, and Al Safarat district in Riyadh, that exemplify a paradigm shift in how public parks are designed and maintained. However, these projects are isolated cases and do not represent the common practice of creating urban public spaces across the region.

Greenways' multiscale connectivity, multifunctionality, and integration with other planning aims were missing in planning SA's public open spaces. It was not until the past decade, through the comprehensive plans of major cities, that greenway planning practices gained political importance and aligned with international models. Furthermore, the recent recognition of greenways' contribution to sustainable transportation in SA indicates that their function as ATCs will be a differentiating factor compared to past implementations. However, reviewing multiple governmental documents concerning urban planning and design revealed that the absence of key performance indicators for AT and its associated infrastructures (e.g., greenways) in SA at the national and local levels is a key issue. Therefore, measuring greenways' social, economic, health, and environmental benefits is needed to monitor progress, identify problems, and improve performance. Such an aspect is critical because translating Western planning and design models into practice has been a key challenge to realising their objectives.

Therefore, when planned green infrastructures are implemented in Saudi cities, how well would the translated greenway planning concepts perform socially, ecologically, and economically? Even if well-connected and maintained greenways are constructed in such cities, will populations whose cultures and lifestyles are wholly car-dependent use them? More research is needed to understand how the successful greenways of Western societies can be adapted to meet the needs of different urban contexts. Fortunately, a history of built projects and scholarship illustrates the numerous potential benefits of attempting to do so.

CHAPTER FOUR

FACTORS INFLUENCING THE USE OF GREENWAYS AS ACTIVE TRANSPORTATION CORRIDORS

4. Chapter Four: Factors influencing the use of greenways as active transportation corridors[10]

If facilitating active travel is an expected function or an intrinsic quality of greenways, why did many studies report meagre commuting trips via greenways? (Chen et al., 2019; Evenson et al., 2005; Gobster, 1995; Hess et al., 2020; Huh et al., 2015; Lindsey, 1999; Lindsey and Nguyen, 2004; Lumsdon et al., 2004; Mundet and Coenders, 2010; Pettengill et al., 2012; Reed et al., 2011; Troped et al., 2005; Troped et al., 2009; Wolch et al., 2010; Wolff-Hughes et al., 2014). Similarly, should all greenways function as ATCs? If not, what is causing the variation in using greenways as ATCs? (see Section 4.4). What are the characteristics of transportation-led greenways or ATCs? (See Section 4.5). When would greenways be used for commuting purposes? (See Section 4.4). What are the study types and data collection methods used to examine or measure the transportation usage of greenways? (See Sections 4.3.2 and 4.3.3). Which countries contribute most to the existing literature about using greenways as ATCs? (See Section 4.3.1). The answer to these questions contributes to the need for further research on the utilitarian usage of greenways (Chen et al., 2019). Therefore, this research aimed to identify and analyse influences on using greenways as ATCs via a systematic review. Though a recent paper used a systematic review to identify and analyse the influences on the use of greenways (Paneerchelvam et al., 2020), to the best of the authors' knowledge, no review has focused on their usage as ATCs. Doing so enhances the understanding of active commuters' perceptions, behaviours, and needs of greenways and how they differ from other user types. These results contribute to activating greenways' function as facilitators of AT.

4.1. Theoretical Framework

Several behavioural change theories and models, such as Schneider's (2013) "theory of routine mode choice decisions", Alfonzo's (2005) "Hierarchy of Walking Needs Within a Social-Ecological Framework", and Saelens et al. (2003) "ecological model of neighbourhood environment influence on walking and cycling", explained that factors influencing people's decision to walk or cycle are multidimensional. It involves understanding complex interactions between personal (e.g., demographics and health), psychological (e.g., attitude and perceptions), behavioural (e.g., self-efficacy), situational (e.g., travel time and cost), temporal (e.g., time of the day), sociocultural (e.g., community norms), regional (e.g., climate and topography), built environmental (e.g., safety, accessibility, and comfort), and policy factors (e.g., incentives and programs). These behavioural change theories can be understood within a larger theoretical framework of urban social-ecological-technological systems (SETS), whereby urban form and function are the product of intersecting natural, human, and technological phenomena (McPhearson et al., 2022). In undertaking a review of urban

[10] The Systematic review was published in the Sustainability Journal (Zawawi et al., 2023). Minor refinements were made to this version to match the thesis format. These include, font change, table reformatting, Section numbering, and changing from American to British English spelling. In addition, most of the introduction was deleted since it is part of Chapter One.

mobility via greenways, it was, therefore, necessary to include literature from a wide range of disciplinary perspectives to ensure all these dimensions are included.

As such, the theoretical framework guided the systematic review to enhance the understanding of where and when greenways influence one's decision to travel actively for commuting purposes. Specifically, in addition to the systematic review results, behavioural change theories and models helped form connections between various factors and influenced the proposed conceptual framework (see Section 4.5.1). They also facilitated the identification of unexamined research areas that may inform the planning and management of greenways, including as ATCs. These contributions strengthen the foundation of knowledge about the AT function of greenways, enhance the accessibility of available evidence to decision-makers, and identify knowledge gaps in this field.

4.2. Method: Systematic Review

To achieve the abovementioned goals, the authors conducted a systematic review using protocols of the Preferred Reporting Items for Systematic Review Recommendations (PRISMA Statement) (Page et al., 2021). The PRISMA checklist documents are provided in the supplementary materials of Zawawi et al. (2023). Additionally, this review was not registered in PROSPERO because it did not measure health outcomes but behaviours (a review protocol was not prepared).

4.2.1. Identification of Studies

The identification of studies via databases about the usage and users of greenways from 1991 until June 2021 had two phases (see Figure 4-1). The search terms provided in Table 4-1 were used to identify the relevant articles in both phases. Moreover, studies were identified using Web of Science, Science Direct, and Scopus databases. Compared to Zawawi et al. (2022a), only journal articles were considered since they typically comprise full methodological details and results that permit a fair assessment of study bias, as required in the PRISMA 2020 checklist (Page et al., 2021). In addition, unlike the previous study (Zawawi et al., 2022a), the presented systematic review included articles (in its first phase) that examined the economic, social, ecological, health, and economic impact of greenway usage. Such a wide scope offers the opportunity to reflect on the greenway usage literature comprehensively. The last difference between the current and the previous systematic review (Zawawi et al., 2022a) is the inclusion of articles that primarily collected data from secondary sources. One of the lessons learned from the previous attempt is that numerous journal articles in the greenway usage literature relied on crowdsource data, automated counters (data from secondary sources), and self-tracking applications, such as Codoon, Strava, MapMyFitness, and more. Despite the advantages of primary source data, they are often unfeasible in such a field. Additionally, these technological advancements broaden research possibilities and could enhance scientific objectivity. Thus, the systematic review was repeated, yielding different results than the first attempt.

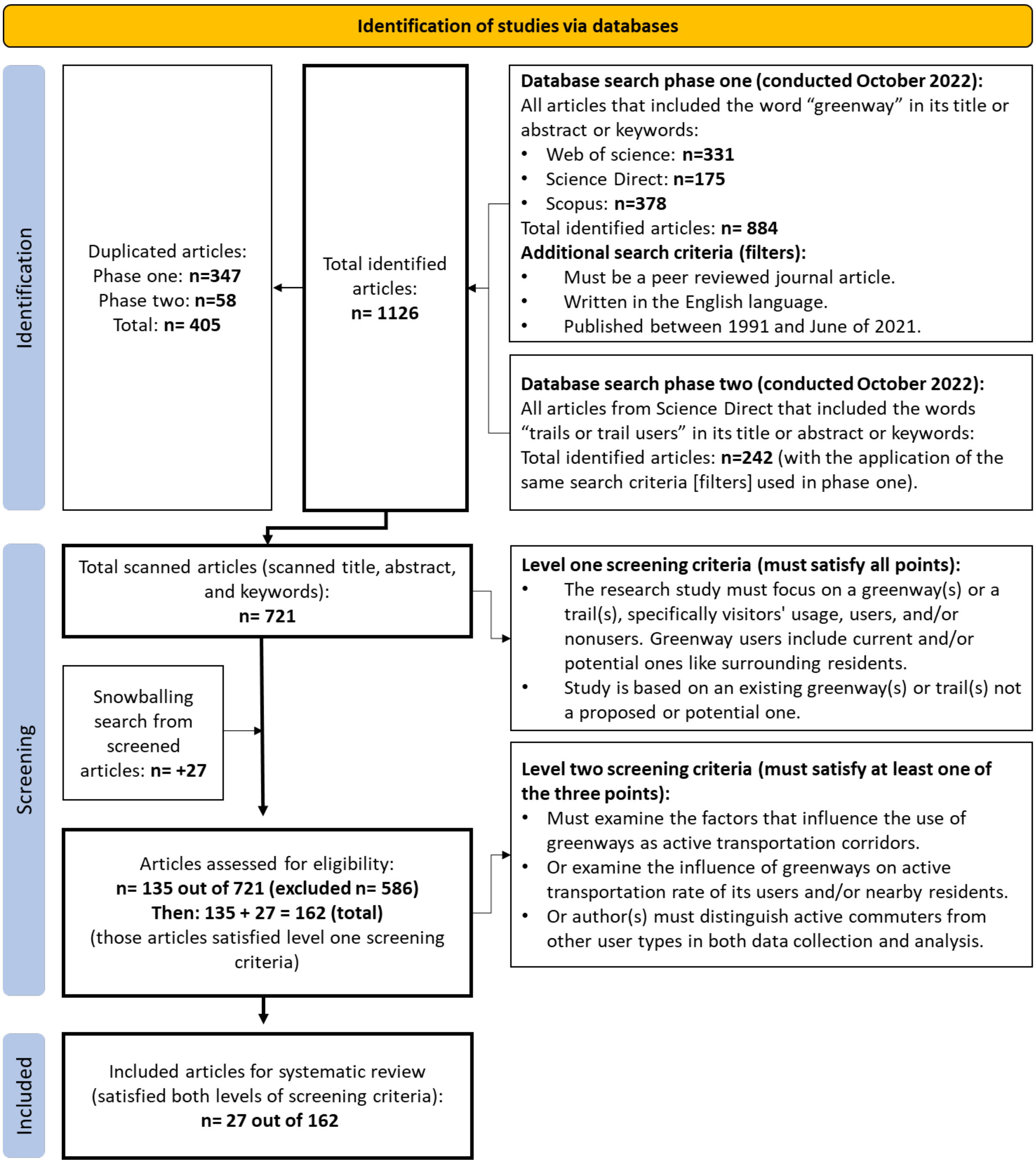


Figure 4-1. Systematic literature review flow diagram.

Table 4-1. Database search strategy.

Electronic Database	Search Terms (All Conducted in Early October 2022)	Results
Web of Science (Core collection)	Used the term "greenway" (via Clarivate) and filtered search results to only show journal articles written in English and published from 1 January 1991 until 30 June 2021.	331
Science Direct	Phase one: used the term "greenway" to identify articles with such a term in their title, abstract, or keywords. Search results were filtered to only show research articles written in English, published from 1991 until 2021.	175
	Phase two: used the term "trails or trail users" to identify articles with such a term in their title, abstract, or keywords. Search results were filtered exactly like in phase one.	242

Scopus	Used the term “greenway” in the search field, then limited the search results using the following Boolean term: TITLE-ABS-KEY (greenway) AND PUBYEAR > 1990 AND PUBYEAR < 2022 AND (LIMIT-TO (PUBSTAGE, “final”)) AND (LIMIT-TO (DOCTYPE, “ar”)) AND (LIMIT-TO (LANGUAGE, “English”)) AND (LIMIT-TO (SRCTYPE, “j”))	213
Total (includes duplicate articles from multiple databases)		1126

Snowballing of screened journal articles added 27 articles that satisfied the first screening criteria.

The database search in phase one had several search criteria. The term ‘greenway’ must be part of an article’s title, abstract, or keywords. Furthermore, it must be a peer-reviewed journal article, written in English, and published between 1991 and June 2021 (added filters). These search terms resulted in 884 articles (a combined total of phase one).

Examining the reference list of recent literature reviews about greenways’ usage (Horte and Eisenman, 2020; Paneerchelvam et al., 2020; Senes et al., 2017) revealed that the database search of phase one did not capture all relevant papers. These uncaptured articles mainly used trails as a synonym for greenways. Therefore, the second phase searched the Science Direct database using the term “trails or trail users” and the same search filters used in phase one to capture other relevant articles, adding 242 articles. Therefore, identified studies from both phases totalled 1126 articles.

Despite these efforts, a comparison between the identified journal articles and recent literature reviews about greenways’ usage (Horte and Eisenman, 2020; Paneerchelvam et al., 2020; Senes et al., 2017) revealed that such a measure (i.e., phase two) did not capture all relevant articles. Therefore, the snowballing process added a total of 27 articles.

Before the screening process, EndNote X9 was used to find duplicates in the identified literature of both phases automatically. Such a method did not capture all duplicates. Thus, manual examination of duplicates was applied as well. As shown in Figure 4-1, phase one had 347 duplicates. The addition of phase two articles resulted in 57 duplicates, amounting to 405 articles in total for both phases (excluding nearly 36%). Microsoft Excel (version 2305) was used to organise and analyse results.

4.2.2. Screening

Screening aimed to identify studies that had AT usage of greenways as a part of their data collection and analysis (see Figure 4-1). Therefore, two levels of screening criteria were used for articles that satisfied the search terms mentioned in Section 4.2.1. The first screening criteria level included articles that focused on usage and users of greenways. Additionally, the study must be based on an existing greenway, not a proposed or a potential one. Thus, studies that incorporated stakeholders’ preferences on a potential greenway development or plan were not included since they are outside the scope of this systematic review. The same applies to studies that aimed to analyse factors influencing AT usage because they are often unfocused on greenways. To clarify, Li and Fan (2020) and Krizek et al. (2007) are two studies that examined the influences on cyclists' travel route choices. Only the latter was included since it focused on the effect of an urban trail system on cyclists' travel route choice. Thus, the latter study can be viewed as a subcategory of studies similar to Li and Fan's (2020), which aimed to examine influences on bicycle usage. With that in mind, the authors successfully retrieved all articles sought for screening via the University of Nottingham's institutional access and library. The extensive first-level screening included 135 out of 721 articles (586 were excluded). With the addition of articles identified via the snowballing method (n = 27), the total became 162 articles.

These 162 articles were classified based on greenway type, country, region/city, contributing academic journals, and study types. Data registration and analysis were achieved via an extensive reading of the included articles and tabulating results via a Microsoft Excel spreadsheet. Such an effort contributes to clarifying the state of existing literature about the usage and users of greenways internationally and improving access to available evidence to decision-makers and future research. The greenway typology used to differentiate between these articles was influenced by Horte and Eisenman (2020). They provided a detailed description of five urban greenway types. However, what is not part of their typology is a multi-setting greenway resulting from its scale, connecting rural to/from the urban context. Similar to those studied by (Jestico et al., 2017; Mundet and Coenders, 2010), greenways of such type are difficult to classify solely based on their landscape context. In other instances, many scholars examined several greenway types in a study. Thus, the multitype greenway(s) was added as a category, amounting to five greenway types used for this study. They are waterfronts and riversides, rail-to-trails, natural trails, active travel corridors (including the freeway-to-greenway type), and multitype greenways. In short, as a result of the first screening criteria, all 162 articles were analysed and categorised based on greenway type, location, contributing academic journals, and study types.

The second screening criteria level was applied to the 162 articles to ensure that an included one must satisfy at least one of three conditions. As shown in Figure 4-1, an included article must examine the factors that influence the use of greenways as ATCs, the influence of greenways on the AT rate of their users or nearby residents, or the collected data must distinguish commuters from other user types in both data collection and analysis. Thus, the second screening level required reading the aim(s), method(s), and result(s) of the 162 papers. Microsoft Excel spreadsheet was used for the tabulation of results. Only 27 out of 162 articles satisfied the second screening criteria and were included for a detailed analysis and synthesis to identify the influences on greenways' usage as ATCs.

4.2.3. Analysis and Synthesis of the Included Articles

The review of the 27 articles identified greenway use forms and the factors influencing their usage. Forms of greenway usage were either reported by users (e.g., use purpose, frequency, and duration via a questionnaire) or calculated using measurement tools (e.g., pedestrian and cyclists' volumes using automated counters). The detailed analysis of the included articles only considered results related to AT usage of greenways. In cases where the data or presented results of included phase two articles were missing or unclear, the leading author read supporting materials and secondary data sources for confirmation (e.g., American Community Survey and Puget Sound Regional Travel Study). In the few instances where such efforts were unsuccessful, the authors stated, "cannot tell". Therefore, no processes for obtaining or confirming data were involved. The review's analysis and synthesis process was conducted by the first author but supervised by the co-authors.

Influencing factors were divided into socioeconomic and demographic influences, weather and temporal influences, environmental and accessibility influences, influences of greenway characteristics, and travel behaviour and individual influences. Each variable category had multiple factors influencing the transportation function of greenways. The arrival of such an analysis framework resulted from synthesising the identified greenway use forms and the factors influencing their usage as ATCs across the 27 articles. Simultaneously, the classification of influences (i.e., variable categories) was influenced by the literature review of Senes et al. (Senes et al., 2017).

The outcomes of the analysis process specified dependent variables (types or qualities of use) and independent ones (factors affecting their use) and their relationship for each of the 27 articles. However, the nature of influence, precisely the direction of correlation or effect size, was not specified in tables and diagrams (only text). Furthermore, the results presented in tables and diagrams indicated what was found to be an 'influencing' variable because an independent variable (e.g., age) can be a factor that increases or decreases the likelihood of greenway usage. Thus, it depends on the study type (e.g., comparison between two greenways), variable measurement, statistical models, and covariates. For example, age groups are not similarly affected by the factors (e.g., motivation) influencing their greenway use (Chen et al., 2019; Sims-Gould et al., 2019). Additionally, results varied according to differences in greenway types, locations, study objectives, time of year, and analytical methods, making it difficult to identify generalisable patterns. Therefore, the tables and diagrams presented in this review do not specify the nature of influence between the dependent and independent variables for the included 27 articles. In short, the presentation of results was synthesised narratively, not statistically combined, to enhance the communication and clarity of findings.

4.2.4. Risk of Bias and Certainty of Evidence Assessment

As shown in Table 4-2, all the included 27 articles utilised surveys (questionnaires and/or AT traffic counting) as a primary data collection method. Therefore, the risk of bias and certainty of evidence assessment of these studies used a tool adapted by Ravensbergen and El-Geneidy (2022) from the Effective Public Healthcare Panacea

Project for survey-based research in urban planning. Guidelines and evaluation criteria are provided in the article mentioned above. The first author was the only assessor of the 27 articles; however, the assessment was supervised by the co-authors.

The risk of bias assessment included eight categories (see Table 4-3). Rating in each category comprised strong, moderate, weak, not applicable, and cannot tell. In addition, a total or global rate was based on the number of weak ratings. If an article had no weak rating in all eight categories, it would receive a "strong" global score; if it had one weak rating, it would receive a "moderate" global rating; and if it had two or more weak ratings, it would receive a "weak" global rating. A limitation of such a tool is that it does not assess qualitative and non-survey methods, analysis, and results. Therefore, the risk of bias assessment for a few articles is incomprehensive and may not be suitable in a few other cases (n = 2).

Table 4-2. Research design, data collection method(s) and sources, and survey sample size of the included articles in phase two (*n* = 27).

No.	**Included Articles (Phase Two)**	**RD. ***	**Data Collection Method(s) and Sources (Brief)**	**Sample Size ** **
1	(Frank et al., 2021)	A	A questionnaire for surrounding residents of two neighbourhoods (experimental and control groups) and a two-day travel diary (pre–post-study).	524
2	(Krizek and Johnson, 2007)	B	Travel behaviour inventory (survey) administered by the regional planning agency. Additionally, a 24-hour travel diary, interviews via phone calls, and GIS map layers from the Minnesota Department of transportation.	1653
3	(Anderson et al., 2019)	B	Intercept Survey, systematic observations, and ArcGIS 10.3.	122
4	(Auchincloss et al., 2019)	A	An intercept survey, systematic observations, and validated Path Environment Audit Tool. Secondary data collection sources were automated pedestrian and bicycle counts, census data, and crime incidents data.	165
5	(Dill et al., 2014)	A	A survey (via flyers and mail), accelerometers, and person-based GPS for treatment and control groups. GIS map layers and meteorological records were secondary data sources.	843 T.
6	(Krizek et al., 2007)	B	An intercept survey was administered by Hennepin County and ArcGIS.	1486
7	(Taylor and Coutts, 2018)	B	A survey was sent to three schools nearby the greenway.	342
8	(Chang, 2020)	B	Onsite evaluations via the Environmental Assessment of Public Recreation Spaces (EAPRS) tool and onsite surveys.	769
9	(Fitzhugh et al., 2010)	A	Manual count survey of pedestrians, cyclists, and more pre–post-greenway improvement (included intervention and Control Neighbourhoods).	**4**
10	(Hirsch et al., 2017)	C	Collected data from the American Community Survey, historical maps, StreetMap Premium 2010 roads database, Census Transportation and Planning Products, and American Community Survey for Minneapolis	>10,000
11	(Wolff-Hughes et al., 2014)	B	Survey, infrared trail counters, and ArcGIS.	616

12	(Chi and Lin, 2019)	D	Two intercept surveys at different months, observations (guided by post-occupancy evaluation method), and structured interviews	99
13	(Shafer et al., 2000)	B	Intercept survey in three greenways and mail-back questionnaire.	1004
14	(Wolch et al., 2010)	B	Survey of neighbouring residents, assessment of trailside neighbourhood characteristics for three (identified) different greenways, and census data.	490
15	(Burbidge and Goulias, 2009)	C	Three activity diaries were conducted at different times. Additionally, an intercept survey was conducted to identify factors that may hinder trail usage.	426 + 31 total
16	(Sims-Gould et al., 2019)	B	Questionnaire and semi-structured interviews for three schools and ArcGIS. Census data were collected as secondary data sources.	41
17	(Evenson et al., 2005)	A	A telephone survey and ArcGIS.	366
18	(Gobster et al., 2017)	C	Infrared counters and observations (several sites). Meteorological records and census data (American Community Survey) were secondary.	**181**
19	(Cook et al., 2016)	A	Intercept surveys and manual count of trail users for a pre–post-study.	3546 T.
20	(Jestico et al., 2017)	B	Crowdsourced data from BikeMaps.org and observational data that includes manual counts for cyclists and motor vehicles at 32 intersections.	313 T.
21	(Chen et al., 2019)	B	Intercept survey results from two non-profit organisations and data from several built environment variables were collected from multiple sources.	734
22	(Zhao et al., 2019a)	C	Automated counter data for multiple sites and meteorological records from several sources.	**350**
23	(Ermagun et al., 2018b)	C	Inductive loop and passive infrared sensors (32 automated traffic counters on multiuse trails in 13 cities) and meteorological records from multiple sources.	**776**
24	(Hankey et al., 2012)	B	Non-motorised traffic counts at 259 locations (weekdays in September of 2007–2010) and secondary data from several governmental, academic, and public sources.	**86**
25	(Mundet and Coenders, 2010)	B	A questionnaire (filled out by the interviewer or self-administered by the participant).	1261
26	(Lowry and Loh, 2016)	D	A GIS tool and data were collected from the Puget Sound Regional Travel Study 2014 and the master plan by the Seattle Dept. of Transportation 2014.	6036
27	(Pettengill et al., 2012)	B	On-site surveys in three different greenways.	841 T.

* Research designs (RD) are A: Experimental, B: Cross-sectional, C: Longitudinal, and D: case study.

** Sample size of questionnaires (QNR). AT traffic count data are in bold text and measured by the number of days because comparing average daily traffic volumes is standard practice (Ermagun et al., 2018b). Total (T).

Table 4-3. Risk of bias assessment for the included 27 articles.

No.	Journal Articles	Selection Bias	Study Design	Confounders	Blinding	Data-collection Methods	Withdrawals and Dropouts	Intervention Integrity *	Analyses	Global Rating
1	(Frank et al., 2021)	S	S	S	S	M	M	S	S	S
2	(Krizek and Johnson, 2007)	M	M	M	M	S	N/A	N/A	S	S
3	(Anderson et al., 2019)	M	W	M	M	S	N/A	N/A	S	M
4	(Auchincloss et al., 2019)	M	S	S	M	S	N/A	M	S	S
5	(Dill et al., 2014)	S	S	S	S	S	M	M	S	S
6	(Krizek et al., 2007)	C	W	M	M	M	N/A	N/A	S	M
7	(Taylor and Coutts, 2018)	M	W	M	M	M	N/A	N/A	S	M
8	(Chang, 2020)	S	W	M	M	M	N/A	N/A	S	M
9	(Fitzhugh et al., 2010)	W	S	S	N/A	S	N/A	M	S	M
10	(Hirsch et al., 2017)	M	M	M	M	S	C	S	S	S
11	(Wolff-Hughes et al., 2014)	C	W	M	M	S	N/A	N/A	S	M
12	(Chi and Lin, 2019)	W	M	M	M	M	N/A	N/A	S	M
13	(Shafer et al., 2000)	C	W	M	M	M	N/A	N/A	S	M
14	(Wolch et al., 2010)	M	W	M	M	M	N/A	N/A	S	M
15	(Burbidge and Goulias, 2009)	M	S	M	M	M	M	S	S	S
16	(Sims-Gould et al., 2019) **	W	W	W	M	M	N/A	N/A	M	W
17	(Evenson et al., 2005)	S	S	M	S	M	S	S	S	S
18	(Gobster et al., 2017)	M	M	M	N/A	S	N/A	N/A	S	S
19	(Cook et al., 2016)	C	M	W	M	S	N/A	M	M	M
20	(Jestico et al., 2017)	C	W	M	M	M	N/A	N/A	S	M
21	(Chen et al., 2019)	M	M	M	M	S	N/A	N/A	S	S
22	(Zhao et al., 2019a)	S	M	M	N/A	S	N/A	N/A	S	S
23	(Ermagun et al., 2018b)	S	M	M	N/A	S	N/A	N/A	S	S
24	(Hankey et al., 2012)	M	W	M	N/A	S	N/A	N/A	S	M
25	(Mundet and Coenders, 2010)	M	M	W	M	M	N/A	N/A	M	M
26	(Lowry and Loh, 2016)	M	M	W	M	S	N/A	N/A	M	M
27	(Pettengill et al., 2012) **	W	W	W	M	M	N/A	N/A	M	W

S: strong, M: moderate, W: weak, C: cannot tell, N/A: not applicable. * Measuring the consistency of intervention exposure (i.e., greenway) in experimental studies was assessed based on calculating the distance from participants' home addresses to the constructed greenway(s). Such a criterion was based on several studies that evidenced the influence of greenways' proximity on physical activity and active travel. ** Qualitative studies (affected rating).

As for the certainty of evidence, the assessment used Prince et al. (2021) decision rules and interpretation of results. However, the risk of bias assessment results was based on the version by Ravensbergen and El-Geneidy (2022), adapted from the Effective Public Healthcare Panacea Project. The evaluation approach of Prince et al. (2021) adapted the GRADE framework (Grading of Recommendations, Assessment, Development and Evaluations), which has five domains: risk of bias, inconsistency, indirectness, imprecision, and publication bias (i.e., reporting only significant or positive results) (Guyatt et al., 2011). Specifically, the assessment considered the research design of articles indicating an outcome (benchmark 75%) as well as consistency of effect (heterogeneity of results), global representation of studies' sample (i.e., external validity), number of studies and participants across all studies (benchmark 10,000), and publication bias. Since several studies primarily used pedestrian and bicycle counts as a data collection method, their external validity considered several factors. These were duration (continuous or short durations), temporal variety (i.e., different seasons, day of the week, and time of the day), location (i.e., different geographic parts of a region, land uses, and socioeconomic characteristics of a community), and technology (automated or manual) (Nordback et al., 2016).

Evaluation of the certainty of the evidence outcome has four categories ranging from high to very low. These scores reflect the confidence in the true direction of the association and the likelihood of future research to change the confidence of that effect. Prince et al. (2021) explained that scores are initially based on the research design. Experimental and longitudinal designs begin with a high score (or when they represent > 10% of studies), and cross-sectional designs begin with a low score (or when they represent ≥ 90% of studies). From there, the score could be downgraded based on the assessment criteria (scale from −1 to 0). For example, if more than ≥ 75% of studies had a moderate/weak global rating score for the risk of bias, it would lose 0.5 points (if ≥ 75% were weak, then −1). The sum of all domain scores determines the certainty of evidence, which was applied to all influencing factors to greenways' usage as ATCs (e.g., gender, distance from home, and more).

4.3. Results

4.3.1. Geographical Location and Greenway Types of the Included Articles

As explained in Section 4.2.2, the first screening level identified 162 articles about the usage and users of greenways, which were all classified based on their trail type and location (see Appendix A, Table A1 in Zawawi et al., 2023). This list showed that 61.3% of the identified greenway usage literature is US-based (the same applies to included phase two articles). The second highest number of studies originated from China (8% or 13 studies), showing significant disparities among countries. The biased outcome toward US-based journal articles could be ascribed to the origin of the term greenway (Fabos, 1995). Another plausible explanation is the multiplicity of synonyms for the term greenway. A database search using such a term will never capture all relevant literature because, as Hellmund and Smith (2006) identified, there are 30 synonyms for greenways designations. Such a number would multiply when considering other languages and resources. As a result, database search using additional greenway synonyms (e.g., LPs or parkways or rail-trails), languages, and publication outlets (e.g., books, reports, and dissertations) in identifying studies about the use of greenways as ATCs will certainly yield unidentified literature. These unidentified studies could add, substantiate, or contradict the offered inferences in this systematic review.

A review of the 162 articles identified patterns in contributing academic journals and greenway types. Results showed that 63 journals contribute to publishing greenway usage articles (see Appendix A, Table A2 in Zawawi et al., 2023). Such wide interest indicates the multidisciplinary nature of the literature on greenway usage. Despite the wide variety and disciplines among these journals, there is a clear focus on topics related to landscape and urban planning, public health (especially PA), tourism, and transport.

As for the studied greenway types, 31.5% were multitype greenways (see Figure 4-2). Those studies examined greenways that traverse through multiple settings or studied two or more types of greenways. ATCs and rail trails are mostly US-based studies (see Appendix A, Table A1 in Zawawi et al., 2023). Synthesis of 27 articles revealed that natural trails were not a greenway type examined by those studies. Such a finding affirms that the transport quality of greenways is likely in (sub)urban contexts.

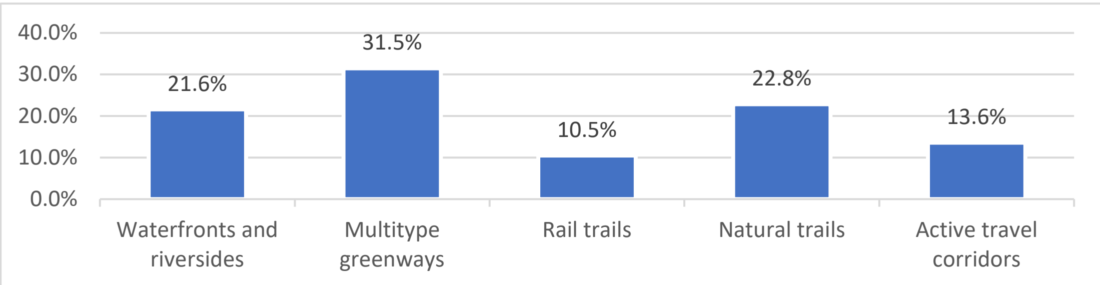


Figure 4-2. Studied greenway types in the 162 journal articles (phase one).

4.3.2. Study Types of Greenway Usage

Synthesis of the included phase one articles identified four study types of greenway usage. Analysing how greenways are used includes the type of use, volumes, frequency, duration, time of visit, intensity, companion preferences, travelled distance, perceptions, attitude perceptions, and more. Methods to measure greenway usage include questionnaires, observations, GPS, self-tracking applications, automated and manual counters, interviews, accelerometers, and more.

With that in mind, the first study type focuses on examining the factors influencing the use of greenways. These factors are numerous, ranging from individual to environmental factors. Furthermore, the greenway's proximity, accessibility, design, and condition are also factors that could influence greenway usage. The second study type concentrates on the effect of greenways' implementation or improvement or proximity on surrounding residents and business owners, including their attitude, PA, travel behaviour (including route choice), social interactions, income, and financial benefits (e.g., travel and healthcare cost savings), and more.

The third study type examines greenway usage's environmental, health, social, ecological, transportation, and economic impacts. For instance, studies about the economic impact of greenway usage frequently examined tourism (e.g., measuring trail demand) and users' expenditures (Ermagun and Lindsey, 2016; Oswald Beiler et al., 2015; Zhao et al., 2018). The ecological impact of trail usage on wildlife, soils, and vegetation is another example of such a study type (Martin et al., 2018; Monz and Kulmatiski, 2016; Sterl et al., 2008). Even though the second and third types may sound similar, they are different. The former includes non-users and focuses on surrounding residents to the site of interest. However, the latter analyses the impact of existing greenway usage (not users per se), which could be positive, negative, or neutral. The fourth study type voices stakeholders' concerns and assesses their satisfaction level to improve existing greenway conditions by analysing their perceptions and preferences. These four study types were common in the greenway usage literature.

4.3.3. Research Designs and Methods of Included Articles

Research design (experimental, cross-sectional, longitudinal, case study, and comparative), methods, examined variables, data types, study location, and greenway type all add to the complexity of greenway usage studies. Most of the 27 studies used quantitative research strategies. Furthermore, nearly 52% used cross-sectional research designs (see Table 4-2). Similar to the conclusions by Evenson et al. (2005) (Evenson et al., 2005) and Wolff-Hughes et al. (2014) (Wolff-Hughes et al., 2014), these results suggest a need for more qualitative research to study, for instance, the influence of trail sitting and design on their usage and users' perceptions. In addition, results show that comparative research designs were not used in the 27 articles. Considering the global standardisation of open space planning and designs, cross-cultural or cross-national studies may, for example, assess the transportation performance of greenways that share similar characteristics. Such an evidence gap could be considered a future research direction that assesses the applicability of greenway planning and designs in contexts of varying nationalities or cultures.

4.3.4. Risk of Bias Assessment Results

Table 4-3 summarises the risk of bias assessment for the included 27 articles. The global rating of all studies revealed that 40.7% were strong, 51.9% were moderate, and 7.4% were weak (see Figure 4-3). Examining the sample's representation of the target population and randomisation of the study design were the primary reasons for the global "moderate" ratings. Articles with a "weak" global rating, specifically for Sims-Gould et al. (2019) and Pettengill et al. (2012), did not control well for confounders in addition to the two factors mentioned above. However, since these studies were mostly qualitative, the adopted assessment criteria may not be suitable despite using questionnaires. In addition, some studies used a questionnaire and AT traffic counting (e.g., Cook et al., 2016). In such cases, the risk of bias assessment considered both methods, especially in the data collection methods category, since the former consists of self-reported data, and the latter consists of measured data. Cells with a "cannot tell" rating were cases that had incomplete or inaccessible information (e.g., secondary survey data sources). In other cases, specifically, Jestico et al. (2017), the sample's representation (from crowdsourced data) of the targeted population is unknown.

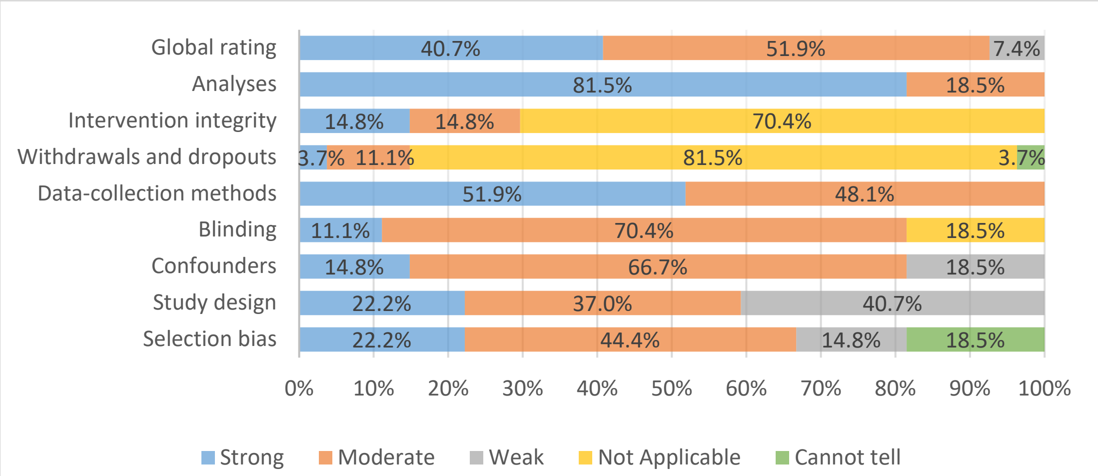
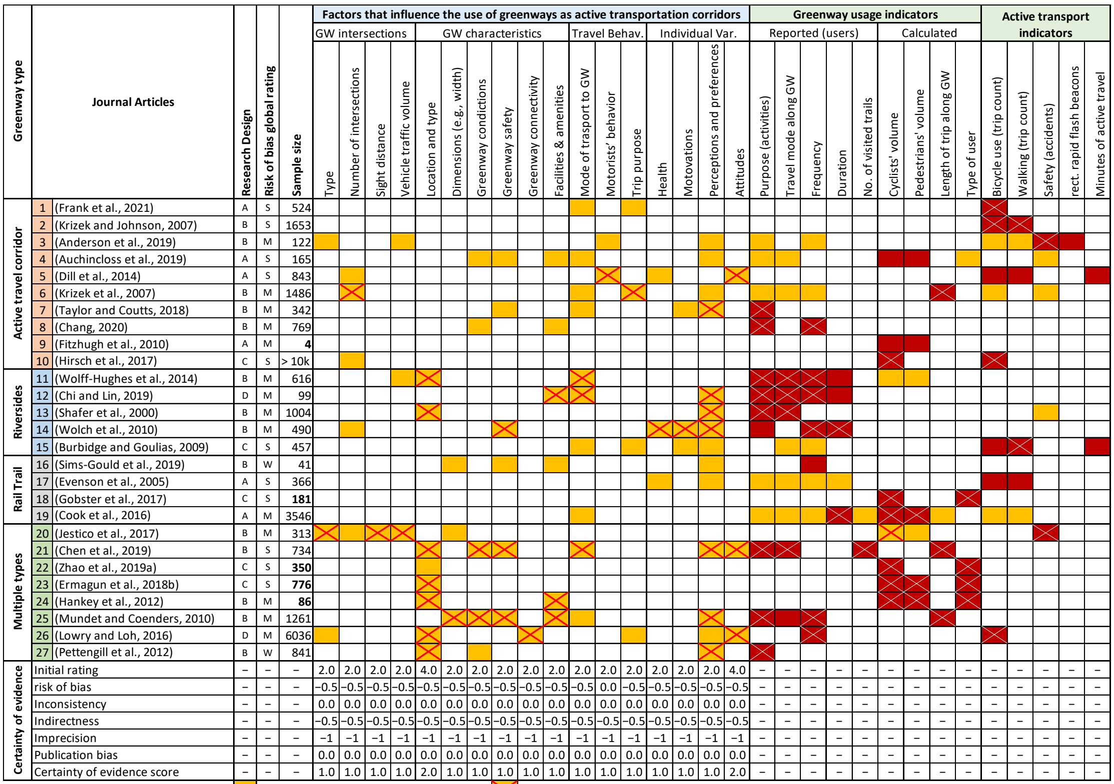


Figure 4-3. A summary of the risk of bias assessment.

4.4. Influences on Greenways Usage as Active Transportation Corridors

In total, nine categories and 51 variables were identified as influences on the transportation function of greenways based on the 27 articles. Figures 4-4 and 4-5 show which variables were examined most, which were least examined, and which identified variables were statistically found influencing across the 27 articles (p-values ≤ 0.05 levels). They also identify which influences had a significant relationship, effect, or difference with a study's dependent variables (e.g., use purpose). Despite the minor overlap between the 27 articles in the examined variables, no study parameters were replicated in different contexts, and none considered all variables (potential endogeneity problems). These differences reflect the variations in study goals, methods, data availability, location, greenway type, authors' specialisation, budgets, and more. Nonetheless, establishing standardised research protocols to examine the influences on greenways' usage for transportation is needed for a more effective synthesis of effect measures. The certainty of evidence assessment for each influencing factor is also part of Figures 4-4 and 4-5. Adding the research design, global rating for the risk of bias, and sample size to these figures facilitated the assessment process. The following paragraphs provide a summary of those findings as well as an interpretation of the certainty of evidence assessment results[11].

[11] see Zawawi et al. (2023) for the full narrative synthesis that identifies patterns, inconsistencies, gaps, and direction of association.



Legend: Examined (independent) variable; Examined dependent variable; Influencing variable (statistically tested); Significant relationship or affect or difference

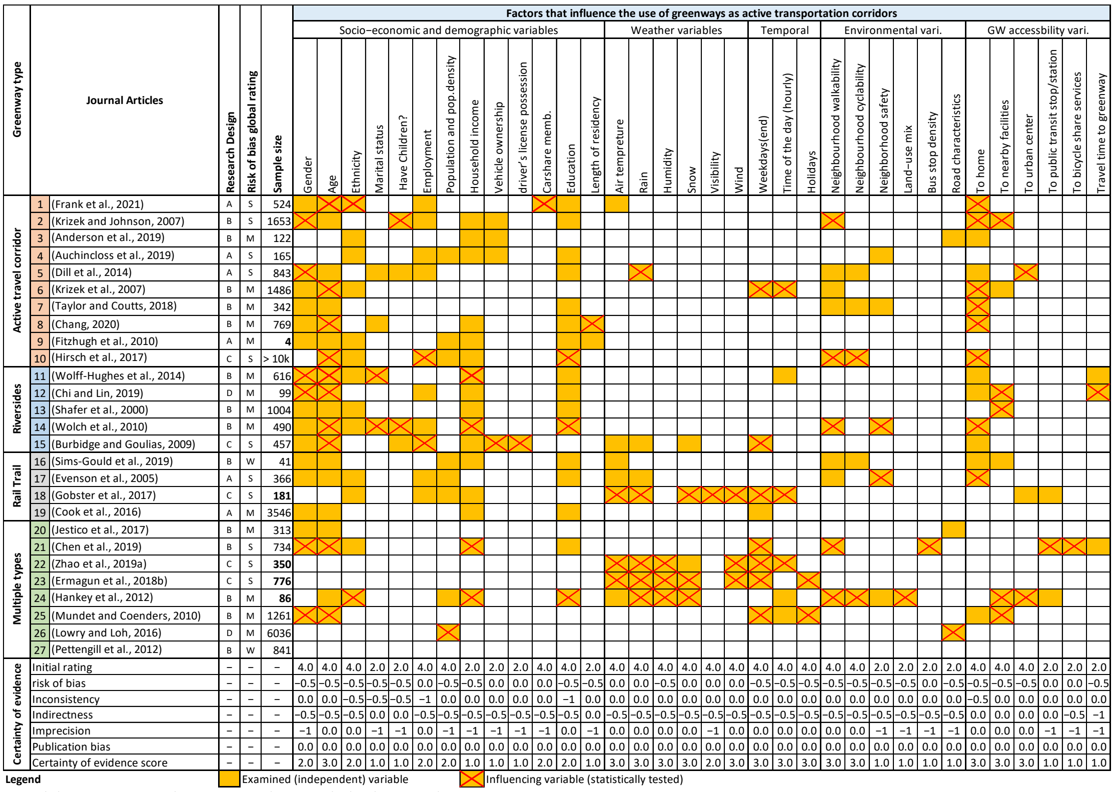
Research designs: A: Experimental, B: Cross–sectional, C: Longitudinal, and D: case study.

Risk of bias global rating: S: strong, M: moderate, W: weak.

Certainty of evidence scores: High (4.0), Medium (3.0), Low (2.0), Very low (1.0).

Sample size: numbers in bold are active travel traffic count data measured by the number of days.

Figure 4-4. Summary of the influences on greenways usage as ATCs (Part One).



Legend: Examined (independent) variable; Influencing variable (statistically tested)

Research designs: A: Experimental, B: Cross–sectional, C: Longitudinal, and D: case study.

Risk of bias global rating: S: strong, M: moderate, W: weak.

Certainty of evidence scores: High (4.0), Medium (3.0), Low (2.0), Very low (1.0)

Sample size: numbers in bold are active travel traffic count data measured by the number of days.

Figure 4-5. Summary of the influences on greenways' usage as ATCs (Part Two).

Based on the review of the 27 articles, active commuters via greenways are more likely to be younger than 40 years old, educated, never married, and from the middle class. They also have intrinsic motivation and a positive attitude towards active travel, and incentives such as end-of-trip bicycle facilities could influence them.

Active commuters' trips via greenways are usually made daily during weekdays, alone, and with less time spent on greenways, especially when compared to recreational uses. While both user types tolerate a slight increase in trip distance to benefit from greenway usage, active commuters' travel distance margin of increase is less than recreational users.

As for the factors affecting the transportation function of greenways, their location, weather, width, safety, maintenance, and available facilities were major influences. The same applies to the walkability and cyclability of their surrounding neighbourhoods (including safety, comfort, and accessibility). Furthermore, greenway's proximity and connectivity to home addresses and other daily commutes (e.g., utilitarian and recreational facilities), specifically less than 400 m, significantly increased their usage as ATCs. Therefore, greenway arrivals via non-motorised modes of transport were more likely to use them for commuting purposes.

Evaluation of the certainty of evidence for 51 influences on greenways' usage for AT, based on the included phase two articles, revealed that 14 (or 27.5%) scored medium, 9 (or 17.6%) scored low, and 28 (or 54.9%) scored very low. Influences that scored medium were age, air temperature, rain, humidity, snow, wind, weekday(end), time of the day, holidays, neighbourhood walkability and cyclability, greenway's distance from home, nearby facilities (e.g., commercial and educational destinations), and urban centres. Influences that scored low were gender, ethnicity, employment, carshare membership, education, visibility (clear and sunny conditions), greenway location and type, and attitude. The rest were very low (see Figures 4-4 and 4-5).

Several factors affected the certainty of evidence assessment outcome. First, 59% of the included phase two articles adopted cross-sectional and case study designs, which limits those causal inferences. Second, 51.9% of the included articles had a moderate risk of bias global rating score, and 7.4% had a weak score. Third, the external validity of the included articles (indirectness), which was part of the risk of bias assessment (see Table 4-3). Fourth, the number of articles contributed to an outcome—many outcomes, such as bus stop density, visibility, distance to bicycle share services, and more, had one study evidencing their influence on greenways' usage for AT. The certainty of evidence results stresses the need for more longitudinal and experimental studies, standardisation of research protocols for examining greenway usage to enhance the validity of results, and further research on influences with low and very low scores.

4.5. Discussion

One of the major issues regarding identifying relevant literature was determining what is and is not a greenway in the urban context. As illustrated by Kullmann (2011), linear parks in cities can exist in several forms, and they usually involve a regeneration/restoration of underperforming and abandoned city infrastructure. However, would all regeneration/restoration efforts automatically transform these streets and abandoned infrastructure into greenways? Due to the overlapping agendas and characteristics between urban greenways (i.e., ATCs) and other policies and design approaches, such as complete streets, identifying urban greenway(s) projects and literature may lead to subjective interpretations that prevent a clear exchange of ideas and evidence-based research.

In addition to the intrinsic qualities of greenways (Ahern, 1995), several scholars and city plans highlighted unique characteristics of transportation-led greenways or ATCs (City of Minneapolis Street Design Guide, 2021; Horte and Eisenman, 2020; Liu et al., 2020; Ngo et al., 2018; Portland Bureau of Transportation, 2021). Unlike complete streets, where all modes of transport are made comfortable, safe, convenient, and accessible for all ages and abilities (Smart Growth America, 2018), ATCs prioritise active commuters in many respects. Primarily, such prioritisation is achieved via the creation of quiet and slow streets, implementation of traffic-calming measures, provision of pedestrian and bicycle facilities and amenities, street vegetation, wayfinding signages, and linkages to recreational and utilitarian destinations. The highest level of prioritisation would be to prevent automobile access for the majority or the entire day (via, for instance, pedestrianisation).

Another notable difference is that ATCs are not only about narrowing or reducing automobile traffic speeds and lanes to add or widen sidewalks and cycle routes. Therefore, we are offering the following definition: ATCs or transportation-led greenways are designed or reclaimed transport infrastructure (due to their abandonment or underperformance) within (sub)urban areas that prioritise safety, comfort, and accessibility for active commuters while performing several functions such as placemaking and ecological services. Despite ATCs' multifunctionality, their high transportation impact (or value) differentiates them from other urban greenway types (Liu et al., 2020).

4.5.1. The Conceptual Framework

A conceptual framework that synthesises research findings and relates to existing behavioural change theories and conceptual frameworks was developed to enhance understanding of the factors influencing people's decision to walk or cycle for transportation via greenways (see Figure 4-6). Doing so also identified future research directions that may inform greenway planning and management, including as ATCs.

Before the use of greenways as ATCs, the systematic review results showed that an individual's health status, perception, preferences, motivations, and attitude towards walking and bicycling for transportation are significant influencing factors to their use for such purposes (Chen et al., 2019; Chi and Lin, 2019; Lowry and Loh, 2016; Mundet and Coenders, 2010; Shafer et al., 2000; Wolch et al., 2010). However, concepts highlighted by the Social Cognitive Theory (Bandura, 1986) were not considered in the most relevant literature (see Appendix A, Table A1 in Zawawi et al., 2023). Concepts such as self-efficacy (confidence to perform the action and overcome barriers such as bicycling along traffic), behavioural capability (knowledge and skill to AT), and observational learning (behavioural acquisition via observing the activities and results of performing that behaviour) can affect bicycling behaviour (Bopp et al., 2018). Alfonzo's (2005) social-ecological framework explained that feasibility factors such as age, weight, physical mobility, time available, trip cost, responsibility for children, elderly, or other commitments could also affect one's decision to drive an automobile or walk. Awareness and availability of AT modes (e.g., bicycle ownership) are positively related to bicycling (Handy et al., 2010). Therefore, when considering walking or cycling for transportation as a behaviour, individual factors can significantly influence that behaviour.

Social support for AT, having a spouse or colleagues who actively travel, subjective norms for AT, and perceived support from an employer positively influence walking and cycling for transportation (Bopp et al., 2018). In the case of children, parents' schedules, attitudes, and participation in AT as well as perceptions of neighborhood safety and security, are among the factors influencing children's active commuting to school (Bopp et al., 2018; Panter et al., 2008). Studies about the Sociocultural factors in SA revealed additional, yet crucial, dimensions that may affect AT, which include religious beliefs, perceptions of privacy, and social norms (Almahmood et al., 2017; Maghrabi, 2019; Zawawi et al., 2022b). Alfonzo (2005) classified these sociocultural factors as moderators at the group level, which are part of an individual's life cycle circumstances. Would the provision of greenways influence the attitudes of residents living in automobile-centric societies towards AT? In short, sociocultural factors are important considerations in understanding travel mode choice decisions.

Several theories and conceptual frameworks identified security, safety, accessibility, cost, comfort, and pleasurability of the built environment as influences on active commuting (Alfonzo, 2005; Bopp et al., 2018; Sallis et al., 2006; Schneider, 2013). These influences overlap with several walkability and bikeability theories and conceptual frameworks that relate urban form and design qualities to walking and bicycling behaviour. These include, but are not limited to, Jeff Speck's General Theory of Walkability (Speck, 2012), Ewing and Handy's (2009) conceptual framework, and Saelens et al.'s (2003) ecological model of the neighbourhood environment. As explained in Section 4.4, urban greenways located within walkable neighbourhoods influence their usage for commuting purposes. Thus, their integration into, for instance, transportation plans to improve intermodal passenger transport efficiency could maximise their potential as ATCs.

Reforming urban laws to build healthy, equitable, resilient, safe, and walkable environments is an essential form of change to enable AT via greenways. According to the UN-Habitat (2016), urban law is "*the broad ranging collection of diverse policies, laws, decisions and practices that govern the management and development of the urban environment*." (p.7). Urban management and development dimensions are important because several scholars argued that projects such as the High Line in New York, US, the Promenade Plantée in Paris, France, and the Atlanta BeltLine in the US are drivers of gentrification and economic inequality (e.g., displacement of locals, small businesses, and industry) (Birge-Liberman, 2017; Heathcott, 2013; Larson, 2017; Loughran, 2017; Roy, 2014). Therefore, urban laws are crucial to balance public and private interests when building a framework for implementing walkable and bikeable urban environments.

AT facilities (e.g., bicycle parking, shower/locker rooms), incentives, and support from workplaces/schools/municipal bodies influence active commuting to daily commutes (Bopp et al., 2018; Guttenplan and Patten, 1995). Advocacy for AT through political support, social media engagement in communication about their benefits, educational programs, community events, and more can increase participation in active commuting (Richards et al., 2010). The review of the 27 articles showed who typically commutes via greenways and where, when, and with whom. Therefore, future studies may focus on who is not commuting via greenways (omitted selection) and how to address the challenges associated with such groups or conditions. Non-users of greenways are one of many stakeholders who may directly or indirectly be affected by the design and regulations of such facilities. For these reasons, stakeholders' participation in the research, planning, and management of greenways is vital.

The proposed framework in Figure 4-6 is based on existing travel behaviour change theories, conceptual frameworks, and the systematic review results. As such, it enhances the understanding of individual and environmental domains. Specifically, how they integrate and interact, responding to a need stressed by several scholars (Panter and Jones, 2010). Unlike leisure walking and bicycling, active commuting (to work, school, delivery of goods, meeting a friend, and more) has a defined destination. Therefore, the proposed conceptual framework is built around a hypothetical trip with a defined origin and destination. In that framework, a person's (or persons') walking or cycling for transportation via greenways to access a desired destination is the dependent variable, which is similar to the most relevant literature (see Appendix A, Table A1 in Zawawi et al., 2023). The rest of the factors are moderators (e.g., outdoor temperature) and independent variables (e.g., gender). The red dotted line represents the context in which the origin, destination, and route connecting both exist. In short, the presented conceptual framework builds an understanding of the influences on a person's or group's decision to incorporate greenways in their journey to daily commutes.

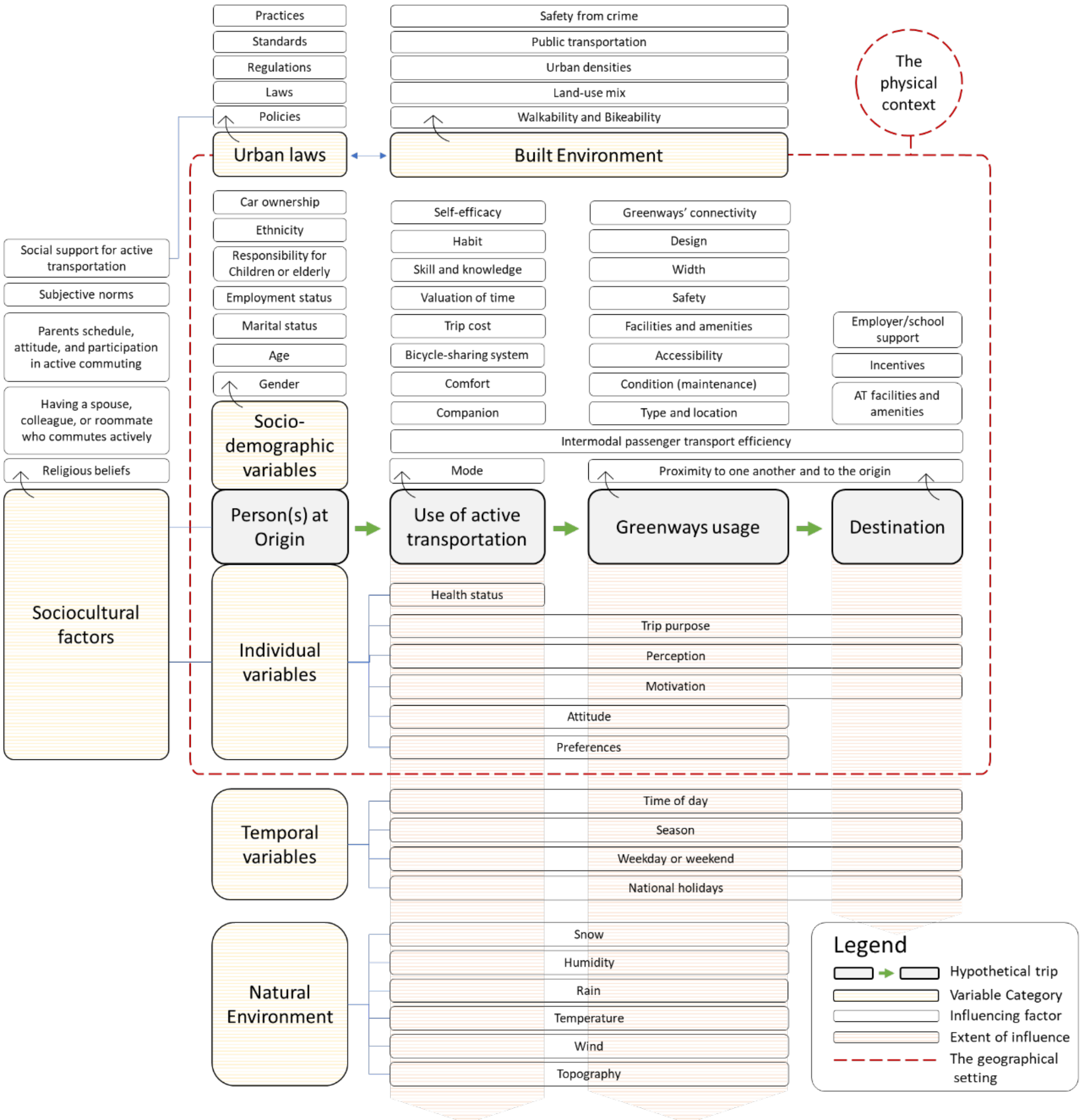


Figure 4-6. A conceptual framework illustrating the influences on greenways' usage as ATCs, a developed version of the one published by Zawawi et al. (2022a, 2022b).

4.6. Chapter Four Summary

This research has evidenced that influences on the use of greenways as ATCs are multidimensional, transcending disciplinary boundaries. The two-level screening criteria in the systematic literature review identified 162 peer-reviewed journal articles that focused on greenways' use and users in its first level. Each of the 162 articles was categorised based on their greenway type and location to facilitate access to available evidence for practitioners and academics in this field. The second screening criteria identified 27 articles that mainly had greenways' usage for AT as a part of their study. Their review highlighted (I) the characteristics of active commuters via greenways, (II) the nature of their trips, and (III) the influences on the transportation function of greenways. These results emphasised the differences between active commuters via greenways and other user types regarding characteristics, perceptions, behaviours, and needs. Simultaneously, forming generalised patterns about commuters via greenways can be challenging due to the complexity and multidimensionality of the influencing factors.

A discussion of the results identified four study types of greenway usage, highlighted methodological issues in literature reviews about the use of greenways, described the characteristics of ATCs or transportation-led greenways, proposed a conceptual framework that illustrates the influences on greenways' usage as ATCs, and offered directions for future research in this field. The identified greenway usage literature was biased towards US-based journal articles due to the greenway term's origin, the multiplicity of synonyms, and the placed language and publication outlet limits in database search criteria. Furthermore, identifying urban greenway(s) projects and literature may result in subjective interpretations that inhibit clear communication of evidence-based research because ATCs and other policies and design approaches, such as complete streets, have overlapping aims and characteristics. Therefore, to distinguish ATCs, a definition was proposed (see Section 4.5). In addition to the suggested future research directions in Sections 4.4 and 4.5, there is a need to (I) address the population gap in research about transportation usage of greenways (specifically, Middle East, Africa, and parts of Asia), (II) examine the transportation impact of greenways using longitudinal and experimental studies that have objective AT behaviour and physical activity measures, and (III) develop standardised research protocols for examining greenway usage to enhance the validity of the results.

An enhanced understanding of the influences on greenways' usage for transportation would increase their use, maximise their potential, and inform their planning, design, and management. Simultaneously, clarifying the state of existing literature about greenways' usage as ATCs helped identify knowledge gaps in this area, strengthen its knowledge base, and improve the accessibility of available evidence to decision-makers.

CHAPTER FIVE

METHODOLOGY

5. Chapter Five: Methodology

This chapter describes the methodology for this PhD research. The overarching research strategy combines elements of quantitative and qualitative research approaches in the data collection, analysis, and interpretation process to answer the research questions (Creswell and Clark, 2018; Leavy, 2017). Chapter Five begins (in Section 5.1) by explaining the adopted philosophical assumption (or research paradigm), specifically, the epistemology, ontology, axiology, and rhetoric behind the study. Section (5.2) presents the research approach. Section 5.3 describes and justifies the research strategy and design, which is the structural framework for the data collection, analysis, triangulation, and interpretation. Next, Section 5.4 defines the research scope, analyses Jeddah's walkways/LPs, and justifies the selection of representative case studies. Then, Section 5.4 describes the data collection methods. It included the aims, justifications, process, sampling strategy, tools, limitations, and examined variables in each method. Lastly, Section 5.5 explains the data analysis and synthesis process.

5.1. Philosophical assumption

This PhD research adopts a pragmatism worldview. It focuses on "what works" and real-world practice to address the primary research objective (See Section 1.5) (Creswell and Clark, 2017). The creation of greenways as facilitators of AT is a clear development direction in Saudi cities, but active commuting is currently low in SA (See Chapter One, Section 1.4). Therefore, it is possible that even after greenway networks are built in Saudi cities (action), they may not be used as intended (consequence), which is partially to "*support multimodal mobility*" (MOMRAH, 2022b, p.152).

As evidenced by the systematic review in Chapter Four, influences on greenways' usage as ATCs are beyond providing a physical network. They are multidimensional (e.g., perception, greenway design, weather, gender, neighbourhood walkability). From a pragmatist viewpoint, "*knowledge and reality are based on beliefs and habits that are socially constructed*" (Yefimov, 2004, as cited in Kaushik and Walsh, 2019, p.3). Therefore, this PhD research has multiple realities, reflecting residents' opinions, preferences, and experiences of Jeddah's walkways/LPs. As such, the thesis results include biased and unbiased perspectives. Since part of those perspectives originate from the research participants, the language of this thesis employed formal and informal writing styles. Research findings are intended to build an understanding of the activation barriers and strategies of greenways as facilitators of AT in SA, using Jeddah as a case study. Such a goal was partially influenced by Schimel's (2012) view on the role of scientists, which is to "*collect data and transform them into understanding. Their role as authors is to present that understanding.*" (p. 11). Beneficiaries of such maximisation to greenways' benefits include (I) decision-makers who plan and manage greenways, (II) residents of Saudi cities via the increase of livability and accessibility, (III) the environment via the contribution to decarbonising urban mobility, which are central goals of the Saudi Vision 2030 and its Green Initiatives.

5.2. An integrated approach to research in landscape architecture

This PhD research followed an integrated approach to knowledge generation in the field of landscape architecture research, which often includes studies of the sites' physical characteristics and layout (referred to as structure), studies of perceptions (referred to as image), and studies of usage behaviours and the factors influencing them (referred to as action) (Bruns et al., 2017). This is because research about landscapes includes a variety of cultural and social factors in addition to the physical aspects of a place since each area holds various meanings that "*emanate from the values by which people define themselves*" (Greider and Garkovich 1994, p.1, as cited in Bruns et al., 2017). Therefore, understanding the influences on greenways' usage as facilitators of AT followed an integrated research approach that explains the mutual dependencies (see Figure 5-1).

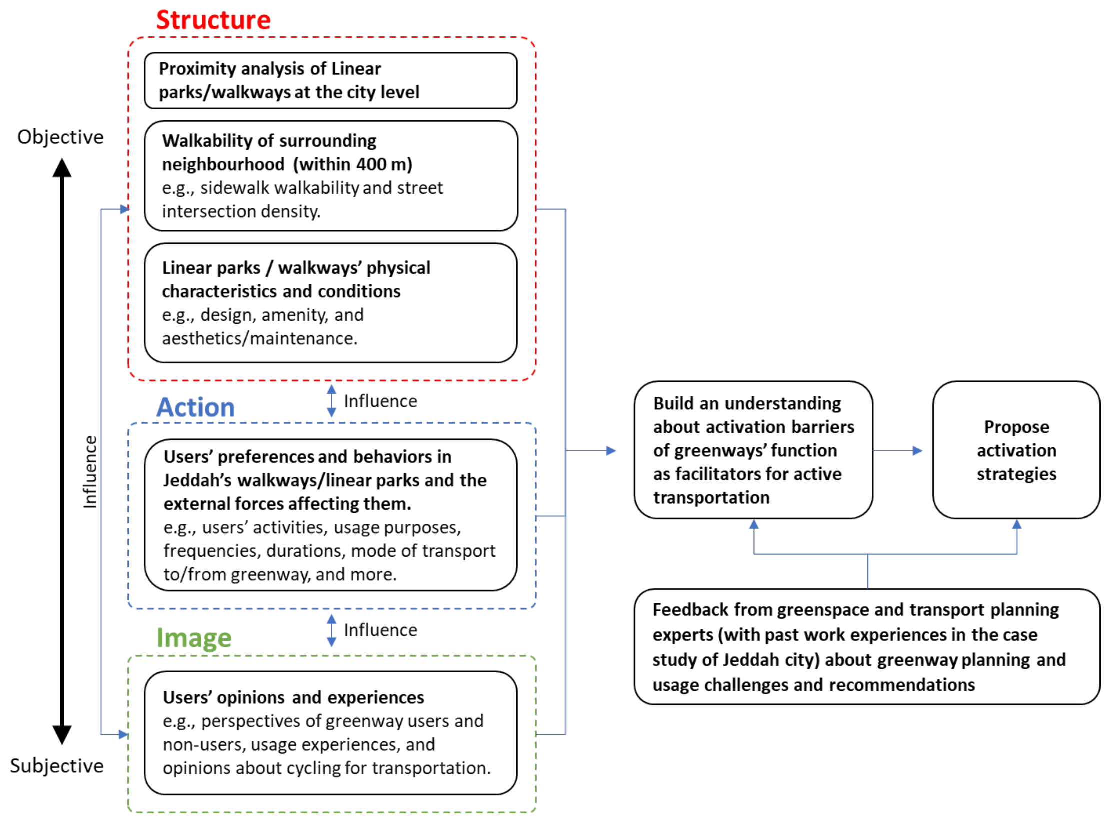


Figure 5-1. The PhD research approach.

In a perfect world, studies concerning the usage of greenways as ATCs would incorporate all the dimensions discussed in the conceptual framework (see Section 4.5.1). However, doing so is impractical and unaffordable, especially in the context of PhD studies, which are usually conducted by one person with time, resources, and regulatory limitations. Therefore, as explained by Bruns et al. (2017), landscape architecture research is usually small in size and short in duration, as observed in the reviewed 162 articles (see Section 4.2.2). The research strategy and design justified the included variables (see Section 5.3).

However, equally important are the excluded variables (also part of Section 5.3). For example, end-of-trip facilities and incentive programs were excluded to narrow the research scope of work on greenways and their usage. Data availability also affected the studied variables. These include factors such as crime rate at the residential district level and crowdsourced physical activity and health data. Practicality-related issues also affected the considered factors. For example, studying the effect of seasonal variations would require visits at different times of the year or automated counters for pedestrians and cyclists. Being based in the UK (Visa and scholarship requirements that limit periods of studying away up to a maximum of 3 months in any 12 months) restricted the amount and type of data that could be collected. Additionally, COVID-19 events made international travel difficult and affected usage patterns of outdoor spaces, which included several lockdown periods. The time, duration, and strictness of COVID-19 restrictions were also unpredictable and differed between the UK and SA. As reported by several scholars (Ermagun et al., 2018a; Bergman and Cohen, 2016), automated counters are susceptible to damage, false readings, and malfunction, requiring occasional physical checks. Therefore, being in the UK for most of the year and COVID-19 constraints restricted the amount and type of data that could be collected.

5.3. Research strategy and design

This PhD research adopted mixed methods case study research due to the complexity of influences on walkways/LPs' function as ATCs (see Chapter Four). The study had two phases (see Figure 5-2). The first phase followed a convergent mixed methods design where both quantitative and qualitative data converged in its analysis and synthesis process, which was thematic. Research findings were triangulated to enhance the understanding of the factors influencing greenways' function as ATCs, specifically showing whether the results of a method support or contradict another while examining new dimensions. Triangulation is also a strategy used to increase the certainty and precision of results (Deming and Swaffield, 2011). Simultaneously, it showed which of the results in phase one needed further explanations before generating inferences; an approach refers to an explanatory sequential design (Creswell and Clark, 2017). Therefore, the topics examined in phase two were influenced by the results of phase one. Furthermore, phase two results aimed to enhance the understanding of these topics while also functioning as a validation strategy that expanded, confirmed, or contradicted phase one results. In short, a combination of quantitative and qualitative research methods was used to enhance the understanding of the factors influencing greenways' function as ATCs as well as the certainty and precision of results.

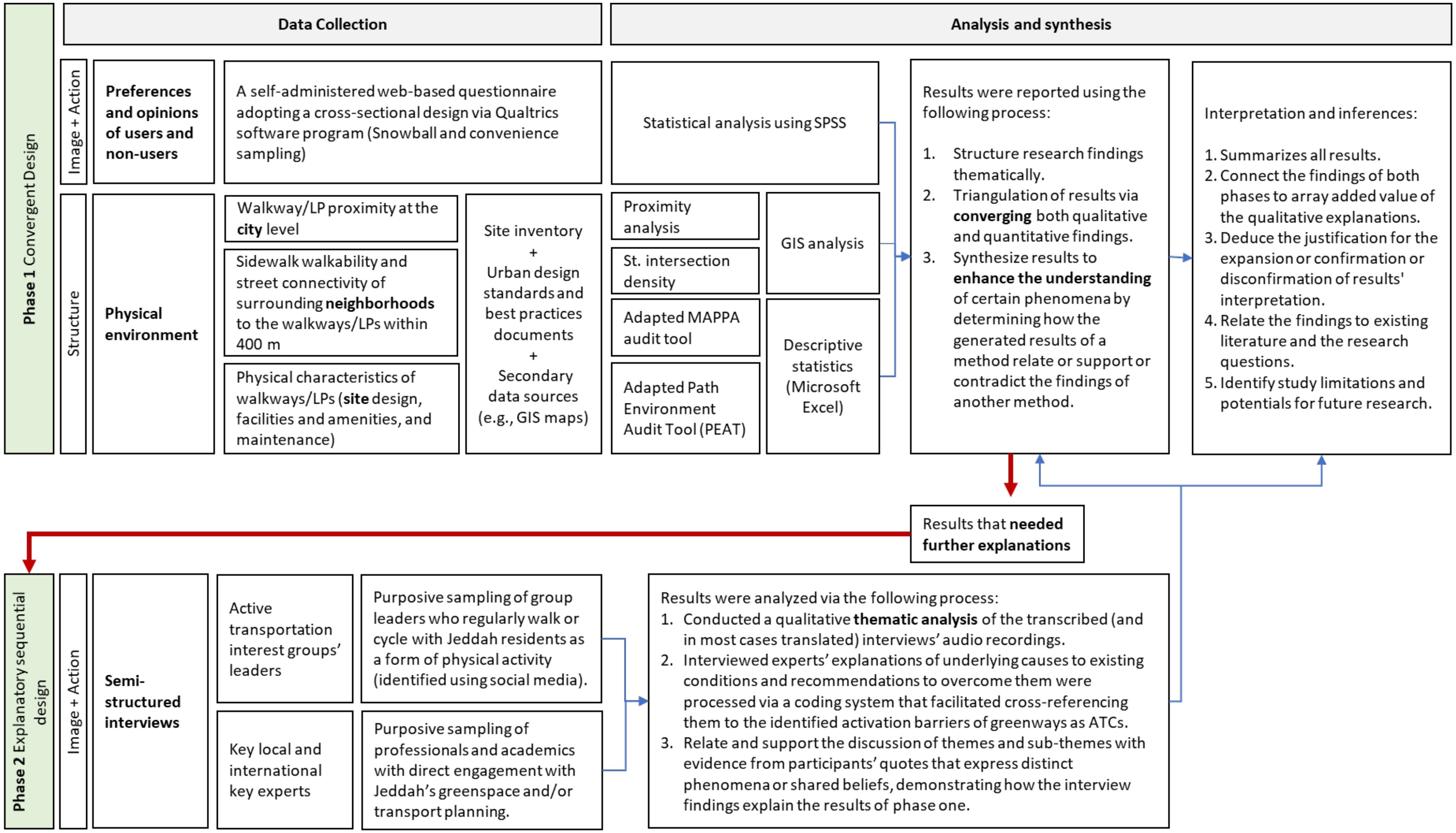


Figure 5-2. An integrated research design illustrating the phased and mixed-methods approach to data collection, analysis, and synthesis.

5.3.1. Phase one: Convergent design

Data collection methods in phase one focused on two elements: (I) the preferences and opinions of walkway/LP users and non-users, and the (II) physical environment (see Figure 5-2). In the former case, data is collected from residents of Jeddah city. In the latter case, it is based on field studies performed by the researcher (i.e., a landscape architect with more than ten years of experience). Incorporating different data collection designs may reveal information that is not possible via one method. For instance, users' sense of safety may not be understood via field studies (i.e., site inventory). Therefore, each of the study elements in phase one contributed to understanding the activation barriers to greenways' usage as ATCs in Jeddah city (assuming that they were not created and used for commuting purposes).

5.3.1.1. The preferences and opinions of walkway/LP users and non-users

For the first study element, the researcher used a self-administered web-based questionnaire adopting a cross-sectional design via the Qualtrics software program (Snowball and convenience sampling). It was designed to understand the factors influencing users' and non-users' preferences (action) and opinions (image) of Jeddah's walkways/LPs as facilitators of AT. Participants' responses could identify barriers to activating greenways' function as ATCs in Jeddah city.

Several decisions were made regarding the questionnaire's design (See Figure 5-3). First, it targeted adults, specifically residents 18 years or older, because research targeting minors requires a unique set of questions (e.g., parents' travel behaviours) and ethical concerns (e.g., a parent's consent). Next, all respondents were asked about the frequency of their usage of the perceived nearest LP (PNLP) from their home addresses, assuming it is the most familiar. The list had the site name and address to facilitate the selection. Such a primary question divided the questionnaire participants into users and non-users. Figure 5-3 shows that each had unique and shared questions. For instance, respondents from both scenarios received guidelines to determine the distance from the selected walkway/LP to their home address (see Figure 5-4). Existing greenway usage literature influenced the WBQ questions (Akpinar, 2016; Chen et al., 2017; Davies and Weston, 2014; Gobster, 1995; Keith et al., 2018; Senes et al., 2017; Zhao et al., 2019b). In brief, profiling the questionnaire participants into users and non-users was a major design decision to understand the opinions and preferences of each.

In addition, the questionnaire design did not only target residents who live within walking distance from a walkway/LP for several reasons. Because of the thesis' focus on the potential of and barriers to greenway use, it was important to not only survey residents who currently live near greenways. Instead, a breadth of walkway/LP users and non-users in Jeddah city were targeted who live at varying distances and whose needs, opinions, and preferences may differ. The variety of participants enabled broad conclusions to be drawn regarding key issues and to identify patterns and trends concerning the impediments to greenways' function as facilitators of AT.

Such insights could facilitate the creation of more effective planning and management strategies. A web-based questionnaire was chosen to engage large numbers of residents with the resources available efficiently, and this was supplemented with various distribution methods (i.e., (I) social media channels, (II) official email to KAU students, academic staff, and employees, and (III) face-to-face in selected LPs in Jeddah city) to overcome such a challenge (see Section 5.5.1 for more information).

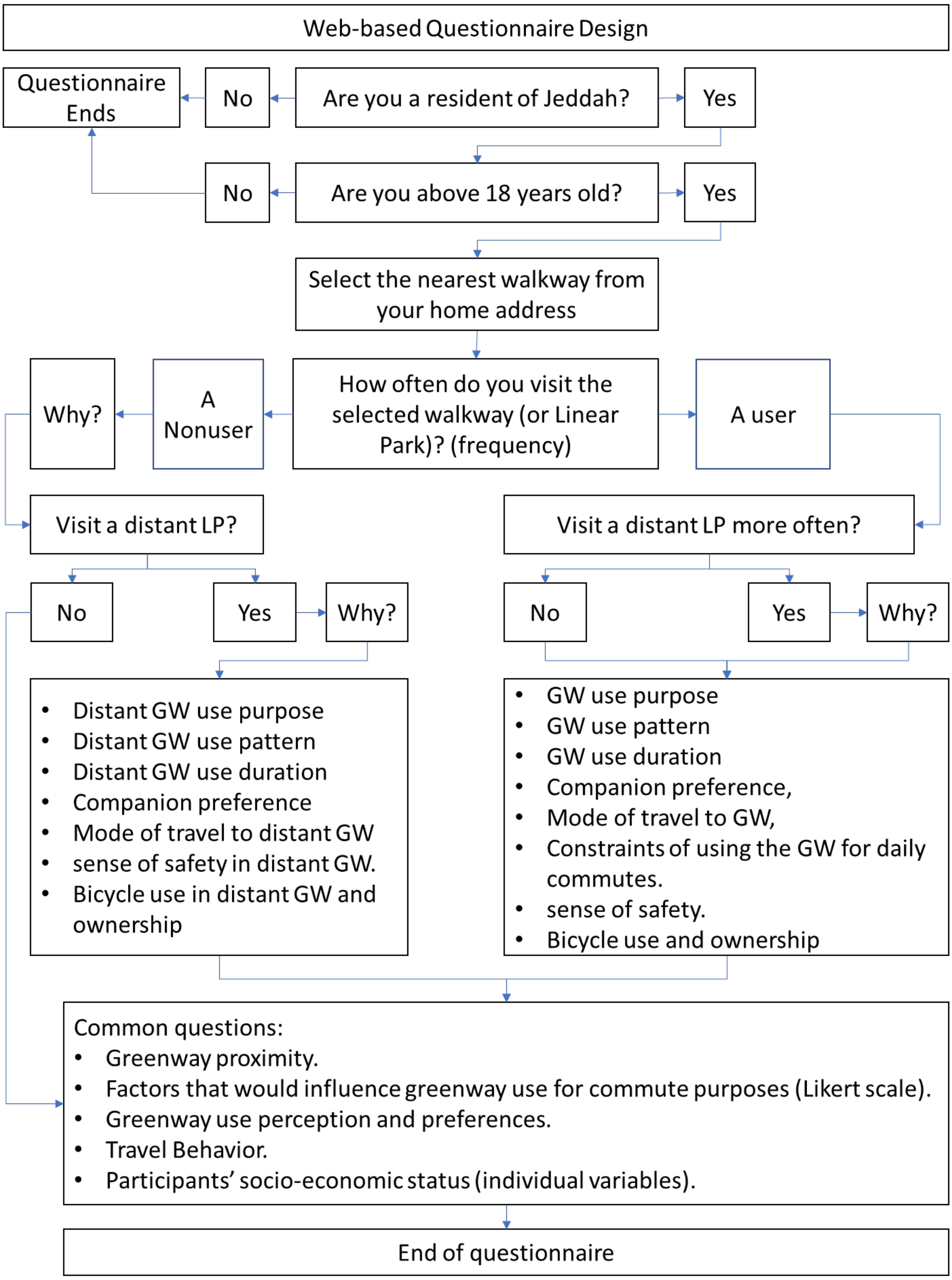
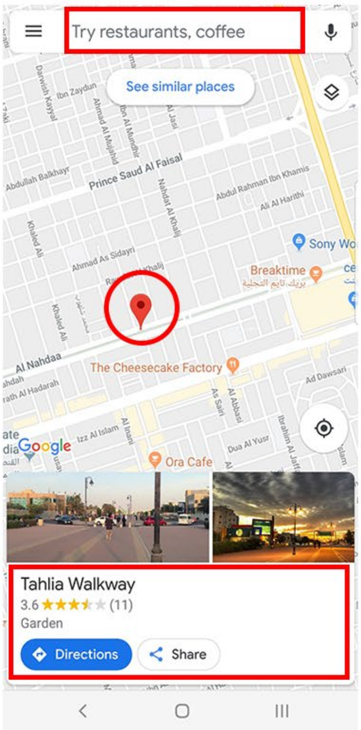
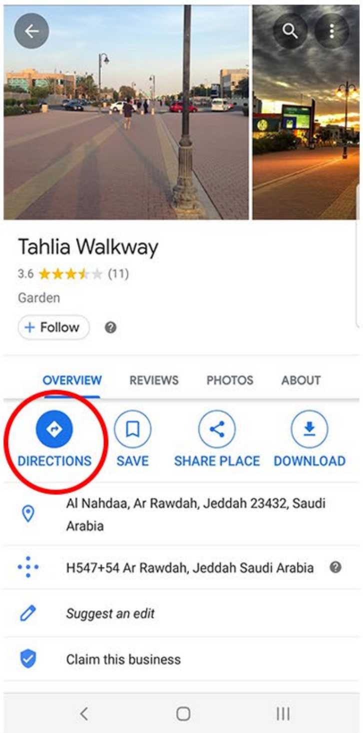


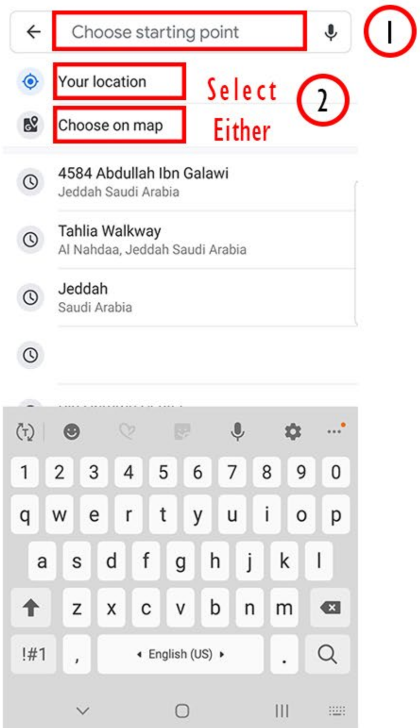
Figure 5-3. The web-based questionnaire design.



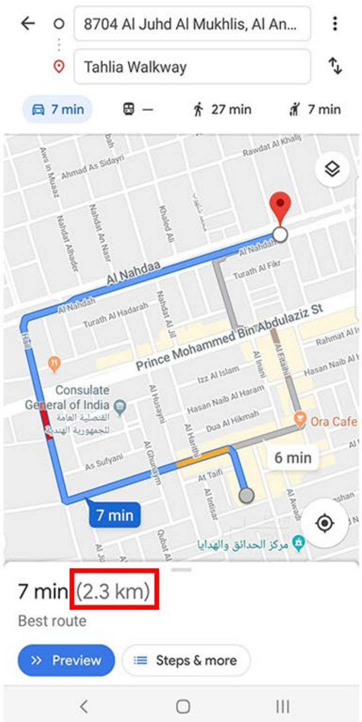
1- Begin by selecting (or typing the name) of the nearest linear park to your home address. Then, tap on the large red box.



2- Click the "Directios" icon as show in the red circle.



3- Choose either "your location" if you are currently at home or select "choose on map" to identify the location of your home address.



4- Use the generated number you see in the red box to answer to distance question in the online survey. Thanks!

Figure 5-4. Guidelines for the questionnaire participants to specify the distance of the nearest walkway/LP from their home addresses.

5.3.1.2. The physical environment

The physical environment (structure) was the second studied element or part in this PhD research. Unlike the questionnaire, the examined elements in this part focused on generating quantitative and spatial data, mainly from Google Earth, GIS, and environmental audits. An environmental audit instrument is defined as "*a tool used to inventory and assess physical environmental conditions associated with walking and bicycling*." (Moudon and Lee, 2003, p.21). The study of the physical environment had three levels: city, neighbourhood, and site level, due to the multidimensionality of influences on greenways' function as facilitators of AT as evidenced in the systematic review (see Section 4.4). Such a multifaceted approach provides a thorough understanding of challenges and needs, explains how they are interconnected, and guides the creation of tailored strategies that integrate seamlessly with Jeddah city's unique urban and cultural context.

At the city level, walkway/LP proximity was examined since it influences greenways' usage as ATCs internationally (Chang, 2020; Frank et al., 2021; Krizek and Johnson, 2007). The proximity analysis via QGIS would show the percentage of built-up areas that are within 800 m (10 minutes walk) and 3200 m (12 minutes to cycle leisurely by an average person) from a walkway/LP, thus building an understanding of their provision. Additionally, the city-level study zoomed in on the NDC as a case study to highlight additional activation barriers of its AT function at such a scale (see Section 5.4 for more information on the NDC).

At the neighbourhood level, two studies were conducted: street intersection density and sidewalk walkability audit. The former is defined as "*the number of intersections (including dead ends) in a given area (km2)*" (Sustainable Building, 2019). A high number of intersections reduces out-of-direction travel. In other words, it reduces the travel distance between one point and another. Based on the Mostadam for Communities, a comprehensive sustainability rating and certification system for Saudi cities, a minimum of 54 nodes (or intersections) per one km² is required (Sustainable Building, 2019).

The sidewalk walkability audit assessed the physical characteristics of sidewalks within 400 m (about a five-minute walk) of representative walkways/LPs at the block segment level[12] (see Section 5.4.1 for more information about the representative case study selections). Such a study assesses the walkability to/from Jeddah's walkways/LPs. Their accessibility and integration with pedestrian infrastructure have been stressed by several scholars internationally as crucial to their function as ATCs (Chen et al., 2019; Chi and Lin, 2019; Wolff-Hughes et al., 2014).

The researcher revised the adapted version of MAPPA (Marchabilité pour les personnes âgées) (Raulin et al., 2016) for Saudi cities by AlQahtany et al. (2021) for several reasons. First, enhance the replicability of the MAPPA audit tool. For instance,

[12] Sidewalks along one side of an urban block (land and buildings defined by the street pattern).

AlQahtany et al. (2021) did not specify sidewalk width dimensions, a factor that differentiates different walkability levels. Second, AlQahtany et al. (2021) omitted important elements from the assessment, such as the availability of curb ramps and streetlights. Therefore, the developed version of the MAPPA audit tool considered additional yet important walkability factors based on Saudi and international pedestrian infrastructure standards and best practices (Jeddah Municipality et al., 2008; MOMRA, 2019b; NACTO, 2013, 2016; Sustainable Building, 2019).

The MAPPA audit tool has five levels[13], ranging from poor to high sidewalk walkability levels. Table 5-1 describes the criteria for each level[14]. A key differentiation between this study and the one conducted by AlQahtany et al. (2021) is that the former considered sidewalks on both sides of a road. This is because walkability levels between both sides may differ. All sidewalk segments in each study area must have a minimum of 85% level three walkability based on the Mostadam for Communities (Sustainable Building, 2019).

Table 5-1. Assessment framework for sidewalks' walkability (an adapted version of the MAPPA audit).

Types	Sidewalk segment criteria
Level one: Unsafe	Without sidewalk OR interrupted sidewalk OR continuous sidewalk width < 0.7 m at any point along the sidewalk segment OR completely damaged.
Level two: Compromised safety	Continuous or uninterrupted sidewalk but has one or more of the following: Sidewalk width is between 0.7 m - < 1.5 m* OR Sidewalk width is ≥ 1.5 m but in poor condition** OR Without a curb ramp*** at one or more crossing points OR Streetlights are unavailable
Level three: Minimum safety****	Continuous sidewalk with a width between 1.5 m - ≤ 1.8 m AND The sidewalk is in good surface condition AND Curb ramp at all crossing points AND Streetlights***** are available for the entirety of the sidewalk segment
Level four: Relative comfort	Continuous sidewalk width ≥ 1.8 m ****** AND The sidewalk is in good surface condition AND Curb ramp at all crossings AND Streetlights are available for the entirety of the sidewalk segment AND Provides a non-green buffer zone (e.g., on-street parking) between the sidewalk and street for most of the sidewalk segment OR Provides a buffer of > 1 m between the property line and the sidewalk for most of the segment
Level five: Complete comfort	Pedestrianized street OR level four + satisfy one or more of the following: Green buffer (in good condition) for most of the sidewalk segment AND/OR Most of the sidewalk segment abuts a public park or garden AND/OR Presence of > 50% of permeable commercial frontages at the ground floor level for most of the sidewalk segment AND/OR Presence of shade via vegetation or street furniture for most of the sidewalk segment*******.

* If, for some reason, a sidewalk segment has parts with a continuous width between 0.7 m - < 1.5 m and parts ≥ 1.5 m, it is considered a level two because parts of the segment compromise safety. In

[13] In the original MAPPA, they were referred to as "types" (Raulin et al., 2016). However, the researcher found the term "levels" are more appropriate since the assessment is based on a hierarchy of walkability levels.
[14] See Alhajaj (2023) and Shaaban (2019) for terms' definitions (e.g., buffer zone).

addition, the specified 1.5 m bare minimum width of the pedestrian through zone (not including the curb face) allows two adults to walk together without exiting the sidewalk (NACTO, 2013).
** Frequent cracks, bumps, holes, or weeds growing on the surface, ≥ 4 per 50 meters.
*** Curb ramps must have a minimum width of 1.5 m and a slope ≤ 10%. Non-conformity to one of these requirements would score a level two.
**** For level three, no physical elements separate (or protect) pedestrians from moving vehicular traffic, such as site furniture (e.g., light poles, benches, and more). Even when on-street parallel parking is provided, the buffer is < 0.6 m or is unavailable.
***** Assessment was based on the Jeddah Municipality et al. (2008) ratio of a 15 m spacing between lighting fixtures with a 4.5 m height.
****** The 1.8 m width of the pedestrian through zone allows two wheelchair users to pass one another, and it is the preferred minimum width globally (NACTO, 2016).
******* Assessment for shading trees is based on 10 m spacing on average (Jeddah Municipality et al., 2008) and shading structures based on a spacing of ≤ 100 m (Sustainable Building, 2019).

At the site (or route or greenway) level, an assessment adapted from the Path Environment Audit Tool (PEAT) (Troped et al., 2006) was conducted on five representative walkways/LPs of their respective types in Jeddah city (see Section 5.4.1 for more information). The adapted PEAT evaluated the design, amenities, and maintenance of Jeddah's LPs/walkways. The assessment results would identify areas needing improvement to activate walkways/LPs' AT function. PEAT is widely used to evaluate several paths and trails used for physical activity internationally (Auchincloss et al., 2019; Troped et al., 2006; Zoellner et al., 2012). However, unlike the original PEAT, the adapted version only focused on physical characteristics for two reasons[15].

First, subjective factors (e.g., people's behaviours) were covered in the questionnaire. Second, the assessment was conducted by a single person (i.e., the researcher). PEAT was designed to be conducted by two observers. These are clearly reflected in the design of its questions. For instance, the safety of intersections (the first indicator in the original PEAT) had no objective measures to differentiate between a poor and a fair score for an intersection. Thus, the interpretation of existing conditions may vary between observers. Hence, inter-rater reliability tests using Cohen's kappa and intraclass correlation coefficients were part of the method.

For those reasons, the original PEAT was transformed into a four-point rating scale, an assessment approach influenced by several walkability studies and environmental audit tools (Alhajaj, 2023; Alhajaj and Daghistani, 2021; Shaaban, 2019; Dannenberg, 2005; National Transport Authority et al., 2021; Victoria Walks, 2023). As such, data collection from the field is easy and provides a summary score that facilitates identifying factors needing improvement and comparing different sites. In addition, several precedents of peer-reviewed journal articles had a single assessor in walkability studies (Alhajaj, 2023; Shaaban, 2019). Following their approach, all indicators were provided with objective measurements based on Saudi and international pedestrian and bicycle infrastructure standards and best practices

[15] The original PEAT had factors such as traffic level, size of the road at intersections, noise, and odour.

(Jeddah Municipality et al., 2008; MOMRA, 2019b; NACTO, 2013, 2016; Sustainable Building, 2019).

The adapted PEAT had two parts: an assessment at the segment and site level. This is because indicators such as public toilets and grocery stores were unexpected to be available per segment. In this study, a segment was the distance between two street intersections because walkways/LPs in Jeddah city intersect with vehicular traffic at multiple locations. Such a method also conforms to the original PEAT segment identification approach. However, future research may define a segment whenever there is a noticeable change in path characteristics or every 400 m[16]. Each assessment part (segment and site) had different indicators. See Troped et al. (2006) PEAT manual for the operational definitions of indicators. Furthermore, Table 5-2 describes the developed assessment measures (19 indicators) using the four-point rating scale. The same applies to the site-level assessments (14 indicators) (see Table 5-3).

A few indicators were added, and a few others were removed from the assessment. Table 5-4 lists and justifies the omissions and additions. However, the assessment of shaded trees and litter differed from the original PEAT because the former was unconsidered, and the latter lacked objective measurement criteria. In the case of shade tress, their assessment was based on their existing conditions (not potential mature size). Based on the most common shade tree types in Jeddah's walkways/LPs, they have ≥ 5 m in height and a dense crown spread of an average ≥ 3 m. Therefore, trees not meeting these measurements or having spare branches and foliage were scored fair. Ornamental and palm trees were also not counted as shade trees (e.g., Roystonea Regia). Trees in bad condition have no or few leaves, brittle trunk or limbs, and cracks.

As for litter, anything smaller than a 200 ml plastic water bottle was not registered. For instance, a cigarette found on the pavement would be ignored. However, a pile of cigarettes is registered, and the same applies to any animal droppings. Additionally, litter registration is by area, specifically 12 m² (3X4m or 2X6m). For instance, if a water bottle and a pile of cigarettes were found within 12 m², they would be registered as one littered area. Lastly, to register a littered area, it must have ≥ 3 items (i.e., three 200 ml plastic water bottles). If < 3 items, it was ignored.

As shown in the assessment criteria (see Table 5-2), the term "most" was used several times as a differentiator between scores. The term "most" in this research refers to ≥ 66.6%. For example, if a segment had ten well-distributed trees and seven of them were ornamental, it would receive a fair score. However, if those seven trees were shading trees, then the segment would receive a good score. The same logic was applied to other indicators.

[16] In such cases, it may require shift some indicators between the segment and site levels.

Table 5-2. Assessment framework of walkways/LPs at the segment level.

Indicator	Unavailable/very poor (score 0)	Poor (score 1)	Fair (score 2)	Good (score 3)
Curb ramp slope and width	One or more pedestrian crossing does not have a curb ramp OR width is < 1.5 m	Available, but the slope is mostly > 10%, and the width is ≥ 1.5 m	Available and slope is mostly ≤ 10%, and width is ≥ 1.5 m	Available, slope is always < 10%, and width is ≥ 1.5 m OR flush with adjacent pedestrian surface using a speed table.
Cautionary signage and signals	One or more pedestrian crossings do not have cautionary signage and signals.	Available but mostly in poor condition, OR most are obstructed by vegetation or physical structures.	Available mostly in good condition and unobstructed	Available and all in good condition and unobstructed
Marking	One or more pedestrian crossing is unmarked.	Marked but mostly with basic visibility (e.g., two transverse lines or other pavement materials) OR most require maintenance.	Marked and highly visible (e.g., ladder and zebra markings) in most cases (one or two used basic visibility or required maintenance)	Marked and highly visible (e.g., ladder and zebra markings) in all cases AND none require maintenance.
Path Width	Interrupted walkway/LP segment by a permanent physical barrier	Continuous or uninterrupted walkway/LP width < 1.8 m for most of the segment	Continuous or uninterrupted walkway/LP width between 1.8 m and < 3 m for most of the segment	Continuous or uninterrupted LP width ≥ 3 m for most of the segment OR the entire right-of-way is pedestrianized
Bicycle lane	Shared with a pedestrian lane	Available but without clear markings and accompanying signage for most of the segment	Available with clear markings and accompanying signage for most of the segment	Available with clear markings and accompanying signage for most of the segment AND separated via a buffer (e.g., vegetation)
Bicycle racks	Unavailable	One is available but in poor condition (e.g., bent or broken)	One is available in good condition (i.e., few or no signs of damage or vandalism)	Available in good condition AND at 300 m intervals (NACTO, 2016)
Vertical clearance (minimum 2.5 m)	There are frequent obstructions (registered in > 5 per 50 m) by overhanging tree branches and other obstructions (e.g., signage, shading structures, and flower baskets)	Most of the segment has 3-5 obstructions per 50 m	Some of the segment has one or two obstructions per 50 m	Minimum vertical clearance (2.5 m) is achieved mostly throughout the segment
Buffer zone between walkway/LP and street	Unavailable	< 1 meter for most of the segment OR partial availability (≤ 50% of the segment does not have a buffer zone)	Between 1- 3m for most of the segment (if on-street parking is available, buffer zone width < 0.6 score fair and ≥ 0.6 m score good).	> 3 meters for most of the segment
Shade trees	Unavailable	Trees are available at intervals > 10 m OR partial availability along the segment OR most are in poor condition.	Trees are available at intervals ≤ 10 m and are mostly in good condition. However, most do not provide enough shade due to their current size, age, or type.	Shading trees are available at intervals ≤ 10 m and are mostly in good condition. Additionally, most provide enough shade because of their size, age, or crown density.

Shading structures	Unavailable	Available mostly at intervals > 100 m or most of the segment does not have shading structures.	Available mostly every 100 m (segments with a linear length ≤ 100 m, a provision of one shading structure result in a Fair score – two or more would result in a good score)	Provided mostly at distances < 100 m intervals
Running slope	Mostly very steep (> 12.5%). Unsuitable for a disabled person and a wheelchair user.	Mostly steep (between 8.3 % and 12.5%, a wheelchair user will require assistance)	Mostly moderate (between 5% - 8.3%)	Mostly flat or gentle < 5%
Cross slope	Mostly steep (≥ 5%). It may cause a pedestrian to lose balance and be exceedingly difficult for a disabled person to walk, unsuitable for a wheelchair user.	Mostly moderate (between 2-4%), but the cross slope is ≥ 5% in one or more areas.	Mostly moderate (between 2-4%)	Mostly gentle or flat (1-2%)
Site distance (see beyond 15 m at any point)	None or few of the segment	Some parts of the segment (the path bends and turns or site elements, e.g., vegetation or physical barriers, obstruct the view)	Most of the segment (there is one sharp turn)	All the segments (generally a straight segment)
Pavement surface condition	Partial pavement unavailability, forcing users to walk along vehicle traffic.	The frequency of cracks, bumps, holes, or weeds growing on the surface makes travelling along the segment difficult for a wheelchair user and a cyclist (≥ 4 per 50 meters).	Few cracks, bumps, holes, or weeds grow on the surface. However, travelling along the segment is easy for a wheelchair user and a cyclist (between 1-3 per 50 meters).	No cracks, bumps, holes, or weeds growing on the surface. The pavement surface condition is considered good.
Lighting fixtures	None is available (light from surrounding buildings does not count)	Lighting fixtures are unavailable in most of the segment (missing three or more fixtures), OR most are clearly damaged (i.e., broken bulbs or damaged post)	Lighting fixtures are unavailable in some parts of the segment (missing one or two fixtures), but most are in good condition (i.e., no damage of any kind)	Lighting fixtures are available in all the segment parts and are in good condition.
Seats	Unavailable	Mostly available at intervals > 100 m OR most in poor condition	Mostly available at intervals between 50 – 100 m AND most in good condition	Mostly available at ≤ 50 m intervals AND most in good condition
Trash can	Unavailable	Mostly available at intervals > 120 m OR most overflown with rubbish	Mostly available at intervals between 60 - 120 m, AND most are not overflown with rubbish	Mostly available at ≤ 60 m intervals AND most are not overflowing with rubbish
Litter	A lot (≥ 5 littered areas per 50 m) in most of the segment	Some (2-4 littered areas per 50 m) in most of the segment.	Little (one littered area per 50 m) in most of the segment.	None (no littered areas for the entirety of the segment).
Vandalism	One or more at intervals ≤ 50 m	One at intervals between 50-100 m.	One at intervals between 100 – 200 m or the entire segment.	None (no sign of vandalism for the entirety of the segment).

Table 5-3. Assessment framework of walkways/LPs at the site level.

Indicators	None (score 0)	Poor (score 1)	Fair (score 2)	Good (score 3)
Spacing of access (or crossing) points	There are no access (crossing) points	Access (crossing) points are, on average, > 250 m	Access (crossing) points are, on average, 100 m – 250 m	Access (crossing) points on average ≤ 100 m
Public toilets	None is available	One is available for the entire site but is in poor condition OR not working.	One is available for the entire site and in good and working condition	Available at 400m intervals, and all are in good condition
Water fountain				
Wayfinding signage	Unavailable	No strategy in its availability OR at intervals > 800 m OR available in poor condition (e.g., damaged or unreadable due to neglect) OR mostly obstructed by vegetation or physical structures.	Available at variable distances but not exceeding 800 m frequency at any point AND all in good condition (i.e., legible) and unobstructed (i.e., visible).	Available mostly every 400 m or less as a part of a strategy (e.g., at major entry/exit points) and all in good condition and unobstructed.
Regulatory signage (for walkway/LP usage)				
Bike rental or bicycle share service	Unavailable OR none is available along the walkway/LP, and crossing to each is unsafe* or is from a distance > 100 m.	Available mostly adjacent but visible from the walkway/LP. Additionally, crossing to each is compliant with national standards AND is from a distance ≤ 100 m.	Available mostly along the walkway/LP at variable distances but not exceeding 800 m frequency at any point (score poor if it does)	Available every 400 m or less along the walkway/LP
Food services (e.g., food trucks)*				
Civic buildings (schools/colleges and mosques**)	Unavailable	One or more are available within one block from the walkway/LP, but crossing is unsafe* or is from a distance > 100 m.	One is available within one block and visible from the walkway/LP AND crossing to it is compliant with national standards (MOMRA, 2019b) AND is from a distance ≤ 100 m.	Two or more (type or number) are available within one block from the walkway/LP, AND crossing to all is compliant with national standards AND is from a distance ≤ 100 m.
Commercial destinations				
Grocery shop(s) or supermarket				
Exercise, Play, or green area(s) **	Unavailable OR none is available along the walkway/LP, and crossing to most is unsafe* or is from a distance > 100 m.	Available at intervals > 800 m. Additionally, crossing to each (if needed) complies with national standards AND is from a distance ≤ 100 m.	Available at variable distances but not exceeding 800 m frequency at any point. Additionally, crossing to each (if needed) complies with national standards AND is from a distance ≤ 100 m.	Available every 400 m or less. Additionally, crossing to each (if needed) complies with national standards AND is from a distance ≤ 100 m.
Transit stops/stations	Unavailable OR crossing to most is unsafe* or is from a distance > 100 m.	Available mostly adjacent but visible from the walkway/LP. Additionally, crossing to each is compliant with national standards AND is from a distance ≤ 100 m.	Available mostly along the walkway/LP at variable distances but not exceeding 1200 m frequency at any point	Available at ≤ 800 m intervals, mostly along the walkway/LP, AND all are sheltered (with seating).
Parking spaces	Unavailable	Concentrated in one location OR mostly without clear markings and accompanying signage	Well-distributed along the walkway/LP AND mostly with clear markings and accompanying signage	Well-distributed along the walkway/LP AND mostly with clear markings and accompanying signage AND provision of parking spaces for people with disabilities (one per 50 cars)
Traffic speed and traffic calming measures	Any traffic speed without traffic calming measures	Traffic speed is ≥ 60 km/h but with traffic calming measures.	Traffic speed is 50 or 40 km/h with traffic calming measures.	Traffic speed is ≤ 30 with traffic calming measures.

* Unsafe crossing has curb ramp slope > 10% or width < 1.5 m or no marking or no cautionary signage or signal is not working for streets with traffic speeds ≥ 60 km/h.

** Because they are among the most common civic/cultural destinations travelled on foot in Jeddah city (AlShareef and Aljoufie, 2020).

Table 5-4. Added and omitted indicators in the adapted PEAT.

Indicators	Comparison to original PEAT*	Justification
Temporary Barrier (i.e., water, puddles, ice, snow, mud)	Omitted	All the examined sites were paved and in urbanized locations. Additionally, Jeddah is in a hot, arid region. Rain occurrences are infrequent.
Vegetative cover/Built enclosure (i.e., lateral visibility).	Omitted	All examined sites had no lateral visibility. Specifically, buildings were on both sides of the studied walkways/LPs.
Shoulder present	Omitted	All examined sites had adjacent roads. Such an indicator overlapped with the buffer elements.
Viewpoint(s) / Point of Interest	Omitted	None of the examined sites has viewpoints. Palestine Street walkway links to the Middle Corniche walkway with a sea view.
Telephone(s)	Omitted	All examined sites are in urbanized locations with good phone signal strength.
Emergency call box(es)	Omitted	
Picnic table(s)	Omitted	No study found a relationship between picnic tables and greenways' usage for commuting purposes.
Glass	Omitted	Combined with litter indicator.
Dog/Animal droppings	Omitted	
Graffiti	Omitted	Combined with vandalism indicator.
Odour	Omitted	Not part of a walkway/LP's physical characteristics.
Noise	Omitted	
Presence of dogs	Omitted	Based on field observations, domestic animals (e.g., dogs) are rare companions of walkway/LP users.
Path width	Added	Path width can affect the sense of safety and comfort of its users.
Bicycle lane	Added	If shared with pedestrian zones, it can cause conflict, which is a safety hazard.
Shade trees	Added	They are an important source of shade, especially when considering case studies in hot arid regions.
Shading structures	Added	
Traffic calming measures	Added	Important physical design elements to improve road safety by, for example, reducing traffic speed.

* To access it, visit the following link: https://www.med.upenn.edu/beat/peat-materials.html.

5.3.2. Phase two: Key informant interviews

Exploring (I) the preferences and opinions of walkway/LP users and non-users and the (II) physical environment was phase one of this PhD study. In phase two, the results that needed greater depth of exploration into particular themes identified from the web-based questionnaire and site analysis were pursued via semi-structured interviews with local and international experts and AT interest groups' leaders (who regularly walk or cycle for physical activity in Jeddah city). Therefore, the design of their questions was influenced by phase one results. Because the interviews were guided or semi-structured, they had predefined themes. The thematic analysis of the interview transcriptions generated subthemes, all providing a deeper understanding of issues and themes identified in phase one (more information about the data analysis process in Section 5.6). Moreover, phase two findings expanded the first phase results and functioned as a validation strategy. Interpretations and inferences of this research result from synthesising the findings of both phases thematically while also relating to existing literature.

In response to the prevalent health issues in SA (see Section 1.2), many local walking/running and bicycling groups in Jeddah city (and SA in general) are leading a cultural change towards physical activity, especially outdoors. Those local walking and bicycling groups represent grassroots and social innovation, indicating the key opportunities and obstacles (Geels, 2019). Simultaneously, their large following on social media (Tens of thousands) (Jeddah Cyclist, 2021) represents their influence on the public perception that challenges existing norms and induces behavioural change for adopting healthier lifestyles, similar to international experiences (Mogaji and Uzondu, 2022). There lies the link and value of their input.

Questions addressed to AT interest group leaders explored their motivations, experiences, opinions, priorities, and needs. Discussed questions focused on the interest groups' goals, supporters, training sessions, members, assessment of Jeddah's LPs' suitability for their routine activities, opinions of walking and cycling for transportation, bicycle use culture in Jeddah city (evolution), and ways to embrace it. In short, interviews with the AT interest groups' leaders shed light on the experiences and opinions of unique LP users identified via site visits in order to elucidate emerging opportunities for greenways' usage as ATCs, and to learn from first-hand accounts how barriers are experienced and overcome.

The second part of phase two interviewed local and international experts who have (or had) direct engagement with Jeddah's greenspace and/or transport planning. Questions addressed to experts differed from those addressed to local walking and bicycling group leaders. The purpose was to expand/explain and validate phase one findings. Therefore, interview questions aimed to understand the factors that led to existing conditions and usage of Jeddah's walkways/LPs. Questions also explored strategies to activate walkways/LPs function as ATCs in Jeddah city. Therefore, the participation of diverse or multidisciplinary interviewees was necessary due to the multidimensionality of the factors influencing the use and improvement of greenways. The design of the experts' interview questions was influenced by phase one results, which facilitated collecting fairly detailed responses. Simultaneously, the design of the questions considered flexibility to seek out interviewees' worldviews about the discussed subjects.

5.4. Selection of case study walkways/linear parks

Jeddah Municipality's main website included a publicly accessible database about its public parks, including walkways/LPs. Their website identified 23 walkways (in 2019/20), which defined the scope of this research study. Middle Corniche Park is Added to that list since it matches other walkways (e.g., Northern Corniche walkway) in the official list regarding location, physical characteristics, facilities, and amenities (see Figure 5-5). Table 5-5 lists the 24 LPs/walkways with specifications of several characteristics. They are type, length, completion date, district (location), population density per km², and predominant adjacent land uses. Such data were obtained from Jeddah Municipality in early 2020 (see Appendix A, Figures A1 and A2). Construction of these walkways/LPs is completed and is publicly accessible. Additionally, no study considered all sites or representative walkways/LPs from each type.

Figure 5-6 illustrates the typical sections of Jeddah's walkways/LPs's five types. First are waterfronts or Corniche parks, promenades along the Red Sea shoreline. Second are reformed segments of Jeddah's drainage channels (see Figure 5-7). They are part of an ongoing plan to convert all open drainage channels into LPs to improve the quality of life and boost the city's economy (MOMRA and UN-Habitat, 2019a). Such a plan has a history dating back to 2005-2007 with Gustafson Porter + Bowman design firm ("Jeddah Metropolitan Park," 2007), but was postponed due to flood events in 2009 and 2011 (AECOM, 2013). Third are walkways along drainage channels, enhanced sidewalks with vegetation and site furniture. The same description applies to walkways, the fourth type, but those exist along various road types. The fifth type is LPs, usually created as an exaggerated median island in the collector and arterial roads (see Figure 5-8). All these walkways/LP types are different forms of recent road retrofits, providing destinations that facilitate physical and social activities.

Jeddah's Linear Parks

No.	Name of Linear Park (or walkway)	Length (km)	Date
1	Jeddah waterfront walkway	4.5	2017
2	Prince Faisal bin Fahad street walkway (Hilton)	1.4	2003*
3	Northern Corniche walkway	3.85	2013
4	Al Shatee Garden walkway	1.5	2017
5	Al Rawdah walkway (Al Tahlia)	2.2	2013
6	Al Yamama Walkway	1.8	2018
7	Al Amir Majid park walkway	2	2014
8	Al Faisalia walkway	1.5	2014
9	Al Safa walkway	1.2	2013
10	Al Safa 2 walkway	1.95	2017
11	Al Samer walkway	2.9	2017
12	Al Rehab walkway	1.8	2015
13	Al Waha walkway	1	2017
14	Middle Corniche Park	3.6	2013
15	Palestine Street walkway	1.2	2013
16	Al Shabab lake walkway	2.1	2014
17	Al Nakheel walkway	1.5	2013
18	Al Nakheel 2 walkway	1.5	2017
19	Al Jamiaa walkway	1	2016
20	Prince Al Fawaz district walkway	4.5	2017
21	Zahrt Al Waha walkway	1	2017
22	Al Saif Beach	3	2015
23	Taibah Walkway	2	2017
24	Dahban costal park walkway	1.1	2015

Notes:
All information included in the table and map are based on Jeddah Municipality's official website (visited February 2020).

* Based on Addas, A. N. (2015). Motivation and Attachment in the Use of Public Open Spaces in Jeddah, Saudi Arabia. Retrieved from http://etheses.whiterose.ac.uk/1/8565/A.Addas Thesis Feb 2015_sheffield_landscape.pdf

Legend
Linear Parks
Jeddah's walkways / linear parks
D1 Al-Samer Dam
D2 Umm Al-Khair Dama
Jeddah satellite map (source: Google satellite map)

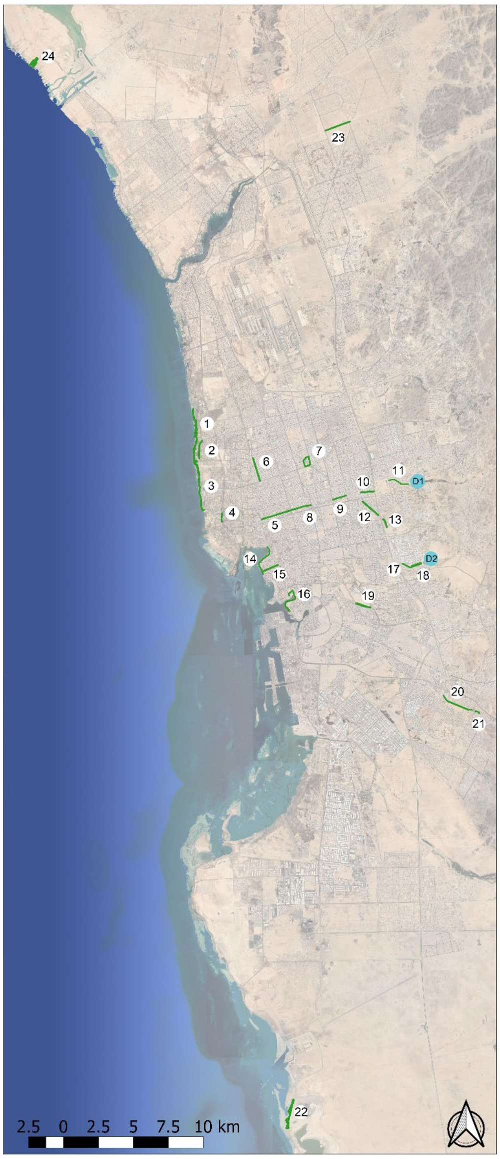


Figure 5-5. Jeddah's linear parks (LPs).

Table 5-5. Characteristics of Jeddah's linear parks/walkways and their surrounding neighbourhood

No.	**LP types (proposed)**	**LP Name**	**Length (km)**	**COMPL. date**	**District (location)**	**Pop. Density per km²**	**Predominate adjacent land uses**
1	Waterfront or Corniche Parks	Jeddah waterfront walkway	4.5	2017	Ash Shati	1873 - 3465	Major comm. corridor
2		Northern Corniche walkway	3.8	2013	Ash Shati	1873 - 3465	Major comm. corridor
3		Middle Corniche Park	3.6	2013	Al Hamrah	6456 - 12971	Governmental / Major comm. corridor
4		Al Saif beach	3	2015	South Corniche	Unavailable	Undeveloped
5		Dahban coastal park walkway	1.1	2015	Dahban	Unavailable	Residential Villas
6		Al Shabab lake walkway	2.1	2014	Al-Baghdadiyah Al-Gharbiyah	6456 - 12971	Local commercial street (not built yet – undeveloped lands).
7	Reformed drainage channel	Al Faisalia walkway	1.5	2014	Al Faisalia	12972 - 27918	Residential apartment buildings.
8		Al Safa walkway	1.2	2013	Al Safa	12972 - 27918	Residential apartment buildings.
9		Al Rehab walkway	1.8	2015	Al Rehab	6456 - 12971	Residential various two floors.
10		Al Nakheel walkway	1.5	2013	Al Nakheel	1873 - 3465	Residential Villas.
11		Al Rawdah walkway	2.2	2013	Al Rawdah	6456 - 12971	Residential Villas.
12	Walkways along drainage channels	Taibah Walkway	2	2017	Al Frosyah	1873 - 3465	Local commercial street (not built yet)
13		Zahrt Al Waha walkway	1	2017	Al Amir Fawwaz Al Junoobi	3466 - 6455	Residential Villas.
14		Al Safa 2 walkway	1.9	2017	Al Safa	12972 - 27918	Residential apartment buildings.
15		Al Samer walkway	2.9	2017	Al Samer	3466 - 6455	Residential Villas and apartment buildings.
16		Al Waha walkway	1	2017	Al Waha	1873 - 3465	Local commercial street.
17		Prince Al Fawaz district walkway	4.5	2017	Al Amir Fawwaz Al Junoobi	3466 - 6455	Local commercial street (not built yet – undeveloped lands)
18		Al Nakheel 2 walkway	1.5	2017	Al Nakheel	1873 - 3465	Residential apartment buildings/warehouses – Industrial.
19	Walkways	Palestine street walkway	1.2	2013	Al Hamrah	6456 - 12971	Major commercial street.
20		Al Amir Majid park walkway	2	2014	Ar Rabwah	12972 - 27918	Garden (walled) / Residential Villas and apartment buildings.
21	Linear Park (median)	Al Jamiaa walkway	1	2016	Al Fayha'a	3466 - 6455	Local commercial street / special development area (not built yet).
22		Ash Shati garden walkway	1.5	2017	Ash Shati	1873 - 3465	Major commercial corridor
23		Prince Faisal bin Fahad street walkway	1.4	2003	Ash Shati	1873 - 3465	Residential Villas and apartment buildings (i.e., hotels).
24		Al Yamamah Walkway	1.8	2018	As Salamah	12972 - 27918	Local commercial street.

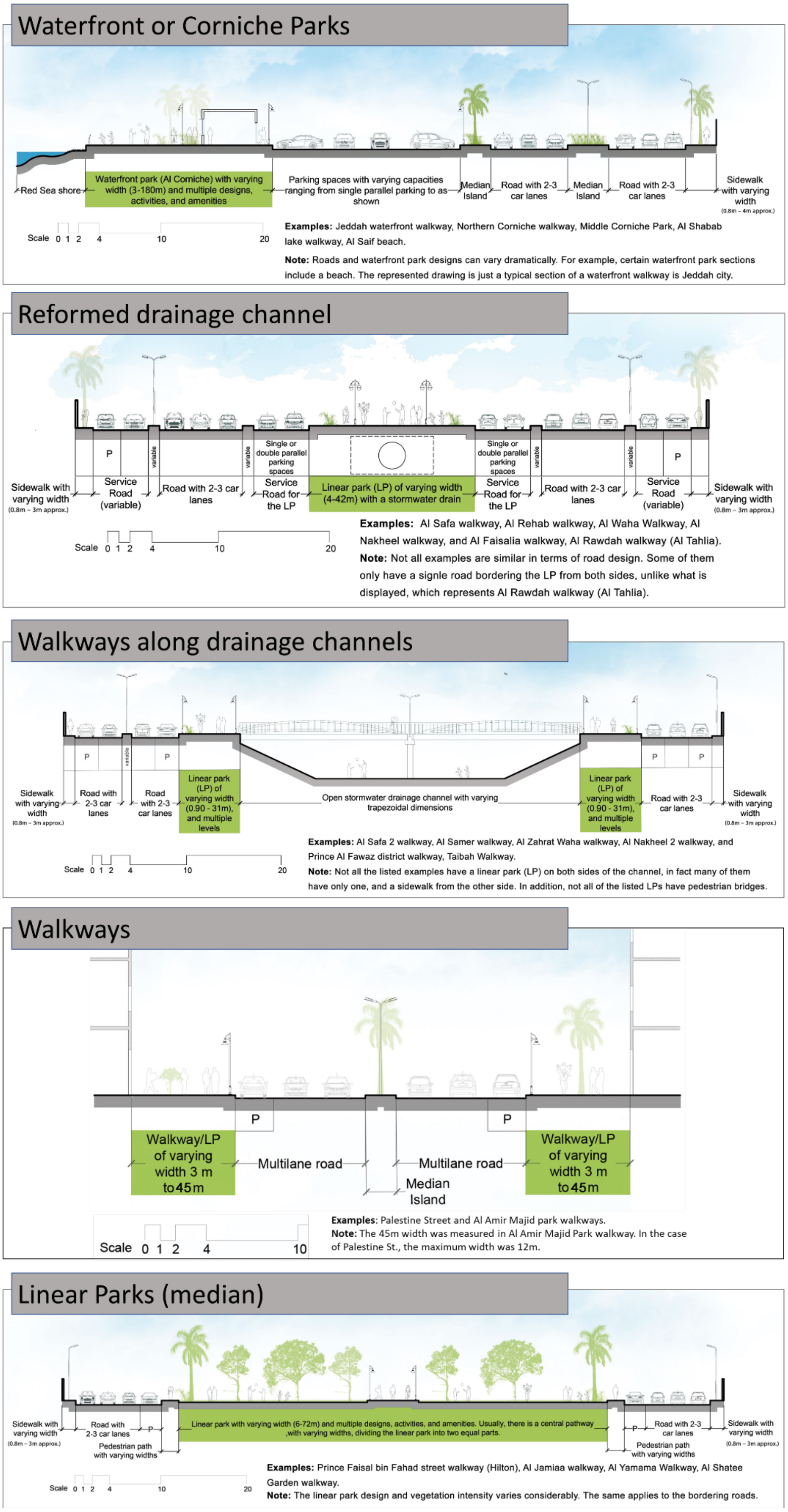


Figure 5-6. Typical Sections of Jeddah's walkways/LP types (by author).

Figure 5-7. Jeddah's drainage channels (retraced via QGIS from MOMRA and UN-Habitat, 2019b).

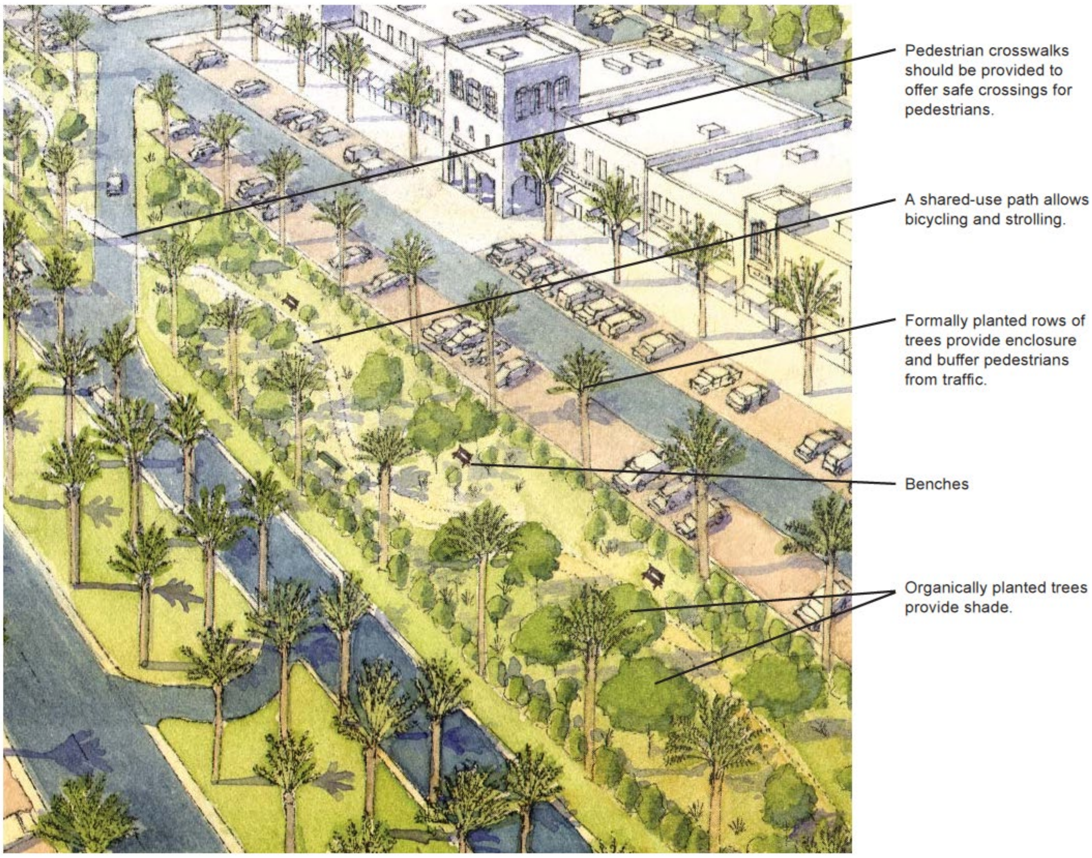


Figure 5-8. The Streetscape and Urban Design Manual description of LPs' characteristics (Jeddah Municipality et al., 2008).

5.4.1. The representative case studies

Five of the 24 walkways/LPs were selected as representative case studies of their respective types. Selection criteria considered different walkway/LP types, population density, and adjacent land use types (see Table 5-5). Additionally, selected walkways/LPs are ones that traverse residential areas. In other words, they could be referred to as community greenways, similar to Chi and Lin (2019). As such, a comparison between one site to another would be fair. Therefore, waterfronts or Al Corniche parks were excluded from environmental audits because they differ greatly from other greenway types, and, within 400 m, they are mostly surrounded by theme parks, playgrounds, hotels, restaurants, cafes, and governmental areas. The selection of such distance was based on greenways' impact on active travel behaviour. As evidenced by several studies, such impact was only found in residents living at distances < 400 m (Chang, 2020; Frank et al., 2021; Krizek and Johnson, 2007). Additionally, the transportation impact of waterfronts is low (Liu et al., 2020) and locally are considered promenades (not greenways) (MOMRAH, 2022b). The last exclusion criterion considered the development of adjacent lands. If the surrounding urban blocks were mostly undeveloped (i.e., vacant lands), those walkways/LPs were excluded to ensure that current usage is typical.

Given these selection criteria, the Palestine Street walkway, Al Yamamah walkway, Al Rehab walkway, Al Rawdah (or Tahlia) walkway, and Al Nakheel 2 walkway were selected as representative of their respective greenway types. Therefore, neighbourhood and site assessments focused on those sites. Figures 5-9 to 5-13 are site location maps identifying primary streets and points of interest. The last three sites (Rehab, Rawdah, and Al Nakheel 2 walkways) are segments of the NDC, which was an important consideration since MOMRA's plans aimed to transform it into a multifunctional LP (MOMRA, 2019b). Therefore, findings would contribute to such a plan as well. Lastly, Figures 5-14 to 5-18 are land use maps for the representative case studies since part of the PEAT assesses a site's accessibility to various destinations within one urban block. These maps function as a reference to discussions in the findings' chapters. Details in Figures 5-14 to 5-18 were based on data collected during site visits in March and April 2023 because data received from Jeddah Municipality does not provide that level of detail.

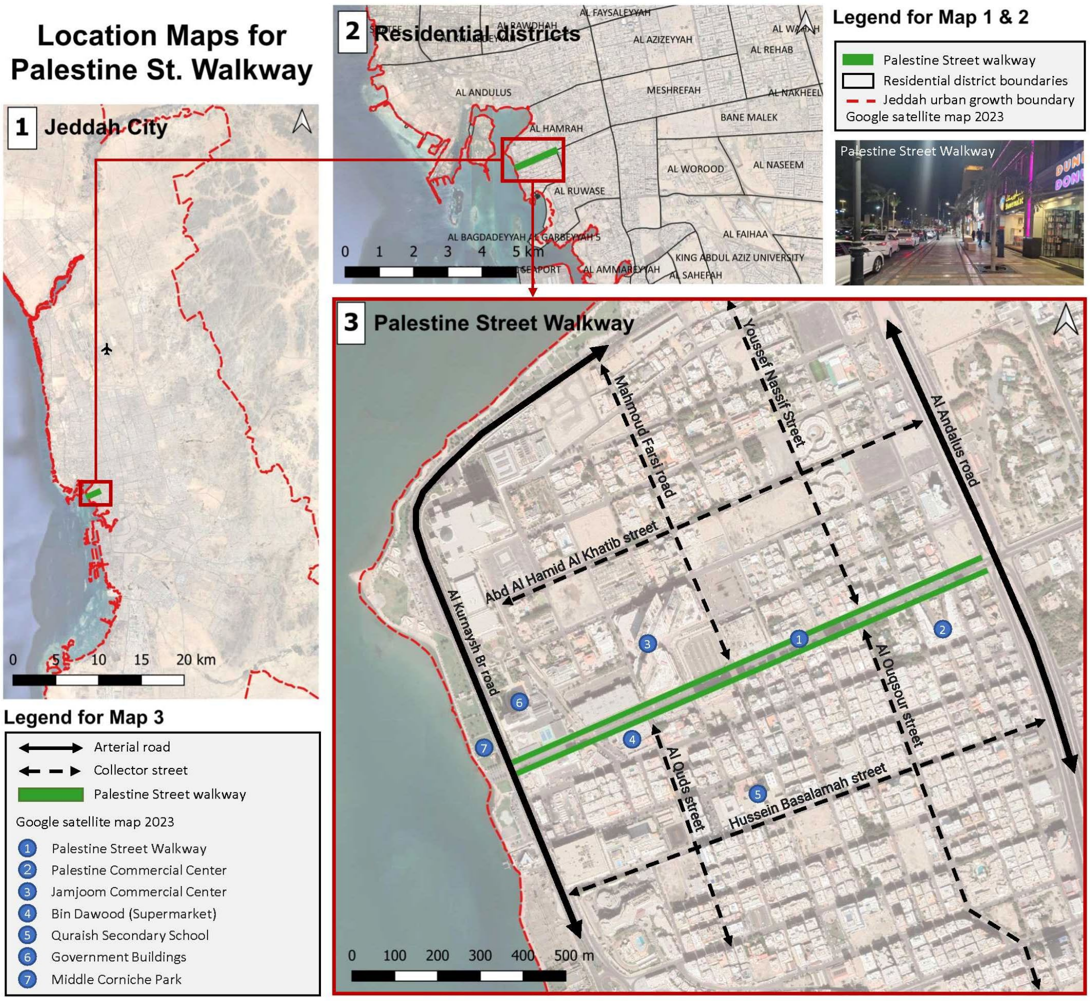


Figure 5-9. Site location for Palestine Street walkway.

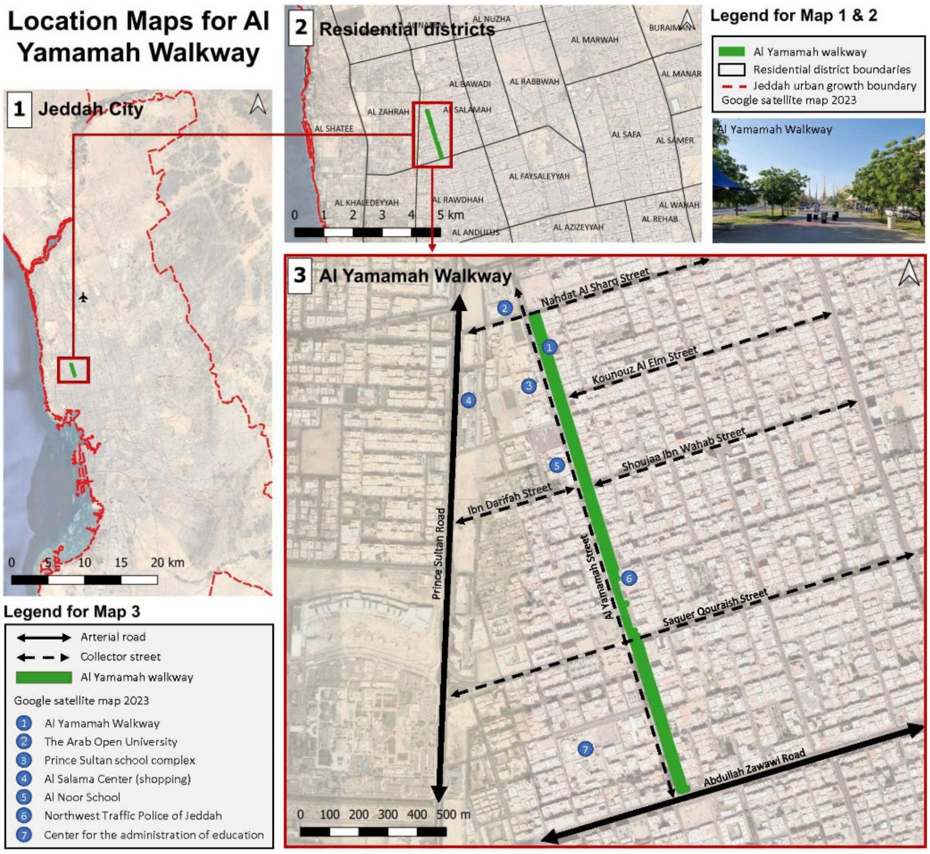


Figure 5-10. Site location of Al Yamamah walkway.

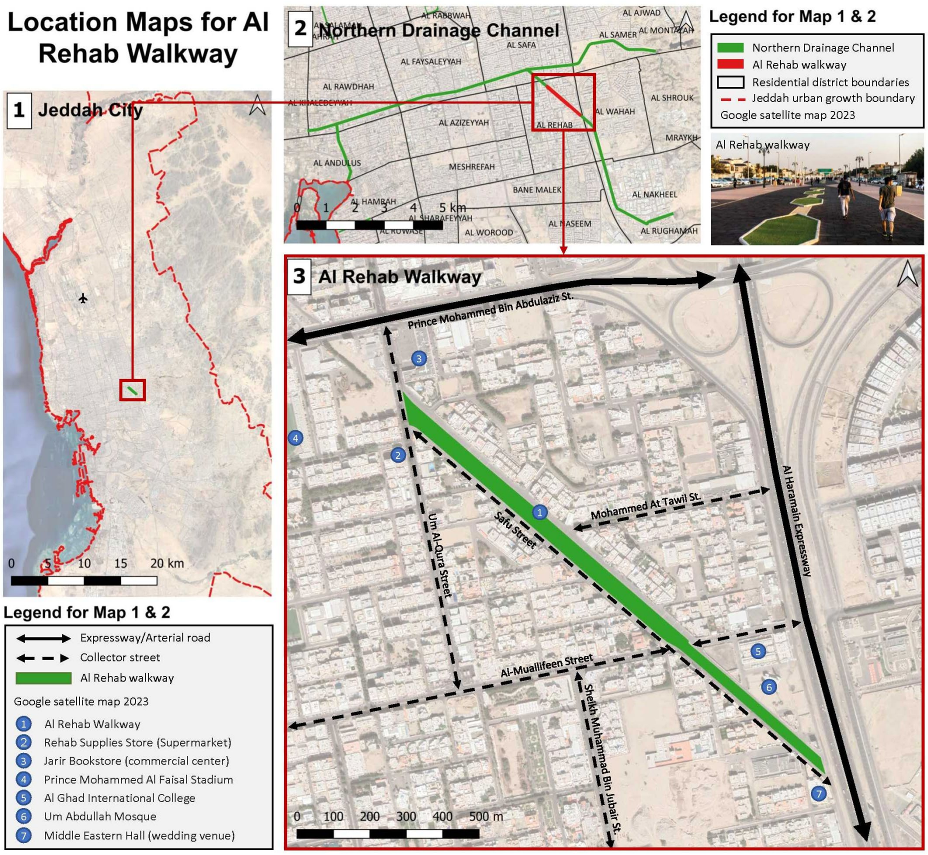


Figure 5-11. Site location of Al Rehab walkway.

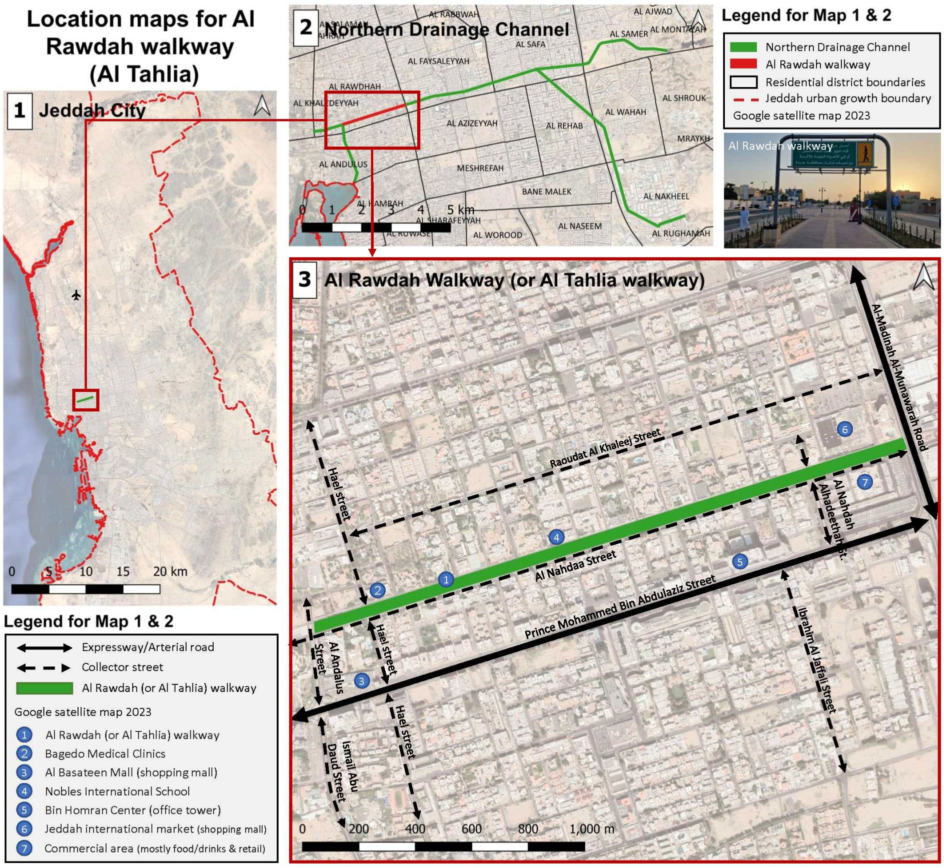


Figure 5-12. site location of Al Rawdah (or Al Tahlia) walkway.

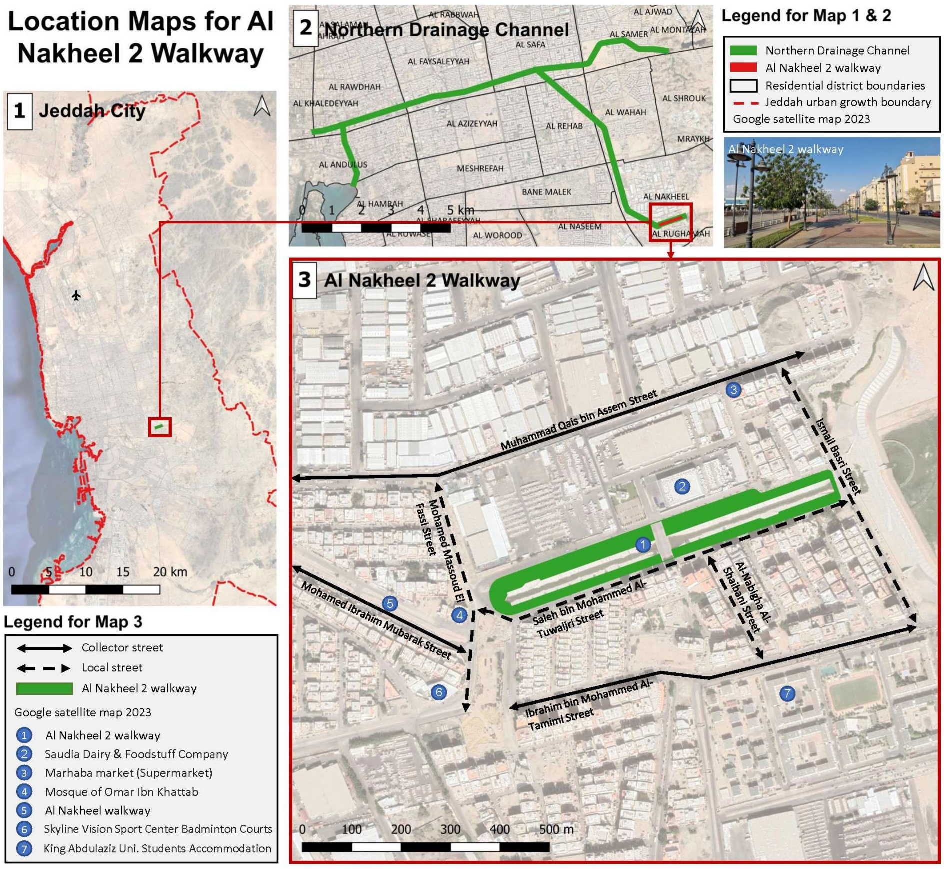


Figure 5-13. Site location of Al Nakheel walkway.

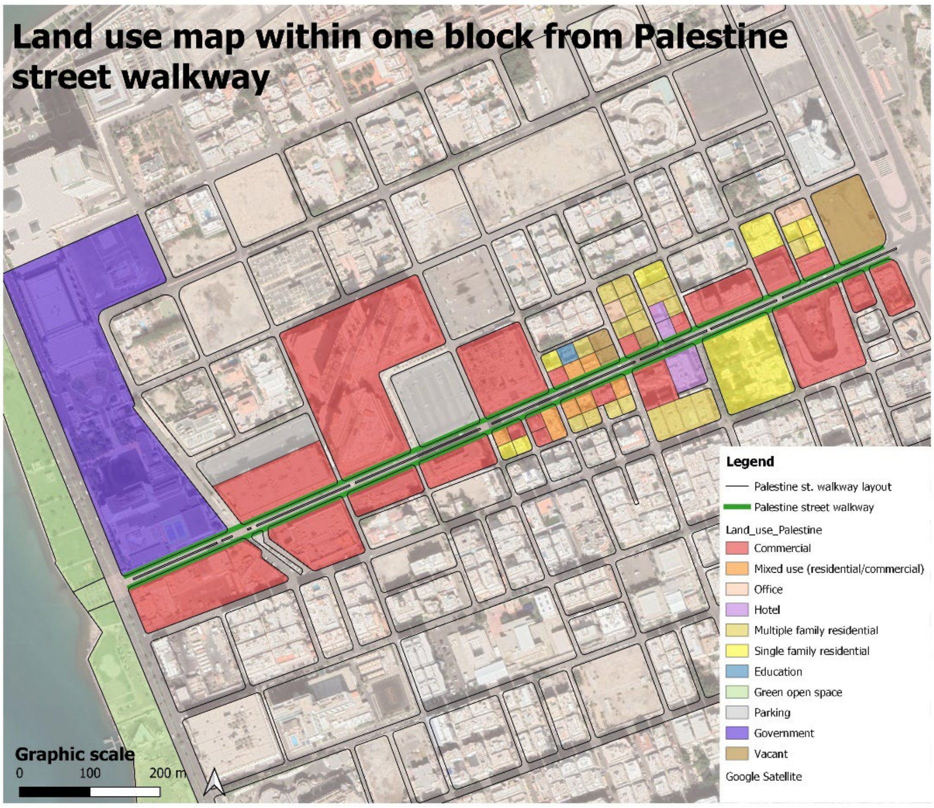


Figure 5-14. Land use map for Palestine Street walkway.

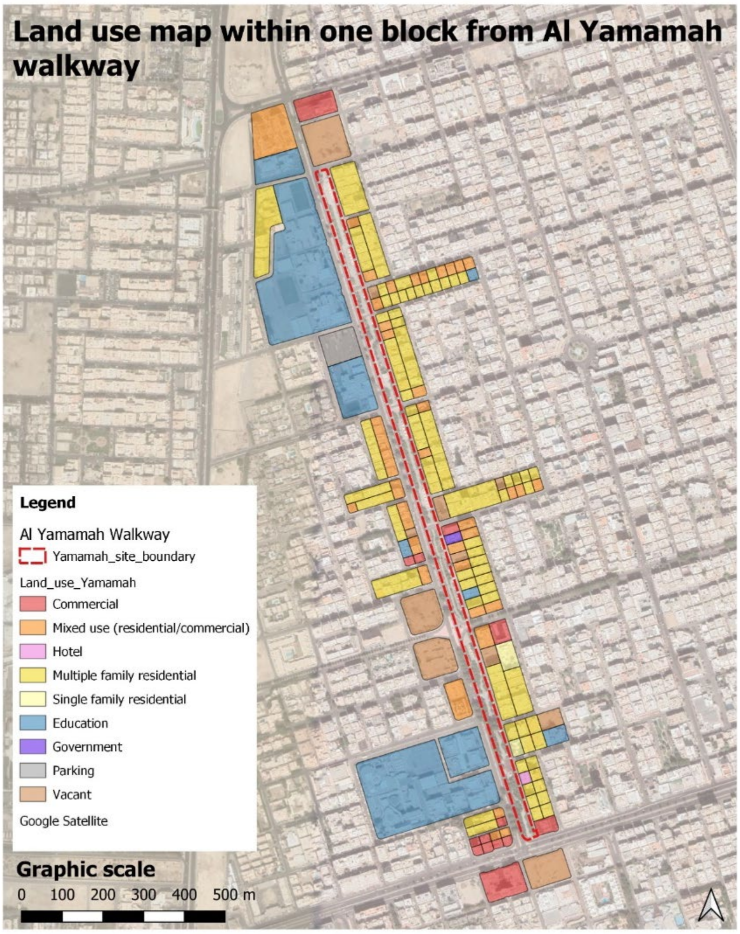


Figure 5-15. Land use map of Al Yamamah walkway.

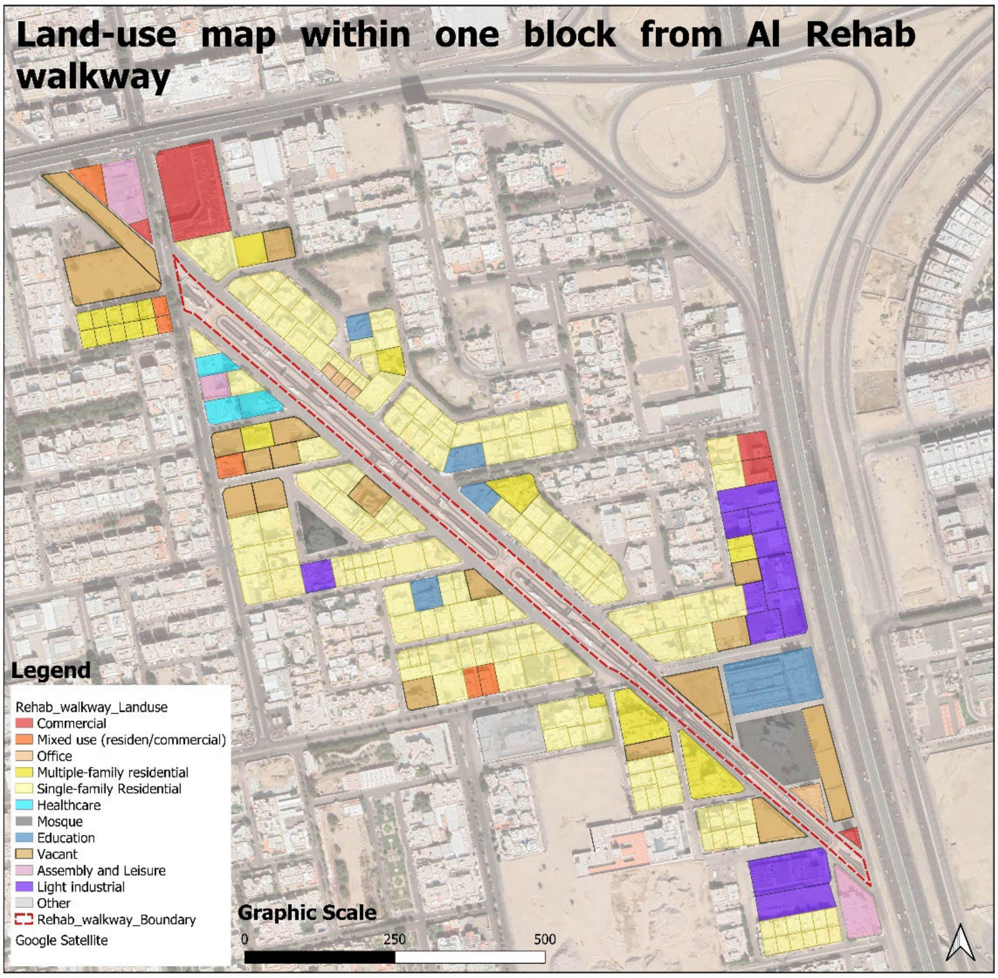


Figure 5-16. Land use map for Al Rehab walkway.

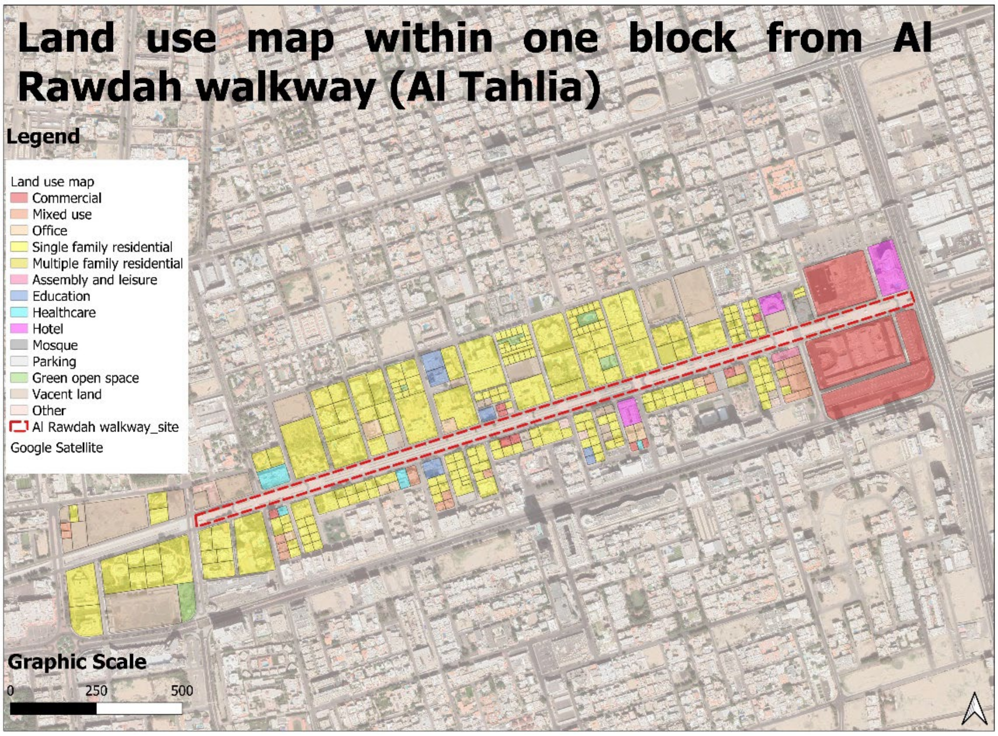


Figure 5-17. Land use map of Al Rawdah (Al Tahlia) walkway.

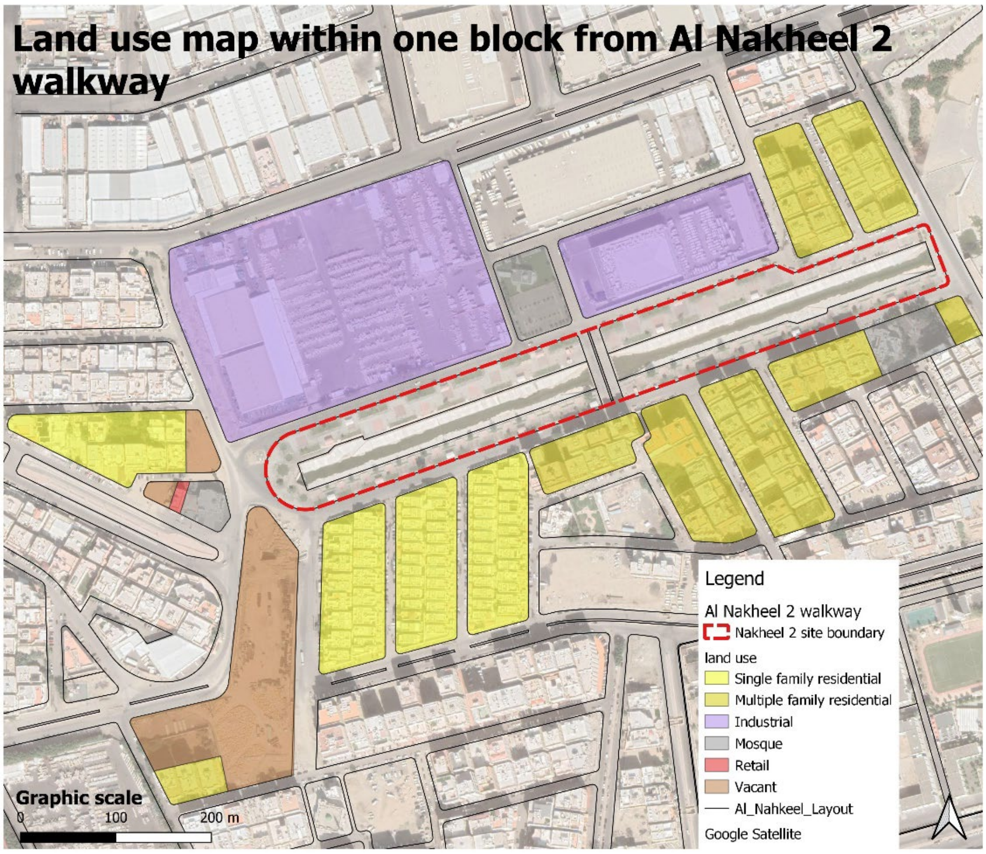


Figure 5-18. Land use map of Al Nakheel walkway.

5.5. Data Collection Methods

Data was collected via a web-based questionnaire, environmental audits, field observations (FOs), and semi-structured interviews. This section details the process of each method. Before engaging in the data collection process, all data collection methods involving human participants (i.e., the questionnaire and interviews) were approved by the Faculty of Engineering's Research Ethics Committee and administration at the University of Nottingham on 1/11/2019 (See Appendix B).

Invitations sent to potential questionnaire and interview participants had an introduction page and a consent request page. Participation was voluntary, and all respondents could withdraw at any time. The consent forms had the researcher's contact information, and participants were informed that they could withdraw from the study at any time. Moreover, all forms and questions via the questionnaire and interviews were communicated in English and Arabic (the native language of Jeddah residents). No data were collected until the researcher received the approval on the consent forms via all methods. In addition, data collection did not involve inquiring about individuals' medical or any forms of public records. Furthermore, it neither involved participants under 18 nor inquired about sensitive subjects such as terrorism or weapons (see Appendix C for the consent form).

All participants in the questionnaire and interviews were anonymised. In other words, none of their identity information was required to answer any questions. The collected responses were stored in a designated private digital directory that is password-protected and located on a secure server at the University of Nottingham. It will be kept securely for seven years following the research publication in accordance with the Data Protection Act at the University of Nottingham. After that, all the collected data will be permanently deleted. Lastly, all collected data are only used for educational and research purposes.

5.5.1. Web-based questionnaire

The questionnaire design aimed to examine users' preferences and opinions of Jeddah's LPs and the factors that influence their use (or non-use) of them as ATCs (both image and action). The questionnaire was a self-administered web-based questionnaire. The questionnaire featured yes/no, multiple choice (single and multiple answers), demographic, Likert scale, ranking, and open-ended questions. Therefore, the generated results from the questionnaire were both quantitative and qualitative.

There were three approaches to identifying and recruiting participants. First, a snowball approach began with personal contacts and groups via various social media channels (i.e., WhatsApp, Facebook, and Twitter). Those contacts received an online invitation asking about their willingness to participate in the questionnaire. See Appendix C to view the invitation, consent form, and questionnaire questions in English with all their details (The Arabic version is available upon request from the researcher). The second approach formally forwarded an online invitation letter via email to an institution in Jeddah city, namely King Abdulaziz University (KAU). The researcher corresponded with the Programs and Development Agency at the Deanship of Graduate Studies, KAU, to have the invitation forwarded via email to all students, academic staff, and employees. Such a service is available to all academic members at KAU[17].

The final form of recruitment was face-to-face. Specifically, from a fixed and visible location within a few walkways/LPs in Jeddah (specifically, Al Rehab, Rawdah, Jamiaa, and Middle Corniche walkway), the researcher handed out an invitation letter with a QR code to pass interested individuals. This process took place from 20/12/2019 until 12/1/2020. The selection of walkways/LPs to hand out the invitation letters was based on the amount of foot traffic. During visits (Dec 2019 and Jan 2020), these sites enjoyed a high number of users.

Additionally, before any site visits were made, the researcher obtained an official letter from KAU that allowed him to hand out an invitation letter to site users. Such a letter was obtained for verification in case anyone inquired about my affiliation or permission. Research assistants were also planned to be recruited to assist with this data collection on-site on subsequent dates; however, disruption caused by COVID-19 prevented this. In short, disseminating the self-administered web-based

[17] For more information about the administrative process and contact details, please visit the Deanship of Graduate Studies website at KAU (https://graduatestudies.kau.edu.sa/Pages-astbanat.aspx).

questionnaire employed a snowball approach using (I) social media channels, (II) official email to KAU students, academic staff, and employees, and (III) face-to-face in selected LPs in Jeddah city.

As shown in Section 4.2.4, the most relevant journal articles with similar intent commonly use a self-administered web-based questionnaire to examine the influences on greenways' usage as ATCs. That said, there were several justifications for using such an approach. The recruitment process had minimal sampling bias, especially since maximizing the reach of the questionnaire invitation was the goal; hence, various recruitment methods were used. Moreover, 97.11% of the total population of Makkah province population own smartphones in 2019 (The General Authority for Statistics, 2019b), which suggests that no demographic group was intentionally marginalised. Another reason for using an online questionnaire was to study the opinions of users and non-users of Jeddah's walkways/LPs, especially since understanding enablers and barriers to active commuting via Jeddah's walkways/LPs is one of the research's main goals. In addition, since there can be difficulties in obtaining responses from female participants due to cultural norms (Addas and Rishbeth, 2018; Daghistani, 2007; Mandeli, 2011), using a web-based questionnaire reduces such barriers. Other general advantages of using an online questionnaire include customisation, question filtration, organisation of data, ease of distribution, and time efficiency (Clark et al., 2015).

Simultaneously, a self-administered web-based questionnaire has several disadvantages (Clark et al., 2015). For example, illiterate and visually impaired individuals may have had unequal access to the questionnaire compared to other demographics. The same applies to people with no internet access. Nonetheless, considering the research questions, the methods used by the most relevant literature identified in Chapter Four (Section 4.2.4), and practicality (see Section 5.4), a self-administered web-based questionnaire was considered a suitable choice.

Qualtrics survey software was used to design and disseminate the questionnaire because it had Arabic translation and other questionnaire design features such as pipe text, skip logic, content editor, data transfer, and analysis. Based on the conclusions of Section 1.2, the questionnaire was designed based on the hypothesis that active commuters via greenways are rare. If the questionnaire aimed only to collect responses from active commuters via greenways, it would have considerably reduced the chances of finding respondents matching such criteria and required more time to collect responses. Nonetheless, given that one of the primary objectives of the research is to explore strategies for overcoming barriers to greenway usage as ATCs in Jeddah city, surveying all types of users and non-users about their opinions, preferences, and behaviours was important. This included questioning why they did (or did not) use greenways as ATCs. These questions were based on a synthesis of themes and questions asked by the most relevant literature identified in Section 4.2.4 and conclusions of Section 1.2.

The (revised) questionnaire followed a cross-sectional design, meaning data were collected via a specific time frame (Leavy, 2017). Responses to the questionnaire were collected from the 9th of December 2020 until the 15th of April 2021. Most responses were received between December and February. The considerably low responses from mid-February until mid-April are attributed to COVID-19 and its enforced restrictions. Increasing the questionnaire's response rate was a primary challenge. Online invitations were not as effective as anticipated. Events of COVID-19 prevented the researcher from physically distributing invitation letters to site users. A method that could have increased and balanced the number of responses among the examined walkways/LPs. The total number of questionnaire respondents is 357, of which 248 were complete responses. Most respondents completed the questionnaire between 8.4 and 20.4 minutes, representing the first and third quartiles. In hindsight, such a lengthy questionnaire may have contributed to the approximately 30% of incomplete responses (out of 357) or respondent fatigue. Furthermore, the high number of questions in the questionnaire (70 questions for both scenarios – users and nonusers) made their organization and analysis time-consuming.

The collected sample is diverse, representing various socio-economic and demographic characteristics (See Table 5-6). The notes presented in Table 5-6 show how some of the variables (choices) were combined (or recoded) using SPSS to satisfy statistical assumptions, like in the case of Chi-square analysis's requirement of not having a variable with less than five responses (or counts). Moreover, recoding was also applied to other questions in the questionnaire for the same purpose (see Section 5.6.2.1). Research findings (Chapters Six to eight) included descriptions of how variables were recorded (when applicable). In addition, Table 5-6 also shows variations in total responses for each of the questionnaire questions. The reasons for such outcomes are incomplete responses, a participant's preference not to share such information, and the researcher's omission to satisfy statistical analysis (low frequencies = less than five responses for a variable or choice). In short, the study sample population has various socio-economic and demographic characteristics.

Table 5-6. Descriptive characteristics of the study sample population.

Category	**Variables***	**Total**		Notes
		Frequency	Valid %	
Gender	Male	157	63.8	None
	Female	89	36.2	
	Total	246	100.0	
Age	18-24 years old	35	14.2	Age above 55 years old = 55-64 years old + 65 years or older
	25-34 years old	82	33.3	
	35-44 years old	70	28.5	
	45-54 years old	36	14.6	
	Above 55 years old	23	9.3	
	Total	246	100.0	
Marital Status	Single	70	31.4	Due to low frequencies, variables such as separated, divorced, and widowed were not considered in the analysis phase.
	Married	153	68.6	
	Total	223	100.0	
	Yes	110	45.8	None

Children ≥ 8 years old?	No	130	54.2	
	Total	240	100.0	
Car Ownership	Yes	202	82.1	None
	No	44	17.9	
	Total	246	100.0	
Employment Status	Employed	155	84.7	Due to low frequencies, the analysis phase did not consider variables such as retired and student.
	Unemployed	28	15.3	
	Total	183	100.0	
Household Income	Less than 6000 SAR	34	16.3	More than 25,000 SAR = 25,000 SAR to less than 30,000 SAR + 30,000 SAR to less than 35,000 SAR + More than 35,000 SAR
	6000 SAR to less than 10,000 SAR	40	19.1	
	10,000 SAR to less than 15,000 SAR	43	20.6	
	15,000 SAR to less than 20,000 SAR	37	17.7	
	20,000 SAR to less than 25,000 SAR	20	9.6	
	More than 25,000 SAR	35	16.7	
	Total	209	100.0	
Years of residency in the same address	Less than five years	92	37.9	More than 20 years = 20-25 years + more than 25 years
	5-10 years	44	18.1	
	10-15 years	32	13.2	
	15-20 years	21	8.6	
	More than 20 years	54	22.2	
	Total	243	100.0	
Years of residency in Jeddah City	Mean = 24.927 Std. Deviation=14.05	248	100.0	None
Total sample population		**357**		Of which 248 were complete responses**

* All "prefer not to say" variables were deleted in each category and not considered in any analysis.
** All incomplete responses (a total of 109) were considered in the analysis. However, only unfinished questions (missing data) were excluded from the analysis since they were incomplete. Therefore, there are variations in the total number of responses between the questionnaire questions.

Several measures were considered to ensure the validity of the questionnaire results. First, before the questionnaire dissemination, all questions were reviewed by experts (Faculty of Engineering's Research Ethics Committee and supervisors) to ensure that they did not have errors or were confusing or leading. Such a measure is called content validity (Leavy, 2017). Second, a pilot questionnaire was conducted as an additional review layer from the 11th to the 22nd of November 2019. A total of 21 respondents, using a snowball sampling strategy, completed the pilot. The questionnaire was revised in response to feedback from the pilot, e.g., rephrasing questions and answers to enhance clarity. Third, the option that prevents multiple submissions was activated using Qualtrics (the software places a cookie in respondents' browsers). Additionally, the questionnaire forced responses in most questions to ensure that all questions were answered. Therefore, no respondent could view the following page or proceed in the questionnaire without responding to the presented question.

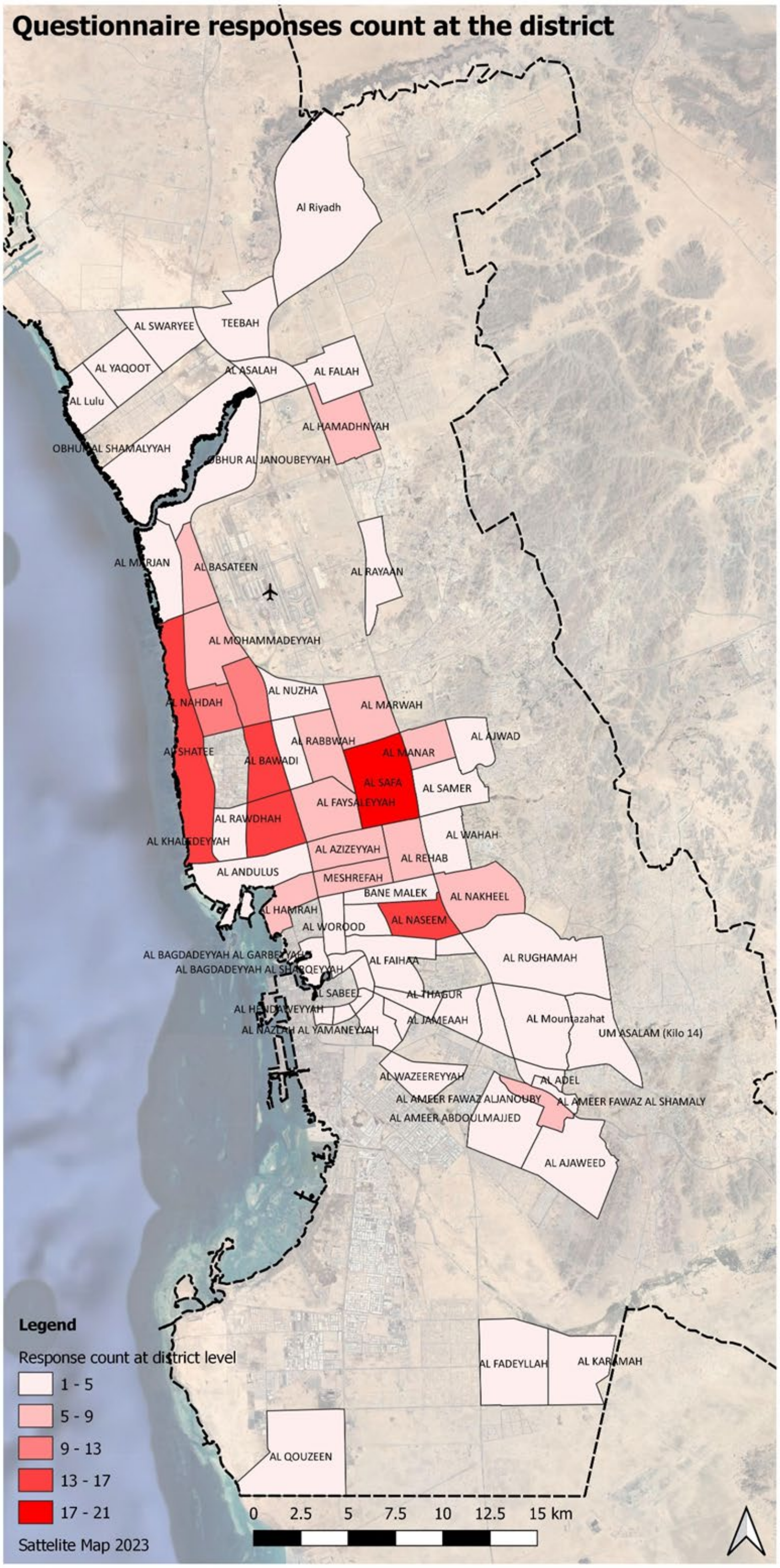
Fourth, Qualtrics was used to transfer data into SPSS to avoid errors in data entry. Fifth, triangulation results from other methodological outputs (e.g., environmental audits and interviews) was an additional step in validating the questionnaire results (see Section 5.6 for more information). The triangulation of results confirmed, contradicted or further explained the questionnaire results and provided a more nuanced picture of the topic. In short, experts' reviews, pilot studies, prevention of multiple entries, controlling of response progression, automated data transfer between applications, and data triangulation were all validation measures of the questionnaire results.

Chi-square Goodness of Fit tests were conducted to determine if the sample was representative of Jeddah's population. Leavy (2017) referred to it as ecological validity. The tested variables were gender, age, and marital status. Other variables were not tested due to data unavailability. Moreover, the population and housing census data used in this analysis were obtained from the Saudi General Authority of Statistics. Specifically, the 2010 census (by city) since it is the latest available on their official website (as of April 2022). As shown in Table 5-7, there are no statistically significant differences between the sample and Jeddah population characteristics. Therefore, the sample generalises to the population of Jeddah city regarding gender, age, and marital status.

Table 5-7. The representativeness of the sample to the population of Jeddah city.

Gender				**Test statistic (α=0.05)**		
	Observed N	Expected N	Residual	Chi-Square	df	Asymp. Sig.
Male	157	143.4	13.6	3.1	1	0.078
Female	89	102.6	-13.6			
Total	246					
Age group				**Test statistic**		
	Observed N	Expected N	Residual	Chi-Square	df	Asymp. Sig.
18-24 years old	35	48.9	-13.9	6.273	4	0.180
25-34 years old	82	76.4	5.6			
35-44 years old	70	60.2	9.8			
45-54 years old	36	34.8	1.2			
> 55 years old	23	25.8	-2.8			
Total	246					
Marital Status				**Test statistic**		
	Observed N	Expected N	Residual	Chi-Square	df	Asymp. Sig.
Single	70	73.1	-3.1	0.2	1	0.655
Married	153	149.9	3.1			
Total	223					

Questionnaire respondents geographically reside in several residential districts in Jeddah city (see Figure 5-19), further validating the representativeness of the collected sample to the population of Jeddah city. However, 59 participants preferred not to share their residential district name. Therefore, Figure 5-19 does not show the distribution of all questionnaire participants based on residential districts. Furthermore, data is lacking from the southern region of Jeddah city since industrial land uses dominate it. With that in mind, Table 5-8 specifies the number of participants for each studied site. Overall, the locations where the questionnaire respondents reside in Jeddah city are widespread, suggesting various living conditions and proximities to walkways/LPs.



Frequeny of responses based on residential districts

Residential district name	Frequency
Al Basateen	8
Taiba	4
Al Yaqoot	1
Al Sawari	1
Al Riyadh	2
Al Lulu	1
Al Falah	2
Al Hamadaniyyah	8
Al Khalidiyyah	4
Ash Shati	14
Al Murjan	2
Al Asalah	1
Al Safa	21
Al Marwah	6
Al Bawadi	3
An Nuzhah	3
Ar Rabwah	9
Ar Rawdah	15
As Salamah	15
Al Naeem	11
An Nahdah	11
Al Mohammadiyyah	6
Al Faisaliyyah	6
Abhur Al Junoobiyah	5
Obhur Al-Shamaliyah	2
Al Fayha'a	5
An Naseem	16
Al Warood	2
Al Rehab	7
Al-Hamra'a	7
Al Andalus	4
Mishrifah	6
Al Ajwad	3
Al Sharafeyah	1
Al-Rawabi	4
Al Thaghr	3
Al Jami`ah	4
Al-Baghdadiyah Al-Sharqiyah	1
Al-Baghdadiyah Al-Gharbiyah	2
Al Sulaymaniyah	2
Bani Malik	3
Aziziyah	7
Al Nakheel	7
Al Kandarah	3
Al Adel	1
Prince Abdulmajeed	2
Al Amir Fawwaz Al Junoobi	6
Al Amir Fawaz Ash Shamaly	2
Al-Hindawiya	1
Al-Wazeeriyah	4
Al Muntazahat	2
Ajaweed	2
Al Waha	2
An Nazlah Al Yamaniyyah	1
Al-Nazlah Al-Sharqiyah	3
Al-Manar	6
Ajaweed	1
Al Samer	4
Ar Rayaan	3
Khumrah	2
Al Fadeylah	1
Al Qwizain	1
Abruq Ar Rughamah	2
Al Sabeel	1
Kilo 14	3
Total	298
Undetermined Values	59
Total	357

Figure 5-19. The locations where the questionnaire respondents reside are in Jeddah city.

Table 5-8. Number of collected responses for the examined sites nearest to participants via the web-based questionnaire.

Walkway/LP name	No.	Walkway/LP name	No.
Northern Corniche walkway	18	Zahrt Al Waha Walkway	1
Jeddah waterfront walkway	52	Al Safa walkway	20
Middle Corniche Park	22	Al Safa 2 walkway	12
Al Shatee Garden Walkway	4	Al Nakheel walkway	6
Prince Faisal bin Fahad Street Walkway	12	Al Nakheel 2 walkway	3
Taibah Walkway	14	Al Jamiaa walkway	46
Al Yamamah Walkway	22	Al Waha walkway	1
Al Samer walkway	16	Al Faisalia walkway	6
Prince Al Fawaz district walkway	22	Al Rehab walkway	35
Al Rawdah walkway	28	Other*	17

* Participants specified many user-defined walkways (i.e., incidental walkways, as defined by Addas, 2015). In many other instances, participants used different names for the listed walkways/LPs. The following were their choices (translated): Al Fayha'a Walkway (which is Al Jamiaa Walkway), Masjed Ibn Katheer Walkway at Albasateen District, Taibah Walkway, Prince Al Fawaz District Walkway, Dahban Coastal Park Walkway, Al Amir Majid park walkway (n=3), Northern Abhur path (n=2), Southern Abhur path, Darb Alharamain walkway, and Al Hamra Corniche (which is Middle Corniche Park). Lastly, few said there were no walkways in my residential district (n= 4).

Finally, the questionnaire ended with an invitation to participate further in the research voluntarily so that the issues raised in previous questions could be examined in greater detail from the respondent's perspective. Response to the invitation was optional with a Yes or No (see Appendix C). Even though many participants expressed their interest in further communicating their thoughts and opinions about the raised topics in the questionnaire, the plan was cancelled for several reasons. First, the questionnaire had several open-ended questions. Notably, it is one where each participant had the opportunity to express their experiences or thoughts about Jeddah's LPs. Unexpectedly, that question gained traction, and the received feedback, while plentiful, had common patterns, leading to data saturation (see Section 5.6 for more information about data analysis). Second, after analysing phase one findings, the raised topics that warranted further examination needed experts' feedback. The researcher determined that the questionnaire respondents would not have the knowledge and expertise to address the newly generated questions for the interviews (see Section 5.5.4). Therefore, all the names and contact information collected about the questionnaire participants were deleted, and the researcher never communicated with those volunteers.

5.5.2. Environmental audits

The assessment of Jeddah's walkways/LPs focused on (I) walkability to/from these sites and (II) their design, amenity, and maintenance. As discussed in Section 5.3.1.2, all these assessments focused on the physical environment using objective measurements. The researcher obtained an official letter from the Department of Landscape Architecture at KAU in March 2023 that permitted him to photograph Jeddah's walkways/LPs (See Appendix D). It was a precaution in case anyone inquired about the researcher's affiliation or permission. This step was necessary because photographs were an essential data collection and validation tool for site characteristics and conditions.

Data sources were from site inventory, GIS, Google Earth, documents about (inter)national road and urban design standards and best practices, and secondary data sources (i.e., Jeddah Municipality). Secondary data were also collected from Metro Jeddah Company (MJC) (i.e., future public transportation network). However, due to an obligatory non-disclosure agreement, the researcher could not use the collected data from MJC in the thesis. In addition, data collected from Google Maps and Earth were primarily satellite images and horizontal distance measurements. Sidewalk and LP audits relied on fieldwork because Google Street View was unavailable in most street segments, unlike in developed countries.

Nonetheless, data collected from fieldwork allowed for more detailed examinations (e.g., up-to-date observations and site measurements). Furthermore, data that were officially obtained from Jeddah Municipality (application number 4000187) were, in some instances, outdated (e.g., street network and buildings layer). In other cases, they were raster data (e.g., land use map and population densities) (see Appendix A, Tables A1 and A2). Therefore, data preparation encompassed updating collected data. In short, data sources included site inventory, documents, GIS, Google Earth, and Jeddah Municipality.

Proximity analysis and street intersection density were based on available and collected data from secondary sources. However, the sidewalk walkability audit of neighbourhoods surrounding the five representative case studies within 400 m using the adapted MAPPA required fieldwork conducted in March and April 2023. Before fieldwork, base maps were prepared for each site, and the sidewalk assessment criteria were reviewed (see Section 5.3.1.2). Furthermore, an iPad Pro was used to document sidewalk characteristics and conditions. Also, a pilot study was conducted on the surrounding neighbourhoods of Al Nakheel walkway. It identified areas needing further clarification, such as sidewalk width and buffer zone for all walkability levels. Site inventory was conducted on foot and using a car. Additionally, geotagged photographs were captured using a smartphone for different sidewalk characteristics, conditions, and obstruction types.

Figure 5-20 shows the different sidewalk walkability levels using the assessment criteria (Table 5-1). A colour was assigned to each sidewalk walkability level (one to five / red, purple, yellow, blue, then green) to enhance map legibility. Lastly, although common, behavioural factors such as illegal parking on sidewalks were not considered since they are not part of the sidewalk's physical configuration.

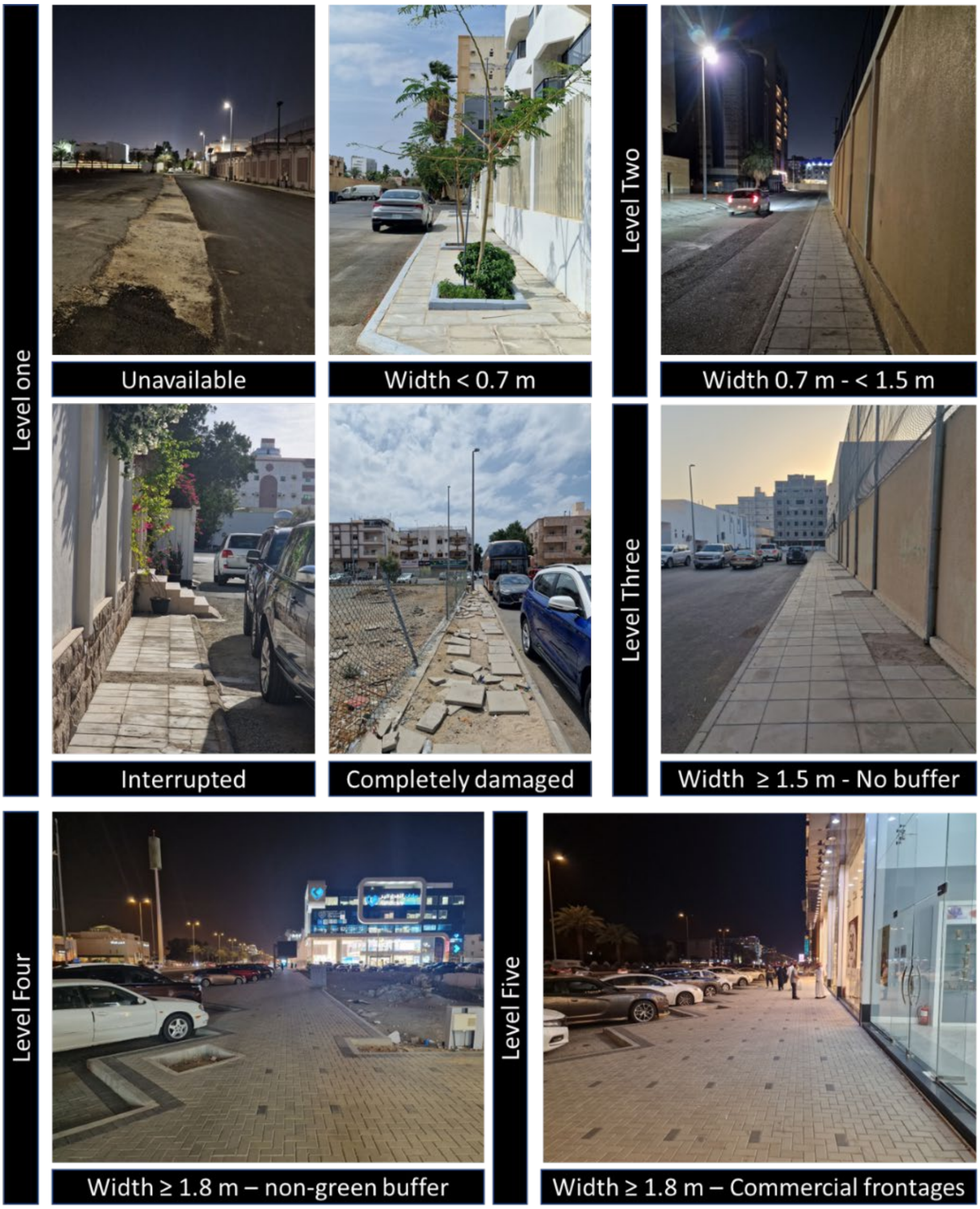


Figure 5-20. Examples of sidewalks in Jeddah city show different walkability levels based on the study assessment criteria.

Assessment of the walkway/LP's design, amenity, and maintenance of the five representative case studies via the adapted PEAT also required fieldwork (see Section 5.3.1.2 for more information). It was conducted during April 2023 only by the researcher. Like the adapted MAPPA, base maps were prepared in advance, and an iPad Pro was used to document existing conditions. Due to the multiplicity of indicators, a printed version of them and their descriptions were important for accurate and consistent assessments. Moreover, each walkway/LP segment was coded (i.e., segment identifier) to facilitate the assessment and identification of areas in need of future improvement (see Figures 5-21 to 5-25). Table 5-9 provides the average segment length and standard deviation for each site and the overall average for all sites.

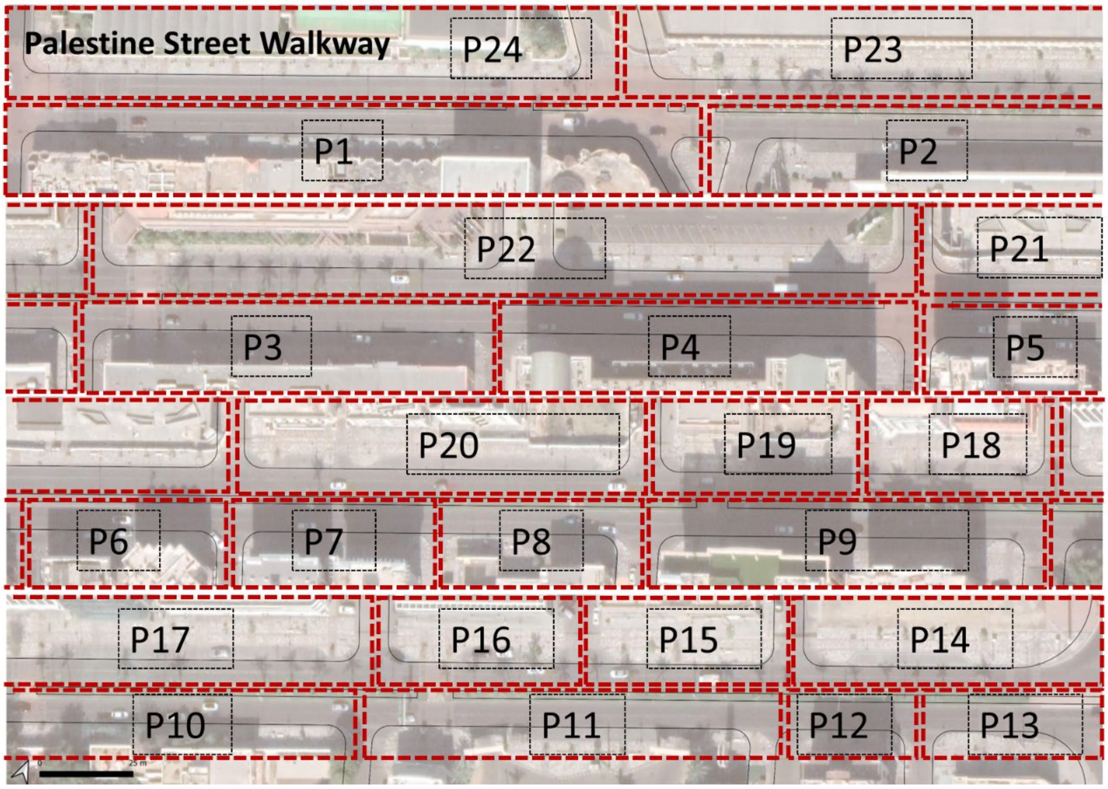


Figure 5-21. Identification codes for Palestine Street Walkway segments.

Figure 5-22. Identification codes for Al Nakheel 2 Walkway segments.

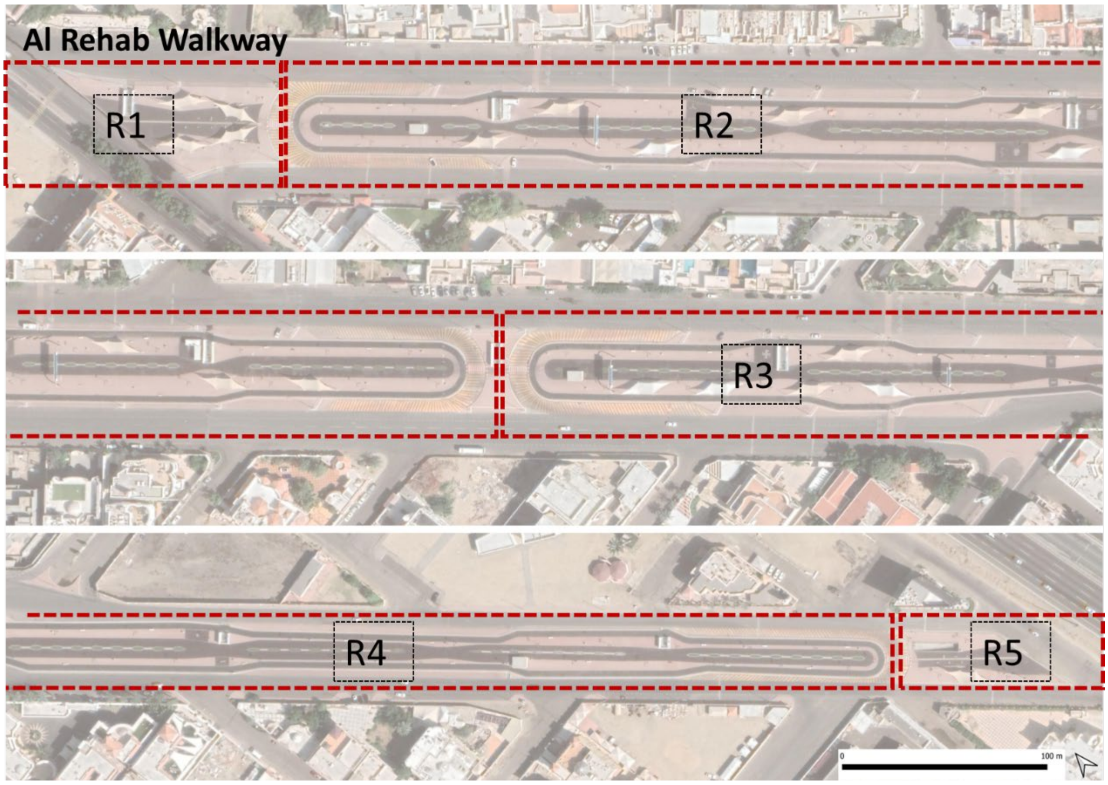


Figure 5-23. Identification codes for Al Rehab Walkway segments.

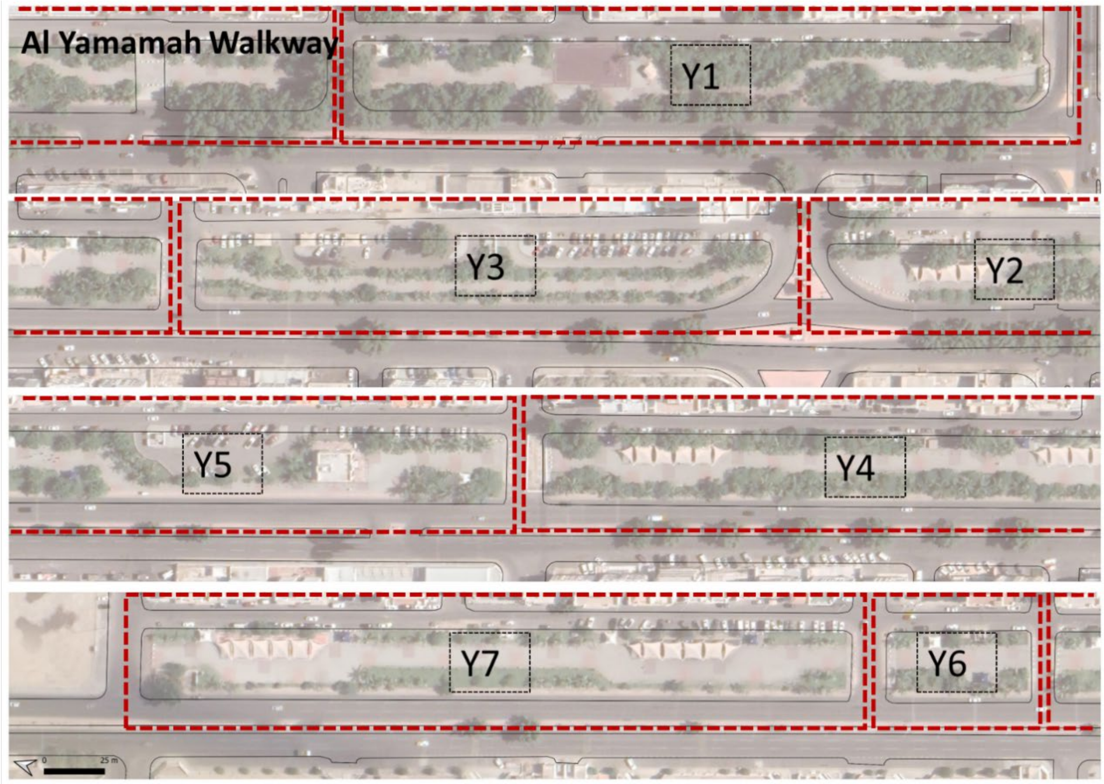


Figure 5-24. Identification codes for Al Yamamah Walkway segments.

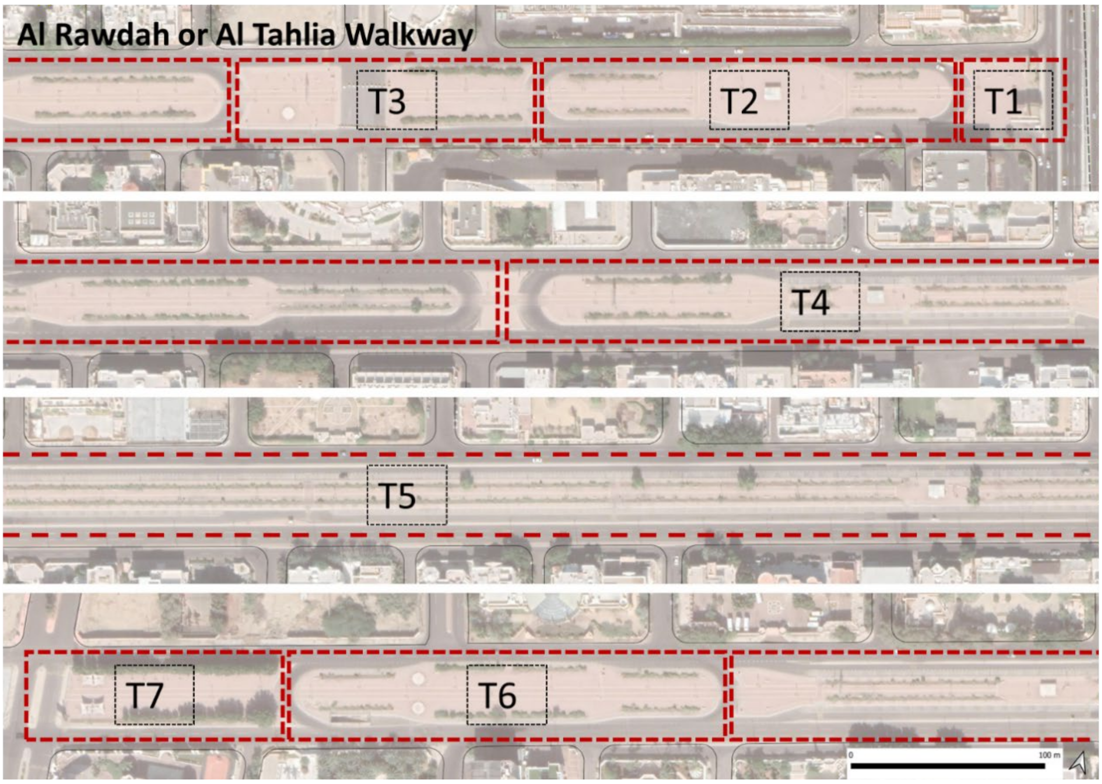


Figure 5-25. Identification codes for Al Rawdah or Al Tahlia Walkway segments.

Table 5-9. Average segment length and standard deviation for all representative case studies.

Site name	No. of segments	Length (average)	Standard deviation (SD)
Palestine Street Walkway	24	99.2	50.9
Al Yamamah Walkway	7	259.8	98.8
Al Rehab Walkway	4	380.0	347.8
Al Tahlia Walkway	7	312.4	327.3
Al Nakheel 2 Walkway	4	356.8	1.5

Site measurements were based on tape measures (for short horizontal and vertical distances), Google Earth Pro (for long horizontal distances), a Clinometer application (for slopes), and AR Ruler: Camera Tape Measure application (for vertical distances). The last two distance measurements were via an Android smartphone. Regarding the Clinometer application, multiple readings were taken to calculate the slope percentage of curb ramps and paths. The AR Ruler application was used to calculate trees' height and average crown spread (measuring the widest and narrowest points, then dividing by two) and lamp posts.

These measurement tools differ from the ones used in the original PEAT, which used a "*Trimble GPS Pathfinder Pro XR receiver and a TSCI Asset surveyor (hand-held unit)*" (Troped et al., 2006) for several reasons. First, there is a 20-year difference in the data collection dates between Troped et al. (2006) and the current study. The accuracy of Satellite images and measurement tools improved since 2003. Second, all thesis case studies are in urbanized locations where Google satellite images display detailed information. This is different from the original PEAT study, which included trails in conservation and rural areas. According to Troped et al. (2006), spatial trail data were unavailable in a consistent format and accuracy; thus, the use of a highly accurate GPS unit was justified.

Nonetheless, based on Trimble Navigation Limited (1997), data collected via the GPS Pathfinder Pro has a submeter accuracy; thus, field measurements via such devices carry a small margin of error. Distance measurement accuracy of Google Earth Pro has an average error rate of 1.45% in on-road path measurements (Harrington et al., 2017), which was believed to be acceptable for the purposes of this research. Such an error rate was factored in when evaluating the distance between site amenities (e.g., seats). Third, most of the adapted PEAT indicators (n=33) required their location and information about their characteristics and conditions. Mapping during fieldwork via the iPad facilitated the use of customized symbols, shapes, colours, and notes that indicate different site element types, characteristics, and conditions (see Figure 5-26). In short, even though site measurement tools differed between the original PEAT and the current study, the intent was to document existing site elements and conditions at a submeter accuracy to evaluate walkways/LPs' designs, amenities, and maintenance.

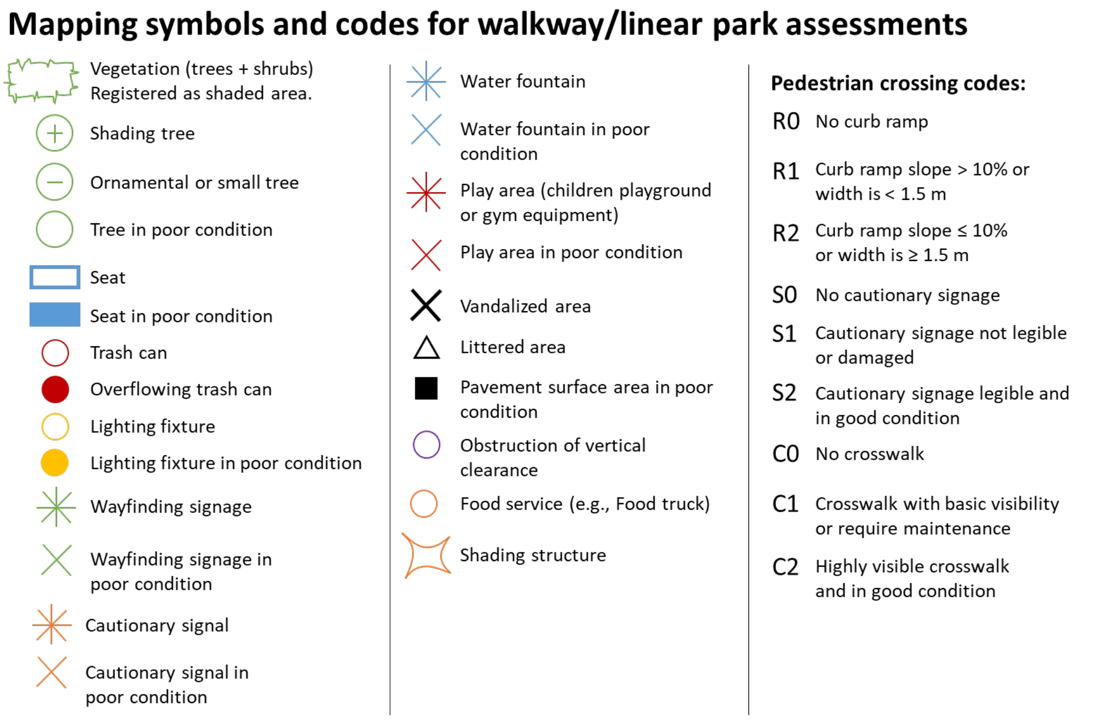


Figure 5-26. Mapping symbols and codes for walkway/LP assessments.

A pilot study was conducted on Al Nakheel walkway and part of the Palestine Street walkway in April 2023. Each site has different characteristics. Therefore, it was important to review the assessment criteria to consider the various site characteristics (see Tables 5-2 and 5-3). Assessments were conducted after inventorying the entire segment. The walkway/LP was walked several times to ensure all site elements were documented. The researcher did not move to the following segment until all fields were assessed. Additionally, photographs were taken for all segments to document existing conditions. Each segment had a separate folder to manage collected data. In short, the pilot study helped refine the proposed assessment criteria in Tables 5-2 and 5-3.

5.5.3. Field observations

FOs aimed to learn about users' behaviours (i.e., user types, forms, and location of activities) in Jeddah's walkways/LPs. Specifically, understand the dynamic relationship between people and places (i.e., greenways) (Deming and Swaffield, 2011). This study extended previous research on greenspaces in Jeddah (Addas, 2015; Maghrabi, 2019) by focusing on existing behaviours that may act as a barrier to greenways' function as facilitators of AT.

Using FOs has several benefits, such as allowing the researcher to compare what the questionnaire and interview participants stated and what was directly observed. Hence, FOs can be used to validate the findings of other data collection methods (Clark et al., 2021; Patton, 2015). Other key benefits include emotionally understanding first-hand what it feels like to be a user (e.g., a bicyclist) in Jeddah's LPs (Cullen 1961 as cited in Addas, 2015). Nonetheless, site visits did not involve participating in any of the users' activities, which Clark et al. (2021) described as non-participant observation. Such an approach facilitated understanding users' behaviours without intervening or manipulating natural settings.

A total of 18 (out of 24) walkways/LPs in Jeddah were visited during three periods: from 20th Dec 2019 until 12th Jan 2020, from 13th Dec 2020 until 2nd Feb 2021, and from 25th Mar 2023 until 25th Apr 2023. The ones not visited were numbers 4, 5, 12-13, 17, and 22, as shown in Table 5-5, since the visited sites cover all walkway/LP types and design characteristics. Furthermore, FOs were mainly conducted during the first period, which overlapped with data collection via the questionnaire. Such a factor is important because the observed behaviours and settings provided an accurate visual representation of participants' experiences in Jeddah's walkways/LPs. However, given the length of the FO period, collected data were an informed, journalistic evaluation type as characterised by Marcus and Francis (1998). Therefore, data collected via FOs was only intended to supplement findings from other methods.

Several reasons prevented longer FOs and utilization of more systematic social science techniques (e.g., user counts). First, COVID-19 disrupted plans to conduct additional fieldwork (the first study period finished a few weeks before the lockdown began). Airlines were significantly impacted, people were forced to stay home, and social distancing was imposed when the lockdown was partly eased. Further readings or FOs would have skewed/impacted the results discussed in the thesis because COVID-19 restrictions limited the movement of residents, not to mention the uncertainties regarding the end of COVID-19 (which lasted for nearly two years). Second, most of the thesis was conducted while living in Nottingham, UK, and the immigration sponsor (i.e., University of Nottingham) prevented spending more than three months in any 12 months outside the UK. Third, as explained in Section 5.2, using automated pedestrian and bicycle counters is expensive and requires occasional physical checks to ensure equipment functionality and validity of collected data (Ermagun et al., 2018a; Bergman and Cohen, 2016). Site visits multiple times a year were not possible due to COVID-19 and budget constraints. Given these reasons, the decision was made to use FOs data (i.e., photographs and notes) to supplement primary forms of data collection in recognition of the practical constraints outlined above. Specifically, the recorded photographs functioned as visual representations of users' behaviours, which may support or contradict the responses received via the questionnaire and interviews.

Before any site visits, the researcher obtained an official letter from the Department of Landscape Architecture at KAU that permitted him to take photographs and videos in Jeddah's LPs (See Appendix E). Such a step was a precautionary measure in case anyone inquired about the researcher's affiliation or permission. Site visits were made daily, including weekdays and weekends. Moreover, field trips were conducted at various times of the day and night to monitor differences in users' behaviours and site activities (between 8 a.m. and 11 p.m.). Thus, all 18 walkways/LPs were visited at least twice. The duration of observation at each site varied depending on the LP's length, ranging from 1 km to 4.5 km. However, no single visit was less than two hours. Furthermore, the researcher walked the entirety of all 18 LPs. During those walks, the researcher selected fixed locations to observe site users (variable duration) and took notes and photographs (3391 images). People's faces were all blurred to protect their privacy and identity.

5.5.4. Semi-structured interviews

Results from the questionnaire and environmental audits that needed further explanation were examined via semi-structured interviews with local and international experts (n=7) and leaders of AT interest groups (n=6). See Appendices F and G for the invitation letters, consent forms, and questions for both, respectively. Furthermore, the Arabic version is available upon request from the researcher. Interviewees from both categories received the same order and phrasing of questions to ensure consistency of results.

All interviewees were purposively sampled. In terms of AT group leaders, they were identified using social media (mostly Twitter). As for greenspace and/or transport planning experts, the process began by building a list of greenspace and/or transport planning experts who had/have working experience in Jeddah city. Aiding the identification and gathering of experts' contact information were colleagues who work in the same field. Once the list was completed, an invitation letter was sent via email and phone number if available. The same applied to AT interest group leaders. Whoever accepts the invitation, a second email/message was sent confirming a specific date and time of the interview as well as a Zoom software link. The number of participants continued until data saturation, which means generating a "*reliable sense* *of thematic exhaustion and variability within data set*" (Guest et al. 2006, as cited in Clark et al., 2021, p.387) was achieved.

All interviews were conducted via Zoom software and audio recorded only. Interviews took place in August and September of 2020. The audio recordings of 10 hours and 51 minutes were transcribed and translated (Arabic to English) and then analysed thematically. Moreover, experts' audio recordings lasted between 36.3 and 73 minutes, and AT interest groups lasted between 23.3 and 65 minutes.

Even though most interviewees voluntarily gave consent to disclosing their name and position/role, the researcher decided only to share a generic role or position to protect their identity, as shown in Tables 5-10 and 5-11. Such a measure is a balancing act between confidentiality and data integrity. A diverse range of interviewees participated. Expert interviewees included academics and practitioners, local and national government role holders, and views from public and private sectors (See Table 5-10). AT interest group leaders reflect male and female views and walking and bicycling groups (See Table 5-11). Chapter Seven, Section 7.6, provides more information about each AT interest group. The codes in the Tables below differentiate interviewees, especially when quoting some of their responses. In short, aside from the socio-demographic differences (e.g., age and gender), the interviewed participants hold different backgrounds, responsibilities, experiences, and expertise.

Table 5-10. The interviewed experts who have (or had) direct engagement with Jeddah's greenspace and/or transport planning.

No.	Experts' Role	Code	Duration	Nationality	Value
1	An academic in the landscape architecture department at King Abdulaziz University	E1	41.5 min	Saudi	Gain an informed perspective from an academic who specializes in a field that contributes to the planning and design of public open spaces in Jeddah city.
2	Former manager at Jeddah Municipality	E2	72.8 min	Saudi	Understand the factors that led to the existing characteristics and conditions of Jeddah's walkways/LPs.
3	Manager at Metro Jeddah Company	E3	37.5 min	Saudi	Learn from a decision-maker responsible for the transportation planning of Jeddah
4	Manager at Jeddah Municipality	E4	73 min	Saudi	Learn about existing plans and challenges to enhance pedestrian and bicycle infrastructure in Jeddah city from a director at Jeddah Municipality overseeing their implementation.
5	Former landscape manager of Jeddah's public parks at a company that worked for the Municipality	E5	51.3 min	Non-Saudi	Gain detailed insights from a landscape manager who contributed to implementing many of Jeddah's walkways/LPs.
6	Manager at an international architectural firm	E6	52.3 min	Non-Saudi	Gain an informed perspective from an international consultant who contributed to the planning and design of Jeddah's transportation plans.
7	Senior advisor at the Ministry of Municipal and Rural Affairs (MOMRA)	E7	36.3 min	Saudi	Learn from an urban planning expert who works as an advisor at MOMRA. This central governmental organization is legally entrusted with the urban planning and regulation of Saudi cities.

Table 5-11. The interviewed interest group leaders who regularly organise walking and cycling training sessions for Jeddah residents.

No.	Active transportation interest group leaders	Code	Duration
1	Jeddah Walkers (Moshat Jeddah)	L1	64 min
2	Buskaleta group (females-only group)	L2	23.3 min
3	Jeddah Cyclists group	L3	46.3 min
4	Masafat and Jeddah Road Runners group	L4	65 min
5	Ajalat Jeddah (Jeddah Wheels)	L5	48.3 min
6	Jeddah Cyclists women's group	L6	39.5 min

Interviews with experts were designed to obtain feedback about factors/barriers that required further explanations (phase one findings). In other words, feedback did not cover all subjects for several reasons. Global standards and best practices could address several barriers (e.g., unsafe pedestrian crossings and unavailability of public toilets). Many of those solutions are part of the environmental audits' score ranking (see Section 5.3.1.2). In other words, overcoming a barrier at a particular factor means achieving a "good" score, representing desirable dimensions, intervals, or qualities based on local and international standards and best practices. In addition, many of the identified barriers emerged from interviews with leaders of AT interest groups. Since interviews with experts and local groups occurred during the same period (each received different questions; see Appendices F and G), barriers identified by the latter were not part of the discussion with the interviewed experts. The same applies to several environmental audit findings. Nonetheless, all topics from interviews are discussed in Chapter Nine by relating them to existing literature and global best practices. This greatly enhances the depth of discussion associated with this research method. Interview topics focused on the salient issues (e.g., greenways' connectivity and usage constraints as ATCs), which were determined via consultation with experts (i.e., the researcher's supervisors).

5.6. Data Analysis and synthesis

Data collection methods had three units of analysis: individuals' responses (aggregated in the case of the questionnaire data), block segment (in the case of the adapted MAPPA), and Jeddah's walkways/LPs. The first unit was subjective data received from users and non-users of Jeddah's walkways/LPs via the questionnaire and interviews. The second and third units were objective data assessed by the researcher via fieldwork. Individual-based data (e.g., participants' responses/opinions about a particular topic or theme) were thematically linked to the location-based findings. Doing so provided a multidimensional approach to understanding the constraints and opportunities for activating walkways/LPs' potential as ATCs.

Analysis of qualitative and qualitative data fed into predefined sub-themes in the form of codes to better understand the nuances, patterns, and variations within each (See Figure 5-27). These predefined themes and sub-themes aided the organization, analysis, and synthesis of results. Qualitative data analysis (e.g., from interviews) often generated multiple coding levels. For instance, regulations under the underlying causes' sub-theme have several lower-level codes.

Triangulated results shared the same topic. For example, opinions about walkability to/from Jeddah's walkways were triangulated with the adapted MAPPA results. Such a process may confirm, contradict, or expand the understanding of existing conditions. Activation strategies had a similar approach; however, generated data were feedback from interviewed experts, existing literature, and global best practices. The following Sections (5.6.1 and 5.6.2) will describe the quantitative and qualitative data analysis process. In brief, as shown in Figure 5-27, codes that fed into predefined themes were triangulated to explore the barriers to and strategies for greenways' function as ATCs while relating to existing literature and best practices.

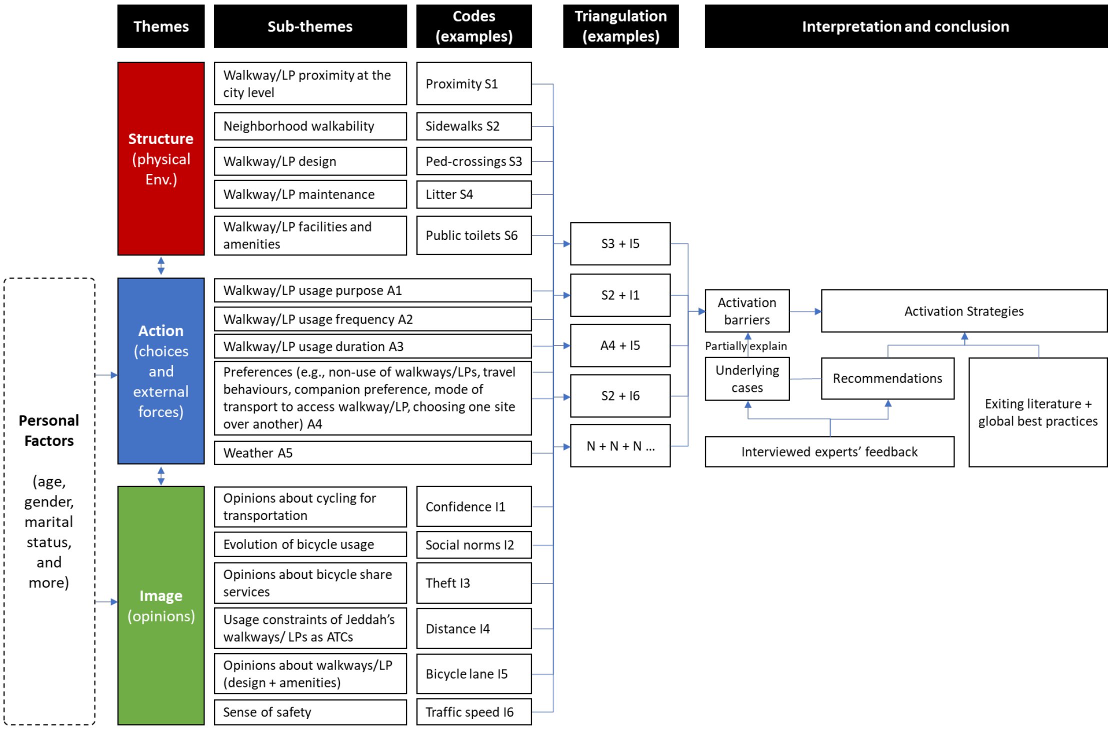


Figure 5-27. Coding and thematic framework.

5.6.1. Qualitative data analysis

Sections 5.3 and 5.5 detailed what, why, when, where, and how data was collected and prepared. This section details the collected qualitative data analysis process, which stemmed from questionnaires, FOs, and interviews.

The qualitative data analysis process began with transcribing and translating responses from Arabic to English as a form of data preparation. All the translated responses were placed in a single file for a thorough exploration and development of ideas. Next, descriptive coding was used to classify the phrases and text fragments (Saldaña, 2014, as cited in Leavy, 2017). Then, related or similar codes were grouped under a theme while recording the number of instances a code was registered. For instance, many participants voiced the importance of public toilets as influencing their preference to use a LP for AT. Each time public toilets were mentioned, it would be considered as an instance. The high number of instances indicates the importance of that factor. Next, links between the sub-themes are identified via the overlapping codes within each, patterns, and contradictions. Notes documenting those links facilitated the development of a narrative that explains the data. Quotes from the questionnaire and interview participants are used as evidence from the codes that underpin the sub-themes. Data interpretation is a result of triangulating the generated results with other methodological outputs, research questions, and existing literature.

The qualitative data analysis process was applied to data collected from several open-ended questionnaire questions and interviews (see Sections 5.3.1.1 and 5.3.2). However, the analysis of the interviewed experts' responses involved additional dimensions. This is because feedback regarding the improvement challenges of Jeddah's walkways/LPs and recommendations to activate their transportation potential stemmed only from the interviewed experts. Therefore, after transcribing and translating (when needed) interviewees' responses, the first layer of analysis differentiated between challenges and recommendations as broad categories (see Figure 5-27). Additionally, all generated codes referenced which expert mentioned or discussed a challenge or recommendation. Aside from these considerations, collected data from interviews followed the qualitative data analysis process mentioned earlier. In short, since data generated about the improvement of Jeddah's greenways stemmed only from the interviewed experts, analysis of their transcriptions had a unique coding frame.

Data generated from FOs focused on users' types and activities in Jeddah's walkways/LPs (see Section 5.5.3 for more information about FOs). Each of the 18 walkways/LPs had a separate digital folder with all its collected data (data preparation). Observational data (notes and photographs) were recorded on-site and subsequently reviewed when more reflective notes and diagrams were generated. In other words, data immersion enhanced the understanding of observational data. This process facilitated the forming of patterns and relationships linked to the predefined sub-themes (see Figure 5-27). The researcher followed an inductive analysis approach where the results' generation (or discovery) had no preconceived framework (Patton, 2015).

5.6.2. Quantitative data analysis

Quantitative data were generated from the questionnaire and environmental audits. The questionnaire data were analysed using the statistical software Statistical Package for the Social Sciences (SPSS). As for the environmental audits, Quantum Geographic Information System (QGIS) and descriptive statistics via Microsoft Excel were used to organize and analyze collected data.

5.6.2.1. Questionnaire data analysis

Analysis of the questionnaire's quantitative data followed several steps. First, data were exported from Qualtrics survey software to SPSS and organised. The organisation of data included renaming, relabelling, and ensuring the right level of measurement (e.g., nominal, scale, or ordinal). Since the questionnaire design had two scenarios (users and nonusers), part of the data organisation involved combining variables (via computing variables) to get totals. Organising data also involved recoding several variables to satisfy statistical assumptions (see Table 5-6). Second, all data (nominal and ordinal) were descriptively analysed in frequencies and means, then presented in tables and graphs (mostly bar charts).

Third, several statistical tests were conducted to understand further the relationships, differences, and influences within the questionnaire's data. Specifically, these tests were the Chi-square, Mann-Whitney U, Kruskal Wallis, and a generalized linear model (logistic regression). Moreover, all statistical tests had a confidence level (CL) of 95%. Before computing and interpreting any test results, all tests' requirements were met, as described in several resources on inferential statistics (Gignac, 2019; Harrell, 2015; Huizingh, 2012; McHugh, 2013; Sirkin, 2011). Selection of the tested dependent and independent variables was contingent upon the univariate test results, the satisfaction of statistical test assumptions (tests' validity), the generated sub-themes via other data collection methods, and the answering of research questions. As shown in Table 5-12, each dependent and independent variable is coded for reference in Table 5-13.

Table 5-12. Examined dependent and independent variables in several statistical tests.

Code	**Independent Variables (IV)**	
A	Sociodemographic characteristics	Gender, age, marital status, children ≤ 8 years old?, car ownership, employment status, income, number of years living in the same address.
B	LP distance from home	Less than 0.5 km (< 500 m); Between 0.5 and 1 km; Between 1 and 2 km; Between 2 and 5 km; > 5 km
C	Mode of transport to access LP	Walking; automobiles
D	Companion preference	By myself; with my family; with my friends; with my relatives
Code	**Dependent Variables (DV)**	
1	LP use purpose	Health and well-being; Recreational activities; Leisure; Social well-being; Events; Commute purposes
2	LP use frequency	Never visited; Once every few months; once a month; once a week; A few times and week or everyday
3	LP use duration	Less than 30 min; 30 min to 1h; more than 1h
4	Sense of safety as a pedestrian	Safe; Somewhat safe; Neutral; Somewhat unsafe; Unsafe
5	Sense of safety as a bicyclist	

Table 5-13. The type and purpose of the thesis's statistical tests.

No.	**IV and DV Codes**	**Nonparametric statistical test type**	**Purpose**
1	A and 1	A chi-square test (alpha value were adjusted using the Bonferroni correction)	Examine the relationship between the use purpose of the PNLPs from participants' home addresses and gender.
2	C and 1		Examine whether walking or driving had large enough differences in the distribution of use purposes to reject the hypothesis of independence.
3	A, B, and 2	Generalized linear model (ordinal logistic)	Model the relationship between use frequency to Jeddah's LPs and two explanatory variables, specifically, gender and distance. This is to determine which independent variables have a statistically significant effect on use frequencies.
4	A, B, C, D, and 2	Chi-square and post-hoc test (Holm–Bonferroni method)	Two goals: First, examine which of the gender and distance variables had large enough differences in the distribution of use frequencies to reject the hypothesis of independence. Second, examine the relationship between use frequencies and other independent variables.
5	A, B, C, D, and 3		Examine the association between the independent variables (A, B, C, and D) and the usage duration of Jeddah's LPs.
6	A and 4	Mann-Whitney U and Kruskal Wallis tests (plus the Bonferroni pairwise tests)	Compare whether there is a significant difference in the sense of safety among pedestrians and bicyclists in Jeddah's LP for any of the sociodemographic groups.

In addition to those tests, several crosstabulations between variables were made to examine relationships and patterns within the questionnaire's data. Those contingency tables analysed several variables by location (i.e., listing Jeddah's LPs). Thus, they were location-based analyses unlike the other nonparametric statistical tests (mentioned in the previous paragraph), which were influenced thematically. These crosstabulations aimed to (1) study users' and nonusers' preferences and opinions of Jeddah's LPs; (2) examine the differences in companion preferences among Jeddah's LPs; (3) understand which of Jeddah's LPs succeed in attracting its visitors to spend more time in it. All results were combined with FOs data to explain (or refute) which LP characteristics influenced the questionnaire's findings. As a result, the findings' chapters comprised several comparisons between Jeddah's LPs.

Fourth, several post-hoc tests were performed for several reasons. In the case of Chi-square tests, to identify the significant differences within the chi-square test variables, the adjusted residuals (z-score at 95% confidence level is +/-1.96 standard deviations) for each combination of variables were calculated in SPSS (Sharpe, 2015). After calculating the P-values for the adjusted residuals in each cell (Gignac, 2019), the Holm-Bonferroni method was used to avoid making a type-1 error when interpreting the results (Holm, 1979). In the case of the Mann-Whitney U and Kruskal Wallis tests, post-hoc tests evaluated the relationship and effect size between the investigated variables (M. Tomczak and E. Tomczak, 2014). As for the GLM (ordinal logistic), the results demonstrated the model fit assessments (see Section 7.2.1). Fifth, all the questionnaire findings converged with other methodological outputs thematically to enhance the interpretation of results. In short, organisation, immersion, analysis, interpretation, and reporting of the questionnaire's data exemplify the first part of analysing the quantitative data (which had 70 questions, as shown in Appendix C).

5.6.2.2. GIS analysis

GIS analysis offers the opportunity to understand patterns and relationships spatially (S. L. Steinberg and S. J. Steinberg, 2015). QGIS software version 3.16 was used to conduct a proximity analysis of Jeddah's walkways/LPs at the city level. It followed the same approach that calculated the open space provision per capita in Jeddah (Addas and Alserayhi, 2020a; Khalil, 2014). However, the presented study focused on walkways/LPs because greenway planning in several cities Worldwide (e.g., Vancouver) aims to provide greenways within walking and bicycle distance (City of Vancouver, 2020). Such a goal is separate but related to the overall open space planning.

The proximity analysis relied on secondary data collected from Jeddah Municipality, specifically streets, buildings, and urban boundary layers. With the addition of a shapefile specifying the location of Jeddah's walkways/LPs (by the researcher), the analysis used several geoprocessing tools found in the vector geometry, overlay, and network analysis tools. For instance, the tool "service area" under network analysis identified built-up areas that are within 800 m (10 minutes walk) and 3200 m (12 minutes to cycle leisurely by an average person) from Jeddah's walkways/LPs. Buffer, dissolve, and overlap analysis tools were used to calculate the area and percentage cover of buildings that were within 800 m and 3200 m. Extracted from the overall calculated area were the airport and areas outside Jeddah's urban boundary.

At the neighbourhood level, two studies were conducted: street intersection density and sidewalk walkability audit. In the former study, the process followed the Mostadam for Communities guidelines to measure street connectivity within one kilometre (Sustainable Building, 2019). It is one of several tools used to measure the walkability of the built environment (Ewing and Cervero, 2010). A one-kilometre circle was drawn at the centre of each representative case study. The streets' layer (centrelines) obtained from Jeddah Municipality was used to define street intersections via the line intersection tool (under vector overlay in QGIS). To ensure the generated intersection points are correct, all street lines were dissolved because the intersection tool algorithm considers line segments as valid intersection points. A minimum of 54 intersections per km is required (Sustainable Building, 2019).

Analysis of data collected from fieldwork about sidewalks' walkability had two parts. The first part calculated the percentage of sidewalks for each walkability level (see Section 5.3.1.2). The process began by creating an urban block layer for the five representative case studies using AutoCAD. These AutoCAD drawings defined the sidewalk walkability level for each block segment. Each level had a separate layer. Next, all drawings were imported to QGIS to produce maps and calculate each level's percentages. Calculations were based on adding geometry attributes (under vector geometry in QGIS) and calculating the overall length via the "show statistical summary" tool. The same process was applied to all the sidewalk walkability levels. Based on these generated data, percentages were calculated. In addition, based on the Mostadam for Communities, a minimum of 85% of level three in sidewalk walkability is required for each studied site (Sustainable Building, 2019). Lastly, a map for each site was produced to display results (i.e., symbology by category).

The second part of the sidewalk walkability study analysed the photographs and notes inductively, a similar approach to the data collected via FOs (see Section 5.6.1). The analysis focused on identifying patterns that hinder the walkability of sidewalks via data immersion. Specifically, results elaborated on the obstructions that affect pedestrians' safety and comfort. Results excluded bicycle infrastructure because none of the examined streets had bicycle lanes, signage, signals, and amenities, which was a shared conclusion to Aljoufie's (2017) study. Discussion of results was related to existing literature to contextualize the results.

5.6.2.3. PEAT data analysis

An adapted PEAT was used at the site level to assess the five representative sites (see Section 5.3.1.2). The segment and site-level scores were recorded in Microsoft Excel along with all the notes. Since all sites had several segments, means and standard deviations were calculated for all indicators individually. Total scores required combining averages and standard deviations because segment and site-level assessments had different indicators (see SCERT, 2019, for the used formulas). Furthermore, Table 5-14 describes the interpretation of (average) scores, highlighting the improvement priority or inadequacy in the design, maintenance, or amenities of Jeddah's walkways/LPs. Lastly, results (combined averages and standard deviations) were compared between the five case studies to identify patterns and relationships.

Table 5-14. Interpretation of scores generated from the adapted PEAT.

Score	Interpretation (improvement priority)
0	Very high
0-1	high
1-2	Moderate
2-3	Low
3	Very low (or no further improvement is needed)

Data collected via the adapted PEAT carried some limitations. Assessments within many indicators were based on local and global standards, which usually specify minimum requirements (see Section 5.3.1.2). What about maximum requirements? A walkway width of 40 m (only pavement) within a residential neighbourhood of moderate population density (6456 – 12971 people per km²) could be viewed as wasteful. In the adapted PEAT assessment, such a condition in Al Rehab walkway had a good score. Therefore, in such instances, photographs were used as illustrative narratives to add deeper insights into the measured site elements. Simultaneously, photographs (and field notes) were used as evidence of existing conditions and a way to communicate the researcher's insights.

Even though the mean and standard deviation scores were the primary method of communicating the adapted PEAT results, mapping linked the collected data to places. Mapping of walkways/LPs' physical characteristics was produced during fieldwork. These maps measured distances between site elements and evaluated various indicators (see Section 5.5.2 for the data collection process). For example, mapping showed which of the site's pedestrian crossings had a poor score. As such, communication of results would be more effective.

5.6.3. Data synthesis

Research findings were synthesized narratively based on links/relationships (themes) between them (see Figure 5-27). For example, quantitative results about sidewalk walkability (structure) are combined with or linked to quotes from the interviewed participants about the same topic (image). Therefore, results were triangulated (using multiple data collection methods) to develop an understanding of the existing barriers to activating greenways as facilitators of AT in Jeddah city.

Barriers related to structure (i.e., physical environment) are reported in Chapter Six and ones related to image and action (i.e., participants' preferences and opinions) are reported in Chapter Seven. The underlying causes of those barriers and recommendations to overcome them stemmed only from the interviewed experts due to their professional experience in greenspace and transportation planning in Jeddah city. The activation strategies of greenways' function as facilitators of AT are generated from the interviewed experts' recommendations, existing literature, and global best practices. In short, research findings were synthesized narratively and structured based on the research approach (see Section 5.2).

Chapter Eight summarises research findings, which are structured based on the structure, action, and image themes (see Section 5.2). The data collection methods used to develop an understanding of a particular result (or barrier in this case) are indicated in tabular form. As such, the triangulation of research results is communicated clearly. Furthermore, each barrier/challenge is assigned a code that would facilitate linking them to experts' recommendations to overcome them. These recommendations are then prioritised based on their ability to address several barriers/challenges simultaneously. In brief, summarizing research results (I) relates them to research themes, (II) indicates the methods used to build an understanding of them, and (III) links them to the interviewed experts' recommendations.

5.7. Chapter Five summary

Chapter five presented a multi-disciplinary methodology for examining the barriers to and strategies for activating greenways' function as facilitators of AT in Jeddah city as a case study. The mixed methods case study research had two phases. Phase one studied (I) the preferences (action) and opinions (image) of walkway/LP users and non-users via a questionnaire (n=357) and the (II) the physical environment (structure) via spatial and field studies (see Figure 5-2). The latter had three levels: the city, neighbourhood, and site level. At the city level, proximity analysis was conducted. The neighbourhood level examined street intersection density and sidewalk walkability (adapted MAPPA). The site level assessed the design, amenity, and maintenance of Jeddah's walkways/LPs (adapted PEAT). Both neighbourhood- and site-level studies were implemented on five representative walkways/LPs of their respective types in Jeddah. Section 5.4.1 provided justifications for their selection. Finally, results that needed further explanations and deeper explorations were examined in phase two via semi-structured interviews with local and international experts (n=7) and AT interest groups' leaders (n=6). The results of phase two expanded those of phase one and served as a validation approach. The interpretations and inferences of this study come from combining the results of the two phases thematically and linking them to existing literature.

The developed thematic structure (structure, image, action) for the thesis had predefined sub-themes that facilitated organization and triangulation of results (See Figure 5-27). These predefined sub-themes encompassed factors related to the physical characteristics of walkways/LPs (e.g., amenities), contextual factors (e.g., neighbourhood walkability), personal and behavioural factors (e.g., sense of safety), and underlying causes (e.g., budget limitations). Thematic analysis of qualitative data (open-ended questionnaire questions, FOs, and interviews) followed an indicative approach to research. Quantitative data were statistically (via SPSS and Excel) and spatially (via QGIS) analysed. Narrative data synthesis was based on topic similarity. Convergence of results expanded, confirmed or disconfirmed the conclusions reached in phases one and two. Doing so provided a multidimensional approach to understanding the barriers and strategies for activating greenways' potential as ATCs.

CHAPTER SIX

ASSESSMENTS OF THE PHYSICAL ENVIRONMENT

6. Chapter Six: Assessments of the physical environment

This Chapter provides evidence on the physical condition of LPs in Jeddah and identifies features that enable and constrain their use for sustainable urban mobility. It, therefore, addresses the RQ4 (see Section 1.5). Addressing this at multiple scales (city, neighbourhood, and site) provides a holistic and integrated understanding of this topic, which has often been lacking in research on urban mobility in SA. At the city scale, Section 6.1 begins with GIS analyses of walkways/LPs' connectivity and proximity while triangulating results with feedback from the interviewed experts. The results in Section 6.1.1 analyse the nine walkways/LPs that form the NDC as a potential city-level greenway to explore further the connectivity and design impediments at such a scale. This is because the NDC permeates Jeddah's urban fabric, forming an east-west connection. At the neighbourhood level, Section 6.2 presents the GIS and statistical analysis results of street intersection density and sidewalk walkability assessments within 400 m of the five representative case studies of their respective types (see Section 5.4.1). The assessment of those case studies continues in Section 6.3 at the site level, focusing on walkways/LPs' physical characteristics, amenities, and maintenance using the adapted PEAT. The conclusions reached in Chapter Six result from triangulating data from multiple methods (i.e., environmental audits, FOs, WBQ, and interviews).

6.1. Assessments at the city level

Mapping of Jeddah's walkways/LPs illustrated that they are fragmented yet offer unrealised potential for AT (See Figure 6-1). Jeddah's walkways/LPs are disconnected from one another and from pedestrian networks, public facilities, transit stops, and commercial destinations (examined in Sections 6.2 and 6.3). In such context, walkways/LPs' connectivity refers to providing physical linkage or access to these facilities/destinations. The interviewed academic in the landscape architecture department at King Abdulaziz University explained,

"The planning and design of Jeddah's linear parks were not intended to link between important nodes or even to work as tourist destinations. They were a result of utilising Jeddah's stormwater drainage channels mainly because of space issues [to provide green open spaces for people without resorting to land reacquisition and public disputes]. Today, Jeddah's linear parks are destinations and not means." (E1, 2020)

In short, disconnectedness represents a major barrier to walkways/LPs' function as ATCs in Jeddah city.

Mapping of existing linear parks in central Jeddah

Legend

Existing linear parks

D1 Al-Samer Dam

D2 Umm Al-Khair Dam

Graphic Scale

0 1 2 3 4 5 km

No.	Linear park name
1	Jeddah waterfront walkway
2	Prince Faisal bin Fahad street walkway (Hilton)
3	Northern Corniche walkway
4	Al Shatee Garden walkway
5	Al Rawdah walkway (Al Tahlia)
6	Al Yamama Walkway
7	Al Faisalia walkway
8	Al Safa walkway
9	Prince Majid Park walkway
10	Al Safa 2 walkway
11	Al Samer walkway
12	Al Rehab walkway
13	Al Zahrat Waha walkway
14	Middle Corniche Park
15	Palestine Street walkway
16	Al Shabab lake walkway
17	Al Nakheel walkway
18	Al Nakheel 2 walkway
19	Al Jamiaa walkway

Notes:

- These linear parks (or 'walkways' as local referenced) are recognized and listed in Jeddah's Municipality official website.
- This map zooms in to the central area of Jeddah city, thus, not including other linear parks located in north and south of Jeddah city (very few).
- Latest updated April 2021.

Figure 6-1. Map of existing linear parks in central Jeddah as of April 2021.

A pedestrian and a bicycle shed analysis of all LPs, via QGIS, in Jeddah city within 800 m (10 minutes walk) and 3200 m (12 minutes to cycle leisurely by an average person) revealed that only 2.1% and 13.4%, respectively, of all built-up areas in Jeddah city have access to those public amenities within 800 m (see Figure 6-2). Thus, providing equal access to a greenway network within a walkable distance is one of the main challenges in activating its AT function.

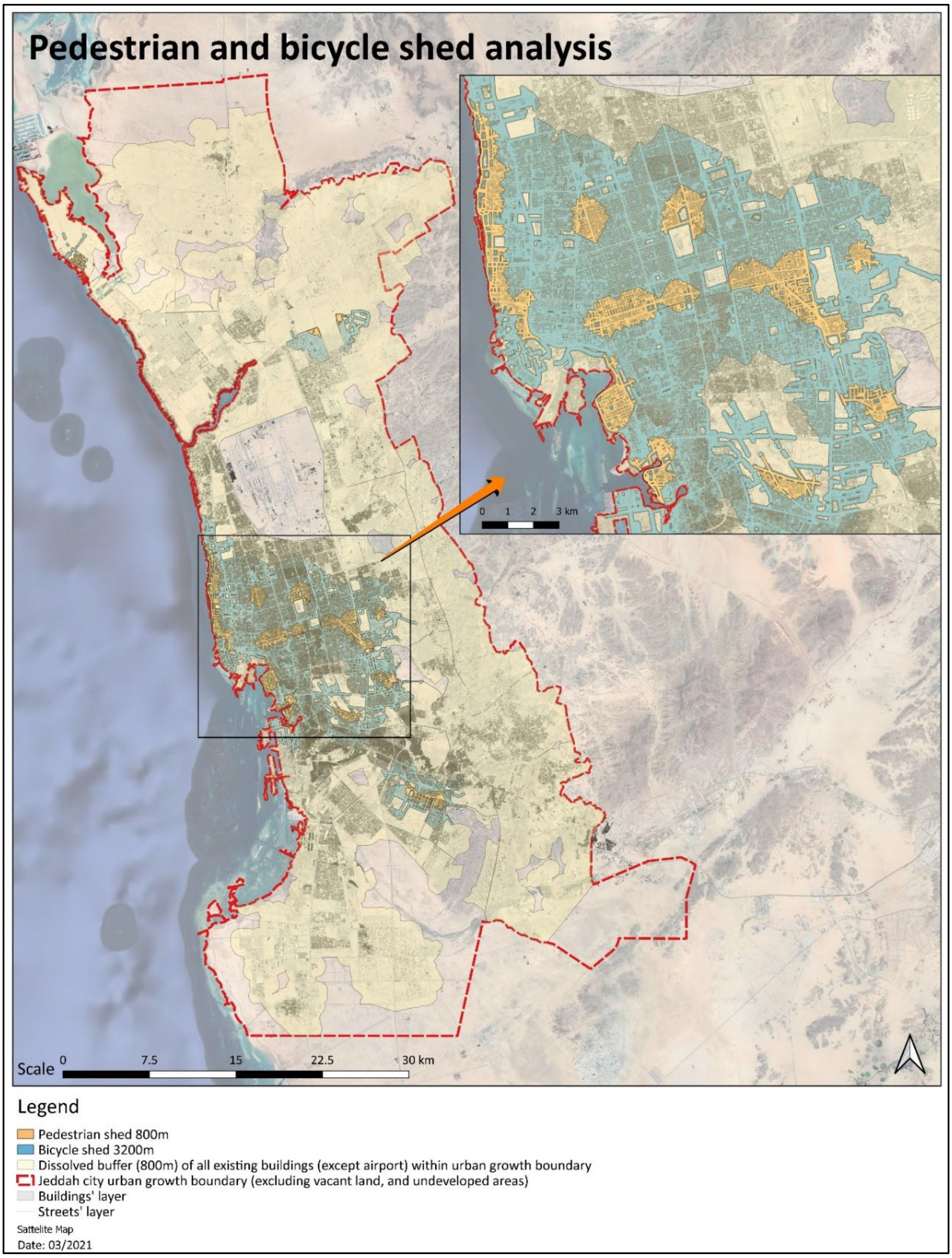


Figure 6-2. Proximity analysis of Jeddah's linear parks.

Despite the walkway network's fragmented nature, some isolated examples demonstrate an attempt to connect walkways. One is the pedestrian bridge that links the Jeddah waterfront walkway (JWW) and the Prince Faisal Bin Fahad Walkway (near Hilton) (See Figure 6-3). Another example is the creation of Al Rabwah walkway/LP that connects to one of Jeddah's main public parks, namely Prince Majid Park (See Figure 6-4). Interviewee E4 (Manager at Jeddah Municipality) described those projects, which were opened to the public in May 2022, as, *“one of our largest development projects in Jeddah city […] One of the nice aspects of this project is its proposed development of a physical link with King Fahad road [شارع الستين]. To establish this link, we redeveloped the street, joining both locations [called Abdullah Bin Safwan], which resulted in retrofitting a walkway in its centre. In addition, since this street links four different districts, any of their residents who wish to visit Prince Majid park could potentially use this proposed walkway to access Prince Majid park on foot or using a bicycle.”* (E4, 2020)

In short, Prince Majid Park and JWW’s pedestrian bridge are two recent and isolated examples but show increased attention to the connectivity of the pedestrian network.

Figure 6-3. Corniche Pedestrian Bridge is a viaduct structure that connects three locations without the need to climb up/downstairs while also overpassing traffic.

Even though fieldwork in 18 out of 24 walkways/LPs identified five types (see Section 5.4), Jeddah’s greenways are homogeneous in their design. While greenways in Shenzhen have different characteristics according to their status as regional, city, and neighbourhood greenways (Liu et al., 2016), Jeddah city lacks regional and city greenways that offer a variety of greenway experiences, natural trails, or links to urban transport nodes. Interviewee E2 explained: *“Most of Jeddah’s linear parks are a result of redesigning road sections such as Al-Tahlia and Al-Rehab walkways, and even the* *old Faisal Bin Fahad walkway. Originally, those walkways were 52m wide roads that had their service roads removed, which as a result allowed for the creation of walkways in their centres."*

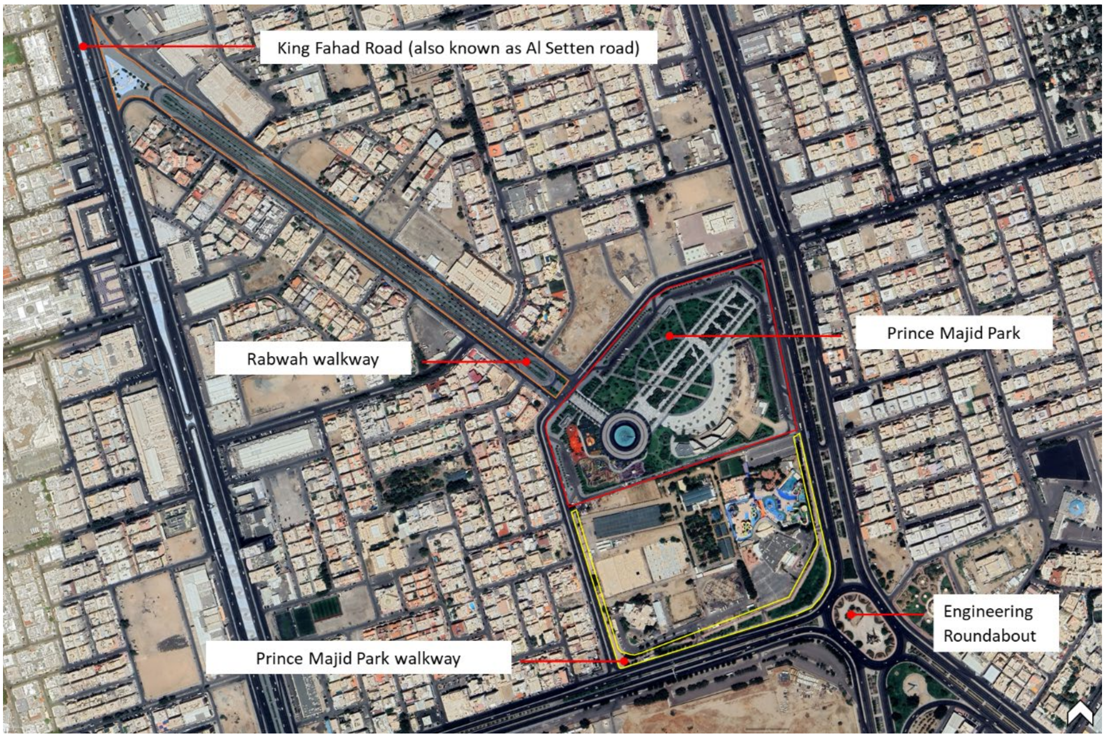


Figure 6-4. An example of recent efforts to use walkways/LPs as physical links to greenspaces.

6.1.1. The Northern Drainage Channel walkways/linear parks

The NDC is an example that represents an opportunity to create an ATC that permeates the city's urban fabric, forming an east-west connection. Specifically, NDC's link to Jeddah's waterfronts is most important because it is a popular attraction, even nationally (See Section 7.2 to learn about the questionnaire participants' preferences). Analysis of the NDC revealed its disconnected nature due to many of its undeveloped segments and conflicts at intersections with arterial and express roads (See Figure 6-5). These undeveloped segments (highlighted in red) are open drainage channels. The ones highlighted in orange colour are segments transformed into subdrainage channels but left with the surface level as vacant (or idle) lands. These segments are expected to follow the same design direction as the implemented ones (highlighted in green). Currently, nearby residents use these vacant segments as parking spaces and, in a few instances, as causal playgrounds (See Figure 6-6). NDC's analysis also revealed intersections with eight high-speed traffic barriers that prevent users from moving from one point. Furthermore, FOs also showed 15 dangerous intersections due to the absence of safe pedestrian crossings (See Figure 6-7). To sum up, NDC's potential to function as a non-motorised transportation route is impeded by the frequent interruptions of arterial and express roads.

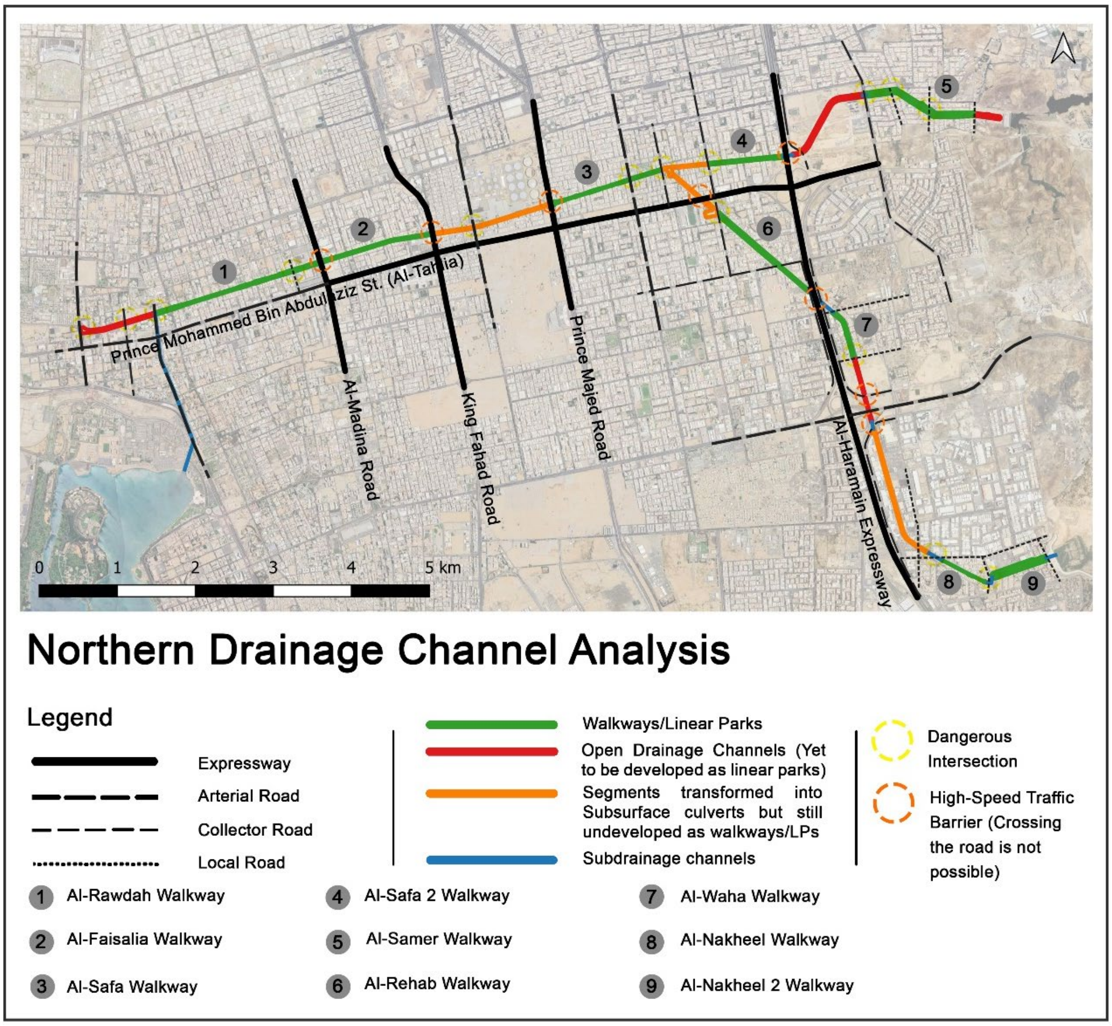


Figure 6-5. Analysis of the northern drainage channel's connectivity as a route for pedestrians and cyclists.

Figure 6-6. Examples of how undeveloped (or idle) segments of the Northern Drainage Channel are used (Jan 2020).

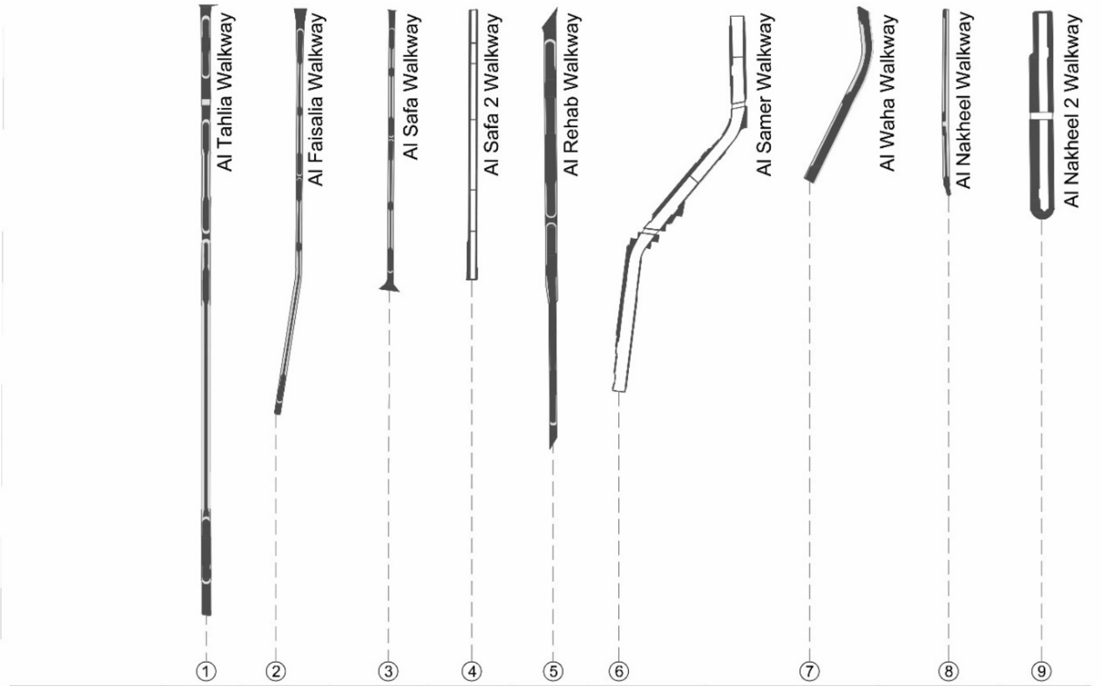
Figure 6-7. The high-speed traffic barrier (near Al-Rehab walkway) cuts the Northern Drainage Channel into several segments and prevents it from being a continuous route for pedestrians and cyclists.

Tracing the satellite imagery of Jeddah's NDC-LPs via AutoCAD 2020 revealed that, on average, 34% of the nine walkways/LPs have areas dedicated to automobiles (median = 29%) (See Figure 6-8). These comprise car parking spaces, driveways (for vehicle access), and narrow median islands that mainly function as traffic lane separators (See Figure 6-9). Specifically, parking spaces are provided along most of the walkways/LPs' length, which acts as a buffer from automobile traffic. Furthermore, in the cases of Al Tahlia, Al Safe, Al Nakheel, and Al Waha walkways, driveways are provided to those parking spaces to reduce traffic speeds and minimise traffic flow disruption on main streets. Such design treatments adapt to automobile-dependent lifestyles by increasing road and vehicle parking capacities (induced demand).

The automobile-centric planning of Jeddah city indirectly impacted the physical characteristics of walkways/LPs in other ways. Among them is the high curbs. While such height (reaches up to 53 cm) is meant to deter drivers from parking inside a walkway/LP perimeter, it is difficult for pedestrians and the disabled to access the park, especially with the distant spacing between pedestrian crossings (see Section 6.3 for further details) (See Figure 6-10). The other observed phenomenon was the placement of lighting fixtures, especially in Al Nakheel, Al Nakheel 2, and Al Samer walkways. Current lighting design treatments are similar to roads, which are rows of evenly spaced fixtures that focus primarily on providing uniform illumination (see Figures 6-11). Such an approach places greater emphasis on safety than aesthetic quality. Lastly, careful placement of lighting fixtures and planters is needed to avoid hindering pedestrian and bicycle movement (see Figures 6-12 and 6-13). In short, a people-centric design approach for the nine walkways/LPs that form the NDC is needed, especially regarding landscape lighting.

Jeddah Northern Drainage Channel Linear parks

Analysis of its physical characteristics



	①	②	③	④	⑤	⑥	⑦	⑧	⑨
People %	64.6%	42.07%	65.44%	71.9%	77.8%	78.9%	70.9 %	30.6 %	90.3 %
Automobiles %	35.3%	57.9%	34.5%	28.1%	22.2%	21.1%	29.01 %	69.3 %	9.6 %
Total area m2	70,503.4	32736.63	34,462.54	13683.67	55613.37	24097.03	27176.87	14347.19	35,437.39
Length m	2187	1445	1003	964	1505	1471	659	664	739

Areas dedicated to people

Areas dedicated to automobiles

Graphic scale

0 100 200 300 400 500 600 700 800 900 1000

Notes:

- All measurements (distances and areas) were based on Google Earth Pro ruler tool (imagery date 12/07/2020) as well as cross-checking with photographs taken from field observations (on Jan 2020). Therefore, measurements carry a small margin of error, and may not be 100% accurate according to Google Help Panel.
- All distances (length) were measured from the centreline (one direction).
- All parallel parking dimensions were drawn with an offset of 2.5 m from curb edge.
- Areas dedicated to people are spaces where vehicles are not allowed to park and drive through.
- Areas dedicated to cars include parking spaces, driveways (for access to linear parks), and narrow median islands that only aims to separate traffic lanes. Streets that are parallel to all linear parks were not included in the calculations.
- Linear parks such as Al Safa 2, Al Samer, and Al Nakheel 2 walkways have open drainage channels. These channels were not included in any calculations since their current use is many to direct water from one point to another and are fenced.

Figure 6-8. Analysis of the NDC’s walkways/LPs to identify the areas dedicated to people and automobiles.

Figure 6-9. With two driveways (each direction) and parallel parking bays, the space dedicated to pedestrians is approximately one-fifth of the total width.

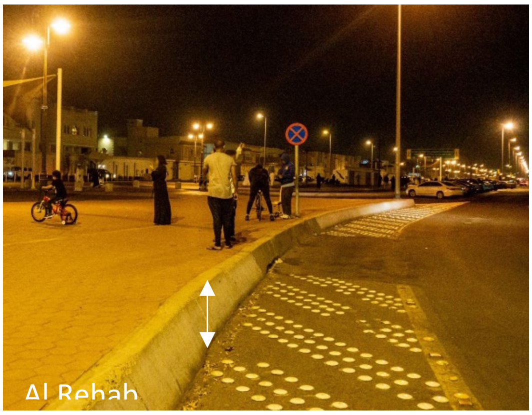


Figure 6-10. The placement of high curbs to protect walkway/LP users makes access to those sites difficult, especially for individuals with physical disabilities.

Figure 6-11. Four rows of evenly spaced lighting fixtures to illuminate a 16.5 m wide walkway in a road-like manner neglects the aesthetic dimension of their provision.

Figure 6-12. Another example of the road-like provision of lighting fixtures.

Figure 6-13. two examples where the placement of lighting fixtures and planting beds reduce the effective pedestrian width of walkways/LPs, which makes many users walk/jog outside the dedicated path, as highlighted in the left picture.

6.2. Assessments at the neighbourhood level

Street intersection density assessment on the five representative case studies objectively measures walkability and accessibility (EPA, 2015). Results revealed they all achieved the Mostadam for Communities[18] minimum requirement of 54 intersections per km (see Figures 6-14 to 6-18). Such results indicate that the existing urban form can be walkable. However, results also showed that street intersection density in Al Rehab, Rawdah, and Al Nakheel 2 walkways is approximately 50% less than the other two sites. For good network connectivity, urban block length should not exceed 200 m (Steiner and Butler, 2007). Thus, site-specific design treatments, such as adding pedestrian paths that target urban blocks with lengths > 200 m, are needed. In short, urban forms that surround the five representative case studies have the potential to be walkable.

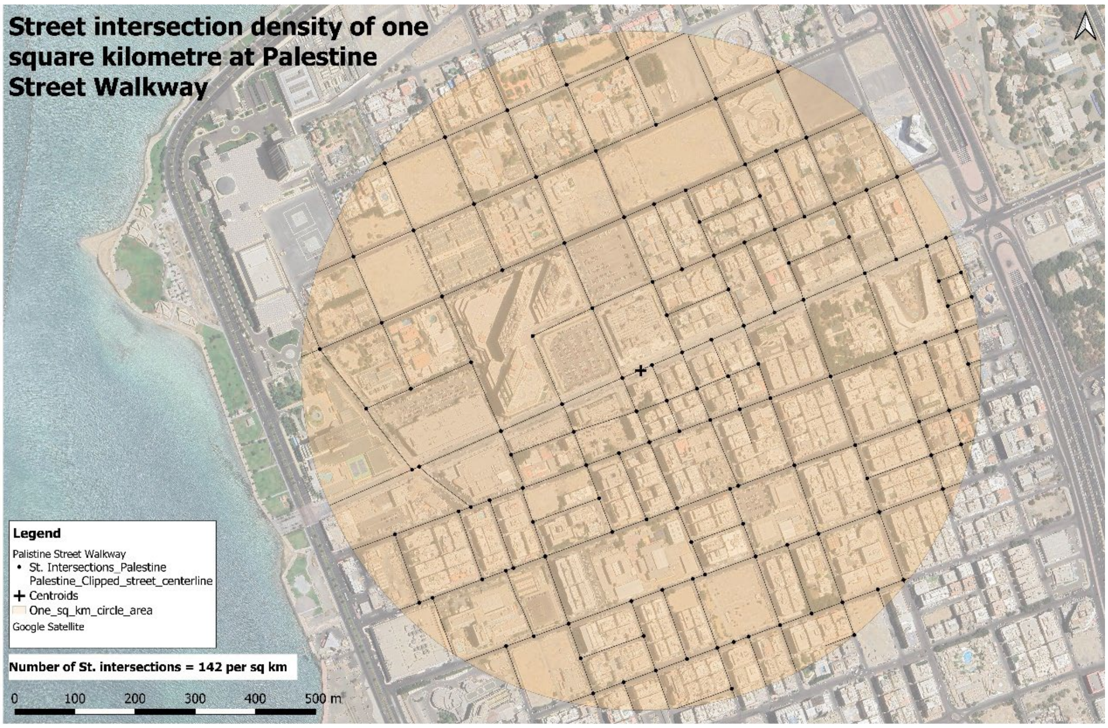


Figure 6-14. Street intersection density at the Palestine Street Walkway.

[18] A comprehensive sustainability rating and certification system for Saudi cities. The specified minimum requirement was based on LEED for Neighborhood Development.

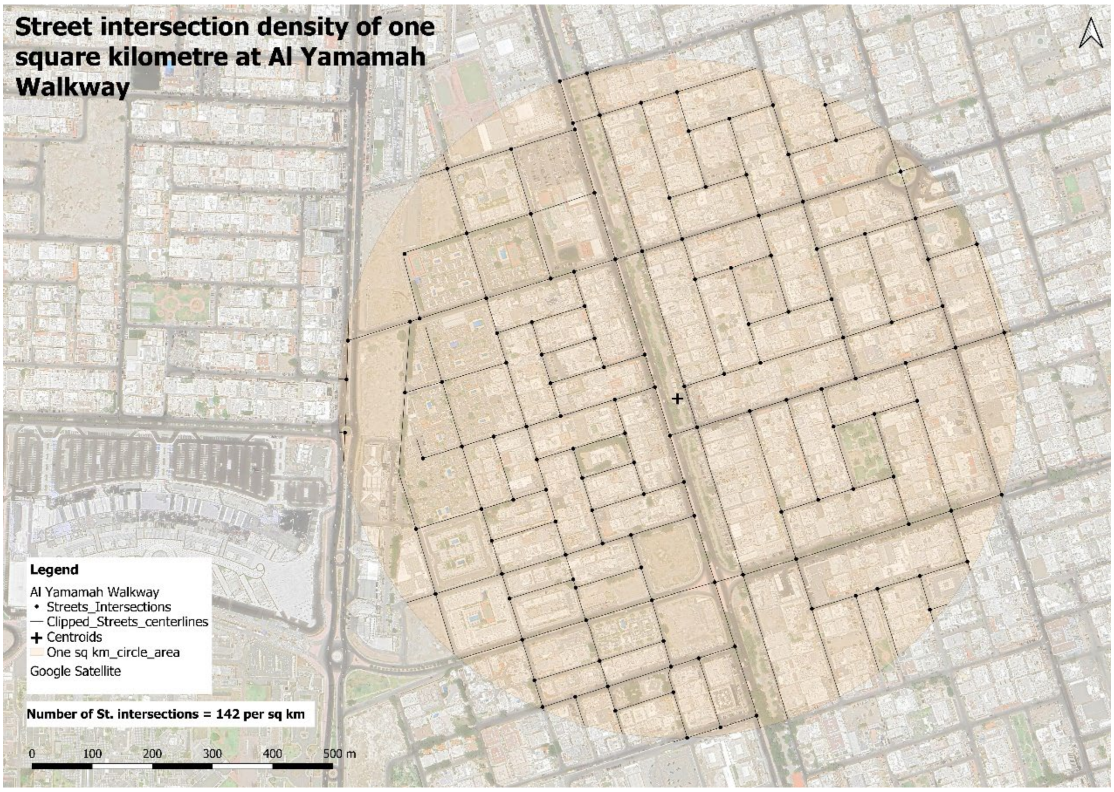


Figure 6-15. Street intersection density at Al Yamamah Walkway.

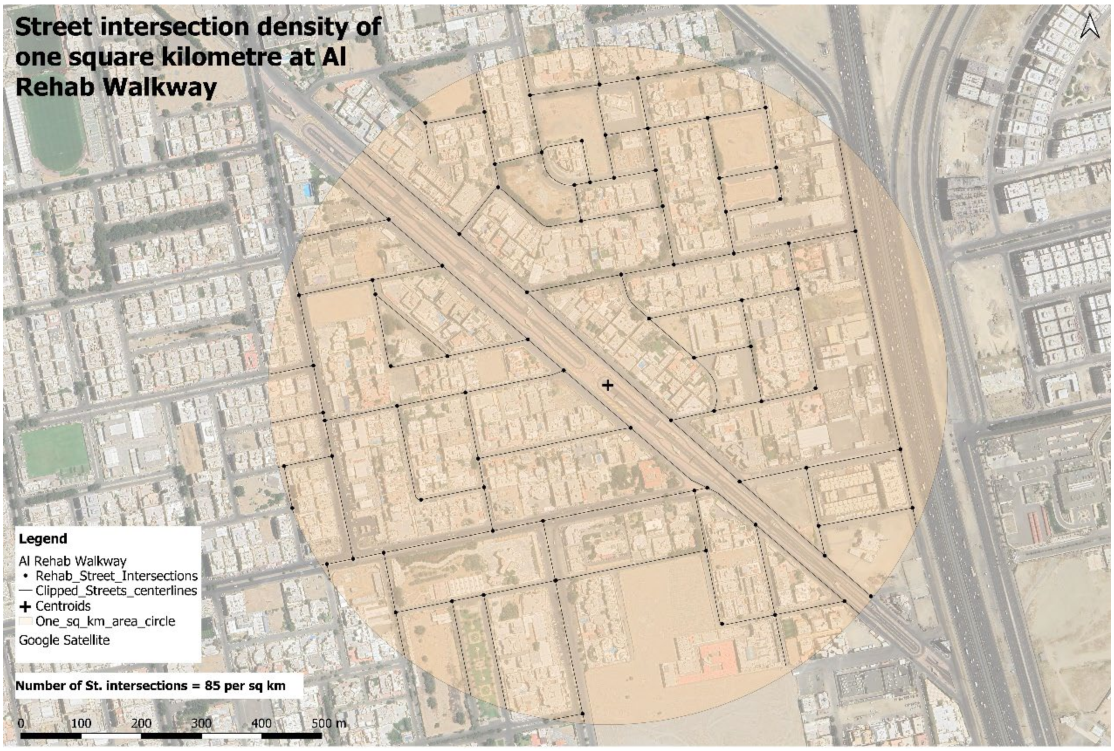


Figure 6-16. Street intersection density at Al Rehab Walkway.

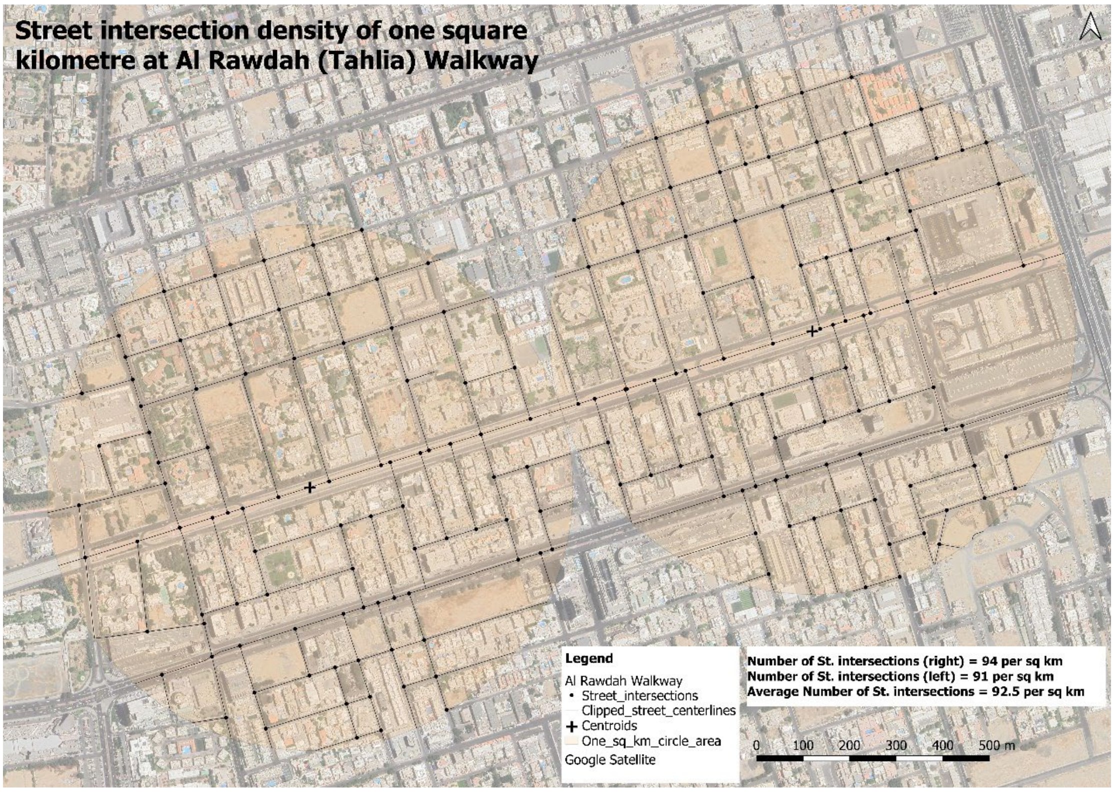


Figure 6-17. Street intersection density at Al Rawdah (or Al Tahlia) Walkway.

Figure 6-18. Street intersection density at Al Nakheel 2 Walkway.

Despite the importance of the distance between street intersections as a walkability measure, other factors, such as the safety and comfort of pedestrian and bicycle networks, are key to activating active transport potential. Therefore, a sidewalk walkability assessment of the five representative case studies within 400 m (surrounding connectivity) was conducted. Results revealed that none achieved the Mostadam for Communities minimum requirements. Specifically, none of the examined sites had at least 85% of all sidewalks within 400 m achieve a level three walkability (see Section 5.3.1.2 for the assessment criteria). As shown in Figure 6-19, an average of 91.3% of sidewalks around the five representative case studies had a level one walkability, which is un-walkable. Figures 6-20 to 6-24 illustrate the size and extent of sidewalk safety and comfort issues. In short, the inadequate pedestrian infrastructure around the five representative case studies is a major barrier to walkways/LPs' function as ATCs.

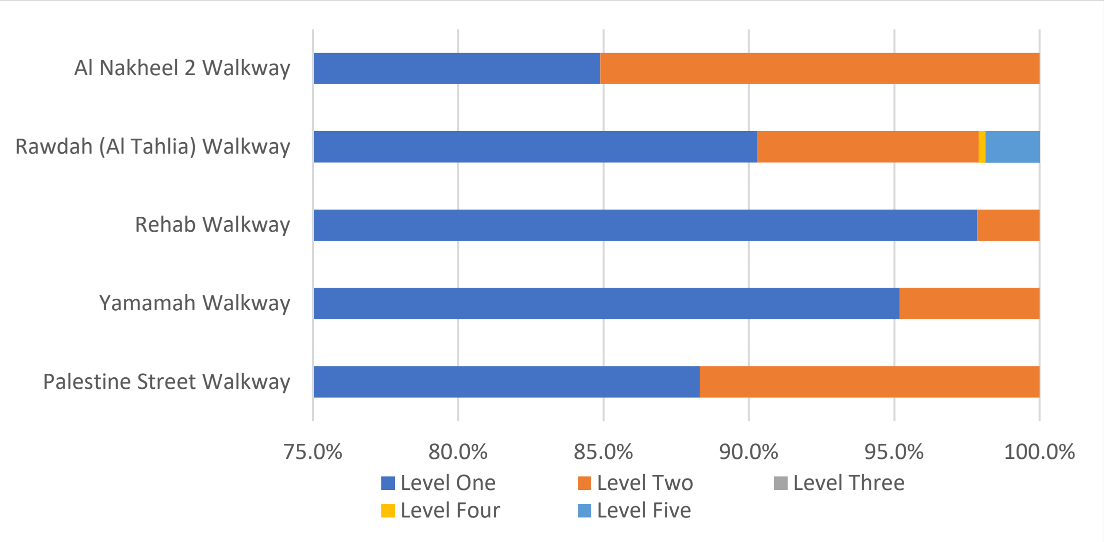


Figure 6-19. Comparison between the representative case studies regarding Sidewalk walkability within 400 m.

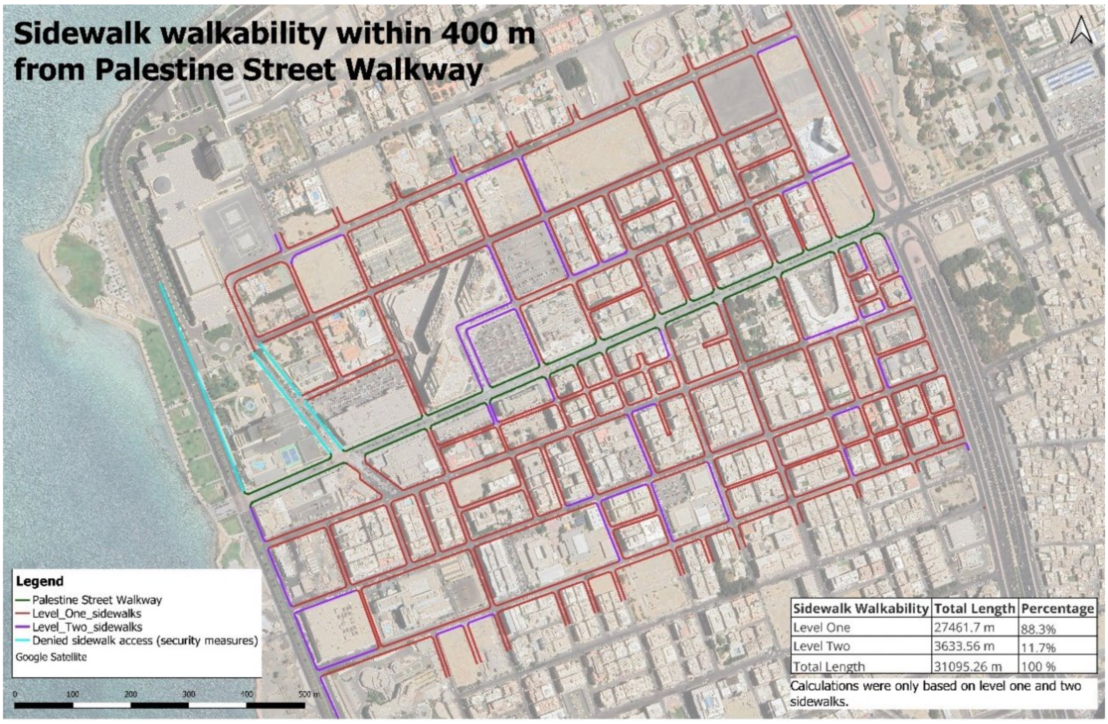


Figure 6-20. Sidewalk walkability within 400 m from Palestine Street Walkway.

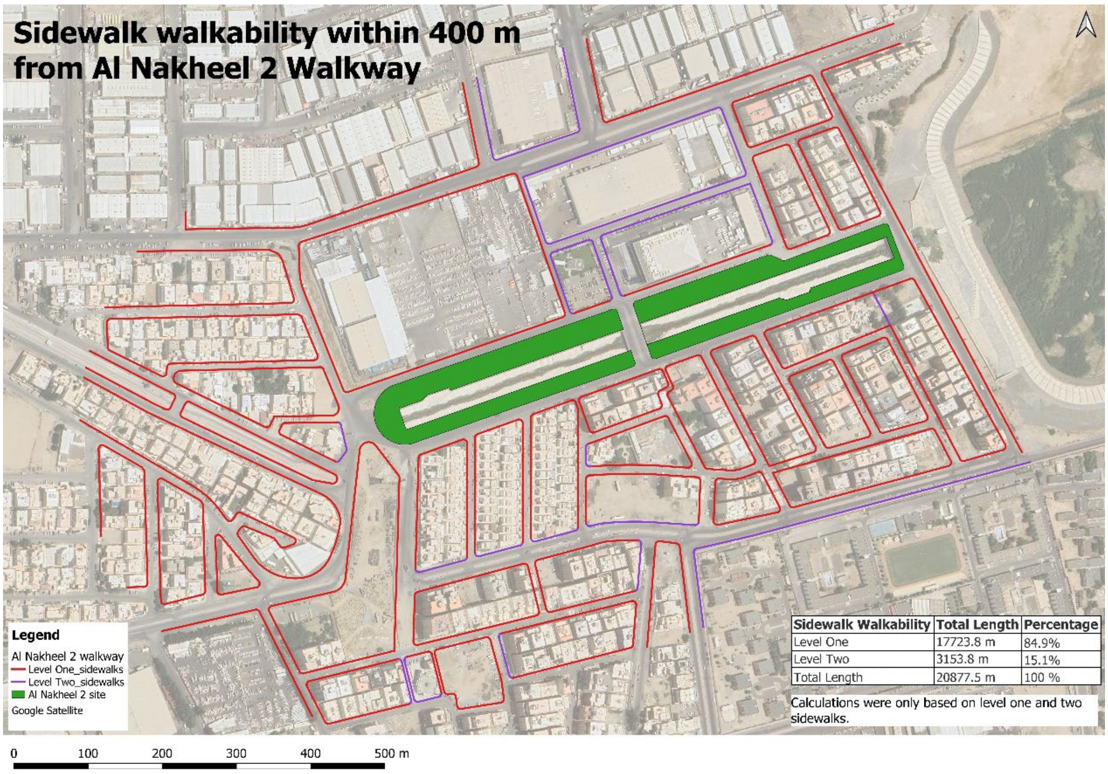


Figure 6-21. Sidewalk walkability within 400 m from Al Nakheel 2 Walkway.

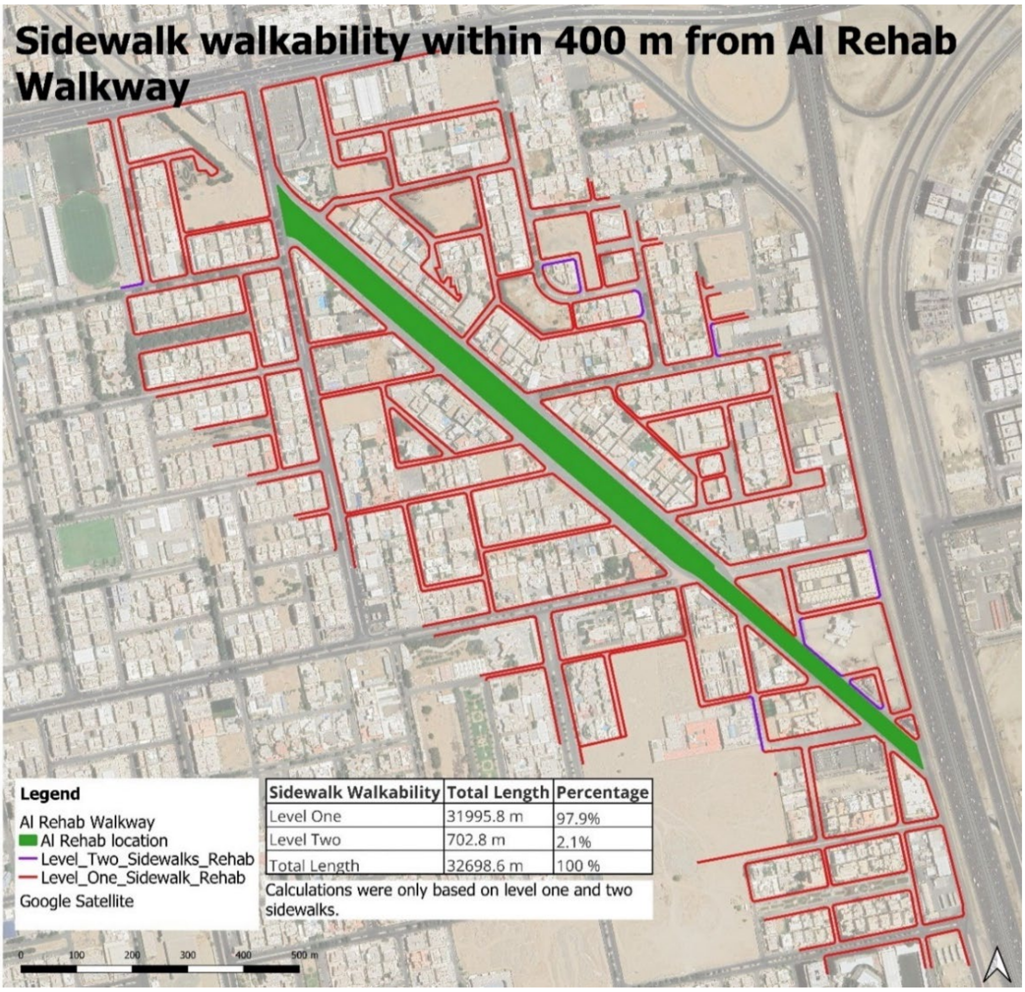
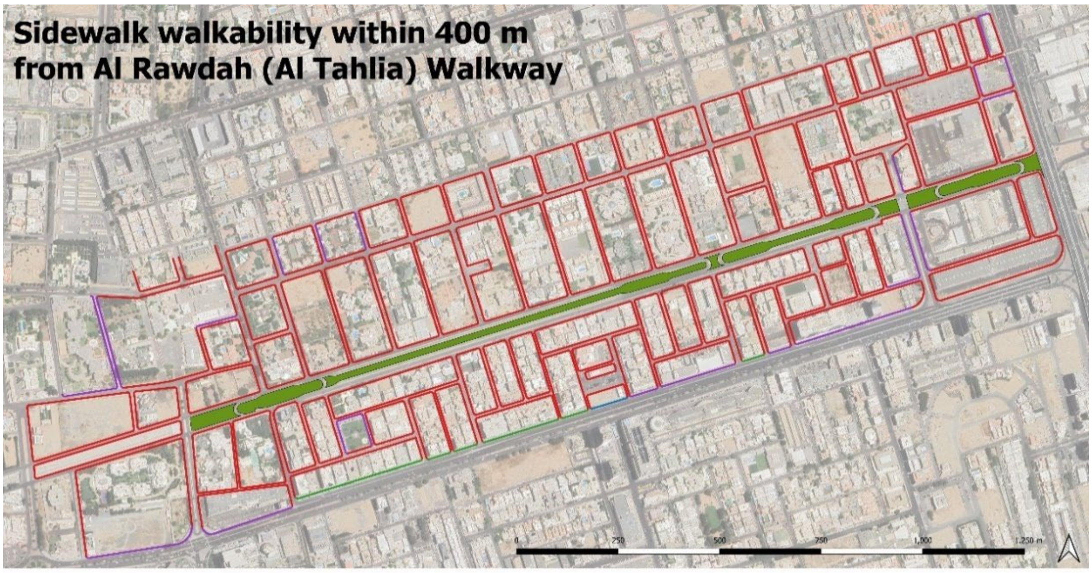


Figure 6-22. Sidewalk walkability within 400 m from Al Rehab Walkway.

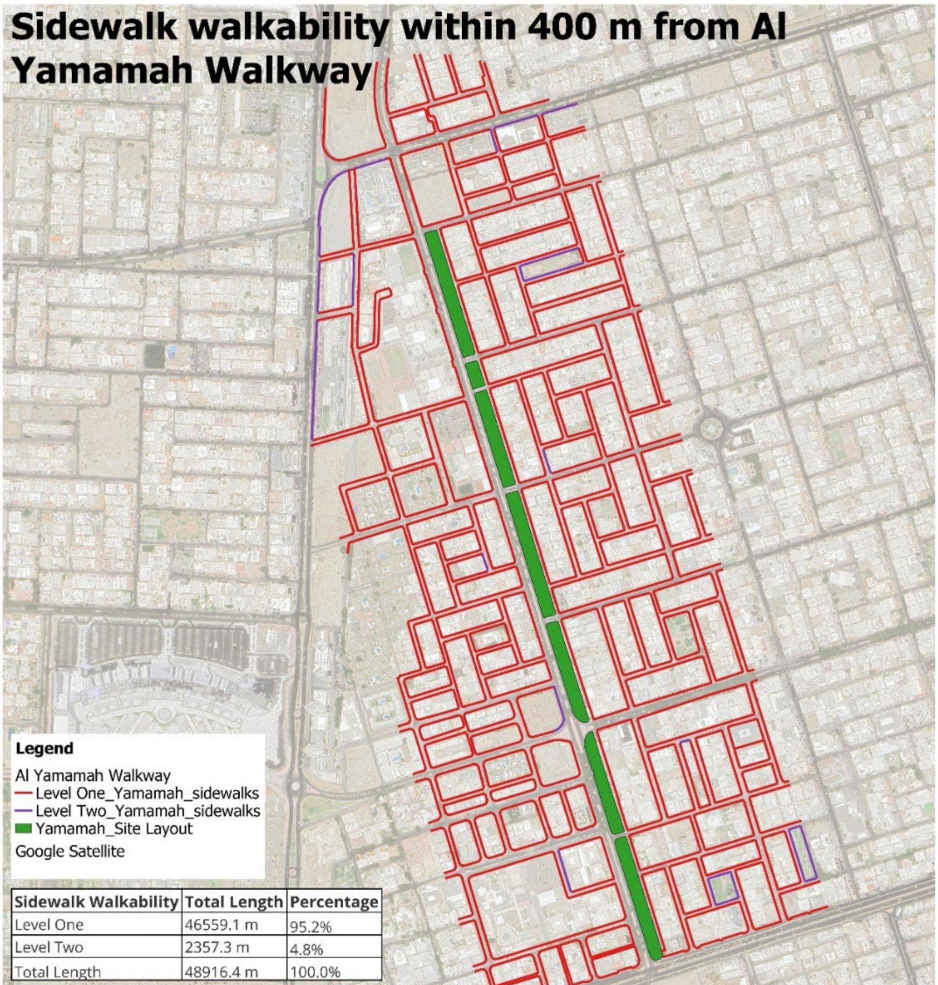


Legend
Al Rawdah Walkway
Level_One_Rawdah_sidewalks
Level_two_Rawdah_sidewalks
Level_four_Rawdah_sidewalks
Level_five_Rawdah_sidewalks
Site_layout_Rawdah_ploygon
Google Satellite

Sidewalk Walkability	Total Length	Percentage
Level One	39561.9 m	90.3%
Level Two	3342.2 m	7.6%
Level Four	101.972 m	0.2%
Level Five	814.1 m	1.9%

Calculations were only based on level one and two sidewalks.

Figure 6-23. Sidewalk walkability within 400 m from Al Rawdah Walkway.



Sidewalk Walkability	Total Length	Percentage
Level One	46559.1 m	95.2%
Level Two	2357.3 m	4.8%
Total Length	48916.4 m	100.0%

Calculations were only based on level one and two sidewalks.

Figure 6-24. Sidewalk walkability within 400 m from Al Yamamah Walkway.

A Chi-Square test was conducted to test if there were differences in the level of walkability between sites. Results revealed no significant differences between percentages of walkability classes (X^2 (4) = 1.215, p = 0.876), confirming that the observed sidewalk walkability problems were consistent.

Such a conclusion is substantiated by the shared dissatisfaction among most questionnaire participants, experts, and interest group leaders interviewed in this research. The following are a few quotes that reflect such discontent:

"The main roads do not have a walking lane to cross the roads. How can we reach the walkways by walking? We have to use cars […] then we use these cars to our other destinations like work or mall." (questionnaire participant, 2020)

"If you look at Al Tahlia street, you find a service road and a three-lane main road in both directions. There is no place for people to walk. Sidewalks are sometimes interrupted by light posts, bins, and planters" (L1, 2020). These sentiments were also reflected in the responses of experts:

"All past guidelines used for the design of streets, projects, and residential districts had old road sections with no to minimal sidewalks specifications, and disregard to all other modes of transport […] it is currently extremely difficult to commute via non-motorised modes of transportation from one district to another while overcoming myriads of obstacles." (E4, 2020)

"if you go to Jeddah today, the pavements where people walk are insufficient. It's either too narrow or the paving material is broken or cracked and in some cases incomplete and in some other cases non-existent." (E6, 2020)

"Even once you get out of your house, the sidewalk itself does not exist. It's either very small or interrupted with light poles and landscaping sometimes. And sometimes it's not even maintained, or it doesn't look like a sidewalk at all." (E3, 2020)

These quotes highlight how Jeddah's streets have been designed for automobiles, lacking pedestrian and bicycle infrastructure, which directly impacts the connectivity and accessibility to Jeddah's LPs; thus, their function as ATCs.

Figure 6-19 shows that the percentage of sidewalk walkability levels higher than one is low. People's encroachments and building and management practices are the primary reasons for the low sidewalk walkability (completely damaged sidewalks were rare). People's encroachments in the form of stairs, ramps, shading structures, building attachments, parking spaces, fences, food stalls, signage, storage, air conditioning units, and more are common forms of interruptions/obstructions (see Figures 6-25 to 6-33). Building and management practices are other forms of obstruction, including walls defining land lots, electricity boxes, water pipes, outdoor seating, street vegetation, and trash bins (see Figures 6-34 to 6-39). Photographs that evidence those obstructions were selected based on their representation of common occurrences. Moreover, all these obstructions leave pedestrians no choice but to walk along with vehicle traffic, which is unsafe (see Figure 6-40). These findings build upon existing literature (Alhajaj, 2014; MOMRA, 2019a) by highlighting additional obstructions requiring different treatment methods.

Figure 6-25. Stairs and driveways of single-family dwellings in Al Rawdah neighbourhood make the presented sidewalk un-walkable.

Figure 6-26. Placement of protective fences to prevent cars from hitting students on their way in/out of schools as well as parking. Simultaneously, these fences block the movement of pedestrians on sidewalks (when available).

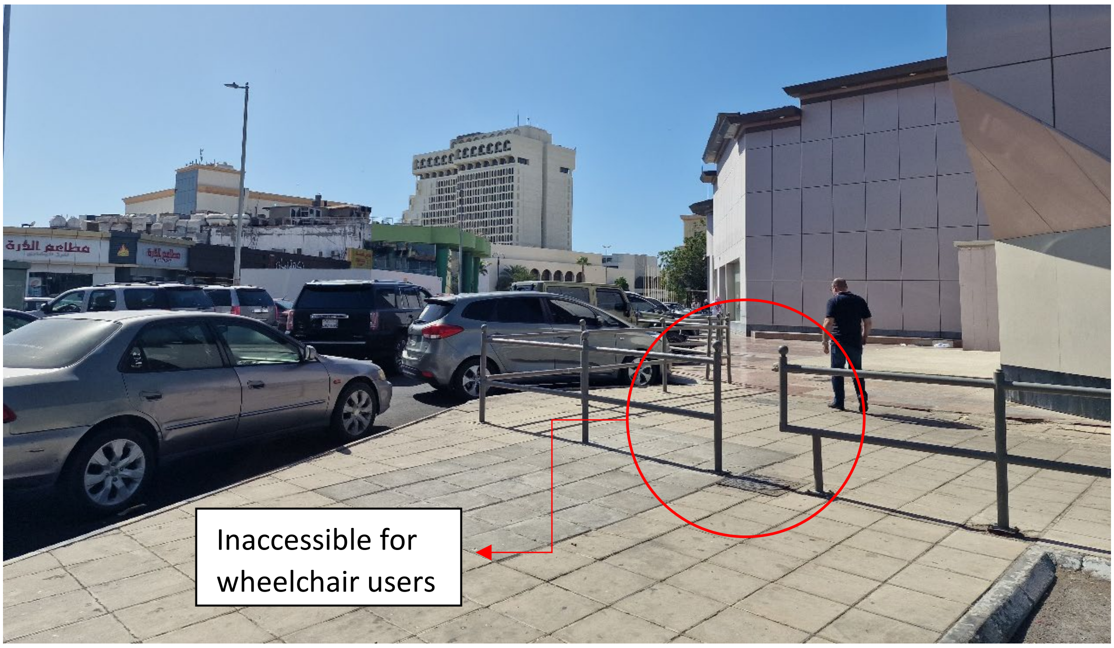


Figure 6-27. Fences are placed to prevent shoppers from stealing, misusing, or straying supermarket trolleys at the expense of obstructing sidewalk continuity.

Figure 6-28. A partition that provides privacy for a school guard's room while also encroaching on the sidewalk zone.

Figure 6-29. Water storage tanks are another common obstruction of sidewalks.

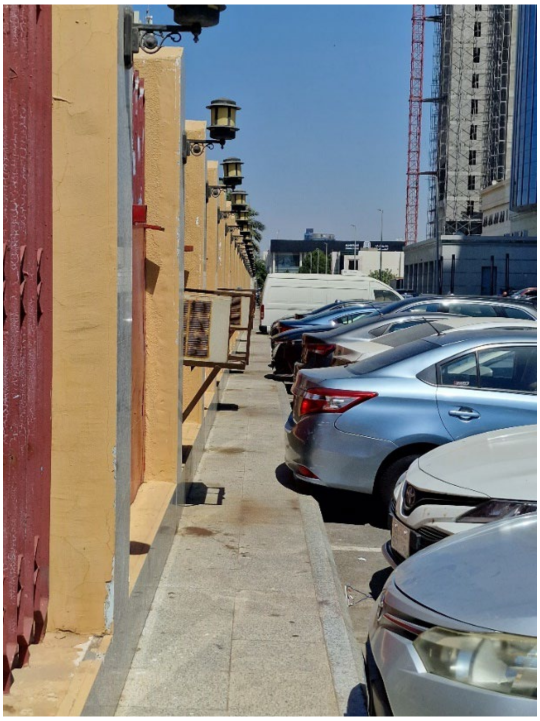


Figure 6-30. Sidewalk obstructions caused by air conditioning units and parked cars.

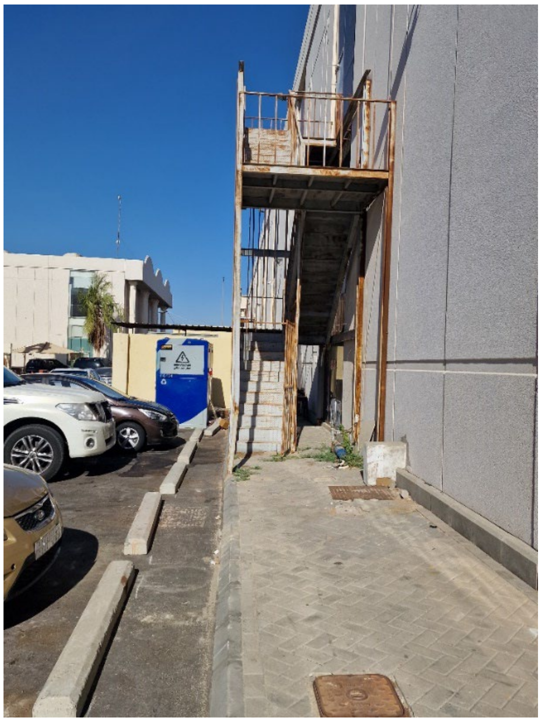


Figure 6-31. A typical example of an external staircase that obstructs sidewalk continuity.

Figure 6-32. Storage and air conditioning units reduce sidewalk's width to 40 cm.

Figure 6-33. Signages of petrol stations and kiosks are common obstructions.

Figure 6-34. Sidewalks created for beautification purposes via vegetation, not offering any space to walk.

Figure 6-35. The placement of pipes and planters reduce sidewalk's effective pedestrian zone to less than 0.7 m.

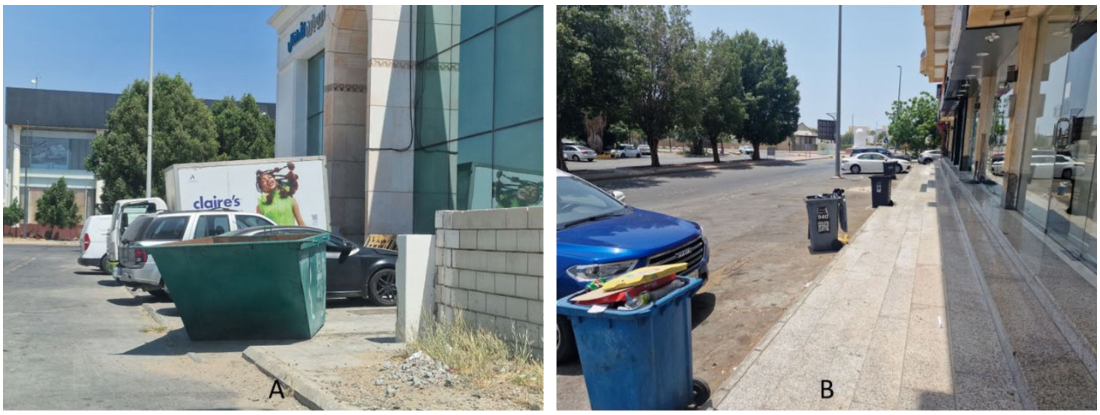


Figure 6-36. Trash bins in both A & B are unaccounted for in the design of sidewalks, which obstruct pedestrian movement in cases such as "A".

Figure 6-37. Walls defining land lots in both cases obstruct sidewalk continuity; however, cases such as the “B” image include electricity boxes or water generators, which is more challenging to resolve.

Figure 6-38. Flagged sidewalk design and obstruction issues.

Figure 6-39. Even though fieldwork showed that outdoor seating and parasols are uncommon street furniture, when placed (such as the displayed hotel), they hinder pedestrian movement.

Figure 6-40. Pedestrians have no choice but to walk along with automobiles due to the absence or inadequacy of sidewalks.

Auditing sidewalks' walkability revealed inconsistency of buildings' setback elevations as another key concern (see Section 5.3.1.2 for the audited factors). As shown in Figures 6-41 and 6-42, differences in buildings' setback elevations can be, in some cases, greater than 1 m, which affects thorough pedestrian movement and their relationship with streets. These elevation differences are neither addressed in the national and local standards and manuals for pedestrian and bicycle infrastructure (MOMRA, 2019a, 2019b) nor in Jeddah's building regulations and controls (Jeddah Municipality, 2019). The complexity of the identified issue extends to the street drainage, utilities, and accessibility to/from buildings.

Figure 6-41. The elevation difference between buildings' ground floor and streets hinders pedestrians' movement—vehicle ramps, like in the exhibited case, encroach streets' right-of-way.

Figure 6-42. The regulation that permitted creating vehicle parking at the ground floor level of residential buildings did not consider its compatibility with the buildings' setback requirements and relationship to streets.

Environmental auditing of sidewalks' walkability also identified ground floor visual impermeability of villas (or single-family dwellings) and car parking regulations of apartment buildings as influences on natural street surveillance and urban liveliness (See Figures 6-43 and 6-44). Urban liveliness is a city's ability to create inviting, multipurpose, and meaningful places that offer opportunities to participate in urban life (Gehl, 2010). Fieldwork showed that all residential villas (and a few apartment buildings) were walled in the five examined sites, thus blocking all forms of intersections with urban life at the ground level. As for apartment buildings (i.e., four floors or less), the building regulations and controls that were released in June 2017 permitted the dedication of the ground floor for car parking (in addition to the four floors + annexe) and required the provision of a car park for areas >150 m² (Jeddah Municipality, 2019). Therefore, reclaiming streets (via, for example, urban greenways) as places for people would require a review of the Saudi building regulations.

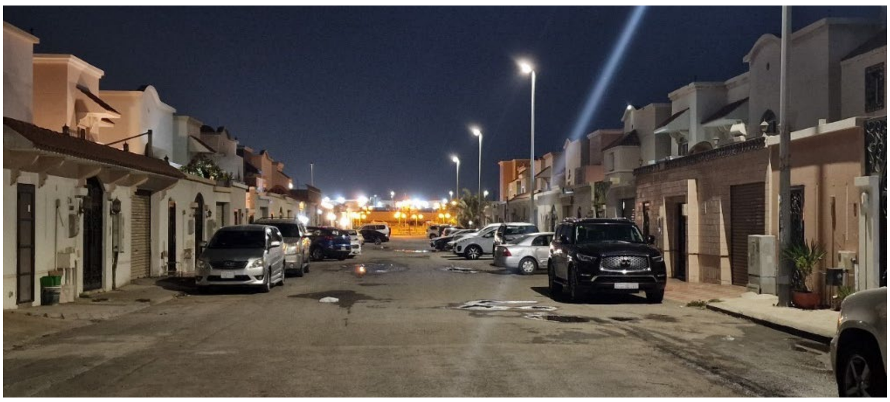


Figure 6-43. Walls impede all forms of communication and participation in urban life at the ground floor level of villas.

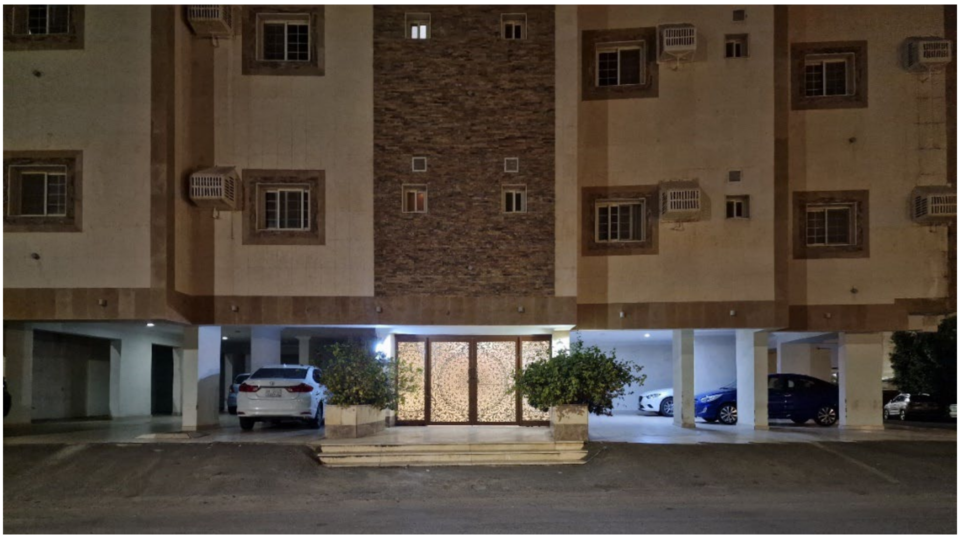


Figure 6-44. Social interaction and activities on the ground floor of apartment buildings are lost via the building regulations that permit parking lots’ placement.

6.3. Assessments at the site level

The five representative case studies’ design, amenity, and maintenance were assessed by recording 33 indicators: 19 were at the segment level, and 14 were at the site level. Site inventory involved mapping, measurements, photographs, and notetaking (see Section 5.4.1). Figures 6-45 to 6-49 display the mapping that facilitated site assessments by referencing observations’ location, number, and distance (see 5.5.2 for the description of symbols). In addition, notes and arrows were drawn on those maps to show additional insights about the site’s condition (e.g., indication of obstructions).

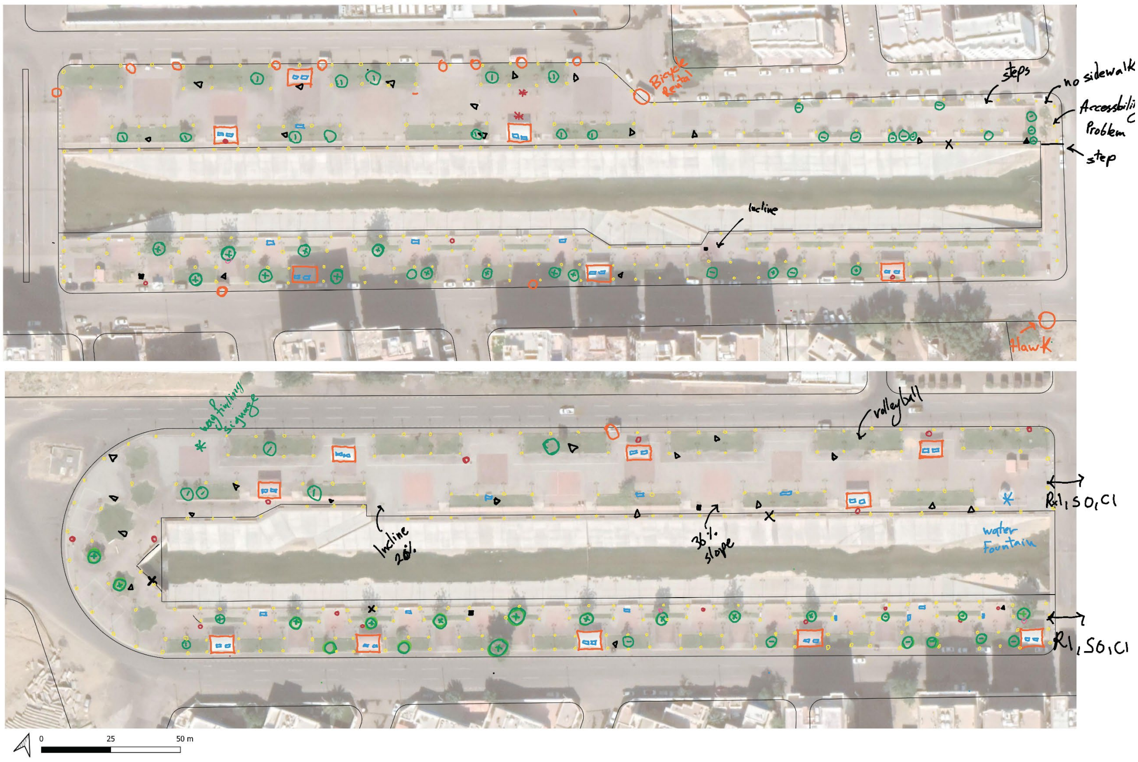


Figure 6-45. Mapping of Al Nakheel 2 walkway design, amenity, and maintenance.

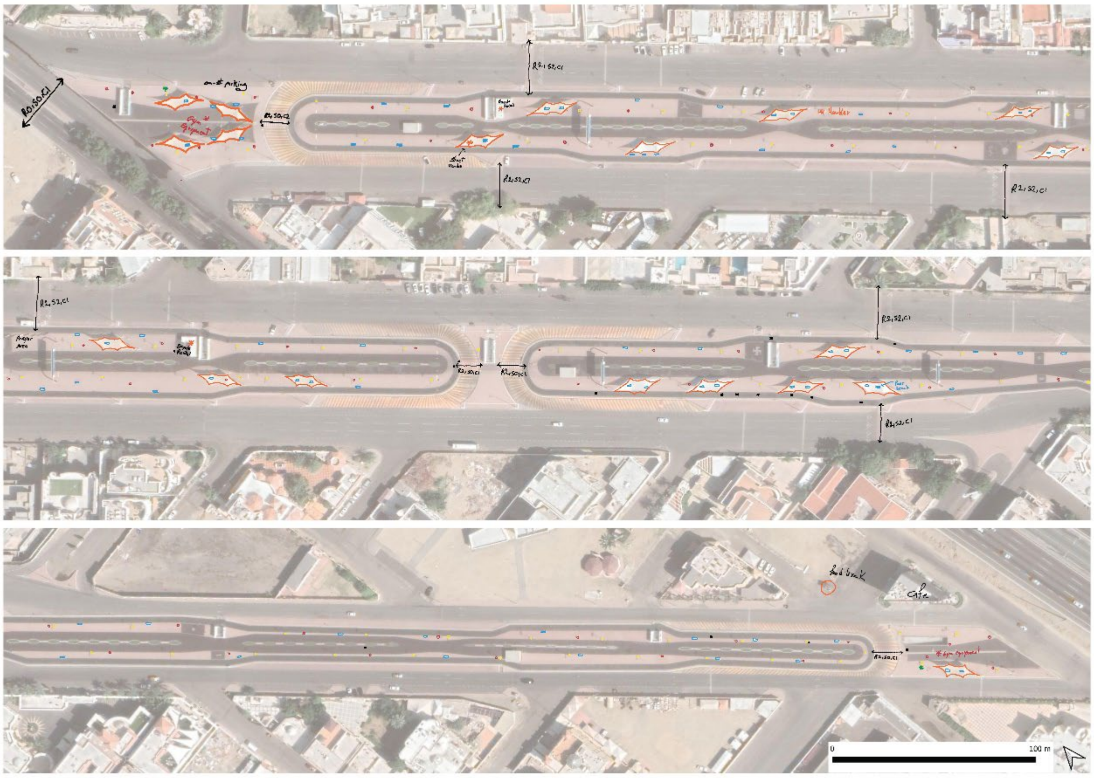


Figure 6-46. Mapping of Al Rehab walkway design, amenity, and maintenance.

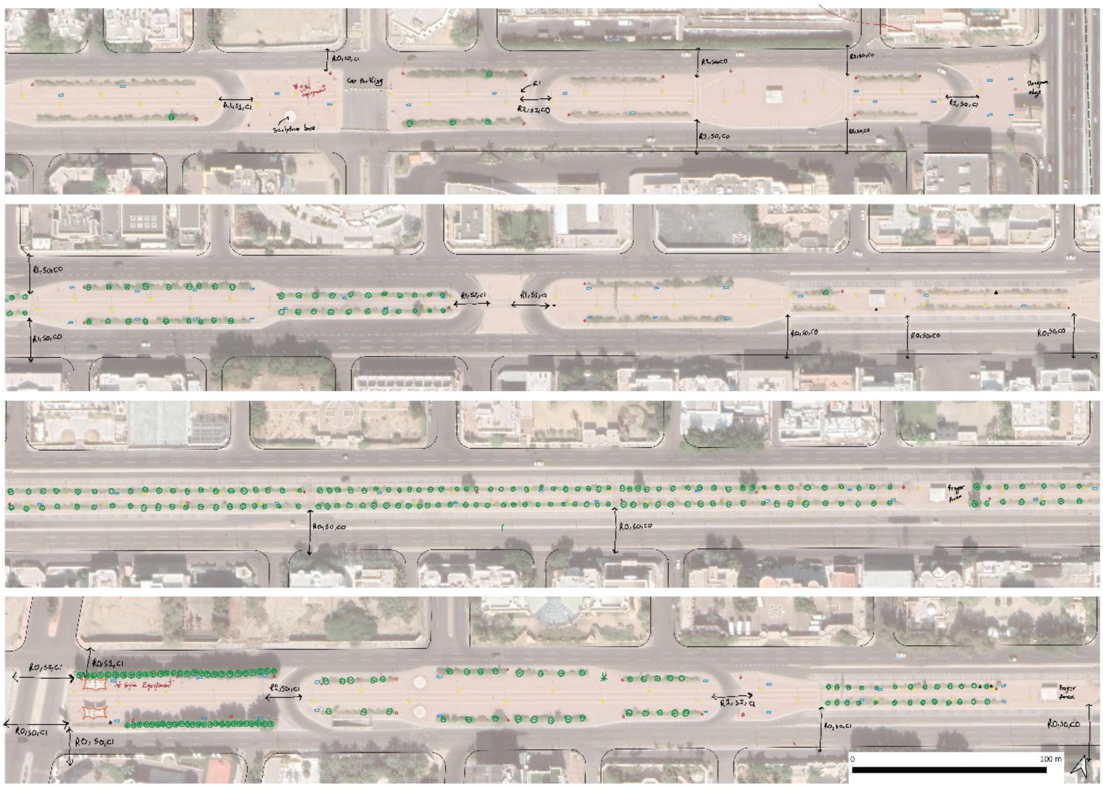


Figure 6-47. Mapping of Al Tahlia walkway design, amenity, and maintenance.

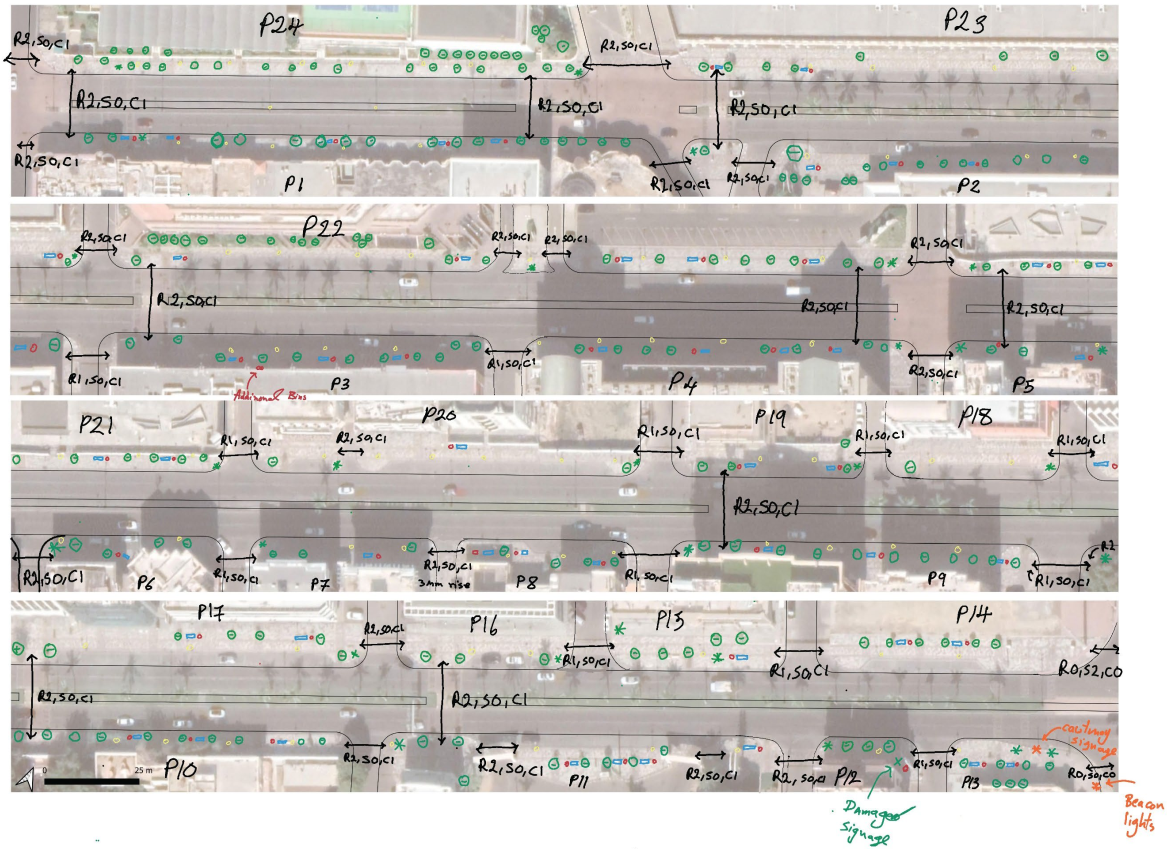


Figure 6-48. Mapping of Palestine St. Walkway design, amenity, and maintenance.

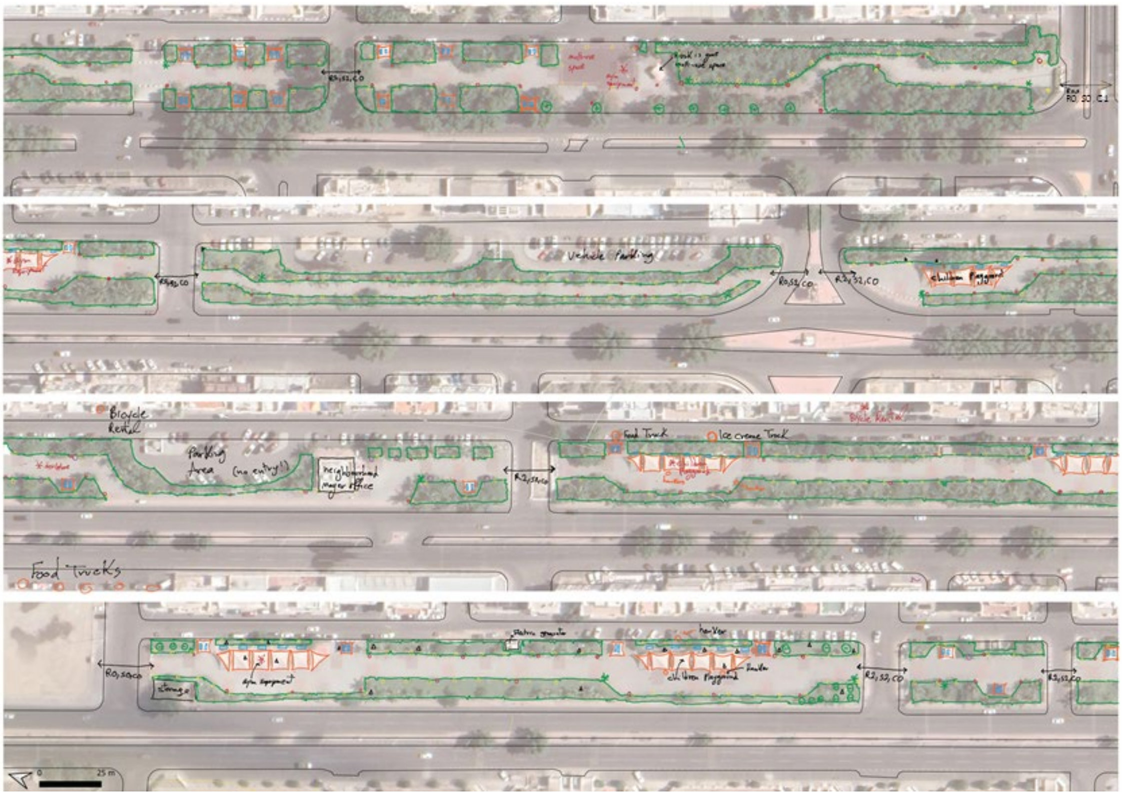


Figure 6-49. Mapping of Al Yamamah walkway design, amenity, and maintenance.

Figures 6-50 to 6-57 display photographs of each segment within the five walkways/LPs as evidence of their design, amenity, and maintenance condition every

100-150 m because most sites were straight routes. In cases where the path meanders (e.g., Al Yamamah walkway), photographs of segments were taken at 50-meter intervals to avoid visual obstruction. Most photographs were captured from the middle of the path to maximise visibility. In a few instances, the standing location shifted when trees or buildings obstruct views.

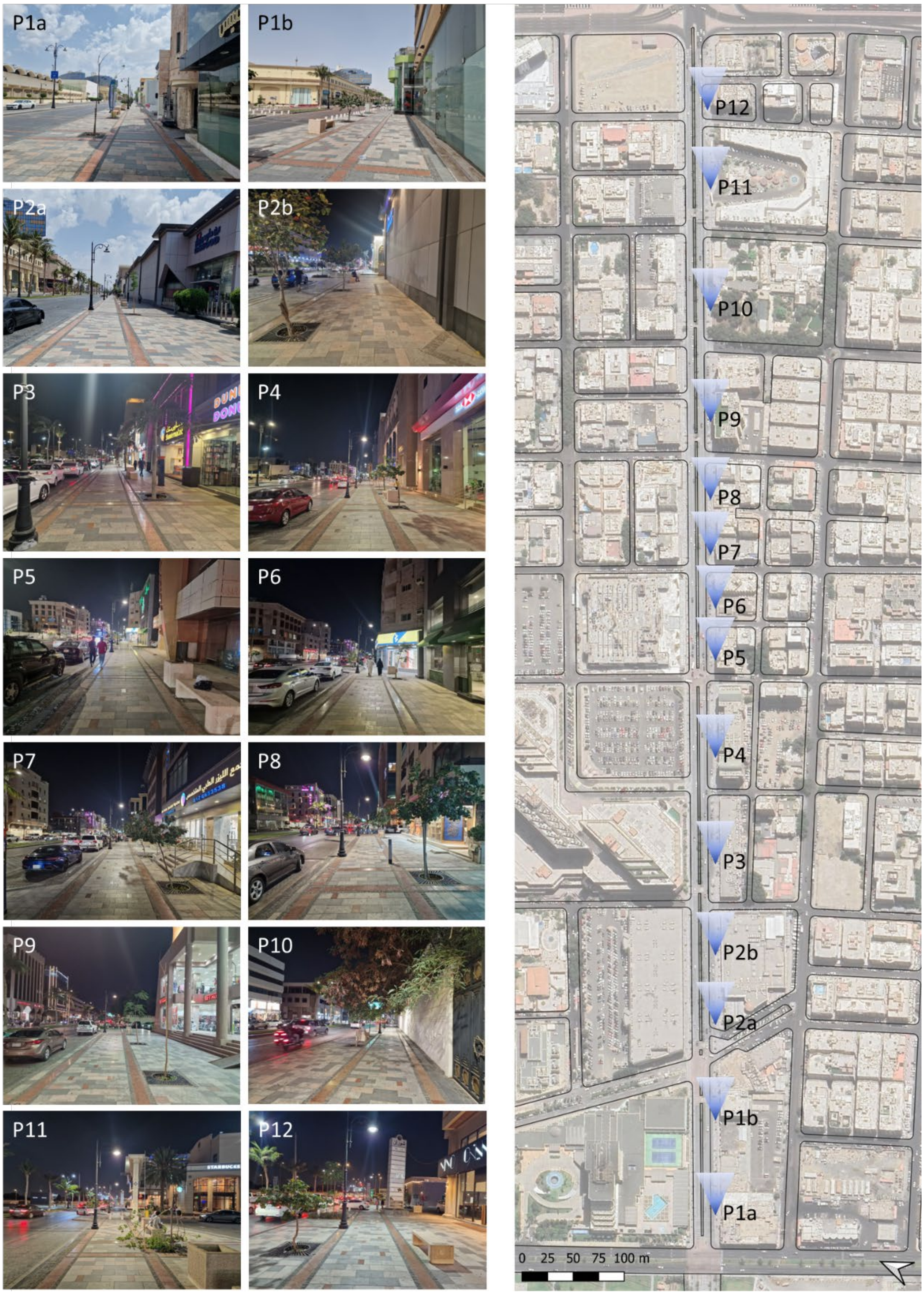


Figure 6-50. Photographs evidencing Palestine Street Walkway's conditions per segment (Part One).

Figure 6-51. Photographs evidencing Palestine Street Walkway's conditions per segment (Part Two).

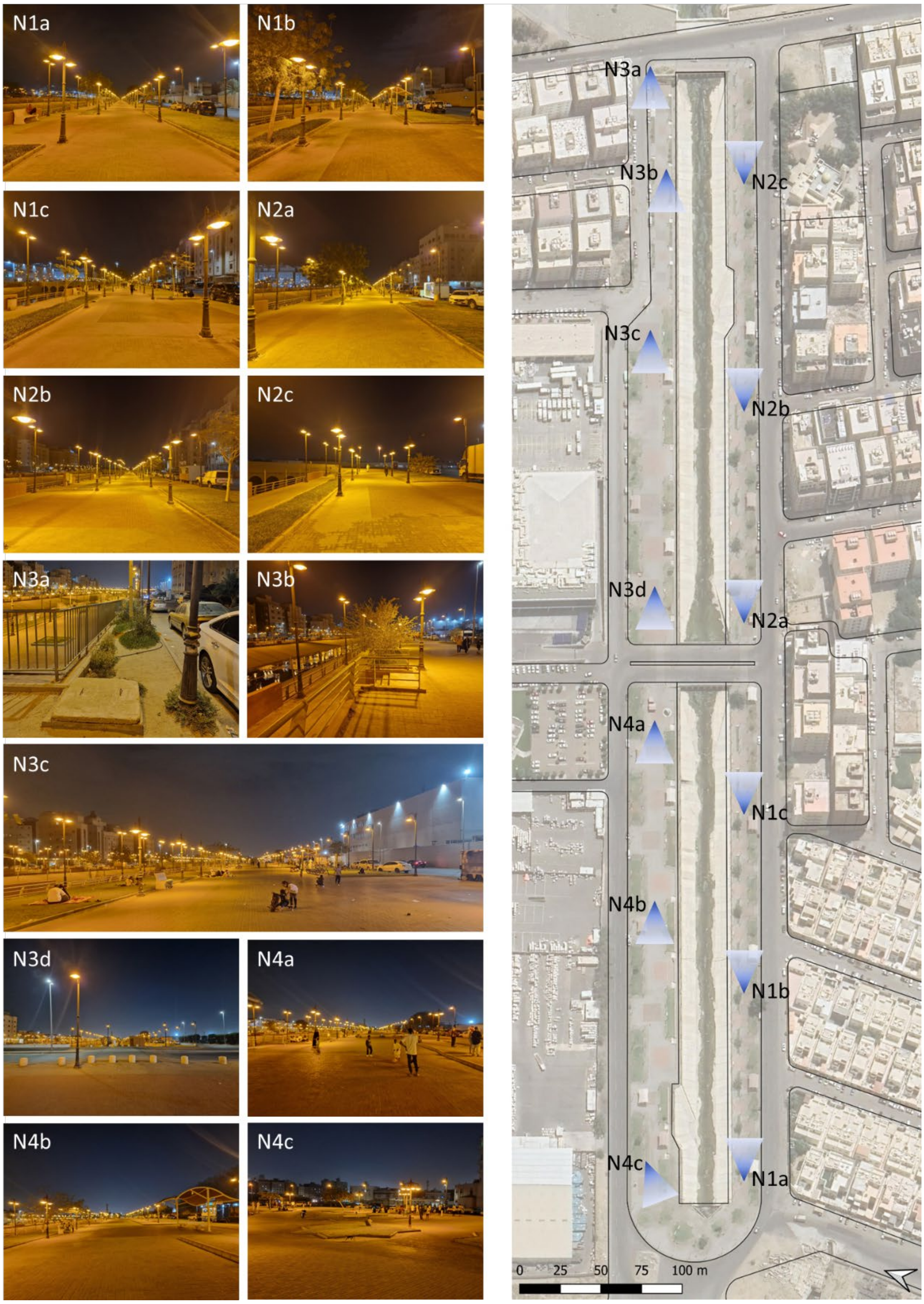


Figure 6-52. Photographs evidencing Al Nakheel 2 Walkway's design, amenity, and maintenance per segment.

Figure 6-53. Photographs evidencing Al Nakheel 2 Walkway's design, amenity, and maintenance per segment.

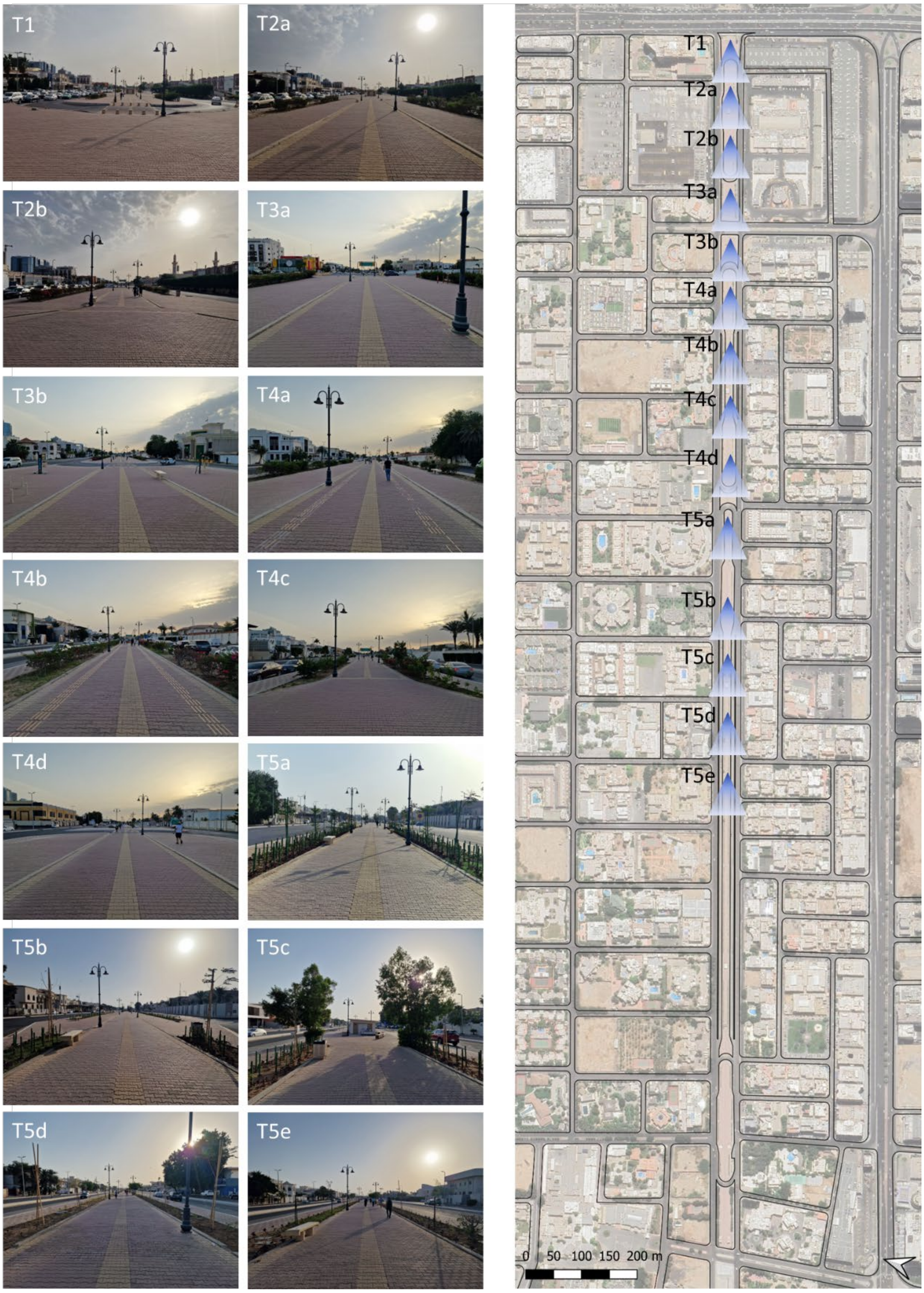


Figure 6-54. Photographs evidencing Al Rawdah (or Al Tahlia) Walkway's design, amenity, and maintenance per segment (Part One).

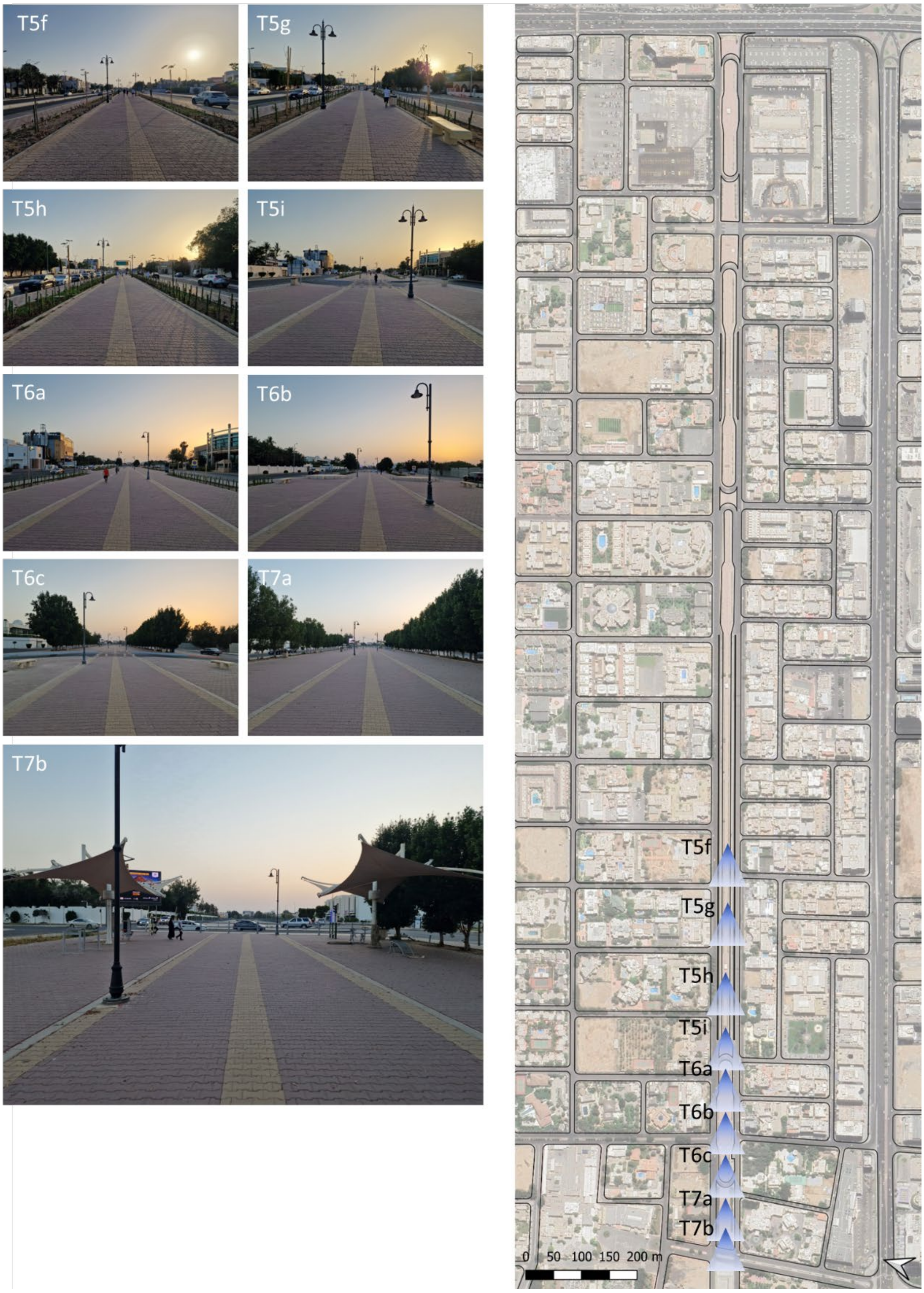


Figure 6-55. Photographs evidencing Al Rawdah (or Al Tahlia) Walkway's design, amenity, and maintenance per segment (Part Two).

Figure 6-56. Photographs evidencing Al Yamamah Walkway's design, amenity, and maintenance per segment (Part One).

Figure 6-57. Photographs evidencing Al Yamamah Walkway's design, amenity, and maintenance per segment (Part Two).

A PEAT assessment was conducted based on site characteristics scores (Table 6.1). These revealed that vertical clearance, buffer zone, running and cross slope, site distance, pavement surface condition, lighting fixtures, availability of seating, trash bins, litter, vandalism, parking spaces, traffic speed, and calming measures are generally not a case of concern (see photographs in Figures 6-50 to 6-57). However, Tables 6-2 to 6-6 show where some of those factors (e.g., litter or cross slope) were an issue. For example, litter was mostly found near playgrounds and sitting areas (e.g., Al Yamamah walkway, segments Y4 and Y7, despite those sites being highly maintained (janitors were frequently observed). Cross slopes, for instance, in Al Rehab walkway, Segment R4, was ≥ 8%, which impacts movement, especially for people with disabilities (See Figure 6-53). In short, the indicators mentioned above are positive attributes of the five examined sites, suggesting that the development priority of those factors is low.

Table 6-1. Summary of adapted PEAT assessment for the five representative walkways/LPs in Jeddah city (average scores).

Assessed indicators			A	B	C	D	E	Ave.
Segment assessment indicators	1	Curb ramp and width	**1.79**	**1.71**	**1.50**	**0.86**	**0.00**	**1.17**
	2	Cautionary signage and signals	**0.00**	2.14	**0.00**	**0.29**	**0.00**	**0.49**
	3	Marking	**0.92**	**0.29**	**0.75**	**0.29**	**0.00**	**0.45**
	4	Width	2.21	3.00	3.00	3.00	3.00	2.84
	5	Bicycle lane	**0.00**	**0.00**	**0.50**	**0.00**	**0.00**	**0.10**
	6	Bicycle racks	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
	7	Vertical clearance	3.00	2.43	2.75	3.00	3.00	2.84
	8	Buffer zone (from the street)	3.00	2.29	3.00	3.00	3.00	2.86
	9	Shade trees	**1.88**	2.71	**0.00**	**1.29**	**1.25**	**1.43**
	10	Shading structures	**0.00**	**1.71**	2.25	**0.29**	2.25	**1.30**
	11	Running slope	3.00	3.00	3.00	3.00	3.00	3.00
	12	Cross slope	3.00	3.00	2.00	3.00	3.00	2.80
	13	Site distance	3.00	3.00	3.00	3.00	3.00	3.00
	14	Pavement surface condition	3.00	3.00	2.50	3.00	3.00	2.90
	15	Lighting fixtures	2.50	3.00	2.75	2.86	3.00	2.82
	16	Seating	2.50	**1.43**	3.00	2.71	2.50	2.43
	17	Trash can	2.50	3.00	3.00	2.29	2.50	2.66
	18	Litter	3.00	2.71	3.00	2.86	**1.50**	2.61
	19	Vandalism	3.00	3.00	3.00	3.00	2.25	2.85
Site assessment criteria	20	Spacing of access (or crossing) points	2.00	**0.00**	**1.00**	**1.00**	**0.00**	**0.80**
	21	Public toilets	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
	22	Drinking fountain	**0.00**	**0.00**	**0.00**	**0.00**	2.00	**0.40**
	23	Wayfinding signage	3.00	3.00	**1.00**	**1.00**	2.00	2.00
	24	Regulatory signage	**0.00**	**1.00**	**0.00**	**0.00**	**0.00**	**0.20**
	25	Bike rental or bicycle share service	**0.00**	**0.00**	**1.00**	**0.00**	2.00	**0.60**
	26	Food services	3.00	**1.00**	**0.00**	**0.00**	3.00	**1.40**
	27	Civic buildings	2.00	**1.00**	**1.00**	**1.00**	**1.00**	**1.20**
	28	Commercial destinations	3.00	**1.00**	**1.00**	**1.00**	**0.00**	**1.20**
	29	Grocery shop(s) or supermarket	3.00	**1.00**	**1.00**	**1.00**	**1.00**	**1.40**
	30	Exercise, Play, or green area(s)	**0.00**	3.00	**1.00**	**1.00**	2.00	**1.40**
	31	Transit stops/station	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

	32	Parking spaces	2.00	2.00	2.00	2.00	2.00	2.00
	33	Traffic speed and calming measures	2.00	2.00	2.00	2.00	2.00	2.00
Overall Average			**1.77**	**1.71**	**1.52**	**1.45**	**1.60**	0.86
Overall Standard Deviation			**1.33**	**1.28**	**1.27**	**1.29**	**1.23**	0.29

Note: Palestine Street Walkway (A), Yamamah Walkway (B), Al Rehab Walkway(C), Al Rawdah (Tahlia) Walkway (D), Al Nakheel 2 Walkway (E). Numbers in bold had scores < 2, which indicates poor conditions.

Table 6-2. Segment-level assessment of Palestine Street Walkway (n=24).

Factors/Indicators		Segments (score 0-3)																								
		P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16	P17	P18	P19	P20	P21	P22	P23	P24	Ave.
1	Curb ramp and width	3	3	2	3	3	1	1	1	1	3	3	1	0	0	1	1	1	1	1	1	3	3	3	3	1.8
2	Cautionary signage and signals	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	Marking	1	1	1	1	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1	1	1	1	1	0.9
4	Width	2	3	2	3	2	2	2	2	3	2	2	2	2	2	2	3	3	3	2	2	3	1	2	1	2.2
5	Bicycle lane	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	Bicycle racks	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	Vertical clearance	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
8	Buffer zone (from the street)	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
9	Shade trees	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	2	2	2	2	1.9
10	Shading structures	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	Running slope	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
12	Cross slope	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
13	Site distance	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
14	Pavement surface condition	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
15	Lighting fixtures	2	3	3	2	2	3	2	3	3	3	3	3	3	3	2	2	2	3	2	3	2	2	2	2	2.5
16	Seats	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	0	2	0	3	2	3	3	2	0	2.5
17	Trash cans	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	0	2	0	3	2	3	3	2	0	2.5
18	Litter	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
19	Vandalism	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Average		2.1	2.2	2.1	2.2	2.1	2.1	2.0	2.1	2.1	2.2	2.2	2.1	1.9	1.9	2.0	1.7	1.9	1.7	1.9	1.9	2.2	2.1	2.0	1.7	–

Table 6-3. Segment-level assessment of Al Nakheel 2 walkway (n=4).

Factors/Indicators		**Segments (score 0-3)**				
		N1	**N2**	**N3**	**N4**	**Ave.**
1	Curb ramp and width	0	0	0	0	0
2	Cautionary signage and signals	0	0	0	0	0
3	Markings	0	0	0	0	0
4	Width	3	3	3	3	3
5	Bicycle lane	0	0	0	0	0
6	Bicycle racks	0	0	0	0	0
7	Vertical clearance	3	3	3	3	3
8	Buffer zone (from the street)	3	3	3	3	3
9	Shade trees	2	1	1	1	1.25

10	Shading structures	3	2	2	2	2.25
11	Running slope	3	3	3	3	3
12	Cross slope	3	3	3	3	3
13	Site distance	3	3	3	3	3
14	Pavement surface condition	2	2	3	3	2.5
15	Lighting fixtures	3	3	3	3	3
16	Seats	3	3	2	2	2.5
17	Trash can	3	3	2	2	2.5
18	Litter	2	2	1	1	1.5
19	Vandalism	2	3	2	2	2.25
Average		2.00	1.95	1.79	1.79	–

Table 6-4. Segment-level assessment of Al Rehab walkway (n=4).

Factors/Indicators		**Segments (score 0-3)**				**Ave.**
		R1	**R2**	**R3**	**R4**	
1	Curb ramp and width	0	3	3	0	1.5
2	Cautionary signage and signals	0	0	0	0	0
3	Markings	1	1	1	0	0.75
4	Width	3	3	3	3	3
5	Bicycle lane	0	1	1	0	0.5
6	Bicycle racks	0	0	0	0	0
7	Vertical clearance	3	3	3	2	2.75
8	Buffer zone (from the street)	3	3	3	3	3
9	Shade trees	0	0	0	0	0
10	Shading structures	3	3	1	2	2.25
11	Running slope	3	3	3	3	3
12	Cross slope	3	3	2	0	2
13	Site distance	3	3	3	3	3
14	Pavement surface condition	3	2	2	3	2.5
15	Lighting fixtures	2	3	3	3	2.75
16	Seats	3	3	3	3	3
17	Trash can	3	3	3	3	3
18	Litter	3	3	3	3	3
19	Vandalism	3	3	3	3	3
Average		2.05	2.26	2.11	1.79	–

Table 6-5. Segment-level assessment of Al Rawdah (or Al Tahlia) walkway (n=7).

Factors/Indicators		**Segments (score 0-3)**							**Ave.**
		T1	**T2**	**T3**	**T4**	**T5**	**T6**	**T7**	
1	Curb ramp and width	0	3	0	0	0	3	0	0.86
2	Cautionary signage and signals	0	0	2	0	0	0	0	0.29
3	Markings	0	0	1	0	0	1	0	0.29
4	Width	3	3	3	3	3	3	3	3.00
5	Bicycle lane	0	0	0	0	0	0	0	0.00
6	Bicycle racks	0	0	0	0	0	0	0	0.00
7	Vertical clearance	3	3	3	3	3	3	3	3.00
8	Buffer zone (from the street)	3	3	3	3	3	3	3	3.00
9	Shade trees	0	0	1	1	2	2	3	1.29

10	Shading structures	0	0	0	0	0	0	2	0.29
11	Running slope	3	3	3	3	3	3	3	3.00
12	Cross slope	3	3	3	3	3	3	3	3.00
13	Site distance	3	3	3	3	3	3	3	3.00
14	Pavement surface condition	3	3	3	3	3	3	3	3.00
15	Lighting fixtures	2	3	3	3	3	3	3	2.86
16	Seats	3	2	3	3	3	2	3	2.71
17	Trash can	0	3	3	2	2	3	3	2.29
18	Litter	3	3	3	2	3	3	3	2.86
19	Vandalism	3	3	3	3	3	3	3	3.00
Average		1.68	2.00	2.11	1.84	1.95	2.16	2.16	–

Table 6-6. Segment-level assessment of Al Yamamah walkway (n=7).

Factors/Indicators		**Segments (score 0-3)**							**Ave.**
		Y1	**Y2**	**Y3**	**Y4**	**Y5**	**Y6**	**Y7**	
1	Curb ramp and width	0	3	0	3	3	3	0	1.71
2	Cautionary signage and signals	0	3	3	3	3	3	0	2.14
3	Markings	0	0	0	0	0	2	0	0.29
4	Width	3	3	3	3	3	3	3	3.00
5	Bicycle lane	0	0	0	0	0	0	0	0.00
6	Bicycle racks	0	0	0	0	0	0	0	0.00
7	Vertical clearance	2	2	3	3	2	2	3	2.43
8	Buffer zone (from the street)	2	3	2	3	1	3	2	2.29
9	Shade trees	3	3	3	3	3	2	2	2.71
10	Shading structures	1	2	0	2	2	3	2	1.71
11	Running slope	3	3	3	3	3	3	3	3.00
12	Cross slope	3	3	3	3	3	3	3	3.00
13	Site distance	3	3	3	3	3	3	3	3.00
14	Pavement surface condition	3	3	3	3	3	3	3	3.00
15	Lighting fixtures	3	3	3	3	3	3	3	3.00
16	Seats	1	2	0	1	1	3	2	1.43
17	Trash can	3	3	3	3	3	3	3	3.00
18	Litter	3	3	3	3	3	3	1	2.71
19	Vandalism	3	3	3	3	3	3	3	3.00
Average		1.89	2.37	2.00	2.37	2.21	2.53	1.89	–

Although many indicators were rated as fair or good (≥ 2) across many walkways, Table 6-1 shows that over half of the indicators/factors had poor and very poor results (< 2), highlighting areas needing improvement. Further, based on the adapted PEAT assessment, scores ≤ 1 indicate areas in need of major intervention. With that in mind, the following paragraphs synthesise results for each of those indicators/factors.

Items 1-3 and 20 (curb ramp and width, cautionary signage and signals, markings, and spacing of access points) in Table 6-1 pertain to pedestrian crossings, a major concern area. Despite the availability of national standards that specify the design criteria of pedestrian crossing (MOMRA, 2005b), noncompliance to those specifications is a consistent pattern among all sites (see Figure 6-58). Noncompliance forms include unavailability of curb ramps or slopes > 10%. Furthermore, the lack of cautionary signages and signals, as well as markings, is a consistent problem. Except for the Palestine Street Walkway, the spacing of pedestrian crossings is >250 m or is unavailable, like in the case of Al Yamamah and Al Nakheel 2 walkways (See Table 6-1). Specifically, the average spacing distance between pedestrian crossing points is 296.8 m, 125.6 m, and 335.3 m for Al Tahlia, Palestine Street, and Al Rehab walkways, respectively (measured via Google Earth). Therefore, based on FOs, jaywalking is common. Table 6-7 summarises the results of pedestrian crossings. For example, the unavailability of markings in Al Tahlia and Yamamah walkways/LPs is a major concern. In short, development priority for pedestrian/bicycle access to/from the examined case studies is high.

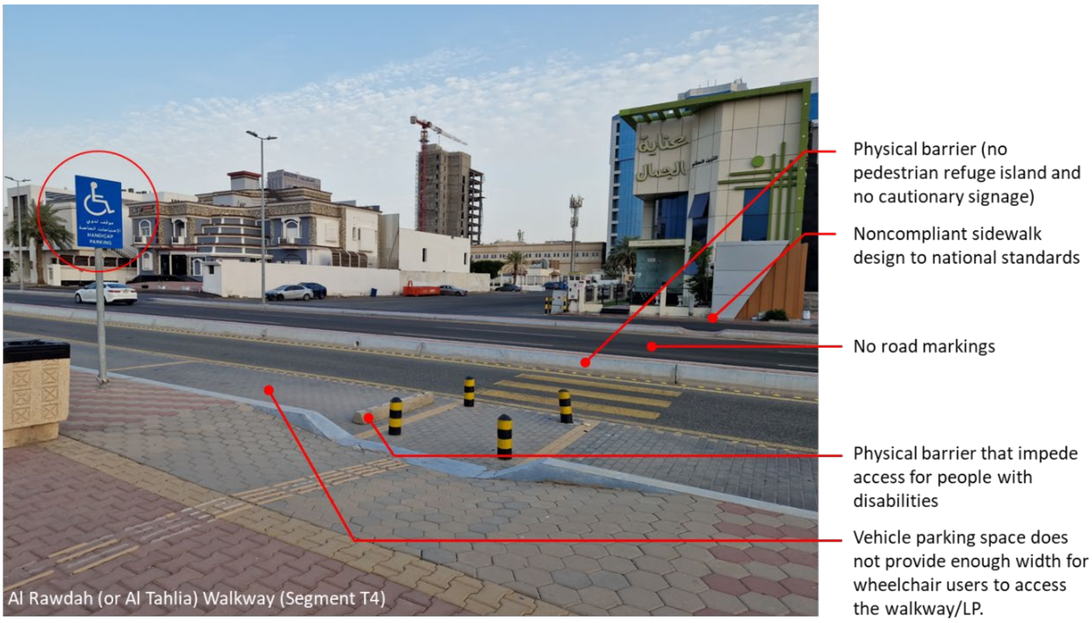


Figure 6-58. Typical pedestrian crossing problems in Al Rawdah walkway.

Table 6-7. Assessment of pedestrian crossings (PCs) for the examined case studies.

Walkway/LP name	# of PCs	Curb ramp and width			Cautionary signage and signals			Marking		
		R0	R1	R2	S0	S1	S2	C0	C1	C2
Al Nakheel 2	2	0%	100%	0%	100%	0%	0%	0%	100%	0%
Palestine St.	41	4.9%	29.3%	65.9%	97.6%	0.0%	2.4%	4.9%	95.1%	0.0%
Al Rehab	11	9.1%	0.0%	90.9%	45.5%	0.0%	54.5%	0.0%	90.9%	9.1%
Al Yamamah	9	33.3%	0.0%	66.7%	22.2%	0.0%	77.8%	88.9%	11.1%	0.0%
Al Tahlia	26	46.2%	19.2%	34.6%	76.9%	0.0%	23.1%	50.0%	50.0%	0.0%

This table shows the results of available pedestrian crossings. However, the adapted PEAT assessment considered a minimum of two pedestrian crossings per segment (presumably at both ends). Therefore, if a segment only had one pedestrian crossing, the unavailability of a second impacted a segment's score (received a 0 score since it compromises accessibility). R0: No curb ramp, R1: Curb ramp slope > 10% or width is < 1.5 m, R2: Curb ramp slope ≤ 10% or width is ≥ 1.5 m. S0: No cautionary signage, S1: Cautionary signage is not legible or damaged, and S2: Cautionary signage is legible and in good condition. C0: No marking, C1: Marking with basic visibility or requiring maintenance, and C2: Highly visible marking and in good condition. PCs: Pedestrian Crossings.

Items 5, 6, and 25 in Table 6-1 pertain to bicycle infrastructure, which is a major shortcoming in the examined sites. Except for segments R2 and R3 in Al Rehab walkway, none of the examined sites have a protected or dedicated bicycle lane. Such an aspect is important because all the examined sites are part of recent street retrofits. However, despite the availability of clear markings and signage for cyclists in parts of Al Rehab walkway, based on FOs, they do not adequately regulate bicycle traffic and minimise conflict (conflict among site users is discussed in further detail in Section 7.4). Such an observation stresses the need for physical separation from other walkway/LP users for thorough bicycle traffic.

As for bicycle rental services, the current provisions in Al Nakheel 2, Al Rehab, and Al Yamamah walkways/LPs are short-period rentals from bike hire shops (see Figure 6-59). Thus, bicycle rentals are unavailable outside shops' working hours, and all bikes must be returned to the same location. Thus, aside from recreational bicycling within the walkway/LP boundaries, the transportation usage potential of such services is limited. Other bicycle amenities, such as racks, are unavailable. The unavailability of bicycle infrastructure at the neighbourhood scale exacerbates those issues. In short, the current provision of bicycle infrastructure in the examined case studies is considerably limited, which stresses the need for plans to enhance accessibility and safety of their usage at the site, neighbourhood, and city scale.

Figure 6-59. Forms of bicycle rental services in the examined case studies.

Assessment of shading trees and structures revealed mixed results but were mostly poor (see Table 6-1). Factors contributing to such an outcome varied at the segment level (see Tables 6-2 to 6-6). In many cases, trees (regardless of the type) were unavailable (e.g., segments T1 and T2 in Al Tahlia walkway). In many other cases, they were partially available or mostly in poor condition (see Table 5-5 and 5-6 for assessment criteria). As shown in Figures 6-50 to 6-57, tree species in the examined case studies (except for Al Rehab walkway because trees were absent) commonly have a combination of shade trees (specifically, Ficus altissima, Conocarpus erectus, and Azadirachta indica), palm trees (specifically, Washingtonia robusta, Phoenix dactylifera, Cocos nucifera, and Roystonea regia), and ornamental trees (specifically, Terminalia catappa, Cordia sebestena, Plumeria obtuse, and Delonix regia). Figures 6-45 to 6-49 show the location of each shading and non-shading (i.e., palm and ornamental) tree. Suppose a shade tree was immature (i.e., < 5 m in height or an average of dense crown spread < 3 m); it was given the same symbol as a palm/ornamental tree. Overall, except for Al Yamamah walkway, the inadequate provision and maintenance of trees in the examined sites is an area of high development priority to enhance walkways/LP's comfort and aesthetic quality.

Regarding shading structures, results revealed a similar conclusion. Existing provisions are in the form of "shade refuges" (Sustainable Building, 2019) placed at variable distances (see Figure 6-60). Thus, inadequate provision of shading trees and structures is critical, especially in a tropical, hot, arid region like Jeddah. It partially explains why using those spaces until late afternoon was scarce across all sites during fieldwork in 2019, 2020, 2021, and 2023. Even in the case of Al Rehab and Al Nakheel 2 walkways, which had fair provision of shading structures, they still have direct exposure to sunlight in most spaces. In short, the assessed case studies (except for Al Rehab and Al Nakheel 2 walkways/LPs) had poor provision of shading structures.

Figure 6-60. Typical shading structure or shade refuge.

The adapted PEAT assessment also considered the availability, accessibility, design, and conditions of various site-level indicators. As indicated in Table 6-1, regulatory and wayfinding signages were poor due to their unavailability in the former case and spacing > 800 m in the latter case (see Table 5-7 in Section 5.3.1.2 for their importance). The same conclusion applies to public toilets and transit stops/stations since they were unavailable across all examined case studies. The interviewed former manager at Jeddah municipality described existing efforts:

"Nothing with regards to public transport has been implemented yet in Jeddah city. Even the recently renewed buses are merely a replacement of the old one [خط البلده], which only cover limited locations in Jeddah city." (E2, 2020)

The lack of an efficient public transportation system in Jeddah city limited AT's effectiveness, practicality, and development potential. A manager at Jeddah Municipality explained:

"since the public transport system in Jeddah city is yet to be complete, which is a system that would alleviate traffic congestions, a bicycle will have no place, especially considering the high population density" (E4, *2020)*

Thus, the limited public transportation service coverage and options hindered walkways/LPs' ability to function as means that facilitate access to places of work and play without resorting to vehicle usage.

As for drinking fountains, only one is available in Al Nakheel 2 walkway. Exercise and play areas (e.g., courts, playgrounds, outdoor gyms, parks, and more) had mixed results, which were impacted by their availability and frequency. In cases such as Al Rehab and Al Tahlia walkways, outdoor Gym equipment is provided at distances > 800 m. Such a result should be interpreted as a need to offer various recreational opportunities. In short, these results stress the need to provide accessible recreational opportunities, public transit stops, drinking fountains, public toilets, and regulatory and wayfinding signages across all sites.

Assessment of the food services, civic buildings, commercial destinations, and grocery shops or supermarkets had poor results except for Palestine Street Walkway because its location is along a major commercial road (see Table 6-1). The primary contributor to such a poor outcome was accessibility. For instance, Al Rawdah (or Al Tahlia) and Al Walkway are also parallel to a commercial road. However, pedestrian crossings to those destinations (e.g., mosques, schools, or grocery shops) were mostly unavailable or unsafe (i.e., non-compliant with national standards). In a few instances, fences limited accessibility, like the Mohammed Ibn Abdulaziz Mosque adjacent to Al Tahlia walkway (segment T3) (see Figure 6-61). Therefore, accessibility in the adapted PEAT assessment carried more weight (or importance) than other indicators. Overall, plans to develop the studied walkways/LPs must enhance accessibility to nearby destinations to activate their transport potential (see Figures 5-14 to 5-18 in Section 5.4.1 for buildings and land use maps within one urban block).

Figure 6-61. Prioritisation of pedestrians' accessibility would be via fence removal, creating a pedestrian crossing, and reducing traffic speed.

Despite the variations of scores per indicator among the five representative case studies, the overall average score is poor across all sites (i.e., between 1 and 2) (see Table 6-1). Such a conclusion suggests that despite some areas of good performance, the potential of these sites to support active transportation is thwarted by many other impediments.

6.4. Chapter Six Summary

This Chapter assessed the physical environment at three levels: city, neighbourhood, and site level to explore the activation barriers of walkways/LPs' function as facilitators of AT in Jeddah city. Results revealed that these barriers exist across multiple scales. Addressing one of them (e.g., improving pedestrian crossings) will not fix the problem due to the multiplicity of impediments, which are legacies of past planning regimes embedded within legal frameworks. At the city scale, results revealed that Jeddah's walkways/LPs are (I) fragmented, (II) disconnected from pedestrian networks, public facilities, and commercial destinations, (III) often obstructed by the road network, (IV) inaccessible within walking and bicycle distance, and (V) lack variety of scales and characteristics that offer various user experiences and benefits. Moreover, the physical characteristics of the examined walkways/LPs were found adaptive to the automobile-centric planning of Jeddah city. Such an effect was observed in the use of high curbs that affect pedestrians' accessibility and the road-like lighting design that neglects the aesthetic dimension of their provision in spaces for people.

At the neighbourhood scale, despite the urban form's potential to be walkable, an assessment of sidewalks' walkability within 400 m of the five representative case studies revealed that they are mostly unsafe (i.e., forcing pedestrians to walk along with vehicle traffic). Such a barrier was consistent across all case studies despite the differences in location, population densities, and land uses. Factors contributing to such an outcome are obstructions caused by people's encroachments and building and management practices. Simultaneously, inactive frontages at buildings' ground floor level negatively affect the urban liveliness of Jeddah's streets. At the site scale, results showed that Jeddah's walkways/LPs are unsupportive to active commuters. Poor accessibility via AT modes, disconnection from surrounding land uses and public facilities, inadequacy of wayfinding and regulatory signages, and lack of facilities and amenities (e.g., public toilets, shading trees, bicycle lanes) briefly explain such an outcome. Overall, results across all scales extend current knowledge by objectively measuring the size and extent of barriers to greenways' function as facilitators of AT in Jeddah city using an assessment framework.

CHAPTER SEVEN

PREFERENCES AND OPINIONS OF JEDDAH RESIDENTS ABOUT THE USAGE OF WALKWAYS/LPS

7. Chapter Seven: Preferences and opinions of Jeddah residents about the usage of walkways/LPs

Chapter Seven explains the factors influencing the preferences (action) and opinions (image) of Jeddah residents about using Jeddah's walkways/LPs for walking and cycling. An enhanced understanding of those factors will be used to identify barriers to activating walkways/LPs as facilitators of AT (see RQ4). Results from the questionnaire, FOs, and interviews are triangulated to generate and validate these insights and build on results from Chapter Six that focus on physical enablers and constraints to the use of greenways. In so doing, these two chapters provide a holistic understanding of the factors shaping the design and use of greenways in accordance with multidimensional theories of urban sustainability, such as the Social Ecological Technical Systems (SETS) framework (McPhearson et al., 2022).

The Chapter begins (in Section 7.1) by identifying the purposes for questionnaire participants using Jeddah's walkways/LPs. Further details about usage frequency and duration are presented in sections 7.2 and 7.3, along with the preferences and opinions of users and non-users of the and how these varied according to sociodemographic characteristics. Including views from both users and non-users, who live at varying distances and whose opinions and preferences may differ, was crucial to understanding the current function of walkways/LPs in Jeddah and their future potential for AT and any barriers to realising this. Section 7.4 examines participants' sense of safety and comfort as potential active commuters via Jeddah's walkways/LPs as recorded via FOs, interviews, and the questionnaire's open-ended responses. Relationships between bicyclists' and pedestrians' sense of safety and sociodemographic group factors are explored statistically. Section 7.5 focuses on sociocultural and individual barriers to bicycling for transportation in Jeddah city. Lastly, insights from interviews with leaders of walking and cycling interest groups regarding changing attitudes towards walking and bicycling for physical activity in Jeddah city are outlined. Chapter Seven concludes in Section 7.6 with an analysis of their experiences, opinions, and needs.

7.1. Usage purposes of Jeddah's walkways/LPs

Questionnaires were administered to explore opinions and preferences about greenways in Jeddah (see Sections 5.3.1.1 and 5.5.1 for methodological details). Questionnaire results from 258 respondents revealed that Jeddah's walkways/LPs are rarely used as ATCs (See Figure 7-1), with health and well-being, leisure, recreation and social connection all far outweighing commuting as reasons for use. This result aligned with insights from the interviewed manager of Jeddah Municipality. He stated that Jeddah's LPs:

"*were not planned and constructed, even since 2013, as a part of a transportation strategy. The goal was to elevate public health quality. Since most of Jeddah's green open spaces did not have walking tracks and bicycle lanes, we wanted to provide recreational opportunities in the fastest way possible.*" (E4, 2020)

The intent to create destinations for physical activity partially explains the walkways/LPs' limited connectivity and accessibility (see Sections 6.2 and 6.3).

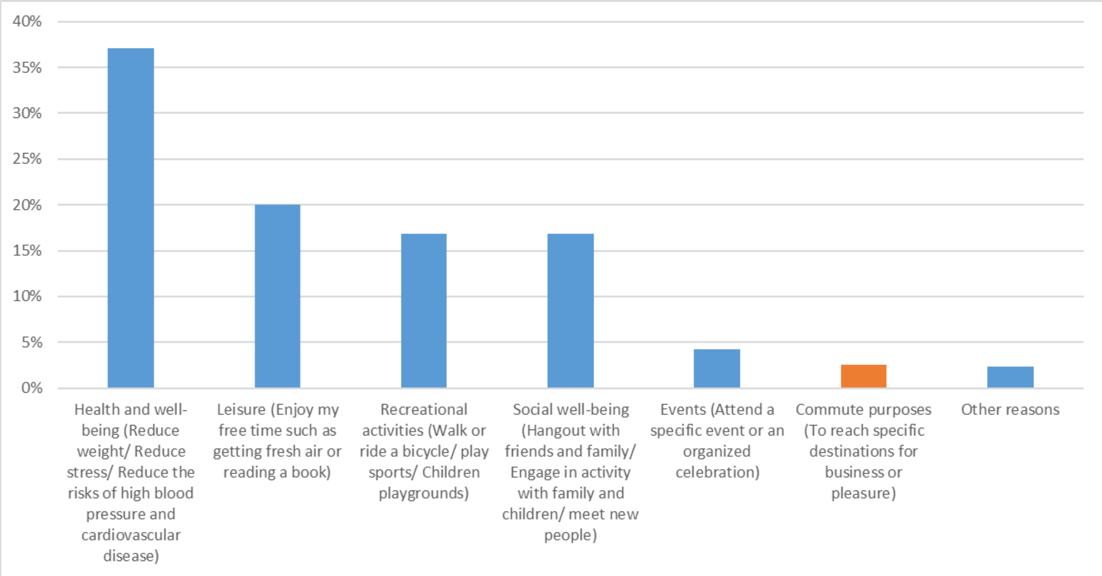


Figure 7-1. Usage purposes of Jeddah's walkways/LPs (n=258).

Site visits to nearby schools of Al Rehab and Al Rawdah walkways (as examples) during opening and closure times at different periods from 2019 to 2023 (see Section 5.5.3 for more details about FOs) showed that most residents pick up/drop off their children from school via their automobiles (Figure 7-2). During those times, walkways/LPs' nearby automobile parking spaces are occupied by chauffeurs and parents. As shown in Figure 7-3, the bar graphs' trend indicates non-commute usage patterns of walkways/LPs (Johnstone et al., 2017). A similar user visitation trend was found in other walkways/LPs in Jeddah city via Google Maps. These observations support the questionnaire results regarding the usage purposes of Jeddah's walkways/LPs.

Figure 7-2. Parents/students depend on their cars to commute to/from school (exhibited is Al Corniche Int. School adjacent to Al Rehab walkway). Date: 03/04/2023.

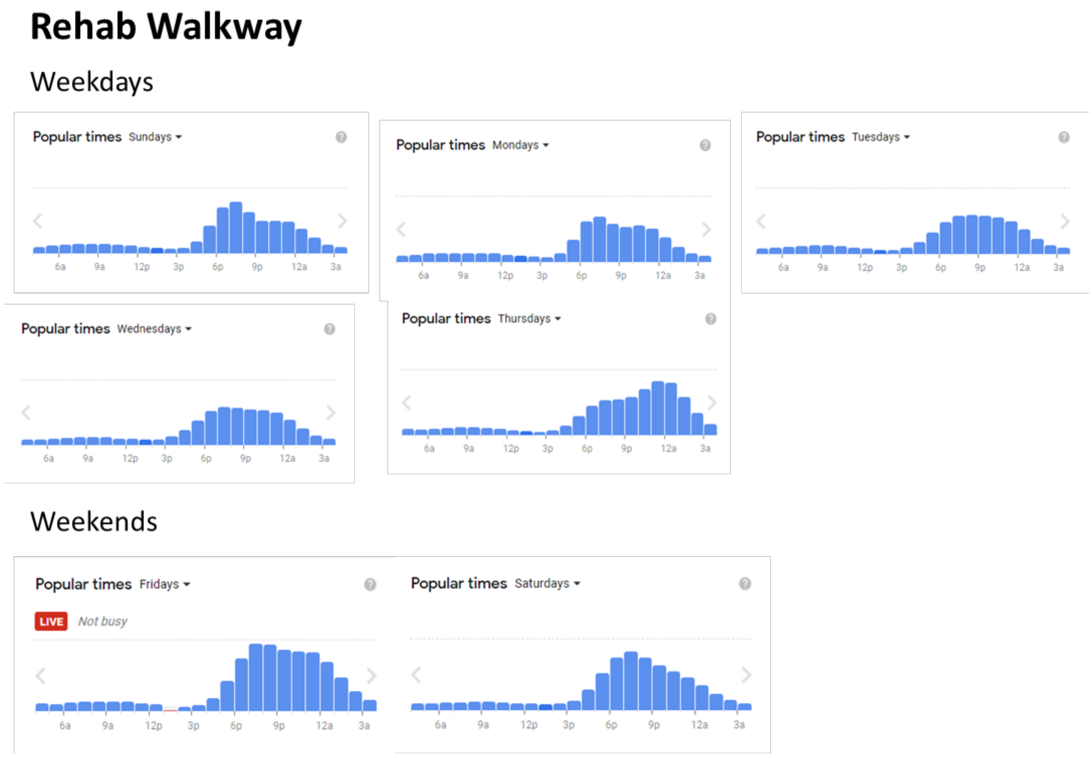


Figure 7-3. Users' visitation pattern to Al Rehab walkway based on Google Maps.

Respondents who did not select commuting as one of the reasons why they used walkways/LPs were prompted with an additional but optional open-ended question about why this was the case. Results revealed that outdoor temperature, accessibility via non-motorised modes of transport, lack of public toilets, absence of dedicated bicycle lanes, and distance from home are the top five use constraints (see Figure 7-4). Additional factors emerged from the thematic analysis of the questionnaire's qualitative data. These are site facilities (e.g., toilets, parking spaces), comfort (e.g., crowdedness and traffic jams), opinions and preferences (see Table 7-1). Many physical factors mentioned by respondents (e.g., facilities, amenities, accessibility, proximity, and more) aligned with barriers identified in the environmental audits in Chapter Six. Thus, the questionnaire results support Chapter Six findings while highlighting additional personal, behavioural, and contextual factors (e.g., crowdedness).

The WBQ participants were asked if they would (hypothetically) consider using the PNLPs from their home addresses for commute purposes; how would they rate (from a 5-point Likert scale) the factors listed in Appendix C, Q10 in terms of influence? The mean from a total of 255 responses revealed that all the factors are influential with minor variations, except for the availability of electric bicycles and scooters in the market (the phrasing of it is likely the cause). Furthermore, the top five influential factors were vegetation, availability of restrooms, outdoor temperature, maintenance, and security. The Cronbach Alpha value was $\alpha = 0.915$, suggesting an excellent internal consistency for the 18 items (Taber, 2018). Overall, results indicate that a holistic approach to walkway/LP improvement is needed, where multiple aspects must be addressed concurrently.

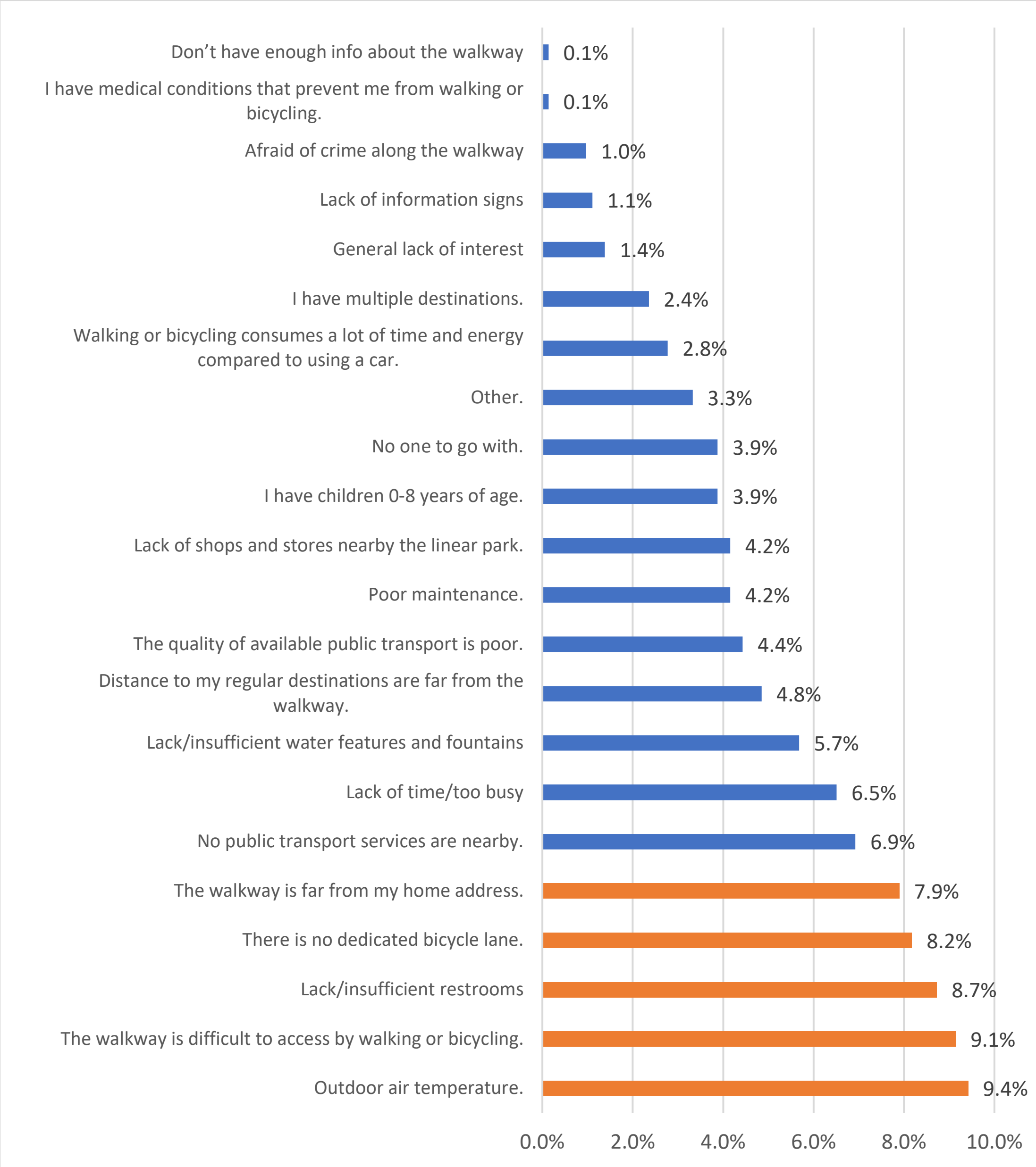


Figure 7-4. Constraints of using the nearest walkways/LPs from participants' home addresses for commuting purposes (N=207).

Table 7-1. Other reasons behind participants' choice NOT to use the PNLP from their home addresses for commuting purposes. Highlighted are the codes that had the highest frequencies.

Theme	Participants' input (codes)	Frequency
Site Amenities	Not enough parking spaces	3
	No public toilet	1
	Lack of dining options	1
	Inadequate lighting fixtures leading to discomfort	1
	Lack of vegetation	1
	Total	7
Sense of safety	Roads' lack of safety towards the walkway due to traffic speed	2
	Lack of grade crossing safety (i.e. no pedestrian bridges, absence of traffic singles, and pavement markings)	1

	Slop is somewhat unsuitable for walking or riding the bicycle	1
	Total	4
Comfort	Too many people – Crowdedness (especially at weekends)	3
	Traffic jam	3
	Cars noise and air pollution	1
	Lack of privacy (one participant mentioned that it is due to its proximity to roads and landmarks)	1
	Total	9
Accessibility	Walkways do not lead to any destinations	1
	No pedestrian and bicycle routes leading to Jeddah's walkways.	1
	Total	2
Opinions and preferences	Jeddah's walkways are places for practising sports and sitting outdoors	1
	I do not sit in Jeddah's walkways	1
	I do not practice sports	1
	My parents' and brothers' mentality does not accept the idea of women walking outdoors	1
	Bad design	2
	Total	6
Users' behaviour	Lack of public courtesy (making loud noises, dressing inappropriately)	2
	People's indifferent attitude towards the parks' cleanliness	1
	Many families do not monitor their kids' behaviour	1
	Total	4
Design and layout	Too many changes in levels	1
	I care about the views from the walkway	1
	Total	2

High outdoor temperature was a consistent factor offered by respondents as a deterrent to walking and bicycling for transportation in Jeddah city. This was seen in the following quotes that related outdoor temperature to comfort and usage preferences of Jeddah's walkways/LPs.

"outdoor temperature is unsuitable for daily commute to work or to finish an errand. You cannot return from work at 3 pm using a bicycle. It is impossible." (L3, 2020)

"how do you encourage people to go out? I think it is not unrealistic during the day. I think it is in the culture and in the DNA that once the sunset, that's when I go out. It's always in the evening. You'll never see anybody in a park or an open space in the middle of the day." (E6, 2020)

"Bicyclists in Jeddah city perceive the use of bicycles as a hobby and as a sport, but not as a mode of transport. This is because the weather here is hot and humid, especially during summer. […] That is the main constraint. However, if people use bicycles as a mode of transport alternative to cars, it would reduce traffic congestion, and it is an enjoyable mode of transport." (L1, 2020)

More research is therefore needed to understand how weather influences walkways/LPs' usage and how enhancements of outdoor thermal comfort via the provision of various site amenities (e.g., shading trees and structures) and materials can promote pedestrian and bicycle use of walkways in Jeddah city.

A Chi-square test of independence was conducted to explore how gender influences the reasons for using PNLPs from participants' home addresses. Results showed no significant association between use purposes and gender, X^2 (6, N = 183) = 8.32, p = 0.21, suggesting that men and women use Jeddah's walkways for similar reasons. Comparisons are presented in Table 7-2.

Table 7-2. Both men and women similarly value the perceived nearest linear park to their home addresses (the "other" choice was excluded).

Use Purposes	Male		Female		Total	
	Count	N %	Count	N %	Count	N %
Health and well-being	90_a	71.4%	38_a	66.7%	128	69.9%
Recreational activities	40_a	31.7%	14_a	24.6%	54	29.5%
Leisure	39_a	31.0%	20_a	35.1%	59	32.2%
Social well-being	43_a	34.1%	10_b	17.5%	53	29.0%
Events	7_a	5.6%	$<5_a$	1.8%	8	4.4%
Commute purposes	6_a	4.8%	$<5_a$	5.3%	9	4.9%
Total	126	100.0%	57	100.0%	183	100.0%

Note: Tests are adjusted for all pairwise comparisons within a row of each innermost subtable using the Bonferroni correction.

The questionnaire results showed that 76% of 251 respondents use their cars to reach the PNLPs from their home addresses (see Figure 7-5). Such a result reflects the 84% of questionnaire participants' dependence on their cars daily to reach their daily destinations (See Figure 7-6). Nonetheless, a Chi-square test of independence was performed to examine if the reasons people used LPs differed according to whether they walked or drove to the location. Findings revealed a significant association between usage purposes and mode of transport, X^2 (6, N = 205) = 20.93, p = 0.002. A column proportions test was performed to determine which categories were responsible for this relationship, and all pairwise comparisons were adjusted using the Bonferroni correction (see Table 7-3). Results showed that participants who drive their cars to use the PNLPs were more likely to do so for recreational and leisure purposes than those who walk.

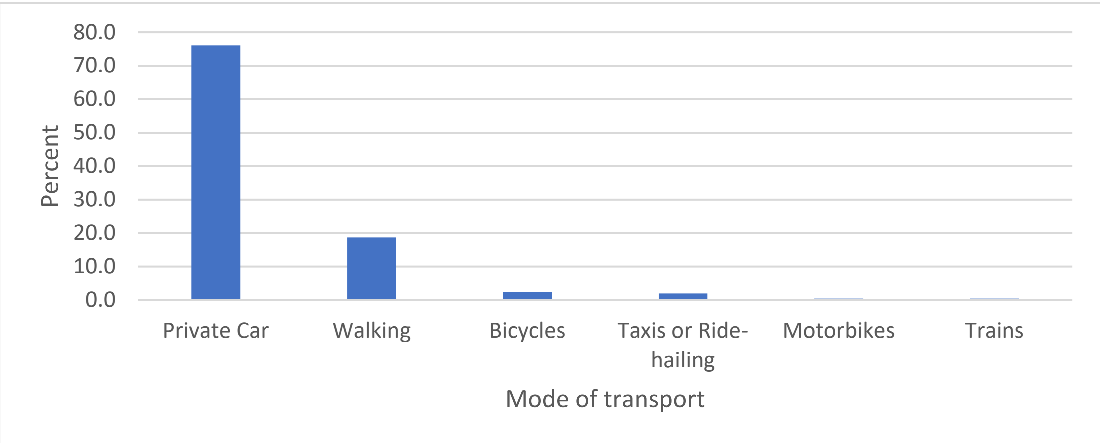


Figure 7-5. Participants' mode of transport to reach Jeddah's linear parks (n= 251).

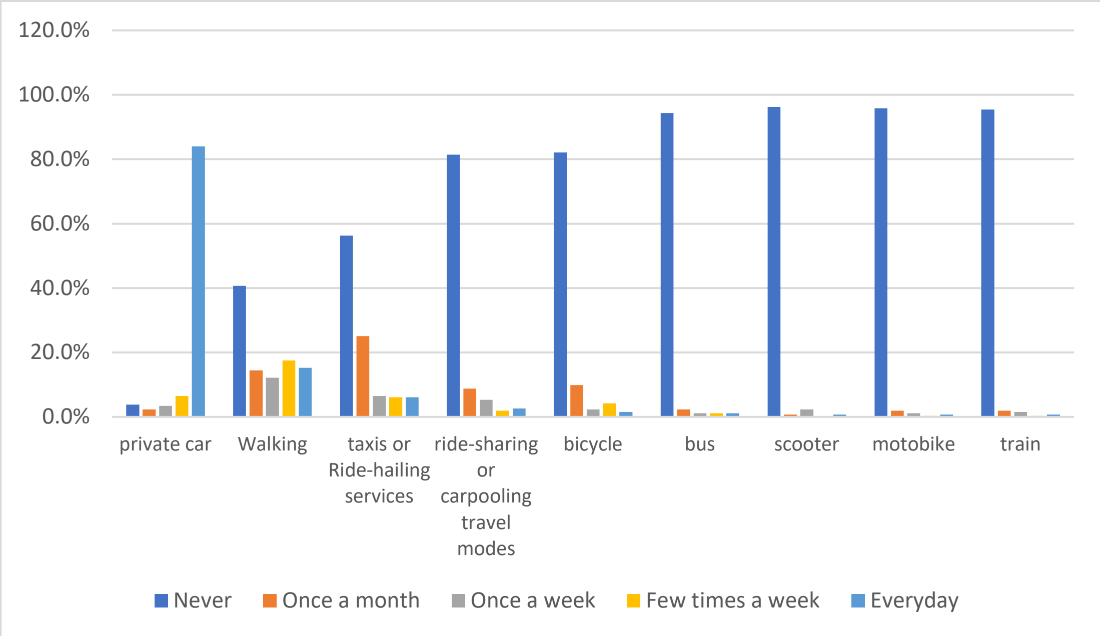


Figure 7-6. Private automobiles are the dominant mode of transport for daily commuting (N=263).

Table 7-3. The usage purposes of Jeddah's walkways/LPs are broken down by the mode of travel used to access those destinations.

Use purposes	Walking		Car		Total	
	Count	N %	Count	N %	Count	N %
Health and well-being	32_a	76.2%	108_a	66.3%	140	68.3%
Recreational activities	6_a	14.3%	54_b	33.1%	60	29.3%
Leisure	8_a	19.0%	61_b	37.4%	69	33.7%
Social well-being	7_a	16.7%	52_a	31.9%	59	28.8%
Events	<5[1]	0.0%	8_a	4.9%	8	3.9%
Commute purposes	<5[1]	0.0%	10_a	6.1%	10	4.9%
Total	42	100.0%	163	100.0%	205	100.0%

Note: Values in the same row and subtable not sharing the same subscript are significantly different at p< .05 in the two-sided equality test for column proportions. Cells with no subscript are not included in the test. Tests assume equal variances [2].

[1] This category is not used in comparisons because its column proportion equals zero or one.

[2] Tests are adjusted for all pairwise comparisons within a row of each innermost subtable using the Bonferroni correction.

Chi-square tests of independence were also performed for all the other sociodemographic characteristics such as age, marital status, income, employment, children ≤ 8 years old (yes/no), as well as other variables such as distance from home address, companion preference, use frequencies, duration, to see whether these influenced how people use walkways/LPs. Unfortunately, Chi-square tests for all the factors above had more than 20% of cells with expected counts of less than 5. Therefore, they were disregarded as the results may be invalid. In particular, the low incidence of active commuting meant it was impossible to explore factors that may increase this behaviour. Nevertheless, the following results provide insights into general patterns of use for all users, which inform potential opportunities and obstacles to future active commuting.

7.2. Usage frequencies of Jeddah's walkways/LPs

Survey respondents were asked how often they visited their PNLP from their home addresses, if at all. Participants were then grouped into users (with various frequency rates) and non-users. Use frequency of the PNLPs from participants' home addresses multiple times a week or every day is rare (13.5% out of 357), indicating that they are not used to reach daily destinations (See Figure 7-7). Equally important, almost a quarter of the 357 participants never used/visited the PNLPs from their home addresses, mainly due to distance from home, weather, lack of time/busy, the distance of regular destinations from the LP, and lack of public toilets (see Table 7-4). These factors overlap with the Constraints of using the PNLPs from participants' home addresses for AT (see Figure 7-4). Lastly, as shown in Table 7-4, 2.6% of participants explained other reasons for their non-usage. They are a preference for practicing sports indoors (i.e., gym), lack of site vegetation, unavailability of bicycle rental services, and the site's desertedness.

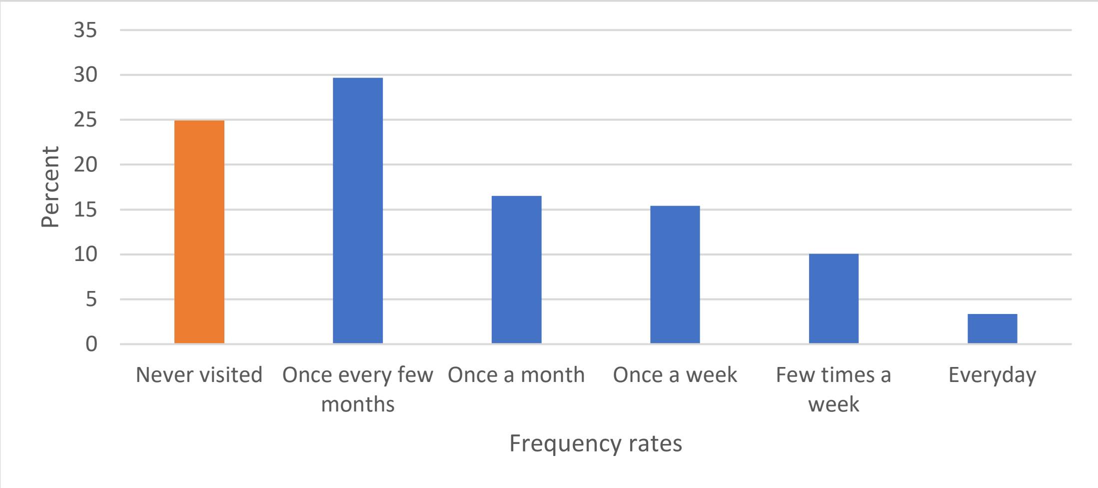


Figure 7-7. Frequent visitation/use a few times a week or more of the PNLPs from participants' home addresses is hardly a common behaviour (n=357).

Table 7-4. Frequencies of non-use reasons (a multiple-response question, n=85).

No.	Reasons for non-use	N	%	% of Cases
1	The walkway is far from my home address.	37	12.0%	43.5%
2	Outdoor air temperature.	27	8.7%	31.8%
3	Lack of time/too busy	23	7.4%	27.1%
4	Distance to my regular destinations are far from the walkway.	22	7.1%	25.9%
5	Lack/insufficient restrooms	22	7.1%	25.9%
6	The walkway is difficult to access by walking or bicycling.	20	6.5%	23.5%
7	General lack of interest	20	6.5%	23.5%
8	No public transport services are nearby.	18	5.8%	21.2%
9	Lack/insufficient water features and fountains	18	5.8%	21.2%
10	Poor maintenance.	14	4.5%	16.5%
11	No one to go with.	13	4.2%	15.3%
12	Don't have enough information about the walkway	13	4.2%	15.3%
13	Lack of shops and stores nearby the linear park.	10	3.2%	11.8%
14	The quality of available public transport is poor.	9	2.9%	10.6%

15	There is no dedicated bicycle lane.	8	2.6%	9.4%
16	Other.	8	2.6%	9.4%
17	I have multiple destinations.	7	2.3%	8.2%
18	Lack of information signs	7	2.3%	8.2%
19	I have children 0-8 years of age.	6	1.9%	7.1%
20	I have medical conditions that prevent me from walking or bicycling.	3	1.0%	3.5%
21	Walking or bicycling consumes a lot of time and energy compared to using a car.	2	0.6%	2.4%
22	Afraid of crime along the walkway	2	0.6%	2.4%

Not all walkways/LPs are created or maintained equally, and that was reflected in the preference of 28.5% out of all the 357 participants to visit distant walkways/LPs (mostly Al Corniche parks) rather than or more often than the one nearest to their home addresses (see tables 7-5 and 7-6). Indeed, 45% of 89 non-users of local LPs and 23% of 268 users of local LPs visited distant walkways more frequently than their local ones. This trend was particularly pronounced for participants with Al-Samer and Al-Safa walkways as nearest to their home addresses (63% and 65%, respectively). Based on FOs, the lack of facilities and amenities may have contributed to such an outcome (see Figure 7-8), especially since the thematic analysis of the questionnaire's open-ended questions highlighted their importance (See Table 7-7[19]). Lastly, 29% of the 89 non-users of the PNLPs from their home addresses do not even use distant LPs, which suggests the inclusion of dimensions beyond site or context-related issues such as social or individual determinants (e.g., lack of interest or busyness). To conclude, participants' preference to visit distant walkways/LPs (mostly Al Corniche parks) rather than the one nearest to their home addresses reflect the former's more appealing characteristics and provision of facilities and amenities.

Table 7-5. Crosstabulation between Jeddah's walkways/LPs and various characteristics of participants who never visited the LP they perceived as the nearest to their home addresses.

Walkways/LP Name*	**Total N**	**%**	**C1**	**%**	**C2**	**%**	**C3**	**%**	**MD**	**%**	**C4**	**%**
Northern Corniche walkway	18	5%	1	6%	0	0%	1	100%	0	0%	4	10%
Jeddah waterfront walkway	52	15%	5	10%	1	20%	1	20%	3	60%	17	43%
Middle Corniche Park	22	6%	3	14%	1	33%	1	33%	1	33%	N/A	N/A
Al Shatee Garden Walkway	4	1%	2	50%	MD	N/A	MD	N/A	2	100%	N/A	N/A
Pr. Faisal bin Fahad St. walkway	12	3%	5	42%	1	20%	4	80%	0	0%	7	18%
Taibah Walkway	14	4%	8	57%	5	63%	1	13%	2	25%	N/A	N/A
Al Yamamah Walkway	22	6%	3	14%	2	67%	MD	N/A	1	33%	N/A	N/A
Al Samer walkway	16	4%	10	63%	5	50%	2	20%	3	30%	N/A	N/A
Prince Al Fawaz district walkway	22	6%	8	36%	7	88%	1	13%	0	0%	N/A	N/A

[19] Table 7-7 combined of two tables that explain users and non-users' reasons for visiting distant LPs more often/rather than the one nearest to their home addresses. Since both yielded similar results, they were combined to increase certainty of results (via increased number of responses).

Zahrt Al Waha walkway	1	0%	0	0%	0	N/A	0	N/A	0	N/A	N/A	N/A
Al Safa walkway	20	6%	13	65%	9	69%	1	8%	3	23%	1	3%
Al Safa 2 walkway	12	3%	2	17%	2	100%	0	0%	0	0%	N/A	N/A
Al Nakheel walkway	6	2%	0	0%	0	N/A	0	N/A	0	N/A	N/A	N/A
Al Nakheel 2 walkway	3	1%	0	0%	0	N/A	0	N/A	0	N/A	N/A	N/A
Al Jamiaa walkway	46	13%	12	26%	4	33%	7	58%	1	8%	N/A	N/A
Al Waha walkway	1	0%	0	0%	0	N/A	0	N/A	0	N/A	1	3%
Al Faisalia walkway	6	2%	1	17%	0	0%	1	100%	0	0%	1	3%
Al Rehab walkway	35	10%	8	23%	2	25%	3	38%	3	38%	2	5%
Al Rawdah walkway	28	8%	4	14%	MD	N/A	2	50%	2	50%	3	8%
Other	17	5%	4	24%	1	25%	1	25%	2	50%	4	10%
Total	357	100%	89	25%	40	45%	26	29%	23	26%	40	100%

* Unlisted walkways/LPs mean none of the questionnaire participants selected them as a preference (i.e., zero responses were received). C: Condition. C1: % of non-users, C2: Never visited but visit/use distant LPs from participants' home addresses, C3: Never visited and do not visit/use other walkways/LPs in Jeddah city, and C4: Non-users' most visited walkways/LPs instead of the ones closest to their home address. MD: Missing Data means that the respondent did not complete answering the questionnaire; however, their response was recorded. Highlighted are notable results.

Table 7-6. Crosstabulation between Jeddah's walkways/LPs and various characteristics of participants who visited/used (at various rates) the ones they perceived as the nearest to their home addresses.

Walkway/Linear Park Name*	**Total N**	**%**	**C1**	**%**	**C2**	**%**	**C3**	**%**	**MD**	**%**	**C4**	**%**
Northern Corniche walkway	18	5%	17	94%	17	100%	0	0%	0	0%	13	21%
Jeddah waterfront walkway	52	15%	47	90%	41	87.2%	5	10.6%	1	2.1%	29	48%
Middle Corniche Park	22	6%	19	86%	12	63.2%	7	36.8%	0	0%	3	5%
Al Shatee Garden Walkway	4	1%	2	50%	1	50.0%	1	50%	0	0%	1	2%
Pr. Faisal bin Fahad St. walkway	12	3%	7	58%	7	100%	0	0%	0	0%	1	2%
Taibah Walkway	14	4%	6	43%	5	83.3%	1	16.7%	0	0%	0	0%
Al Yamamah Walkway	22	6%	19	86%	15	78.9%	4	21.1%	0	0%	0	0%
Al Samer walkway	16	4%	6	38%	3	50%	3	50%	0	0%	0	0%
Prince Al Fawaz district walkway	22	6%	14	64%	7	50%	7	50%	0	0%	0	0%
Zahrt Al Waha walkway	1	0%	1	100%	1	100%	0	0%	0	0%	0	0%
Al Safa walkway	20	6%	7	35%	5	71.4%	2	28.6%	0	0%	0	0%
Al Safa 2 walkway	12	3%	10	83%	6	60.0%	4	40%	0	0%	0	0%
Al Nakheel walkway	6	2%	6	100%	6	100%	0	0%	0	0%	1	2%
Al Nakheel 2 walkway	3	1%	3	100%	2	66.7%	1	33.3%	0	0%	0	0%
Al Jamiaa walkway	46	13%	34	74%	20	58.8%	13	38.2%	1	2.9%	1	2%
Al Waha walkway	1	0%	1	100%	1	100%	0	0%	0	0%	0	0%
Al Faisalia walkway	6	2%	5	83%	2	40.0%	3	60%	0	0%	0	0%
Al Rehab walkway	35	10%	27	77%	23	85.2%	4	14.8%	0	0%	2	3%
Al Shabab lake walkway	0	0%	0	0%	0	0%	0	0%	0	0%	1	2%
Al Rawdah walkway	28	8%	24	86%	19	79.2%	5	20.8%	0	0%	2	3%

Other. Please specify.	17	5%	13	76%	11	84.6%	2	15.4%	0	0%	7	11%
Total	357	100%	268	75%	204	76.1%	62	23.1%	2	0.7%	61	100%

* Unlisted walkways/LPs mean none of the questionnaire participants selected them as a preference (i.e., zero responses were received). C: Condition. C1: % of users (at various rates), C2: % of users who do not use other walkways/LPs more often than the one nearest to their home address, C3: % of users who visit other walkways/LPs more often than the one nearest to their home address (from total N), and C4: distant walkways/LPs users' most preferred walkways/LPs. MD: Missing Data means that a respondent did not complete answering the questionnaire; however, their response was recorded.

Figure 7-8. Images showing how Al-Samer and Al-Safa walkways lack site amenities.

Table 7-7. Questionnaire participants' reasons for preferring distant walkways/LPs (primarily Al Corniche parks) over the ones nearest to their home addresses (n=102).

Theme	Participants' input (sub-themes)	Frequency
Facilities and amenities	Availability of hotels, shops, cafes, restaurants, and food stalls (refer to services).	21
	Being vegetated or more vegetated (palms, trees, grass areas, etc.)	13
	"Because I can go biking there" or availability of bicycle rentals	8
	Availability of bathrooms	7
	Availability of bicycle lanes	5
	Availability of parking spaces	2
	Availability of better children's playgrounds	2
	Presence of High-rise buildings	1
	Water recreation and sunbathing	1
	Availability of rubber pavements	1
	Availability of seating areas	1
	Total	62
Comfort	The general atmosphere is beautiful regarding the variety of cultures, businesses, and activities.	4
	Quite or relaxing atmosphere	3
	The waterfront is a relaxing space and a more social	2
	Family fun	2
	An open environment {refer to the waterfront park)	2
	Loud noises due to the proximity of Al-Taibah walkway to health clinics and the passing of frequent trucks	2
	It's more convenient or comfortable	2
	"because it is lively and inviting. I enjoy seeing others exercise, ride their bikes or just brisk walk."	1
	The place is set for walking	1
	Total	19
Preferences	Availability of companions or where my friends and family meet	6
	The purpose is to practice sports by walking, jogging, or running.	3

	Presence of human movement at all times	2
	Change of scenery	2
	Due to my frequent visits there (Jeddah Waterfront Park)	2
	I prefer trees more than palms	2
	The waterfront does not have illegal street vendors	1
	It meets my required walking distance	1
	Due to crowdedness during weekends	1
	To stroll and walk while shopping	1
	Outside Jeddah city	1
	The walkway length is suitable for an hour's walking cycle	1
	Less crowded	1
	"I play Pokémon there; it is better than my nearest walkway."	1
	I prefer the Arab Mall's upper floor since it is hot and humid outdoors	1
	Because of the community there {refer to the waterfront}	1
	Because the walkway has more privacy {refer to Al-Eskan}	1
	Total	28
Accessibility and connectivity	Proximity to the city's main arterial roads	1
	Because it is close to the gym (Fitness Time)	1
	I walk in my residential district, specifically around a mall, since no walkways are nearby.	1
	Because it is closer to my place of work	1
	There is no walkway near my home address	1
	Ability to enter the Aramco Park, which is next to it; I have an Aramco Card	1
	Availability of pedestrian crossings at frequent intervals connecting the restaurants, hotels, and many activities located in the west to the waterfront located in the west.	1
	Total	7
Red Sea or Beach	Proximity to the Red Sea or beach (a positive attribute)	24
	The geography and nature of the walkway in terms of the landscape and views.	10
	A sea breeze or fresh air	4
	Total	38
Design and physical characteristics	The walkway has a longer length	4
	Because it is bigger	4
	Dimmer lighting or not annoying	3
	Availability of multiple paths	1
	The waterfront has a modern design	1
	Total	13
Maintenance	The waterfront is cleaner and more luxurious	5
	"Well talking care of" {refer to the waterfront park}	2
	It is organised	1
	Total	8
Sense of safety	The Security guards are everywhere, so it's safer, and if something happens, there are security cameras	2
	The people there are not annoying, and if they're annoying, I can get along with them; the police are there {refer to the waterfront}	2
	The safety rate is very high or higher	1
	Total	5

Note: codes highlighted in light yellow had ≥ 3 frequencies.

A further extrapolation of results (i.e., Tables 7-5 to 7-7) indicates that the current availability, characteristics, and conditions of Jeddah's walkways/LPs contribute to automobile traffic congestion. In other words, since high-quality walkways/LPs are unavailable to all residents within walking distance, many residents use cars to travel to those that are more attractive, such as Al Corniche. This was highlighted by the manager at Metro Jeddah Company, who criticised development approaches of public parks since they are generating more vehicle traffic on the road,

"Al Amana [referring to Jeddah Municipality] is concentrating on some public areas and specific areas that are really well maintained, but sometimes or most of the time, it's far away from everybody's house. So for you to get into a reasonable Park or go to the Corniche, you need to use your car." (E3, 2020).

These factors influence residents' preferences, visiting a distant but generally better walkway/LP (from their view) than the ones nearest to their home addresses.

As shown from emergent themes that aggregate common topics and views from participants' responses in Table 7-7, facilities and amenities (e.g., vegetation, public toilets, bicycle rentals, and more) are not the only incentives to visit distant walkways/LPs (mostly Al Corniche parks). The sense of comfort expressed via relief, calmness, and enjoyment of the beautiful atmosphere, from sea views, breeze, and being at the waterfront, is a major incentive. Furthermore, Al Corniche Parks, specifically the Jeddah Waterfront Walkway (JWW), provides 4.5 km of uninterrupted pedestrian and bicycle routes by vehicle traffic and driveways, which is an unrivalled city-wide feature. In addition to the waterfront parks' maintenance quality, the thematic analysis results suggest that their family and friends' choices influence questionnaire participants' preferences. The 2017 redevelopments of Jeddah's Corniche parks transformed them into a beloved recreational destination locally and nationally. The interviewed leader of Al Masafat group explained why and how it is fostering the use of bicycles in Jeddah City,

"All our members […] compliment the Jeddah Waterfront Walkway for many reasons. Being close to the Red Sea, availability of green open spaces and the provision of dedicated pedestrian and bicycle lanes[…] it is a role model that should be replicated […] Nowadays, many people started to walk, and bicycles are in abundance. Previously, you would only see two to three pedestrians and no bicycles. Now, it is non-stop and sometimes in large groups." (L4, 2020)

Therefore, bicycling in JWW has become an attractive recreational activity, which is reinforced as a culturally desirable location as more people participate.

FOs showed that JWW's bicycle lanes are crowded daily, suggesting a high demand for similar projects. The interviewed manager at Jeddah Municipality said,

"We are noticing a considerable turnout for the use of bicycles, especially in Al Corniche, which is an indicator. Another indicator is the number of rental bicycle shops that recently opened. Today, bicycle shops target professionals as their main consumer group, and those shops are experiencing substantial turnout." (E4, 2020)

The pleasure of seeing physically active people and the presence of social groups that promote healthy lifestyles in Jeddah's Waterfront Parks created an attractive atmosphere that influences people's preferences (further discussed in Section 7.6). These attractive qualities were found, via the thematic analysis of the questionnaire's open-ended questions, to influence participants' preference to visit distant walkways/LPs rather than the one nearest to their home addresses. The last notable mention from the results presented in Table 7-7 pertains to the crowdedness as well as light and noise pollution, which were all mentioned as inconveniences (see Section 6.1.1 for additional insights about lighting). However, more research is needed to measure the size and extent of those issues, especially since FOs revealed that the degree of those issues varied among Jeddah's walkways/LPs. Despite such variance, they influenced participants' preferences, as stated by the questionnaire and interview participants. Furthermore, according to interviewee E7, noise sources from children's toy cars/scooters (car-like horns!), food trucks' gasoline or diesel engines, surrounding road traffic, and more *"affect the quietness and tranquillity of these gardens, which some users required"* (E7, 2020). There appear, therefore, to be diverging responses to these activities, with some users finding the busyness of the site attractive and indicative of social value, and others repelled. Thus, these behavioural issues are further discussed in Sections 7.4 and 7.5.

7.2.1. Gender and distance as factors that influence visitation/use frequencies

A generalised linear model (GLM) (logistic regression) was used to investigate whether gender and distance from home (proximity) were associated with questionnaire participants' usage frequency of the perceived nearest linear park (PNLP) from their home addresses (see Table 7-8). Since gender partially influences the design characteristics, usage, perception, and regulation of public open spaces in Saudi cities (see Section 2.3), the GLM aimed to determine whether females are more affected by distance than males in Jeddah. Including other sociodemographic factors in the model was not possible because of high instances of missing data for variables such as employment status and household income due to participants preferring not to disclose these. Nonetheless, separate Chi-square tests for each sociodemographic factor were conducted to independently assess their influence on visitation frequencies (presented later in this Section).

Table 7-8. Categorical variable information shows the factors and the variables included in the analysis.

			N	Percent
Dependent Variable	Visitation Frequencies	Never visited	61	24.8%
		Once every few months	71	28.9%
		Once a month	40	16.3%
		Once a week	38	15.4%
		A few times a week or every day	36	14.6%
		Total	246	100.0%
Factor	Gender	Male	157	63.8%
		Female	89	36.2%

		Total	246	100.0%
	Distance from home (proximity)	< 500 m	21	8.5%
		Between 0.5 and 1 km	31	12.6%
		Between 1 and 2 km	38	15.4%
		Between 2 and 5 km	55	22.4%
		> 5km	101	41.1%
		Total	246	100.0%

Before the model could be developed, statistical assumptions were checked. The Goodness of fit table showed that the deviance test [$\chi^2(31)=32.968$, $p=1.063$] and the Pearson chi-square test [$\chi^2(31)=29.992$, $p=0.967$] were both non-significant (see Table 7-9), suggesting a good model fit. In addition, the Omnibus Test indicate that there is a significant improvement in the fit of the Final model over the null model [$\chi^2(5)=23.65$, $p<.001$]. Lastly, the Likelihood Ratio Chi-Square tests show that both gender [$\chi^2(1)= 7.098$, $p=0.008$] and distance from home (proximity) [$\chi^2(4)= 16.383$, $p=0.003$] factors have statistically significant results. These results suggest that the GLM (logistic regression) test assumptions were satisfied.

Gender was one of the significant positive predictors that influenced the visitation/use frequency of the PNLP from participants' home addresses (p=0.008) (see Table 7-9). Since gender was measured as a binary variable, the slope represents the difference in log-odds between males and females. The model indicates, therefore, that, for men, the odds of higher visitation/use rate of PNLPs from participants' home addresses are 1.9 times greater than for women. Thus, males were found to visit PNLPs from their home addresses more frequently than females.

Table 7-9. The results of the generalised linear model (ordinal logistic) show the regression coefficients, Wald Chi-Square tests, and odds ratios.

Parameters		B	Std. Error	95% Wald Confidence Interval		Hypothesis Test			Exp(B)	95% Wald Confidence Interval for Exp(B)	
				Lower	Upper	Wald Chi-Square	df	Sig.		Lower	Upper
Threshold	Never visited/used	-0.567	0.2455	-1.048	-0.086	5.336	1	0.021	0.567	0.351	0.918
	Once every few months	0.778	0.2473	0.294	1.263	9.904	1	0.002	2.178	1.341	3.536
	Once a month	1.524	0.2606	1.013	2.035	34.182	1	0.000	4.589	2.754	7.649
	Once a week	2.492	0.2919	1.920	3.064	72.910	1	0.000	12.089	6.823	21.421
Gender: Male		0.642	0.2424	0.167	1.117	7.007	1	0.008	1.900	1.181	3.055
Gender: Females		0[a]							1		
Distance: < 500 m		1.158	0.4290	0.317	1.999	7.288	1	0.007	3.184	1.373	7.380
Distance: Between 0.5 and 1 km		0.889	0.3674	0.169	1.610	5.859	1	0.016	2.434	1.184	5.000
Distance: Between 1 and 2 km		0.379	0.3388	-0.285	1.043	1.251	1	0.263	1.461	0.752	2.838
Distance: Between 2 and 5 km		-0.316	0.3062	-0.916	0.284	1.066	1	0.302	0.729	0.400	1.328
Distance: More than 5 km		0[a]							1		
(Scale)		1[b]									
Dependent Variable: Visitation Frequencies. Model: (Threshold): Gender and Distance from home.											

a. Set to zero because this parameter is redundant.
b. Fixed at the displayed value.

An additional chi-squared test was carried out to identify which visitation frequency category was responsible for driving the differences observed between males and females. Using a post-hoc test, specifically the Holm–Bonferroni method (see Table 7-10), the differences in visitation frequency between men and women are due to the 'never visited' category (adj residuals= +/- 2.7, P-value= 0.0061). Such an outcome suggests that the reported non-use reasons in Table 7-4, such as proximity, accessibility, weather, and availability of public toilets, affect women’s visitation frequencies to Jeddah’s walkways/LPs more than men. Aside from such observations, there were no significant differences in the distributions of visitation frequencies between men and women (see Figure 7-9).

Table 7-10. Statistical tests for multiple factors to determine their relationship with participants’ visitation frequencies.

No.	**Non-parametric test**						**Post hoc**			
	Factors	**Test type**	**Result**	**df**	**N**	**Asymptotic Sig. (2-sided) - P-value**	**groups in question**	**Adjusted residual +/-2**	**Calculated P-value**	**Adjusted Sig. levels via Holm–Bonferroni method**
1	Gender	Chi-square	9.523	4	246	0.08992	Never visited	-2.7 (Males) +2.7 (Females)	0.0061	1st rank 0.0083 2nd rank = 0.01
2	Age	Chi-square	20.012	16	246	0.22	25-34 years old	3.4 (once every few months)	0.0007	1st rank = .0020 2nd rank = 0.00208
								-2.2 (Once a week)	0.0263	
3	Marital status	Chi-square	9.67	4	223	0.085	No adjusted residuals +/-2	None	N/A	N/A
4	Have children between 0-8 Y? (yes/no)	Chi-square	5.587	4	240	0.349	Once every few months	+2.3 (Males) -2.3 (Females)	0.024	1st rank 0.0083
5	Car ownership	Chi-square	1.594	4	246	0.902	No adjusted residuals +/-2	None	N/A	N/A
6	Employment status	Chi-square	Not possible due to the violation of the chi-squared assumption of having a cell expected count less than 5 (no more than 20%)				None	None	N/A	N/A
7	Total household income	Chi-square	9.04	20	209	0.982	No adjusted residuals +/-2	None	N/A	N/A
8	Years in Jeddah city	Kruskal-Wallis	4.405	4	248	0.354	N/A	N/A	N/A	N/A
9	Years living at the same address	Chi-square	17.017	16	243	0.384	5-10 years	2.4	0.016	1st rank 0.002
10	Mode of transport (walking or vehicle use)	Chi-square	7.118	3	243	0.068	No adjusted residuals +/-2	N/A	N/A	N/A

11	Distance from home	Chi-square	23.317	16	298	0.106	Less than 0.5 km (< 500 m)	-2.7 (Never visited)	0.007	1st rank = .0020
							Between 0.5 and 1 km	+2.5 (once a week)	0.011	
12	Companion preference	Chi-square	25.298	9	211	0.003*	By Myself	Once a week	0.004	1st rank = 0.0031 2nd rank = 0.0033 3rd rank = 0.0035
							With my family	Once every few months as well as Once a week	0.001 and 0.003	
							With family relatives	Once a month	0.04	
* P value <0.05										

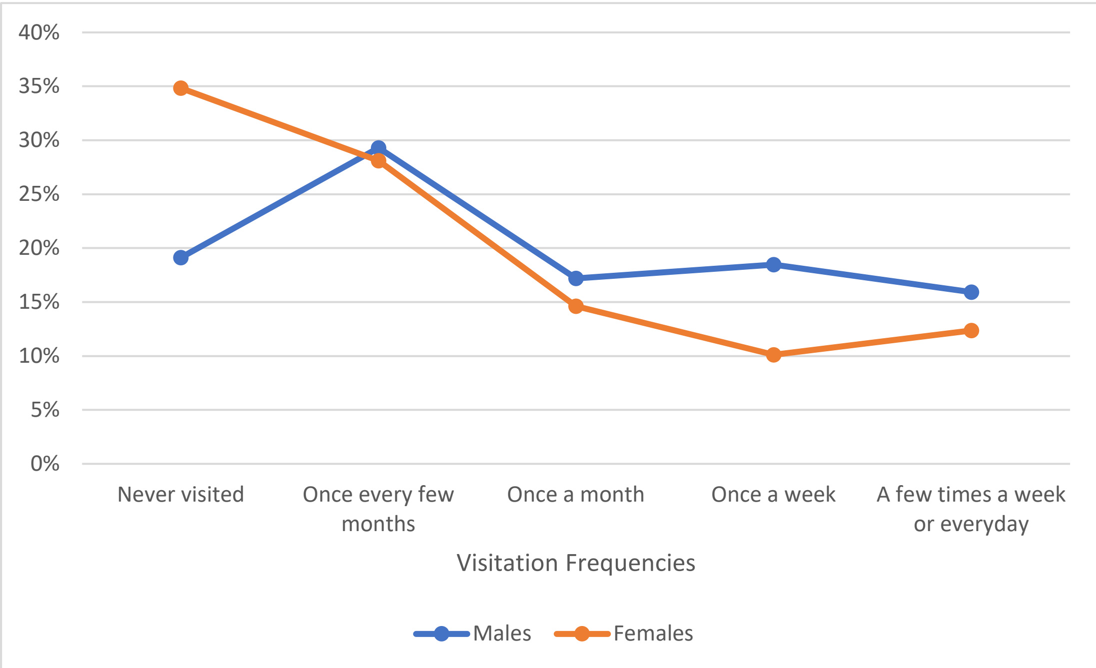


Figure 7-9. Notice how males' and females' proportions differed only in the never visited/used variable.

The distance of the PNLPs from participants' home addresses is another significant predictor influencing the visitation/use frequency, as suggested by the GLM ordinal logistic (See Table 7-9). For distances less than 1 km, the odds of higher visitation/use rate (compared to lower) to the PNLP from participants' home addresses is greater than distances > 5 km. Increasing distance did not influence the visitation frequency for LPs beyond 1 km from participants' home addresses. In short, walkways/LPs located at distances < 1 km from participants' home addresses have a significantly increased probability of higher visitation frequencies (See Figure 7-10).

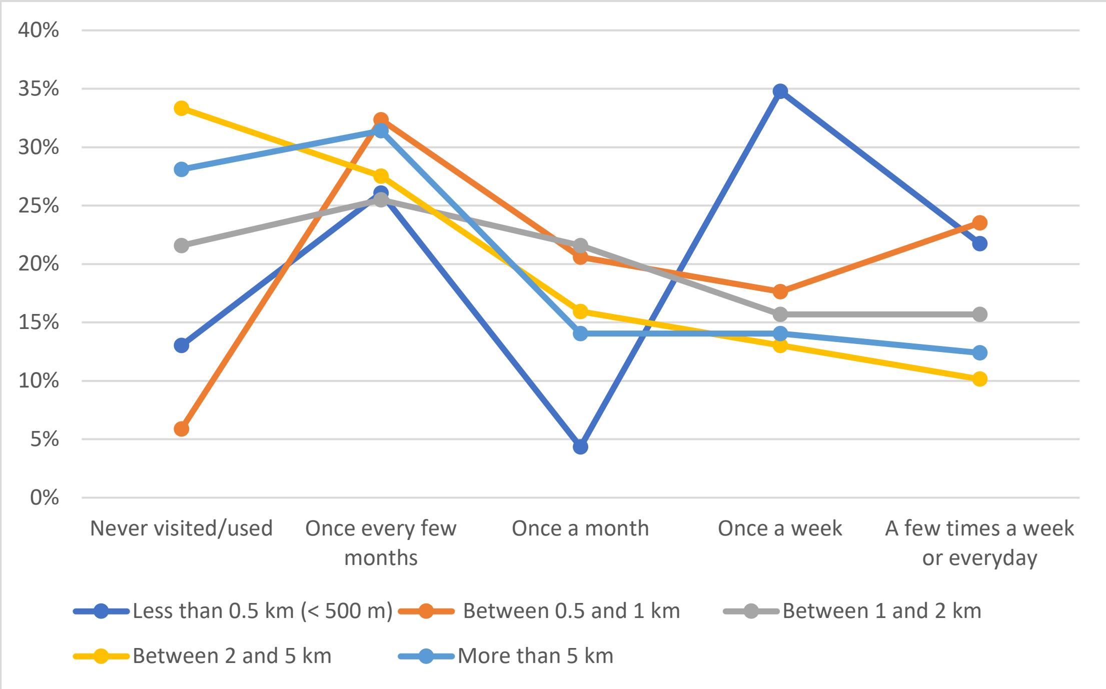


Figure 7-10. This diagram (generated from crosstabulation) illustrates a similar distribution of usage frequencies among varying distances, except distances < 1 km.

7.2.2. Companion preference influences on visitation/use frequencies of Jeddah's linear parks

Attraction is a key indicator of whether a certain walkway/LP has the qualities and features to welcome certain types of users (e.g., families) more than others. For example, Figure 7-11 shows that walkways/LPs such as Al Rawdah walkway attract unaccompanied individuals more than others[20]. At the same time, other walkways/LPs such as Jeddah Waterfront, Al-Jamiaa, and Al Yamamah walkways were found to attract families and friends more than solo visitors, especially due to their provision of playgrounds and lawn areas (confirmed via FOs). Cases such as Al-Rehab and Prince Fawaz walkways succeed in attracting both accompanied (e.g., families and friends) and unaccompanied individuals. It can be inferred, therefore, that walkways/LPs such as Al Tahlia walkway may benefit from adding site elements and programs that attract families to increase the variety of users (e.g., bicycle training sessions for kids).

[20] Many walkways/LPs were omitted from the comparison because they had responses less than 19.

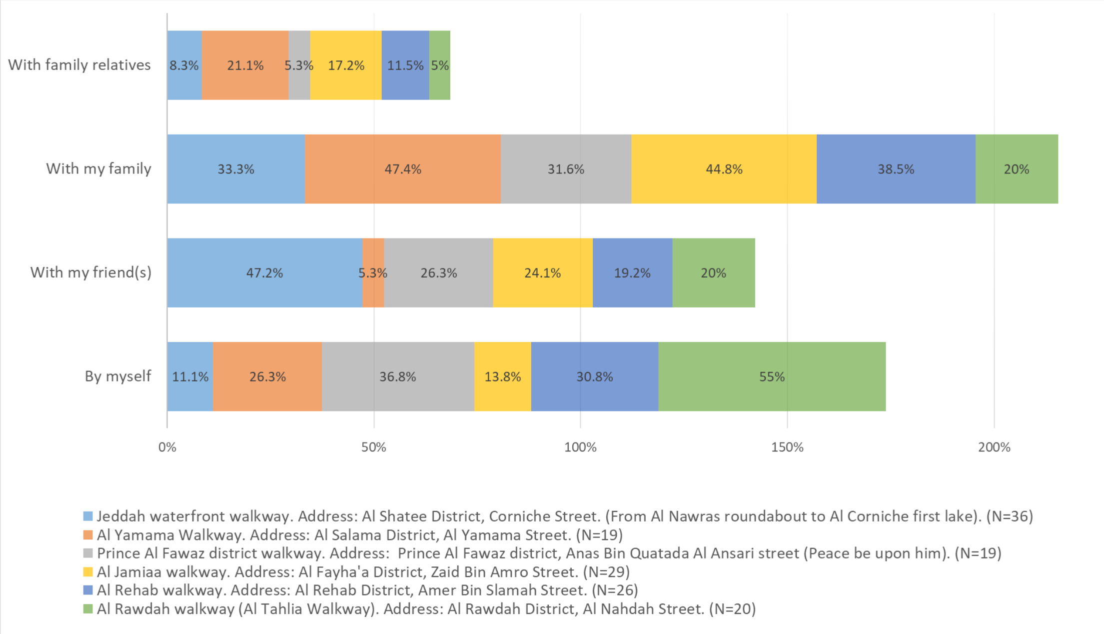


Figure 7-11. A stacked graph that compares several of Jeddah's LPs based on visitors' companion preferences.

Questionnaire results revealed that Jeddah residents visited LPs most commonly with their families (see Figures 7-12 and 7-13). A Chi-square Goodness of fit test explored whether companion type was associated with the visitation of near versus distant LPs. The X^2 test score X^2 (3, N=211) = 21.899, P-value= < 0.001, both "myself" and "with my relatives" are significantly different (see Figure 7-12). Therefore, those who prefer to visit by themselves are likely to choose the one nearest to their home addresses for physical and leisure activities[21].

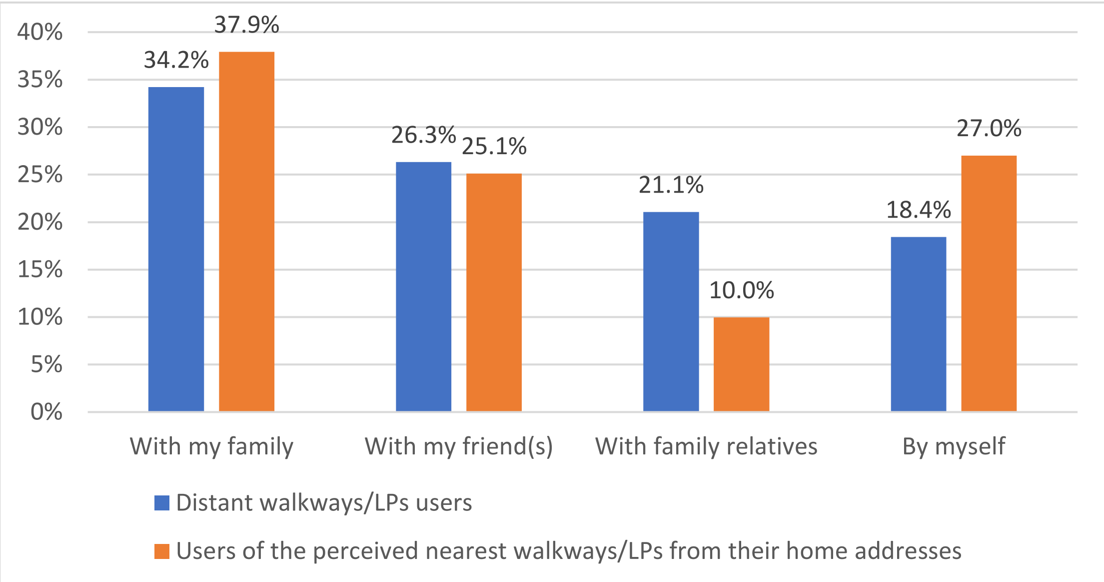


Figure 7-12. Comparison between users' companion preferences for near (n=211) and distant (N=38) walkways/LPs.

[21] There are other purposes where one might go to a walkway/LP by him/herself such as flirting or selling food/drinks, but they were not part of the usage purpose choices (see Figure 7-1).

Figure 7-13. Jeddah's LPs, especially Al Corniche parks, attract groups or multiple families (with relatives) of approximately 10-20 individuals.

Do all the companion preferences have similar visitation frequencies to the PNLPs from their home addresses? Results affirmed such association via the Chi-square test X^2 test score X^2 (9, N=211) = 25.298, P-value= 0.003. A closer examination of its crosstabulation table revealed, after applying the Holm-Bonferroni method, that users who usually visit Jeddah's walkways/LPs with their families are more likely to have infrequent visitation rates (i.e., once every few months) (see Table 7-10 and Figure 7-14). These results affirm existing views of walkways/LPs as recreational and physical activity destinations. None of the other companion preferences had statistically significant P values after applying the Holm-Bonferroni method.

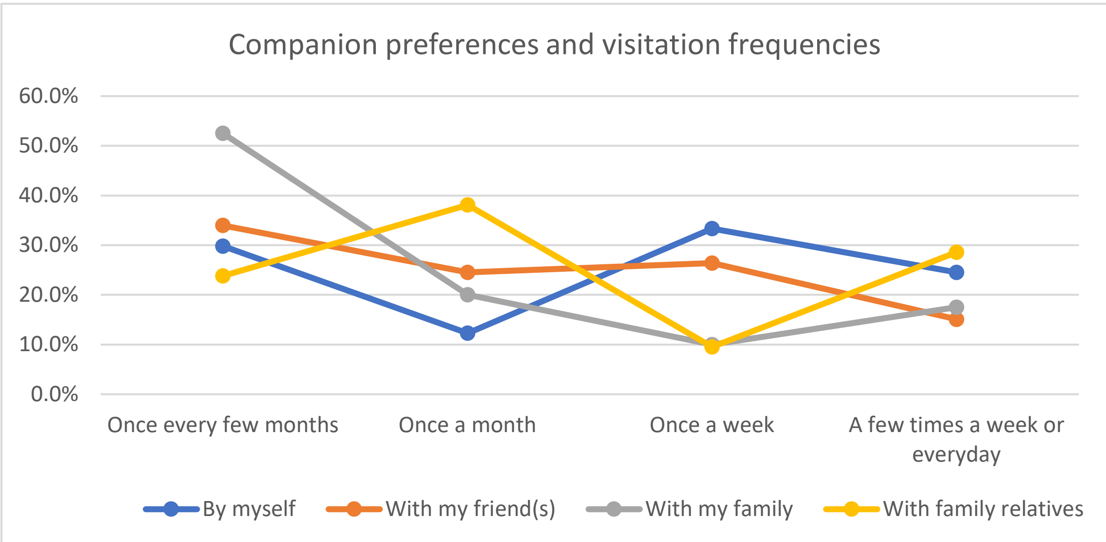


Figure 7-14. More than half of the WBQ participants who usually visit the PNLPs from their home addresses with their families do so once every few months (N=211).

Associations between LPs' visitation and other socio-demographic or lifestyle variables were found to be non-significant after performing Chi-square tests (Table 7-10). The specific variables explored included age, marital status, children ≤ 8 years old (yes/no), car ownership, employment status, total household income, number of residency years in Jeddah city, number of years living in the same address, and the used mode of transport to reach the PNLP from participants' home addresses. In other words, none of the factors mentioned above is related or associated with the visitation/use frequencies to the PNLPs from participants' home addresses.

7.3. Usage duration of linear parks

Most LPs are used between 30 minutes to an hour, and such common use behaviour affirms the health-focused use of Jeddah's LPs (See Figure 7-15). In addition, a higher percentage of visitors at walkways/LPs such as Jeddah Waterfront and Al Jamiaa walkways spent noticeably more time (> 1 hour) than other locations (see Figure 7-16). Based on FOs, the most likely factors contributing to such an outcome are the provision of greenspaces, public toilets, children's playgrounds, and food stalls. Thus, sites such as Al Rawdah and Prince Fawaz District walkways would benefit from the provision of such facilities and amenities to increase usage durations. Doing so potentially translates to more time spent outdoors, social interactions, and pedestrian traffic that supports small businesses (e.g., food truck owners).

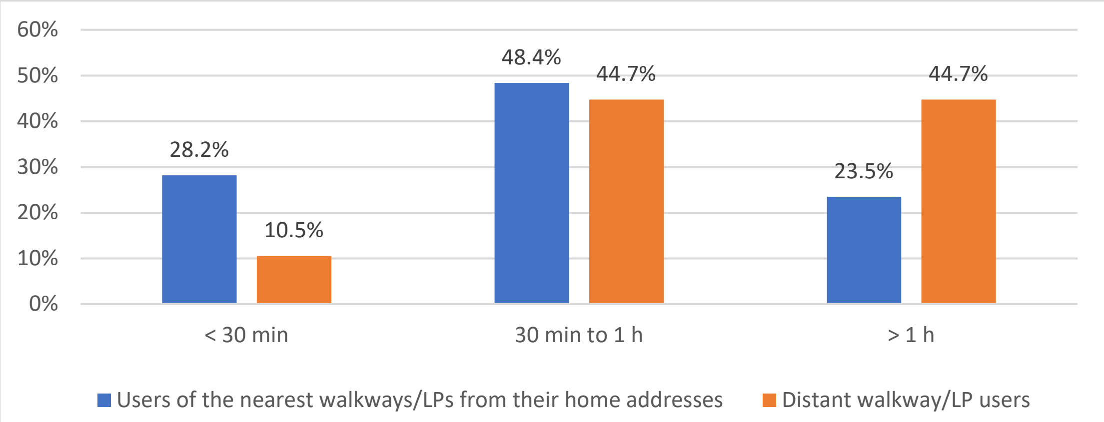


Figure 7-15. Comparison between the time spent in participants perceived nearest (N =213) and distant (N=38) walkways/LPs from their home addresses.

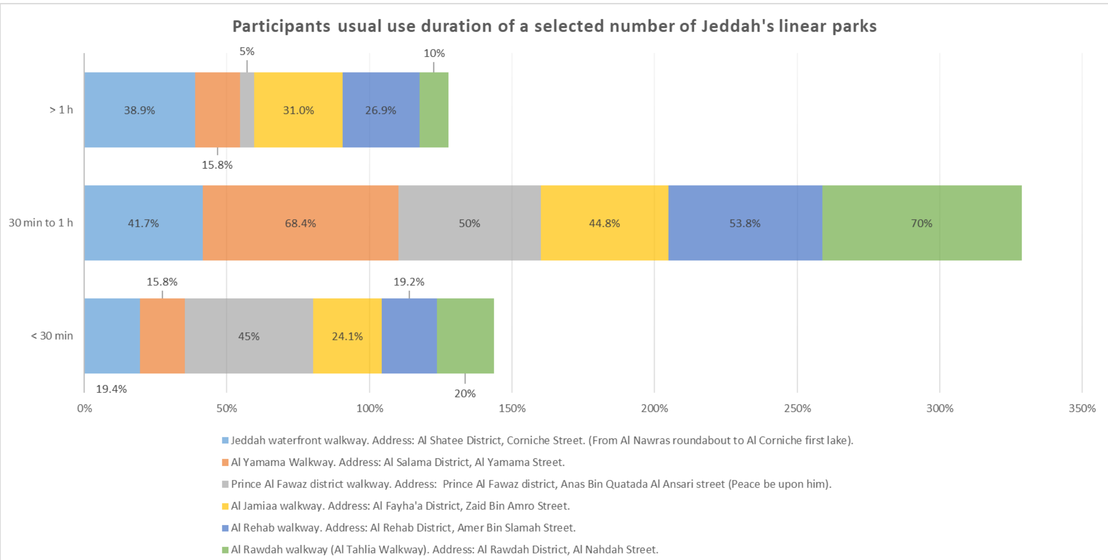


Figure 7-16. A stacked graph that compares Jeddah's LPs in terms of usage duration.

The amount of time visitors spent at different LPs differed between sites nearest to their home address and those they travelled further to visit (X^2 (2, N=213) = 85.351, P-value= <0.0001) (see Figure 7-15). Users typically spend less time (< 30) at their nearest walkway/LPs on any given visit compared to distant LPs. Indeed, visitors of distant walkways/LPs (mostly Al Corniche parks) are more likely to spend > 1 hr there (see Table 7-7 for explanations of such preference). Such an outcome supports the inference that distant walkways/LPs are sought for purposes beyond physical activity (e.g., socialisation and recreation) with the company of friends and/or family. Based on FOs, stationary activities within LPs were primarily observed in areas overlooking the Red Sea, lawn areas, sitting areas, street furniture (e.g., bollards), kiosks/food trucks, prayer areas, and near children's playgrounds (See Figures 7-17). These empirical results clarify existing usage behaviours regarding Jeddah's walkways/LPs, which partially reflect their physical characteristics, amenities, and maintenance.

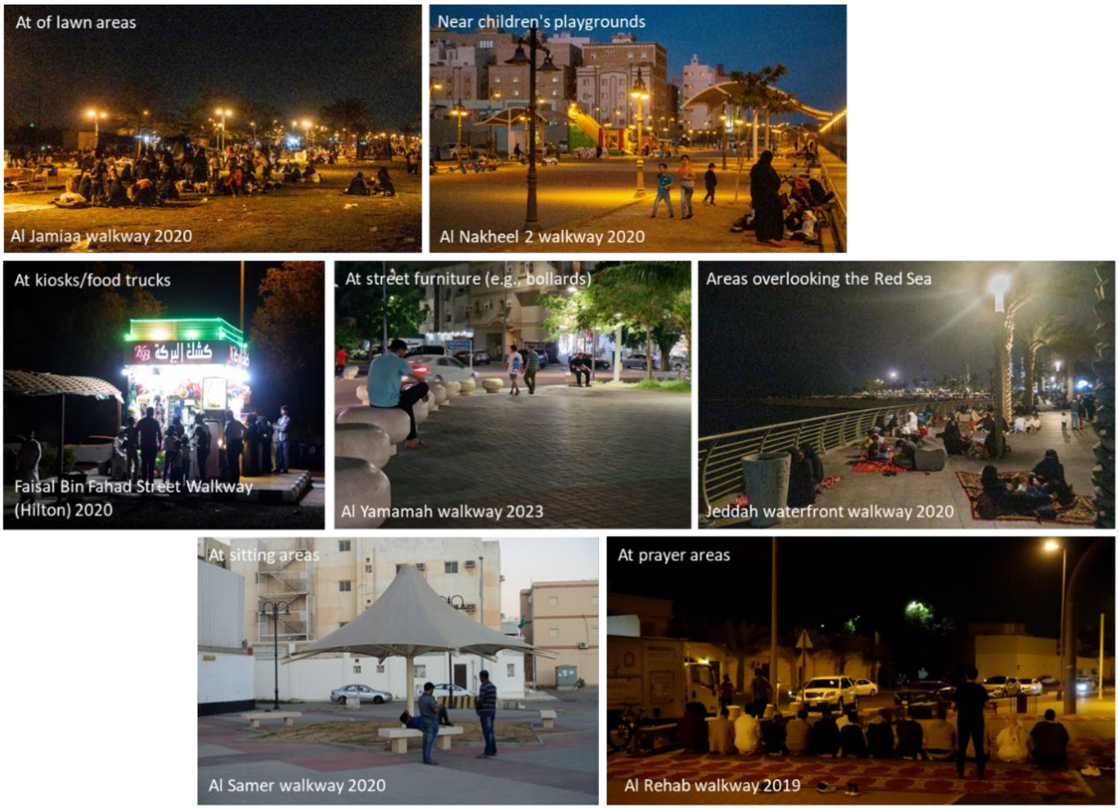


Figure 7-17. Common locations of stationary activities in Jeddah's walkways/LPs.

Further statistical analysis revealed that sociodemographic characteristics are unrelated to the use durations of the perceived linear parks from participants' home addresses (See Table 7-11). In other words, no evidence suggests that the factors listed in Table 7-11, such as gender or household income, are associated with usage durations of Jeddah's walkways/LPs, although the mode of transport to the LP was approaching significance.

Table 7-11. Statistical tests for multiple factors to determine their relationship with participants' usage duration of the PNLPs from their home addresses[22].

Factors		Test type	Result	df	N	Asymptotic Sig. (2-sided) - P-value
1	Gender	Chi-square	0.09	2	185	0.956
2	Age	Chi-square	11.009	8	185	0.201
3	Marital status	Chi-square	1.498	2	168	0.473
4	Have children ≤ 8 Y?	Chi-square	0.588	2	185	0.745
5	Car ownership	Chi-square	0.825	2	185	0.662
6	Employment status	Chi-square	Not possible due to the violation of the chi-squared assumption of having a cell expected count less than 5 (no more than 20%)			
7	Total household income	Chi-square	11.505	10	159	0.32
8	Years in Jeddah city	Kruskal-Wallis H	4.144	2	186	0.126
9	Years living at the same address	Chi-square	8.929	8	184	0.348
10	Mode of transport	Chi-square	5.062	2	208	0.08
11	Distance from home	Chi-square	10.492	8	213	0.232
12	Companion preference	Chi-square	8.129	6	211	0.229

7.4. Perceptions of safety and comfort among potential active commuters

The questionnaire participants reported potentially feeling safer as pedestrians than cyclists (X^2 4, n=240) = 61.069, P-value= <0.001; see Figure 7-18). The questionnaire participants explained numerous factors contributing to such an outcome, though many attributed automobiles' traffic speeds, congestion, and crowdedness as key concerns (see Figures 7-19 and 7-20). Nevertheless, based on FOs, the level of crowdedness varied among Jeddah's walkways/LPs. Specifically, crowdedness was observed as an issue in walkways/LPs that provide green spaces, playgrounds, bicycle rentals, and kiosks, attracting users seeking activities besides enhancing physical fitness and health. As for traffic speeds and congestion, they signify accessibility issues to/from the walkways/LPs, as explored in Chapter Six. Overall, results about the sense of safety as potential active commuters via Jeddah's walkways/LPs highlighted that crowdedness, automobile traffic speeds and congestion were key concerns.

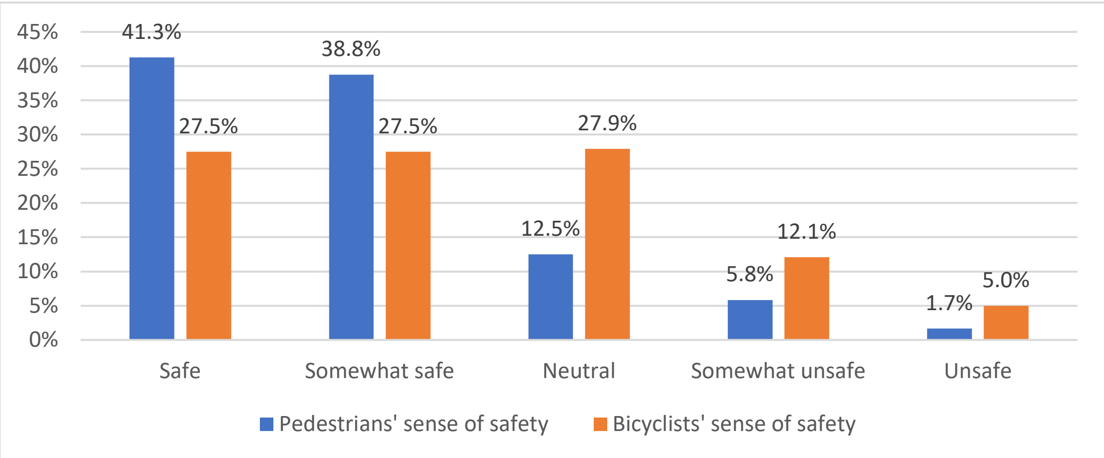


Figure 7-18. Comparison between questionnaire participants' sense of safety as potential active commuters via Jeddah's walkways/LPs (n=240).

[22] Only users of the PNLPs were considered in the statistical analyses.

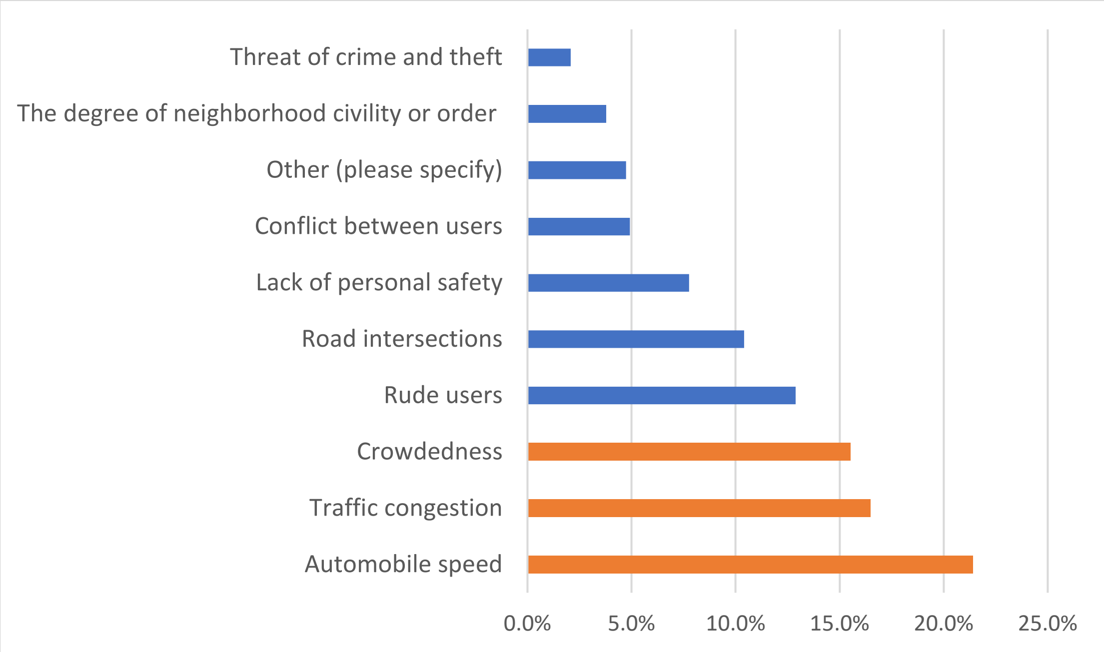


Figure 7-19. Reported factors influencing participants' sense of safety using Jeddah's walkways/LPs as ATCs (N= 240).

Figure 7-20. Adjacency to a mall in an automobile-dependent city can be a disadvantage since abutting streets are usually congested and noisy.

The following quotes are responses to the open-ended or the "other" option in questions 15 & 53 in Table 5-2, Chapter Five, Section 5.3.1.1 that highlight additional safety dimensions (i.e., harassment, harms of open drainage channels on public health):

"reckless driving and indifference towards you as a human […] since there are no bicycle lanes, bicyclists not only congest our pedestrians' paths but also harass us." (Questionnaire participant, 2020) (see Figure 7-21). A similar concern was shared by the Masafat and Jeddah Road Runners group leader: *"I avoid going there [Al Corniche] as much as possible, not even for walking or running. The unusual congestion was not anticipated. In addition, I am sorry to say this, but the incivility of young people. They go there to flirt with women, not for sports, and the same applies to women." (L4, 2020).*

"The presence of a foul odour coming from the drainage channel harms our health when inhaled, and also the floor is uneven and causes severe back and knee pain." (Questionnaire participant, 2020) (see Figure 7-22).

"Adjacency of the water drainage channel, narrow walkway, and proximity of passing vehicles." (Questionnaire participant, 2020).

Nonetheless, more research is needed to confirm the size and extent of harassment cases and the impact of Jeddah's open drainage channels on public health.

Figure 7-21. An example showing teenagers' improper usage of bicycles, which is a safety concern, as reported by several participants.

Figure 7-22. Nearly stagnant, untreated, and unfiltered water can indirectly harm walkway/LP users (or nearby residents) by becoming a breeding ground for mosquitos that can transmit diseases.

Mann-Whitney U and Kruskal Wallis H tests were performed to determine whether the sense of safety among pedestrians and bicyclists in Jeddah's walkways/LPs was related to sociodemographic factors, such as gender and age. None of the nine sociodemographic factors tested were found to be significant (see Tables 7-12 and 7-13). Any significant differences, like bicyclists' age and companion preference groups, occurred by chance (see Tables 7-14 and 7-15). This conclusion was reached after applying the Bonferroni adjustment to (P) values via SPSS.

Table 7-12. Mann-Whitney U tests to compare differences between multiple variable groups' sense of safety as potential active commuters via Jeddah's walkways/LPs on foot and using a bicycle.

Factors*	**Variables**	**N**	**Mean Rank**	**Sum of Ranks**	**Mann-Whitney U**	**Z**	**Asymp. Sig. (2-tailed)**	**Decision**
PED. Gender	Male	147	108.68	15975.50	5097.5	−0.987	0.324	Retain the null hypothesis.
	Female	75	117.03	8777.50				
	Total	222						
BIC. Gender	Male	147	112.50	16538.00	5365	−0.337	0.736	Retain the null hypothesis.
	Female	75	109.53	8215.00				
	Total	222						
PED. Marital Status	Single	62	103.85	6438.50	4194.5	−0.409	0.682361	Retain the null hypothesis.
	Married	140	100.46	14064.50				
	Total	202						
BIC. Marital Status	Single	62	96.60	5989.50	4036.5	−0.818	0.412902	Retain the null hypothesis.
	Married	140	103.67	14513.50				
	Total	202						
PED. Children <8 Y	Yes	102	110.63	11284.50	5698.5	−0.388	0.69767	Retain the null hypothesis.
	No	115	107.55	12368.50				
	Total	217						
BIC. Children <8 Y	Yes	102	112.22	11446.50	5536.5	−0.736	0.461564	Retain the null hypothesis.
	No	115	106.14	12206.50				
	Total	217						
PED. Car ownership	Yes	183	111.54	20412.50	3560.5	−0.023	0.981128	Retain the null hypothesis.
	No	39	111.29	4340.50				
	Total	222						
BIC. Car ownership	Yes	183	113.27	20728.50	3244.5	−0.920	0.35744	Retain the null hypothesis.
	No	39	103.19	4024.50				
	Total	222						
PED. Employment	Employed	141	82.99	11701.50	1690.5	−0.007	0.994026	Retain the null hypothesis.
	Unemployed	24	83.06	1993.50				
	Total	165						
BIC. Employment	Employed	141	83.83	11820.00	1575	−0.561	0.574505	Retain the null hypothesis.
	Unemployed	24	78.13	1875.00				
	Total	165						

* PED refers to pedestrians, and BIC refers to bicyclists (their sense of safety).

Table 7-13. Kruskal-Wallis H tests to compare differences between multiple variable groups' sense of safety as potential active commuters via Jeddah's walkways/LPs on foot and using a bicycle.

Categories*	**Variables**	**N**	**Mean Rank**	**Kruskal-Wallis H**	**df**	**Asymp. Sig.**	**Decision**	**Effect size (E^2R)****
PED. Age	18-24 years old	32	110.55	3.573199	4	0.467	Retain the null hypothesis	N/A
	25-34 years old	76	112.55					
	35-44 years old	62	116.74					
	45-54 years old	32	94.36					
	Above 55 years old	20	120.23					
	Total	222						
BIC. Age	18-24 years old	32	109.80	9.719116	4	0.0454	Reject the null hypothesis***	0.043978
	25-34 years old	76	98.86					
	35-44 years old	62	125.10					

	45-54 years old	32	102.19					
	Above 55 years old	20	134.98					
	Total	222						
PED. Income	Less than 6000 SAR	31	86.03	5.932383	5	0.3128	Retain the null hypothesis.	N/A
	6000 SAR to less than 10,000 SAR	38	95.54					
	10,000 SAR to less than 15,000 SAR	39	90.99					
	15,000 SAR to less than 20,000 SAR	34	113.79					
	20,000 SAR to less than 25,000 SAR	17	94.88					
	More than 25,000 SAR	31	90.87					
	Total	190						
BIC. Income	Less than 6000 SAR	31	87.11	1.759871	5	0.881272	Retain the null hypothesis.	N/A
	6000 SAR to less than 10,000 SAR	38	97.47					
	10,000 SAR to less than 15,000 SAR	39	94.35					
	15,000 SAR to less than 20,000 SAR	34	103.81					
	20,000 SAR to less than 25,000 SAR	17	97.12					
	More than 25,000 SAR	31	92.92					
	Total	190						
PED. Years in the same address	< 5 years	85	109.28	7.659763	4	0.104867	Retain the null hypothesis	N/A
	5-10 years	40	130.30					
	10-15 years	30	92.13					
	15-20 years	18	103.50					
	More than 20 years	47	110.27					
	Total	220						
BIC. Years in the same address	< 5 years	85	109.82	4.087131	4	0.394342	Retain the null hypothesis	N/A
	5-10 years	40	124.46					
	10-15 years	30	94.70					
	15-20 years	18	107.56					
	More than 20 years	47	111.06					
	Total	220						
PED. Companion preference	By myself	53	102.79	1.9196	3	0.589261	Retain the null hypothesis	N/A
	With my friend(s)	52	99.56					
	With my family	77	104.53					
	With family relatives	19	85.63					
	Total	201						
BIC. Companion preference	By myself	53	106.63	8.361016	3	0.039111	Reject the null hypothesis ***	0.041805
	With my friend(s)	52	84.71					
	With my family	77	111.21					
	With family relatives	19	88.50					
	Total	201						

* PED refers to pedestrians, and BIC refers to bicyclists (their sense of safety).
** E²R refers to the epsilon-squared estimate of effect size (King and Minium, 2009, as cited in M. Tomczak and E. Tomczak, 2014).
*** None of the pairwise tests were significant after the Bonferroni adjustment that multiplies the unadjusted p values by the number of comparisons in SPSS. Post hoc test results indicated that the observed differences occurred by chance.

Table 7-14. Pairwise Comparisons of age groups.

Sample 1-Sample 2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj. Sig. [a]
25-34 years old-45-54 years old	-3.326	13.090	-0.254	0.799	1.000
25-34 years old-18-24 years old	10.935	13.090	0.835	0.404	1.000
25-34 years old-35-44 years old	-26.243	10.631	-2.469	0.014	0.136
25-34 years old-Above 55 years old	-36.113	15.611	-2.313	0.021	0.207
45-54 years old-18-24 years old	7.609	15.530	0.490	0.624	1.000
45-54 years old-35-44 years old	22.917	13.521	1.695	0.090	0.901
45-54 years old-Above 55 years old	-32.788	17.707	-1.852	0.064	0.641
18-24 years old-35-44 years old	-15.308	13.521	-1.132	0.258	1.000

18-24 years old-Above 55 years old	-25.178	17.707	-1.422	0.155	1.000
35-44 years old-Above 55 years old	-9.870	15.974	-0.618	0.537	1.000
Each row tests the null hypothesis that the Sample 1 and Sample 2 distributions are the same. Asymptotic significances (2-sided tests) are displayed. The significance level is .05.					
a. Significance values have been adjusted by the Bonferroni correction for multiple tests.					

Table 7-15. Pairwise Comparisons of companion preferences.

Sample 1-Sample 2	**Test Statistic**	**Std. Error**	**Std. Test Statistic**	**Sig.**	**Adj. Sig.[a]**
With my friend(s)- With family relatives	-3.788	15.083	-0.251	0.802	1.000
With my friend(s)- By Myself	21.921	10.982	1.996	0.046	0.276
With my friend(s)- With my family	-26.496	10.099	-2.624	0.009	0.052
With family relatives-By myself	18.132	15.045	1.205	0.228	1.000
With family relatives-With my family	22.708	14.413	1.575	0.115	0.691
By myself-With my family	-4.576	10.042	-0.456	0.649	1.000
Each row tests the null hypothesis that the Sample 1 and Sample 2 distributions are the same. Asymptotic significances (2-sided tests) are displayed. The significance level is .05.					
a. Significance values have been adjusted by the Bonferroni correction for multiple tests.					

Several of the interviewed interest group leaders (walking and bicycle groups) linked crowdedness, users' behaviours, and age groups to conflicts among site users, which is a safety concern.

"Even though Jeddah Waterfront Walkway has a dedicated bicycle lane, it is crowded by people and other bicycle community groups. In addition, the lane is used by all people, including children, tricycles, and more. Therefore, bringing our group there would not be suitable. " (L5, 2020)

"You find joggers, music listeners, walkers, people lying down, roller skaters, and children using bicycles on top of each other, especially during peak hours. Thus, this lane is not dedicated to professional bicyclists who ride at high and comfortable speeds. You have to be extremely alert for any movement around you. In short, this lane is used by all." (L3, 2020)

"Another aspect is the unusual abundance of bicycles, which resulted in a lack of lane discipline despite the availability of a bicycle lane in each direction. Furthermore, because bicyclists ride in pedestrian lanes and vice versa, many accidents occur, which result in broken bones and injuries. One of those accidents was the death of a woman who was hit by a bicycle that fell on her head. This could have been easily avoided if there were competent security guards every 100m." (L4, 2020)

"It [referring to JWW] is delivered in high quality because there are dedicated lanes, but unfortunately, there is no lane discipline. Pedestrians use bicyclists' lanes and vice versa. Many accidents occurred because of this, including accidents with one-two years old children." (L6, 2020)

These prevailing attitudes suggest that bicycling for PA (and potentially AT) is currently unsafe in Jeddah's walkways/LPs, especially during peak hours. In brief, users' movement patterns, speeds, and perceptual, cognitive, and motor abilities vary due to the variety of user types, visitation intents, and age groups (see Figure 7-23).

Figure 7-23. Based on FOs, there is a lack of lane discipline in locations that offer dedicated bicycle lanes, such as the exhibited case study.

Based on FOs, contributing to the conflict among walkways/LPs' visitors is the usage of children's toy cars/scooters (battery operated), which hawkers mostly offer as short rentals (see Figure 7-24).

"I hope for increased scrutiny from responsible authorities about the car-ride toys available and provided by illegal labourers in walkways. They hinder pedestrian flow and generate noise." (Questionnaire Participant, 2020).

Even though using these e-scooters and children's toy cars is not limited to Jeddah's walkways/LPs, they are unregulated, especially for young children.

Figure 7-24. Based on FOs, children ride e-scooters competitively, thus increasing collision risks when used in pedestrian pathways.

With that in mind, FOs of Jeddah's walkways/LPs revealed a vast difference in the occupancy of permitted and unpermitted commercial activities. Commercial activities in Jeddah's walkways/LPs include restaurants, cafes, kiosks, food trucks, hawkers, short-term rental providers of outdoor playground equipment (e.g., Trampoline and inflated slides) as well as scooter/bicycle/e-cars for kids (for both children and adults), face painters, and privately organised activities for adults and children. According to a manager at Jeddah municipality, what differentiates permitted from unpermitted commercial activities within LPs is the procurement of licenses from the concerned authorities (depending on the type and location of business). They also mentioned that the number or percentage of commercial activities depends on:

"linear parks' length, location, urban density, potential user density, and many more […] There is no global and Saudi standard, to the best of my knowledge, that specifies the number of shops or kiosks or commercial activities based on the project type […] Ultimately, it is a ratio of fit." (E4, 2020)

Contrastingly, a former manager at Jeddah municipality believes that,

"The extent of commercial activities in walkways depends on sub-municipalities and their leader because there might be four walkways in a residential district or one. Thus, a sub-municipality leader decides the appropriate number." (E2, 2020)

However, FOs suggested that rather than commercial activities being determined by standards or municipal directives, they were associated with visitor density. Further, a positive feedback dynamic appears to be in play, whereby desirable LPs attract more people and result in more vendors and hawkers, transforming a walkway/LP into an outdoor bazaar whenever people start showing up, usually 5:00 pm onwards (see Figures 7-25 and 7-26).

Figure 7-25. Since Al Corniche parks enjoy high foot traffic daily, they are also targeted by unlicensed vendors and short-term rental service providers.

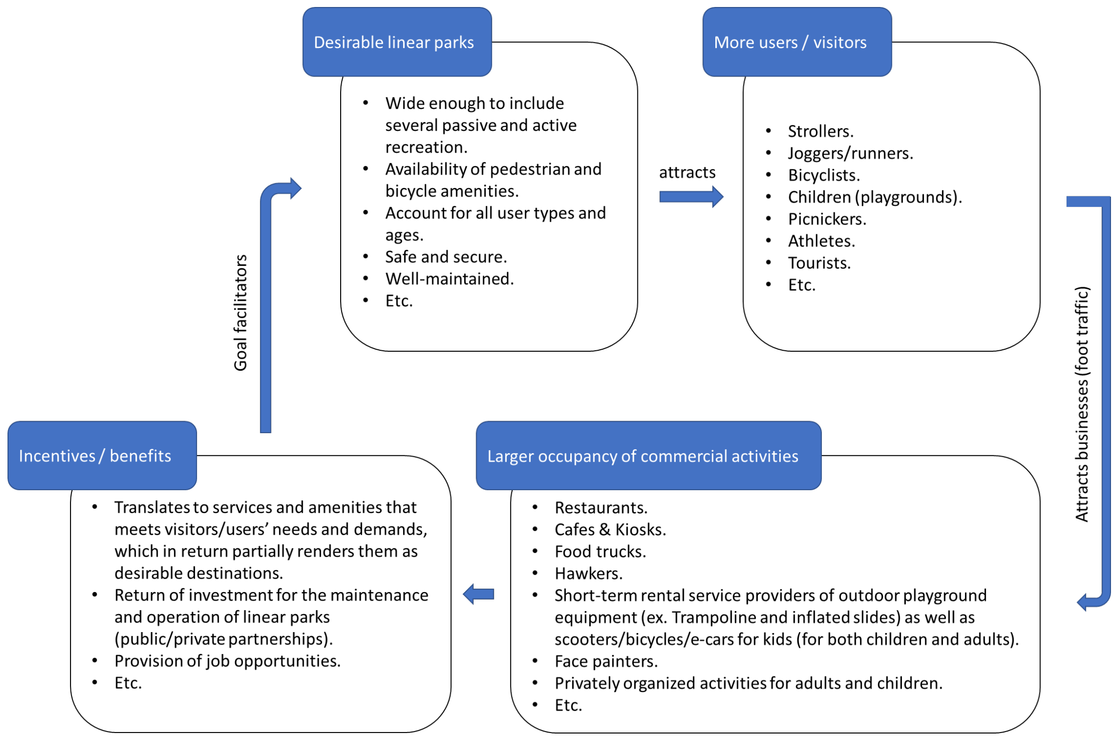


Figure 7-26. Based on FOs, a reinforcing cycle is proposed as driving the extent of commercial activities in Jeddah's walkways/LPs.

Although unlicensed vendors, hawkers, and bicycle rental service providers' goods and services respond to users'/visitors' needs, they pose safety hazards due to their mismanagement. A former landscape manager of Jeddah's LPs explained how these vendors pose safety hazards and disrupt site maintenance:

"They are using those things [gasoline generators], which are flammable, and they [rental service providers] don't have fire hydrants. There is no means to extinguish the fire in case of an accident, and the kids are there [referring to children playing inside the jumping castle]." (E5, 2020)

"They [rental service providers] stop us from irrigating the lawn. [Vendors would say] You are putting water on our things." (E5, 2020)

In addition to those concerns, public image and neighbourhood disorder are also other factors, as stressed by interviewee E1:

"One of the Vision 2030 quality of life program projects discussed the issue of organising street vendors to avoid it being an aspect that would disfigure urban image—[stressing the importance of this issue]." (E1, 2020)

Based on FOs and the interviewed experts, unlicensed vendors and short-term rental service providers, who were usually found in activity/popular zones, pose safety hazards, disrupt walkways/LPs' maintenance, cause conflicts among site users, and affect space intended functions (see Figures 7-27 to 7-29).

Figure 7-27. Unlicensed Hawkers are selling food and goods in Jeddah's walkways/LPs.

Figure 7-28. Notice how the power extensions, transformers, and e-generators used to charge those e-scooters and other unaccounted-for commercial activities conflict with the linear park maintenance (in this case, irrigation) and create a potential safety hazard for nearby children.

Figure 7-29. Hawkers offer e-scooters to young children without safety equipment and occupy considerable percentages of public spaces to practice their unlicensed commercial activities. Notice the location of the trampoline assembly, adding unaccounted uses.

Despite the issues mentioned above, many of those hawkers and street vendors are personalising parts of LPs to meet their customers' needs while also contributing to making those LPs attractive destinations (see Figures 7-30 and 7-31). Interviewee E4 (Manager at Jeddah Municipality) explained that food trucks and the like are meant to cover the maintenance and operations costs of parks and *"support the young Saudi entrepreneurs who wish to enter the job market with limited capital"* (E4, 2020). Complete prohibition would impact them financially. Thus, regulation is a necessary treatment, as recommended by all interviewed experts. To conclude, local productive families and businesses (e.g., farmers' markets), in some cases, are assets that contribute to increasing walkway/LP usage and desirability.

Figure 7-30. Cooking and selling food are prevalent commercial activities in Jeddah's LPs that enjoy high foot traffic.

Figure 7-31. Local families are selling local food and drinks while compensating for the lack of seating options, encouraging social interactions and various group sizes.

7.5. Sociocultural and individual impediments to bicycling for transportation

The questionnaire explored attitudes towards cycling as a mode of transport to reach the LP nearest to participants' home addresses. The top five factors shaping the likelihood of cycling are (I) bicycle ownership, (II) absence of bicycle lanes to/from Jeddah's LPs, (III) unavailability of bicycle share systems, (IV) unfavourable or uncomfortable weather conditions, and (V) lack of confidence in bicycling for transportation (see Figure 7-32).

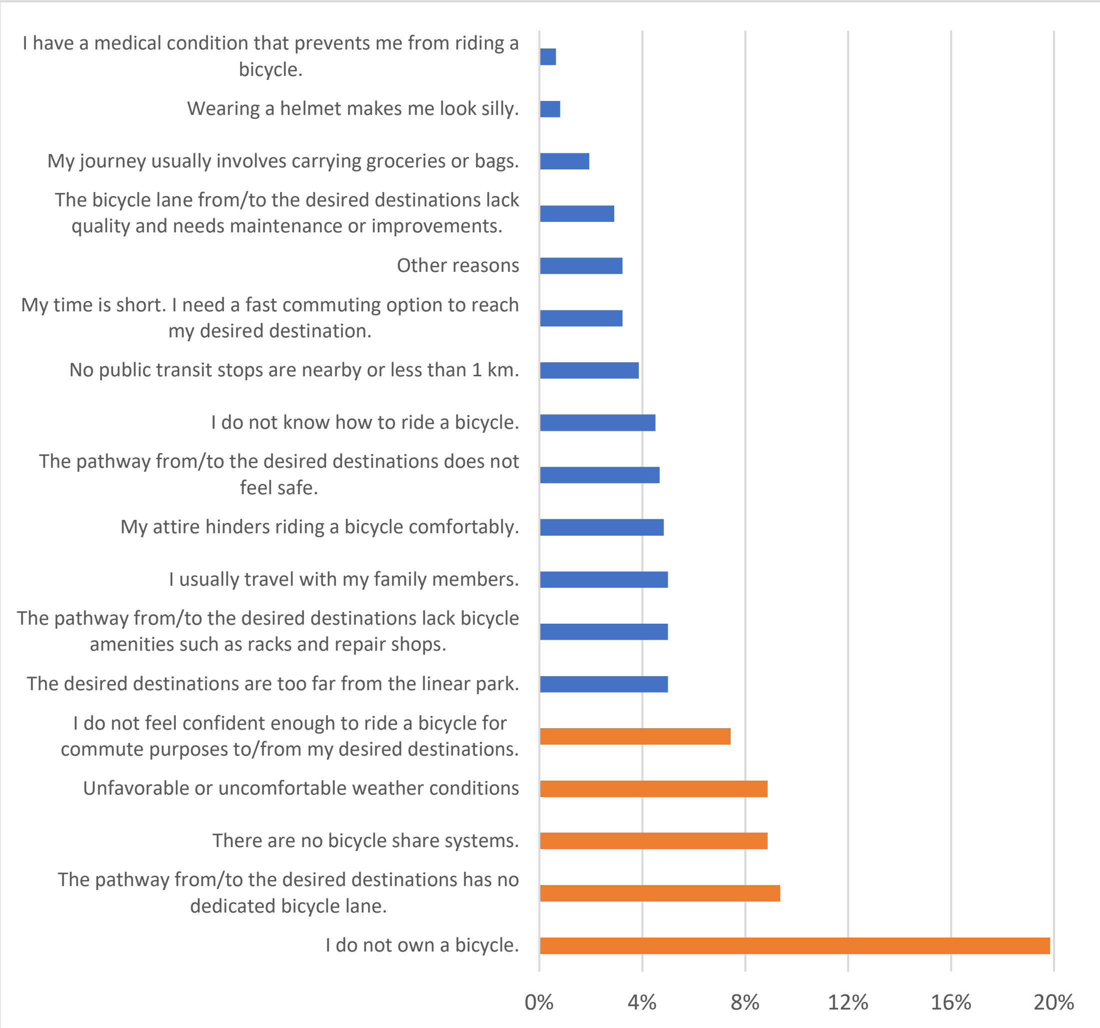


Figure 7-32. A multi-choice question inquired about participants' reasons for not using a bicycle in/from/to reach the PNLPs from their home addresses (N=211).

The questionnaire results revealed that 85% of 251 respondents never used a bicycle in/to/from the PNLPs from their home addresses. Moreover, of the 15% of participants who have used a bicycle (n = 38), half owned bicycles and half rented or borrowed them. Thus, many local cyclist groups provide them with minimal rental fees to their members. Interviewee L2 explained,

"We provide rental services. Many people find owning and bringing a bicycle to the training location difficult. Therefore, we provide those bicycles. This way, we facilitate and encourage the use of bicycles." (L2, 2020)

Several sponsors of those bicycle-focused groups also help overcome the bicycle ownership issue and advocate for the use of bicycles. Interviewee L3 said,

"There are shortcomings in spreading bicycle use culture to attract investors and supporters. However, six sponsors support us and encourage the team by providing trophies for new members and free bicycle use hours." (L3, 2020)

The lack or limited scope of bicycle share systems in Jeddah is a reported barrier by the questionnaire participants (see Figure 7-32). To them, their availability would increase the probability of cycling in/from/to the PNLPs from their home addresses. However, interviewed experts argued that their implementation in an automobile-dependent city like Jeddah is only practical as a recreational activity. They said, *"I believe it exists in Al Corniche and Al Balad [Old Jeddah] as a type of recreation, and not as a means to transport from one destination to another"* (E1, 2020).

"In the short term (about two years), I do not believe that bicycle share services will be effective because no pathways link living to workplaces and public transport stations. Thus, if they were to be effective, they would only be for recreational purposes as it is already available in several locations. However, in the mid-term, if the bus transport network is to be completed, I believe bicycle share services will have an impact since it will be beneficial." (E4, 2020)

Most of the interviewed interest group leaders attributed the lack of bicycle share services in Jeddah city to bicycle theft and vandalism. The following quote is an example that refers to the same story, confirming the details reported via several local news outlets (Fareed, 2015).

"This service is available in Jeddah city and was tendered as an investment opportunity for investors. I remember the first day we placed the bicycles in different stations, such as Corniche, Al Balad, Tahlia, and many others. They were organised, and the bicycles were clean, maintained, and supervised by technicians. I remember the following day, all the bicycles were stolen." (E2, 2020)

The unfortunate outcome was attributed to insufficient security measures, public unawareness, unfamiliarity with bicycle-share schemes, and low bicycle ownership rates. Interviewee E1 elaborated, *"Public awareness is essential in administrating these projects because there is a high probability that those bicycles would disappear in Saudi Arabia."* (E1, 2020). In addition, existing schemes require users to pay, whereas in the past, they did not. Interviewee L4 explained:

"The culture around this sport was not widespread. People disparaged the use of bicycles and bicyclists, and many did not own bicycles. Therefore, when they saw unintended bicycles on the street, why would they not take them? However, today, the success probability rate is higher compared to previous endeavours despite it being offered for free in the past. The system that was placed in the past was based on trust. A user would use an application and specify the basic information and the number of hours he intends to use the bicycle. There were no credit cards involved or security

checking. Moreover, it was not a commercial project but rather a community service. We wanted people to feel the enjoyment of riding a bicycle and practising sports. People adhered to the guidelines in the first two days, but after that, they were broken and stolen." (L4, 2020)

Therefore, trust issues and abuse of the system show how culture and behavioural norms shaped existing practices concerning bicycle share schemes in Jeddah city more than infrastructure provision. Even though there are no public records on the number of stolen bicycles in Jeddah city, based on the results of the collaboration project between Jeddah Municipality and the Saudi Investment Bank's Social Responsibility program, bicycle theft and vandalism are factors that impede the implementation of bicycle share services in Saudi cities, which are vital to the realisation of bicycling for transportation.

Lack of confidence in riding bicycles for commuting purposes is another reported barrier in Figures 7-32 as one of the top reasons for not cycling in/to/from the PNLPs from participants' home addresses. Several factors influence confidence in cycling for transportation. They include but are not limited to fear of falling or crashing, lack of experience, sense of safety, unawareness of traffic rules and regulations, and feeling tired or nauseous. In addition, based on FOs and talking to most bicycle rental shops nearby, many residents, especially women, do not know how to ride a bicycle. Thus, several residents prefer tricycles and quadricycles, especially since it allows for sharing the cycling experience with more friends/family members (See Figure 7-33). Even though educational and training programs would participate in overcoming the shared lack of confidence, it is worth noting that most interviewed leaders of bicyclist groups are operating their regular training sessions voluntarily with limited support from public and private entities.

"my partner and I are volunteering to be captains [group leaders]. We are finding it difficult to find committed captains. The training session is cancelled if my partner and I have external commitments." (L6, 2020)

In short, the confidence level is a common factor influencing the likelihood of using bicycles to reach daily destinations.

Figure 7-33. Many residents prefer tricycles and quadricycles to overcome the lack of experience riding a bicycle while simultaneously enjoying the ride with friends and family members.

Health conditions and age were also two reported deterrents for using bicycles as a mode of transport to reach Jeddah's LPs. Health is a shared goal by all the interviewed bicycle and walking/running group leaders.

"Obesity, diabetes, and high blood pressure are prevalent diseases among Saudi societies. Therefore, bicycles are just a way to encourage people to move.… it [Jeddah Cyclists group] is a response to people's needs" (L3, 2020)

The interviewed leader of Jeddah Road Runners reflected on the health state of the people he encountered, *"I have seen many people, once they reach 50 years old, they prepare for either death or sickness."* (L4, 2020). Based on the qualitative questionnaire findings, obesity had the highest reoccurrences among participants as one of the health-related deterrents to using bicycles to reach daily destinations. Still, it can be difficult for some and impossible for others due to adverse injuries and illnesses. Those patients prefer walking as a health routine. The interviewed leader at the Jeddah walkers group (Moshat Jeddah) *said, "Because once a person reaches the 40s age group, some of them begin to experience health issues. Thus, we find such individuals interested in walking. This is what drives most of them."* (L1, 2020). To conclude, while considering its link to age, individuals' health state is a factor that deters many participants from bicycling to daily destinations.

Bicycle use culture is another factor influencing AT use in Jeddah city. The interviewed leader of the Jeddah cyclists group shared how bicycle usage emerged in Jeddah city. He also explained how such ideas and social habits echoed among past generations and how they will continue reverberating in upcoming ones. During the interview, he summarised past challenges and constraints, as well as the bicycle culture's optimistic future,

"In the beginning, riding a bicycle was a solitary and recreational act where one would use it along the waterfront but never within his residential district due to fear of embarrassment [...] People believed that bicycle usage was meant only for children [...] Next, the status developed, and three to four people rode their bicycles together [...] As the numbers grew, the fear of embarrassment was broken [...] Recently, Jeddah municipality [...] created a dedicated bicycle lane in the Jeddah Waterfront walkway, which attracted large groups of people [...] women were also interested in riding bicycles, but opted to rent tricycles to ensure safety because many did not have prior experience. Then, it became a familiar scene to find a woman riding a bicycle with her child in that lane. As a result, the bicycle use culture began to grow gradually." (L3, 2020)

In short, the residents' perception of bicycle use is a factor that limits the extent of potential adopters of this mode of transport.

Another angle to the culture of bicycle use is from a religious perspective. One woman wrote in the questionnaire, "*I am uninterested in owning a bicycle because it requires exposure [referring to body parts] and contradicts Sharia's order for women to wear veil [referring to covering face and body to strangers]"*. (Questionnaire

Participant, 2020). Another participant said in the questionnaire, *"My customs, traditions, and decency prevent me from riding a bicycle in the city."* (Questionnaire Participant, 2020). The interviewed manager at Metro Jeddah Company said that the Hijab and thoub are unpractical outfits for bicycle use despite being official attires worn by most residents.

"It's still going to be unlikely due to the fact that we wear Thob and Ghutra to work. It would be completely uncomfortable to wear this when I'm biking. Women wear Abayah (عبايه) or something of a similar nature. It would be more difficult to bike unless, like I'm saying, it's a very short distance." (E3, 2020)

The level of opposition to using bicycles from a religious and practical perspective is met with contradicting opinions that do not view them as a problem.

"I thankfully wear Hijab, and I always tell women that Hijab is not a constraint. We designed and tailored a special Abayah (Hijab) for bicycle riding. So there are solutions and alternatives. We also encourage women to practice this sport." (L2, 2020)

"Nowadays, the bicycle community is being widespread strongly. Hijab is not an issue. Some trousers do not define women's bodies and cover all body parts. Some bicycles are designed not to have clothes get tangled with the bicycle. Women's groups have dedicated captains as well." (L3, 2020)

"I do not view religious reasons, fitness abilities, and budget as constraints. I believe the biggest constraints are the weather and lack of dedicated pedestrian and bicycle lanes, especially in main and expressways." (L1, 2020)

In brief, for some people, religious beliefs influence whether one would use a bicycle or not in public. These views encompass men's perceptions concerning how women should practise religion. The same contradictory perspectives apply to the formal Saudi attire's practicality for bicycle usage.

Wearing a hijab or not extends not only to individual determinants but also to public perception. For example, when the use of bicycles by women mainly attracts those who do not wear hijab, it sends a public image of bicycle usage attached to those demographic groups that might be unfavoured by other social groups. A leader at Jeddah Cyclists (a women's group) explained,

"Whenever I see someone wearing a full Hijab, I encourage her to join the training session. I want people who wear full hijab to join us to prove that bicycle riding is not a deterrent. Moreover, we can do anything while wearing the Hijab. Riding a bicycle is not contingent upon taking off the Hijab. However, the truth is that women who come to us wearing full hijab are only a few, probably due to shyness." (L6, 2020)

The interviewed Ajalat Jeddah group leader discussed the subject from a public etiquette perspective. He said,

"I have my own reservations. I do not allow women who are joining our session to not wear hijab appropriately. The culture has yet to accept women riding a bicycle. The

same applies to men. They must wear suitable outfits to go to a souq [i.e., marketplace]. Thus, I stipulate wearing outfits that do not reveal private parts. Anything long that covers the body is suitable. After all, we are entering a souq, a place both men and women occupy; you must be respectful to be respected." (L5, 2020)

In short, fear of public judgment in Jeddah city discourages many people from riding bicycles for recreation, transportation, sport, or other purposes.

Socially constructed beliefs about what is perceived as respectful behaviour in Saudi society when riding bicycles are ambiguous. As described by several questionnaires and interview participants, the social unacceptance of riding a bicycle in public spaces stems from sociocultural and personal factors. One female participant commented in the questionnaire, *"As a woman, I do not dare to ride a bicycle midst men [referring to those who are believed to be strangers to her]."* (Questionnaire Participant, 2020). Another female respondent also said,

"Perhaps it is our customs and traditions. I am a lady and a mother." And *"I do not believe that commuting via bicycles is appropriate for women."* (Questionnaire Participant, 2020)

Additionally, the public's resistance to the unfamiliar is sometimes expressed in harassment, which, as a result, deters many bicyclists from practising what they enjoy.

"The community's perception is yet to accept a man and his wife riding a bicycle. That is why we ride in groups at certain locations. There are safety precautions and control. Any harassment can be avoided from early on without developing into something big. However, two [man and women] riding a bicycle together would face issues." (L5, 2020)

"The society has yet to accept bicyclists. You know the North is different compared to the South. To us ladies, we are yet to be accepted there [south] as bicyclists. However, if we go to Al Balad, we go at sunrise." (L6, 2020)

"The community did not accept sports for women, but with time, people became more informed, aware, and engaged about sports." (L2, 2020)

Therefore, adhering to what is socially perceived as acceptable behaviour is another factor that influences the use of bicycles in public places such as LPs. Such a phenomenon is called injunctive social norms, where behaviour is influenced by what most approve or disapprove (Cialdini et al., 1991, as cited in Nyborg, 2018). These external sociocultural forces influence personal norms that shape an individual's behaviour regarding where, how, when, and with whom they should bicycle in public places.

Automobile drivers dominate Jeddah's streets. When bicyclists share those lanes, they are often harassed and disrespected (which impacts the sense of safety, as discussed in Section 7.4). The disregard of other road users, and in some cases, bullying, not only threatens the safety of bicyclists but also discourages those interested in adopting a new lifestyle revolving around using bicycles as a daily activity.

"Reckless drivers because there are no dedicated bicycle lanes except for the part where the Jeddah Waterfront Walkway is located. However, our bicycles share the road with cars for the rest of the training session. This is the biggest risk, whether from dangerous overtaking, reckless driving, indifference towards bicyclists where some drivers do not leave a safe and amble distance between themselves and us." (L3, 2020)

"There have been many bicycle accidents in the past three years. For instance, in Abu Arish [south of Saudi Arabia], ten bicyclists were killed instantly after a car crashed into them last year. In Jeddah city, a guy named Sultan Basha was also killed in a car crash five months ago. Not to mention the countless injuries that are due to traffic accidents. Generally, drivers are still disparaging and belittling bicyclists. We still hear it while we ride." (L3, 2020)

Many interest group leaders believe that these problems are attributed to the public's lack of awareness about other road users.

"Lack of awareness about bicyclists as a part of road users. In addition, harassment from some people by their motorbikes. There were also theft incidents, sometimes while riding the bicycle, where the thieves stole our mounted cell phones using their motorbikes or while parked. Fear of being a victim of theft made them insecure about any upcoming motorbikes or having our cell phones mounted on the bicycle." (L5, 2020)

"No dedicated bicycle lanes is the biggest issue. Additionally, some drivers do not respect this sport [referring to bicycle usage]. Furthermore, those drivers crossed us while riding our bicycles and threw water bottles at us. Thus, people are yet aware of this." (L2, 2020)

To summarise, road design and the general unawareness of traffic rules and regulations for cyclists are two reasons that deter the use of bicycles as a mode of transport (see Figure 7-34).

Figure 7-34. Al Madinah Road, one of Jeddah's main arterial roads, segregates residential districts and the Northern Drainage Channel. As shown, road design prioritises automobile drivers.

There is a lack of city-wide policies and regulations that specify where, how, and when bicycles should (or should not) be used on Jeddah's roads, which impedes bicycle usage for commuting purposes. Since there is a lack of bicycle infrastructure in Jeddah city, existing bicyclists frequently conflict with other road users and entities responsible for managing traffic. Interviewee L3 explained, *"We are stopped by traffic officers, who may be misinformed about using bicycles. Our training sessions are sometimes interrupted and halted by traffic police commands, preventing street access. Therefore, the problem is that there is no clear guideline about bicycle use."* (L3, 2020). The lack of communication about the codes and rules for using bicycles on Jeddah's roads often results in conflicts, damages, injuries, and, in some cases, fatalities. Adding to that conflict is the parcel and food delivery, which regularly expose neighbourhoods to outsider automobile traffic. Interviewee E4 explained, *"The advancements of purchasing methods such as Souq and Amazon considerably changed* parcel and food delivery*, the density of traffic volumes, and the exposure extent of outsider traffic into the hearts of residential districts. Thus, considering a* parcel and food delivery *strategy is important to resolve long and short-term movement in a city."* (E4, 2020). Therefore, there is a need to enable active commuters (e.g., free up road space), establish education programs, and manage automobile traffic.

Policies and regulations related to zoning systems and transport sectors directly impact where people work, learn, and play, hence, daily travel durations and distances. Interviewee E4 explained some of the existing problems, *"One of the biggest problems in Jeddah city, identified from the traffic model created in 2013, is that less than 10% of residents work in their residential district. As a result, you will find that a resident who lives north of Jeddah works in its south and vice versa. The same applies to schools. A considerable percentage of students are not studying in their designated zones."* (E4, 2020). When distances between daily destinations (e.g., home, work, school, university, and other daily destinations) are far from one another, non-motorised modes of transport are impractical without an efficient public transportation system. The same applies to using greenways as ATCs. Using them for such cases is influenced by the proximity and diversity of nearby destinations (or land-use mix) (see Section 4.4.3). Interviewee E1 asserted this aspect: "*My destination is the deciding factor whether I would be walking on the asphalt of a via a greenway."* (E1, 2020). To conclude, the lack of policies and regulations that promote the use of AT is a factor that can, directly and indirectly, influence the transportation function of greenways in Saudi cities, including Jeddah.

Finally, cheap fuel prices mean that there is little financial incentive for adopting cycling as a form of transport over automobiles. Interviewee E1 elaborated, "*Saudi Arabia is one of the leading oil-exporting countries. The use of bicycles is yet to be justified financially. In other words, we have yet to see the cost-effectiveness of using bicycles over cars.*" (E1, 2020). Two interviewed experts (i.e., E1 and E5) raised such an argument, suggesting a need to investigate the extent of such attitudes in Saudi cities. Simultaneously, more research about the cost-benefit analysis of using bicycles for daily commutes in Saudi cities is needed.

7.6. The experiences of active transportation interest groups in Jeddah's linear parks

Based on FOs, those community-led groups are distinct LP users since their activities are organised, and their attachments to one another are location-based. Moreover, interviews with six group leaders revealed that Jeddah's walkways/LPs are routes that partially enable those communities to achieve their social and health-related goals. Although past Sections incorporated responses from their leaders that explained existing conditions, this Section focuses on their experiences, opinions, and needs.

Ironically, most local walking/running and bicycle group members arrive at the starting point of their training sessions via their private cars. The following are samples of the transcribed and translated dialogues from the interest group leader interviews about the reasons behind the dependence on private automobiles:

"We come from different locations in Jeddah city…. there are no continuous walkways that enable you to walk these distances." (L1, 2020)

"Cars because we do not have dedicated bicycle lanes." (L2, 2020)

"We have a specific start time that demands everyone's presence at the same time. In addition, the home location of most members is far away to use a bicycle to reach the training starting point." (L3, 2020)

"Cars due to the lack of public transport in Jeddah city. You have no other choices besides taxies." (L4, 2020)

In short, many attributed the use of cars to reach the starting point of their regular training sessions due to distance, lack of dedicated bicycle lanes, disconnected sidewalks, insufficient public transportation coverage, and the need to have all group members arrive at a predefined schedule.

Where are those starting points, and how do they relate to Jeddah's walkways/LPs? Four of the six groups that were interviewed have a starting point within or near the Jeddah waterfront walkway (See Table 7-16). However, the concept/intent behind the activities and the availability of facilities and amenities determines the starting point for them and the other two groups.

"The selection of Al Sheraton's location as a starting point was determined 12-13 years ago, since the beginning of this group, for multiple reasons. First is the availability of parking spaces for large groups. Second, space availability allows all bicyclists to meet and give a small lecture about safety, announcements, and more. This space is also used for stretching and cardio exercises." (L3, 2020)

"We use the Jeddah Waterfront walkway, Al Yamamah, Taibah, and Al Rehab walkway. There are approximately 12 walkways in Jeddah city. However, we always use the ones within Jeddah's well-serviced urban area with toilets and parking spaces." (L1, 2020)

"*We specialised in historic Jeddah and its surrounding neighbourhoods."* (L5, 2020)

“Because it [referring to Al Jowharah stadium] is well-prepared with safety measures, no cars, availability of an ambulance, and people, there are very encouraging to practice sports.” (L2, 2020)

“Because it [referring to Jeddah Waterfront Walkway] is the location where female bicyclists are most accepted. Only a few people do not accept bicyclists and do not respect us. However, the majority respect us by allowing us to stop at entry points [referring to JWW]. Until today, it is the safest in Jeddah city. ” (L6, 2020)

As can be seen, what determines the starting point of most groups varies, but JWW succeeded, to a certain extent, in creating a socially acceptable and well-serviced environment that attracts those groups (See Figure 7-35).

Figure 7-35. Jeddah Waterfront Walkway fostered the growth and attraction of bicycle usage in Jeddah city.

However, none of the local interest groups practise or exercise exclusively within the boundaries of Jeddah’s walkways/LPs or, in many cases, within JWW. It is part of their journey due to insufficient length of walkways/LPs.

“The bicycle lane at Jeddah Waterfront walkway is no more than 20% of our journey, and the rest are on public streets.” (L3, 2020)

“There are no walkways with long distances. […] Currently, the best walkway in Jeddah that addresses the need for a lengthy pathway is the Jeddah Waterfront Walkway. If you walk there back and forth, it is about 9.5km.” (L1, 2020)

To conclude, none of Jeddah’s walkways/LPs addresses the growing demand for longer LPs that would satisfy local walking/running and bicycling groups’ training sessions (see Table 5-5 in Section 5.4 for info. about the length of Jeddah’s LPs).

Table 7-16 summarises the interviewed walking/running and bicycling groups local to Jeddah city and their training sessions. Findings revealed that the dominant age group among most groups is no younger than 20 years old, and most members of two out of six groups are older than 40. The interviewed Masafat group's leader explained why this is the case for his group,

"We cannot run because some of our members cannot run. Thus, if we run, those members would not want to be part of our team. Our team's title is the Jeddah Walkers Team, which promotes the benefits of walking, including being healthy. Those interested in running can join other groups." (L1, 2020). In addition, the mix between males and females during training sessions is limited, and the general preference is leaning toward separate groups for each gender type.

"*We never had women in our regular training sessions. However, men and women were on special, organised, and city-wide events such as the international sports day. Each walked separately. Men were at the front, and the ladies followed the same route in the back."* (L1, 2020)

"This is a ladies' group, and some people are uncomfortable being mixed with men. However, other bicycle groups have dedicated days for families. A family to our group would be a mother with her child" (L2, 2020). As for the groups' training sessions, they usually have no less than ten members per session, while groups such as Jeddah Cyclists have more than 50 members per session regularly. Collectively, their organised and structured workout schedules revealed that there are training session opportunities every day and at various locations within Jeddah city, which suggests the daily usage of some of Jeddah's LPs by those groups. Their training sessions are primarily during the evening and at least for an hour. Moreover, walkers/runners' regular travel distances are > 5 km and < 12 km, while bicyclists are at least 20 km and no more than 80 km. To conclude, location, day of the week, time of the day, gender, route distance, bicycle usage experience, and fitness abilities determine the variety of walking/running and bicycle groups' organised training sessions.

Just as these walkways/LPs promote healthy living and fitness, these walking/running and bicycling groups are advocating the same message to the public. Their presence in walkways/LPs reinforces this growing momentum in Jeddah city and Saudi Arabia. Ajalat Jeddah's leader intentionally selects a route that passes by crowded areas for part of his training sessions because he wants *"exposure to the public and spread awareness."* (L5, 2020). To these groups, being active is key to happiness. The interviewed Moshat Jeddah group's leader said:

"Lately, with the development of human lifestyle, it has become mainly sedentary whether at home or work or while commuting. A day would end without walking or practising any sports. Over time, this would deteriorate one's health and impact productivity at work or in life, especially if that person is under pressure. Being healthy is a source of happiness." (L1, 2020).

Therefore, these interest groups join a shared effort with several public and private entities (e.g., the Ministry of Sports) to make their societies physically active while encouraging the use of Jeddah's walkways/LPs.

Table 7-16. Some of Jeddah's local walking/running and bicycling groups and the location, frequency, duration, regularly achieved distances, access transport method to the starting point, gender, number of members, age groups, and number of teams for their training sessions.

Type	Interest group name	Regular destination/journey		Frequency		Time of the day	Duration in hours		number of members per session	Distance in Km		Access to starting point (majority)	Gender		Highest age group	Teams	Notes
		From	To	Weekly Frequency	Days of the week		From	To		Minimum	Maximum		M or F	Regularly allow mix gender (families)			
Walking/Running	Jeddah walkers (Masafat)	Jeddah Waterfront walkway		2	Friday or Saturday, and Tuesday	After sunrise on weekends and at night during the weekdays	1	2.5	10 to 20	5	9	Car	M*	No	>40 y	One team	Mixed gender on special events
Walking/Running	Jeddah Road Runners	North Corniche and passing Jeddah Waterfront walkway	Mosque of the Custodian of the Two Holy Mosques	2	A weekend and a weekday*	Night	1.5	2	30 to 50	5	12	Car	M	Yes	20 to 40 y	Beginners and experts	Announced on weekly basis
Bicyclists	Jeddah Cyclists	Jeddah Waterfront walkway (Al Sheraton Hotel) passing Al Malik road	Camels' roundabout, but accelerators' group reach even further distances	3	Monday, Wednesday, and Friday	After sunrise on weekends and at night during the weekdays	1	Undetermind	<50 (regularly about 100)	25	50 (for professionals) - maximum is Undetermind	Car	M	No*	40 to 50 y	Beginners, experts, and acceleration team	There is a separate women's group, but family groups are considered
Bicyclists	Jeddah Women Cyclists	Jeddah Waterfront walkway (Al Sheraton Hotel) passing Al Malik road	marine sciences roundabout*	2	Sunday and Tuesday	Night	1.5	Undetermind	10 to 18	20	Undetermind	Car	F	No	20 to 30 y	One team	Few professional members travel further distances (i.e. Obhor)
Bicyclists	Buskaleta	Al Jowharah stadium [King Abdullah Sport City Stadium]		2	Every Tuesday and on a weekend	early morning or late afternoon	2	Undetermind	20 to 25	20	30 to 80	Car	F	No	25 to 30	One team	Teach children how to ride the bicycle as a service. Sometimes they go to Jeddah Waterfront walkway to Camels' roundabout
Bicyclists	Ajalat Jeddah	Jaffali Mosque (usually Fridays) or King Saud Mosque or Al-Anani mosque or Al Farsi Jewellery Store in Al-Baghdadiyah	Historic Jeddah and other neaby landmarks or attractions such as Prince Abdullah Al Faisal Stadium , Historical Palace Khuzam and King Abdulaziz University	3	Saturday, Sunday, and Tuesday	Night	1.5	4	<30	20	50 to 80 (sometimes travel further)	Car	M	No*	30 to 60	One team	Mixed gender on special events

7.7. Chapter seven summary

In addressing RQ4, this Chapter explained the impediments to using walkways/LPs as facilitators of AT in Jeddah city via understanding the preferences and opinions of their users and non-users. Even though these linear spaces are valued as destinations for physical, leisure, and social activities, their potential for active commuting remains largely untapped. This research highlighted significant barriers that need to be acknowledged and addressed, pointing to a broader issue in urban planning and societal norms. These include long commuting distances, adverse weather conditions, inadequate AT infrastructure, fear of public judgment, limited access to greenways within walking distance, lack of bicycling skills and knowledge, and park facilities and amenities. Many of these impediments were found to affect women's visitation patterns more than men's.

These results indicate a disconnection between the design of these linear spaces and residents' daily active mobility needs. Additionally, the allure of facilities and amenities at more distant LPs, like Al Corniche parks, suggest a preference for quality over convenience. Simultaneously, results raise questions about the equitable distribution of quality greenways across Jeddah city.

The diverse functions of Jeddah's walkways/LPs bring challenges to safety and comfort. Crowdedness, unregulated commercial activities, automobile traffic speeds, congestion, and drivers' behaviours were all highlighted as key concerns. Adding to the complexity of those issues is the diversity of LP users' visitation intents, age groups, behaviours, and movement patterns. Collectively, these factors are causing different forms of conflict among greenway functions and users. Thus, bicycling for transportation or physical activity in unpredictable environments such as Jeddah's greenways poses safety hazards to other users (e.g., collision), especially children. Despite these challenges, the interviewed participants described an increasing interest and a changing attitude towards bicycling. To most of them, the recent redevelopment of Al Corniche Parks created a cultural momentum and traction towards healthy living and fitness that aligns with their goals. Their contributions to the residents of Jeddah city are actively addressing several sociocultural and personal barriers.

CHAPTER EIGHT

THE UNDERLYING CAUSES AND RECOMMENDATIONS FOR THE IDENTIFIED BARRIERS

8. Chapter Eight: The underlying causes and recommendations for the identified barriers

Chapters Six and Seven identified and examined the factors hindering the usage of Jeddah's walkways/LPs as ATCs. Table 8-1 summarises those factors while referring to the data collection methods. Table 8-1 follows the research approach that oriented the study (i.e., structure, image, and action) (see Section 5.2 for more information). The summarised findings in Table 8-1 have five groups (bold text). Three are about the physical environment, divided into three levels: city, neighbourhood, and site (the same structure used in Chapter Six). The remaining two groups summarised Chapter Seven findings about perceptions (image) and preferences (action). Barriers/challenges within each group were assigned a unique code that facilitated linking them to experts' recommendations (see Section 8.2 for more information).

Based on Table 8-1, it can be inferred that the way Jeddah's walkways/LPs were designed and maintained is influencing their usage. Therefore, Chapter Eight begins by analysing experts' explanations for the factors contributing to the physical characteristics, designs, and conditions of Jeddah's walkways/LPs (see Chapter Six). Section 8.2 presents the interviewed experts' recommendations for addressing the identified barriers to greenways as facilitators of AT in Jeddah city.

Table 8-1. A summary of the factors hindering LPs' usage as ATCs in Jeddah city.

Code	Activation barriers to walkways/LPs as facilitators of active transportation in Jeddah city	Data collection methods											
		Interviewed local and int. experts							Interviewed interest groups' leaders		FOs	WBQ	EAs
		E1	E2	E3	E4	E5	E6	E7	PED.	BIC.			
Physical environment at the city level (Structure)													
CS.1	Existing walkways/LPs are fragmented.												
CS.2	Unavailability of greenways within walking or bicycling distance.												
CS.3	Greenways' variations in terms of scale and characteristics are lacking.												
CS.4	Frequent interruptions of arterial and express roads.												
CS.5	On average, one-third of walkways/LPs' total space is dedicated automobile driveways and parking spaces.												
CS.6	The automobile-centric planning influenced the physical characteristics of the NDC-LPs (e.g., curb heights lighting design).												
CS.7	Workplaces are unequipped with bicycle facilities (e.g., showers, racks, lockers, and more).												
CS.8	Inadequate public transportation / limited-service coverage												
CS.9	Destinations are widespread / the distance between where people live and work/study is widespread.												
Physical environment at the neighbourhood level (Structure)													
NS.1	Poor sidewalk walkability in Jeddah city												
NS.2	Sidewalk encroachments in the form of stairs, ramps, shading structures, building attachments, vehicle parking, and more.												
NS.3	Sidewalk barriers caused by building practices such as walls defining land lots, street vegetation and lighting, and more.												
NS.4	Sidewalk obstructions caused by management practices such as the placement of trash bins, fences, and more.												
NS.5	The regulations that permitted creating vehicle parking at the ground floor level of residential buildings did not consider its compatibility with the buildings' setback requirements, existing practices, and relationship to streets, thus hindering pedestrian movement.												
NS.6	Ground floor vehicle parking at apartment buildings as well as the fortifications of residential villas (inactive frontages), limit social interactions and activities at the ground floor level.												

Physical environment at the site level (Structure)													
SS.1	Poor spacing between pedestrian crossings												
SS.2	Noncompliant pedestrian crossings to national design standards, thus affecting pedestrians' and bicyclists' accessibility.												
SS.3	Lack of bicycle lanes and racks												
SS.4	Lack of bicycle rental/share services												
SS.5	Inadequate provision of shading trees and structures.												
SS.6	Unavailability of public toilets and drinking fountains.												
SS.7	Poor pedestrian access to food services, civic buildings, commercial destinations, grocery shops, and exercise/play areas (including green spaces).												
SS.8	Absence of transit stops/stations												
SS.9	Unavailability of regulatory signages												
SS.10	Poor spacing between wayfinding signages												
SS.11	The length and width of several walkways are insufficient, a problem exacerbated by their poor accessibility and sidewalk walkability of surrounding neighbourhoods												
Opinions of Jeddah residents (Image)													
IM.1	Jeddah residents view bicycle usage as a physical and recreational activity (not commuting).												
IM.2	Active transportation is perceived as unworthwhile financially.												
IM.3	Saudi formal attire of both males and females is unsuitable for bicycle use.												
IM.4	Public awareness about the benefits of active transportation is low.												
IM.5	Women bicycling is socially acceptable only at certain locations, such Al Corniche parks.												
IM.6	Inexperience about riding a bicycle												
IM.7	Fear of public judgment about the use of bicycles												
IM.8	Lack of confidence in riding a bicycle, especially for commuting purposes												
IM.9	Age and health reasons hinder active commuting, including riding bicycles.												
IM.10	Cultural and social norms against riding bicycles												
Preferences and external forces affecting them (Action)													
AC.1	Lack of interest / busy												
AC.2	Conflicts between site users because of crowdedness, improper use of e-scooters, unregulated commercial activities, and site users' activities.												
AC.3	Theft incidents, misconduct (e.g., harassment), and vandalism acts												
AC.4	Traffic speeds and congestion (reckless driving).												
AC.5	Lack of policies and regulations that promote and protect active commuters												
AC.6	Residents of Jeddah city developed a habit of using automobiles for commuting purposes.												
AC.7	Weather causes discomfort for pedestrians and bicyclists.												
AC.8	Low Bicycle ownership												
AC.9	Inconvenience caused by noise pollution												
AC.10	Foul odour coming from drainage channels.												
AC.11	Parcel and food delivery regularly expose neighbourhoods to outsider automobile traffic.												

PED Refers to pedestrians, and BIC Refers to bicyclists. EAs refer to environmental audits. CS Refers to City Structure, NS Refers to Neighbourhood Structure, SS Refers to Site Structure, IM Refers to Image, and AC Refers to Action. See Section 5.5.4, for information about the interviewed experts.

8.1. Interviewed experts' explanations for walkways/LPs' existing conditions

Thematic analysis of experts' interview transcriptions resulted in five themes that explain the (I) fragmentation, (II) design, and (III) conditions of greenways in Jeddah city as ATCs. Consequently, it influenced participants' opinions and preferences (see Chapter Seven). The following three Sections describe each subject separately, but they collectively explain the rare use of Jeddah walkways/LPs as ATCs. The emerged themes are as follows:

1. Financial and economic issues
2. Operational problems

3. Regulatory challenges
4. Cultural and social constraints
5. Environmental barriers

Each of those themes comprises several codes (or factors). Table 8-2 summarises them. Overall, the thematically analysed transcriptions from the interviews with local and international experts explained the factors that led to their existing conditions.

Table 8-2. A summary of the interviewed experts' explanations for the factors contributing to the existing conditions of walkways/LPs.

Code	Explanations for the identified barriers of greenways function as active transportation corridors in Jeddah city	Interviewed experts						
		E1	E2	E3	E4	E5	E6	E7
Financial and economic issues								
Ex.F1	Since linear parks are governmental projects, there are limitations to the types of activities/programs and investment opportunities.	■	■		■	■		■
Ex.F2	Low to no budget for creating and maintaining parks (impacting design direction).	■	■	■	■	■	■	■
Ex.F3	Generated funds from investment opportunities within residential districts and LPs are not always fed back to the concerned entities but to the Ministry of Finance.		■					
Ex.F4	High modification costs of utility infrastructure	■	■					
Ex.F5	Jeddah's utility infrastructure is yet to be implemented in many areas (competing priorities).		■		■			
Operational problems								
Ex.O1	Limited availability of good locally-based contractors.	■	■					
Ex.O2	No unified system exchanges information between municipalities and sub-municipalities regarding trusted contractors, tested construction materials, price comparisons, and more.					■		
Ex.O3	Even though contractor-related violation (depending on type and scale) incorporates technical, administrative, financial, and legal terms and conditions, integration with concerned governmental entities to resolve disputes and enforce fines are yet effective.		■			■		
Ex.O4	Appointing professionals to tasks beyond their expertise (a need to enhance the description of job responsibilities and relationships with stakeholders).	■	■					
Ex.O5	The tender-awarding process automatically favours the lowest bidder regardless of his past track record and abilities.	■	■			■		
Ex.O6	Fragmentation of responsibilities		■					
Regulatory challenges								
Ex.R1	Ineffective enforcement of fines for contractor violations.		■			■		
Ex.R2	No design contracts for linear and district parks (reliance on typical design and bill of quantities).	■	■		■			
Ex.R3	Inconsistent development priorities, especially regarding public parks (e.g., caused by Municipal administrative changes).		■			■		
Ex.R4	Land ownership.	■					■	
Sociocultural constraints								
Ex.S	Public unwillingness to cooperate in enhancing their shared urban environment		■			■		
Environmental barriers								
Ex.E1	Lack of water resources to irrigate vegetation		■	■	■		■	
Ex.E2	Lack of green open spaces		■			■	■	

8.1.1. Explanations for landscape fragmentation of linear parks

As described and illustrated in Section 6.1, Jeddah's walkways/LPs are fragmented and spatially disconnected from one another and other natural landscape features. Connectivity is an essential quality of greenways, especially if they were planned to function as ATCs (see Section 1.3, Table 1-2). To summarise, based on the interviewed experts, the reasons behind their current disconnected nature are a result of the following: the lack of green spaces; planning strategy of open spaces; fragmentation of responsibilities among the concerned authorities; high modification costs of utility infrastructures; numerous stakeholders; the presence of competing urban development priorities; acts of vandalism; and people's unwillingness to cooperate in enhancing their shared urban environment.

An assessment performed by the interviewed former manager at Jeddah's Municipality of Jeddah's public parks in the early 2010s revealed that *"only tens out of hundreds of all Jeddah's parks are actively being used."* (E2, 2020). A more recent evaluation, between 2017 and December 2019, done by the interviewed former landscape manager of Jeddah's public parks at a company working for Jeddah Municipality revealed that *"Out of those two thousand and two hundred parks, only 200 parks where people can go and walk."* (E5, 2020). Mapping of existing conditions via GIS also confirmed these assessments, especially since most walkways/LPs do not connect to other forms of greenspaces. Furthermore, these nearby greenspaces are usually vacant lots referred to locally as idle lands (See Figure 8-1). Therefore, the shortage of green spaces in Jeddah city partially hindered the sought-after benefits of building green infrastructure.

Figure 8-1. An example of vacant (or idle) land meant to be greenspace based on Jeddah Municipality's official land-use map.

The lack of green spaces in Jeddah city (0.5 m² per capita as of 2020) revealed competing priorities for allocating resources to expand greenspace coverage or elevate the quality and maintenance of a few locations. As discussed in Chapter Three, previous greenspace provision strategies in Jeddah city were insufficient in addressing its past and present challenges. The interviewed manager at Jeddah Municipality confirmed the problem and described the current greenspace provision strategy to address the ongoing issues. He/she said, *"I believe a decentralised approach to establishing linear parks that provide geographic diversity for its users will have a higher tangible impact than focusing only on Al Corniche, especially in a large city like Jeddah. Adopting this decentralised approach will be more visible, and its impact will reach several locations and satisfy not only many residents but also different types of people."* (E4, 2020)

Thus, as shown, the current strategy for delivering walkways/LPs in Jeddah's city is like other public parks, valuing proximity over connectivity (see Figure 6-1 in Chapter Six, Section 6.1 for a map of existing walkways/LPs). Therein lies the problem. Without a connected greenways network, Jeddah walkways/LPs will remain fragmented destinations rather than multifunctional routes facilitating access to daily destinations[23].

Utility infrastructure is a crucial deterrent to developing a greenway network in Jeddah city due to fragmentation of responsibilities, high modification costs, and conflicts in land-use regulations. The interviewed former manager at Jeddah Municipality said,

"We found out this proposal [retrofitting of Al Tahlia Street] had planning and conflicts with existing businesses, especially since the spaces in front of the shops are allocated for them and water and electrical companies. Infrastructure was a key deterrent that should have been taken into consideration." (E2, 2020)

Therefore, any modifications will include coordination with various stakeholders and, in some cases, partial reacquisition of properties, making greenway projects complex and, in some cases, expensive.

In addition, since many areas of Jeddah city do not have all utility infrastructure, decision-makers and citizens often prioritise them. The interviewed manager at Jeddah Municipality said,

"…the construction of the city's sewerage network, of which 50% is incomplete. As a result, the city's water table is high, which affects roads and buildings. Today, in the Northeast of Jeddah, asphalt road cracks have begun to show due to the high water table after six months despite the implementation being based on standards. In some areas, water levels are −1, and in other areas, they are −60. Therefore, most of Jeddah's issues are infrastructure-related. In addition, the stormwater drainage system is yet to be completed." (E4, 2020)

As described, there are competing priorities for the development of Jeddah city and the allocation of resources. Thus, considering existing conditions, creating a greenway network for AT in Jeddah city can be perceived as something nice to have or secondary instead of necessary. To summarise, limited-service coverage of utility infrastructure,

[23] Strategic and structure plans for Jeddah city addresses asserted the landscape fragmentation problem and proposed an integrated and connected open space system (AECOM, 2015). Implementation progress of such plans is unavailable and unknown.

expensive alterations of installed ones, and the multiplicity of concerned parties all hinder the creation of the greenways network in Jeddah city.

Residents' misconduct and unwillingness to cooperate in improving their shared urban environment were cited as social and cultural barriers that can hinder the creation of greenway networks. The interviewed former manager at Jeddah Municipality emphasised this issue. He/she said,

"Changing its [referring to residential districts] sidewalks is impossible, and the same applies to attempts to change people's behaviours and culture. These are residential plots. We cannot change the direction of traffic lanes and sidewalks' width. All people will object. [He/she explains] If people fight over the placement of the garbage disposal containers where no one wants them in front of their home, imagine how they would react to narrowing or widening sidewalks by their homes or taking away a couple of their parking spaces [….] Attempting to change their culture with the provision of a garden will only result in it being vandalised by a group from those residential districts. I remember back then, we would receive weekly alerts of vandalism acts that included things that sat on fire. Furthermore, people would bring glass and break it in those sports fields, making one wonder the reasons behind those acts." (E2, 2020)

Interviewee E2's professional experience is supported by Aldegheishem's (2023) findings regarding public participation in urban planning projects in SA. Specifically, Aldegheishem (2023) concluded that "*social beliefs, a low trust in urban institutions, and centralisation [of governance] play a significant role in determining an individual's willingness to participate*" (Aldegheishem, 2023). He added that the low levels of public participation in SA are also caused by poor interactive communication about urban problems via social media channels. Nonetheless, recent efforts (since March 2020) via the e-participation platforms that facilitate consultation (via the Public Consultation Platform), feedback (via various e-platforms such as Watani, Amir, Tawasul, and more), co-creation (via Fekra Platform), and communication (via social media) must be noted, as they exemplify important strides towards achieving SA's Vision 2030 goals where community involvement plays a central role ("About E-Participation," 2023). However, more research is needed to determine the size and extent of residents' willingness to participate in decision-making based on urban planning and development project type, scale, geographical location, and community involvement forms and levels. In brief, acts of vandalism and people's unwillingness to cooperate in enhancing their shared urban environment are challenges that impact the creation of greenways in Jeddah city.

8.1.2. Explanations for the existing design of Jeddah's linear parks

Except for Al Corniche parks, the observed walkways/LPs in Jeddah city share similar design characteristics and amenities. Thus, the identified shortcomings in Chapters Six and Seven were consistent. The interviewed manager at Jeddah Municipality described them as *"old walkways are dull straight lines, lacking visual diversity, sapping the energy of its visitors."* (E4, 2020). He/she further said, "*They all* *comprise of the same interlock pavers, lighting fixtures, a couple of benches, and parking spaces. However, this repetitious pattern has changed in the past two years."* (E4, 2020). The interviewed manager at Jeddah Municipality shared a similar view on past efforts (before 2018) and said, *"There was no implementation strategy for Jeddah's linear parks and no variety."* (E4, 2020). Interviewee E5 also confirmed the same observation. He/she said,

"You can see the same materials, same Jogging track, children's playgrounds almost the same, same company […] When you see in Al Ameer Majid Park, the same model we used in Al Corniche. And most of the items are the same. What we use in the Corniche, but only design a little difference." (E5, 2020)

Therefore, this Section describes the reasons behind the design monotony, shortcomings (e.g., lack of public toilets and poor pedestrian crossings), and ill-consideration of active commuters. To summarise, they are restrictions set by governmental contracts, administrators' misassignment of professionals, influences from the municipal leadership, limited budgets, and disruptions caused by unforeseen circumstances.

First is the restrictions set by governmental contracts for public parks, specifically LPs. The interviewed former manager at Jeddah Municipality described the nature of such restrictions,

"To develop and enhance those walkways, Jeddah Municipality should have given it to the private sector. As long as these are governmental projects, we are restricted by governmentally permitted activities. We [Jeddah Municipality] are not permitted to provide investment opportunities in those governmental projects without a tendering process. Furthermore, we cannot add additional activities, even face painters, without it being an investment opportunity. These restrictions have changed in the past few years." (E2, 2020)

It is important to note that the Ministry of Municipal and Rural Affairs sets the description, program, and specification of public open spaces, including walkways/LPs (Mandeli, 2011). Consequently, municipalities have little control over redefining walkways/LPs' environmental, social, economic, transport, and recreational potential. Thus, bureaucratic management's rigidity and delays discourage modifications and enhancements attempted by municipalities for public parks. In short, since walkways/LPs are governmental projects, they have a predefined scope and restrictions that limit their potential, which explains the resemblance of their designs and range of activities.

Second is the misassignment of professionals to the appropriate tasks, and in this case, to plan and design Jeddah's walkways/LPs. In some cases, decision-makers are entrusting a professional to perform duties outside the realm of his/her expertise. Interviewee E7 believed "it is limitations of creativity and innovation. *Furthermore, provision of those materials is possibly more economical."* (E7, 2020). However, interviewee E2 believed the responsibility lies in the professional's inexperience and the administrator's misallocation of human resources. He/she said,

"Those who design those parks allocate a high ratio of hardscape materials with unrealistic specifications such as marble, unlike other countries. When others design a park, you will observe greater attention towards softscape elements compared to civil engineering work […] On another note, designers from the Environmental Designs [referring to the faculty] lack background knowledge about plants and irrigation systems even though they are proficient in designs. Thus, civil engineering work is predominant in those parks, especially in pavement overall percentages." (E2, 2020)

In short, relying on professionals or contractors to work on tasks outside their expertise and mismatching human resources to the appropriate jobs partially resulted in the design shortcomings of Jeddah's walkways/LPs.

The third is the influence of political leadership, especially when the great majority of walkways/LPs in Jeddah city were created in six years (2013-2018) under the same mayor, Dr Hani Mohammad Aburas. In the past decade, many of Jeddah's walkways/LPs were built on top of those urban drainage channels in response to the increasing need for recreational public spaces. The interviewed manager at an international architectural firm said about the general design of Jeddah's walkways/LPs (except corniche parks), *"I don't think they're looking at it as an experiential place, but more as a functional place. Yes. That allows people to walk in there providing the bare minimum."* (E7, 2020). Interviewee E3 argued that great turnouts are not a sign of success but rather a lack of better options. He/she said, "*it has worked here, so it will work there. And people are using it [refer to walkways/LPs] because of no other options."* (E3, 2020). In short, since several walkways/LP projects were created relatively short and under the same administration, it influenced the design language and selection of materials.

Fourth, the limited budgets for public parks constrain their potential. As a principle, awarding tenders to the lowest bidder may be sound, but in practice, it favours price over the quality or competence of a contractor. Interviewee E2 explained,

"I do not believe that the similarities found between Jeddah's walkways are intentional. Nobody wants to do the same thing. However, it is the limitations set by contracts and budgets. Additionally, projects are awarded to a contractor who is the lowest bidder, and usually, that contractor is the worst in the market. Usually, those contractors do not have the abilities and means to fulfil these projects." (E2, 2020)

Interviewee E5 referred to this problem as the *"low price syndrome"* (E5, 2020), alluding to the disadvantages of awarding public projects only to the lowest bidder. Therefore, walkway/LPs' design decisions and implementation were partially influenced by budgets assigned to those projects.

Fifth is disruptions caused by extreme events. Gustafson Porter and Bowman's design proposal in 2005-2007 for Jeddah's NDC was cancelled after the flood caused substantial losses of people and properties. In response, Jeddah Municipality appointed AECOM in 2011 to work on Jeddah's Stormwater Drainage Program to protect the city and its residents from future flooding events (AECOM, 2013). Therefore, the planning strategy for Jeddah's drainage channels was reactive to the impacts of past extreme flooding events; while important, it neglected many of their other potentials, including their function as ATCs.

8.1.3. Explanations for linear parks' conditions

Conditions in this context refer primarily to providing and maintaining vegetation (i.e., trees, shrubs, lawns, and more). Aside from Al Yamamah Walkway and Al Corniche parks, vegetation is a key concern based on environmental audits and FOs. To summarise, factors that led to their condition are limited availability of competent contractors locally, inefficient processing and enforcement of contractor-related violations, lack of integration with the concerned authorities, budgets allocated for maintaining public parks, water scarcity, hot outdoor temperatures, and administrative restrictions that halt reinvestment of revenues, and disruptions caused by leadership successions within municipalities.

The first factor is the competency and management of contractors responsible for implementing and maintaining public parks. Issues relating to contractors were marked as one of the main factors affecting the construction and maintenance of LPs (and public parks in general). Interviews with experts revealed that many local ones lack the necessary skills and incentives to perform high-quality work. Even though contractor-related violations (depending on type and scale) incorporate technical, administrative, financial, and legal terms and conditions, integration with concerned governmental entities to resolve disputes and enforce fines is yet effective.

"*Only a limited number of contractors are available and able to perform maintenance…. if you take him [a contractor] out of a project and prove his incompetence, you will have to sit for a while without a contractor to maintain the project because of this switch, which means a major failure at the site that will lead to the death of plants.*" (E2, 2020)

Additionally, the local and national miscommunication among the authorities who share the same responsibilities further enabled contractor-related violations. Interviewee E5 explained, *"Some of the contractors are blacklisted in Jeddah Amana, and now they are bidding here in Al Riyadh."* (E5, 2020). Therefore, no unified system exchanges information between municipalities and sub-municipalities regarding trusted contractors, tested construction materials, price comparisons, and more. In short, the limited availability of competent contractors locally, inefficient processing and enforcement of contractor-related violations, and lack of integration with the concerned authorities all impact the construction and maintenance of LPs.

Second, limited budgets affect the design decisions of walkways/LPs and maintenance. Interviewee E1 clarified,

"Funds allocated for maintaining Jeddah parks are low. Thus, proficient contractors are discouraged from participation, especially since their asking price is usually high. As a result, tenders typically end up with incompetent contractors, many of whom are blacklisted today." (E1, 2020)

With the lack of public parks in Jeddah city, limited budgets forced Jeddah Municipality officials to cut corners. Moreover, water scarcity impacts the cost of implementing and maintaining walkways/LPs in Jeddah. For example, the interviewed manager at Jeddah Municipality explained,

"The scourge of government projects in Saudi Arabia is its maintenance and operation. Provision of water tanks, irrigation systems, and plant-soil requirements for having a vegetation cover in a city like Jeddah. Thus, it is expensive. Past approaches to creating walkways without vegetation were not intentional but solely due to financial and budget issues that were not part of project contracts. Therefore, the fastest approach to create walkways was without vegetation." (E4, 2020)

To conclude, low budgets allocated for public parks and water scarcity partially explain why the condition of several walkways/LPs in Jeddah share the lack of vegetation.

Third is administrative procedures that constrain the reinvestment of revenues generated from the district and linear parks. The interviewed former manager at Jeddah Municipality explained,

"Usually, when applying investment projects in these locations [public parks], their income does not go to the concerned ministry or even to the Municipality. Generated income goes to the Ministry of Finance; thus, it does not benefit the concerned authority." (E2, 2020)

Since public parks need continuous operation and maintenance expenditures, sustainable sources of income are critical. Therefore, administrative restrictions that impede the reinvestment of revenues affect the maintenance of walkways/LPs.

Fourth is the inconsistent development plan priorities, especially regarding public parks. Leadership succession within Jeddah Municipality influences the allocation of resources and management of assets, including public parks. The project lifecycle of public parks is often interrupted by administrative changes, wasting time and resources. The interviewed former manager at Jeddah Municipality explained,

"The existing strategy changes when the pyramid top changes. Nothing is constant. Therefore, the strategy focus changed from creating gardens, Corniches, and green places to bridges and tunnels, and today, the policies have changed to something even different. Therefore, the strategy we had seven years ago is expired." (E2, 2020)

In brief, in some cases, leadership succession can deter public parks' implementation and maintenance process.

Many of the implementation and maintenance challenges discussed in Sections 8.1.1, 8.1.2, and 8.1.3 are similar to other forms of public open spaces (see Section 2.4.3). The identified overlap of challenges is expected because walkways/LPs are part of the public open spaces. Yet, implementation and maintenance challenges such as conflicts with the road networks and regulating land were unmentioned topics partially because the current planning and design practices of walkways/LPs are like other green spaces (e.g., neighbourhood parks). These aspects are further discussed in Chapter Nine.

The identified implementation and maintenance challenges in Sections 8.1.1, 8.1.2, and 8.1.3 build on the discussions of several scholars about the challenges of public parks in Jeddah city by highlighting additional insights and relationships that explain current design and management practices (Addas & Rishbeth, 2018; Addas, 2015; Alhajaj, 2014; Almahmood et al., 2018; Bogis, 2015; Hammadi, 1993; Maghrabi, 2019; Mandeli 2011; Sobaihi, 1995). Simultaneously, reiterating these challenges indicates that many are still relevant today.

Lastly, the reported explanations in Sections 8.1.2 and 8.1.3 do not apply to Jeddah North Corniche since its redevelopment addressed many challenges (inaugurated on 29th of November 2017). The interviewed experts (E1 and E4) attributed the success of JWW to its concurrence with the Saudi Vision 2030 (launched in 2016), consultation of a planning and design firm, and incorporation of investment opportunities that generate sustained income. The quality of life program initiatives such as Humanizing Cities (see Section 3.5 for more information) are among several programs in Saudi Vision 2030 that gave momentum and support to urban regeneration projects aiming to elevate urban living conditions and quality of services. Moreover, the consultation of a planning and design firm, specifically KLA Kamphans Landscape Architecture (a German office), differentiated the Jeddah North Corniche in terms of quality and level of service. The interviewed academic in the landscape architecture department at King Abdulaziz University explained,

"Jeddah North Corniche is a leading project that involved an international consultant, and thus, there were different material specifications. As for the rest of the walkways, the majority of them are governmental projects, thus had a predetermined and standardised set of materials." (E1, 2020)

Another key factor to JWW's success was that the generated funds are fed back to the maintenance and operation of the project. A manager at Jeddah Municipality emphasised,

"It [referring to Jeddah North Corniche] has an investment dimension, which critically addresses the scourge of maintaining and operating governmental projects such as Jeddah's walkways. Certainly, one of the success secrets of Al-Corniche Walkway is its financial self-sufficiency. The investment returns cover 80% of its maintenance costs […] In all honestly, Al Corniche project experience opened our eyes. It made us learn

about several aspects to a point where now we insist on maintaining the quality in future subsequent projects."(E4, 2020)

The sustained income generation via the investment opportunities that covered most of JWW's maintenance and operation costs ensured its sustainability. To conclude, *Jeddah North Corniche* is an exception, not the norm, in terms of how public open spaces are designed and maintained in Jeddah city. However, the implementation experience is likely to influence the subsequent creation of public parks.

8.2. Interviewed experts' recommendations for addressing the identified challenges

Before presenting the results regarding experts' recommendations, some cast doubt on walking and cycling for transportation in Jeddah city. The first argument used an analogy to stress the insignificance of pedestrian and bicycle infrastructure in influencing travel behaviour in Saudi cities. The interviewed expert (E2) used King Abdullah Economic City and King Abdulaziz University as examples.

"At the university [King Abdulaziz University], students are supposed to move between buildings with their bicycles, but that is not the case. They commute using their cars and cause traffic congestion, even though the university has dedicated bicycle lanes. In King Abdullah Economic City, all streets and roads have bicycle lanes, but no one rides bicycles except those who commute from the supermarket to the hotel and so on, and it is for recreational purposes. However, going to work or buying grocery items via a bicycle, I do not think it is realistic." (E2 2020)

In other words, if these locations failed to encourage their visitors/students/residents to walk and cycle for commuting purposes despite the provision of sidewalks and bicycle lanes, why would one expect people to use proposed greenways for AT in Jeddah city? This argument assumes that a physical network is the only necessary element to induce an AT culture (see Section 4.4 to understand the influences on greenways' usage as ATCs).

The second argument indicated that walking and bicycling to daily destinations are meant for short or comfortable distances, especially considering the hot and humid climate of Jeddah city. Thus, contemporary planning models encourage compact and mixed-used developments to reduce travel distances and durations. Interviewee E3 emphasised that,

"the logical aspect for people to be using a bicycle or walking would be for short distances within their communities or neighbourhoods." (E3, 2020).

The interviewed manager at an international architecture consultancy firm also favoured the same concept. He/she said,

"The city needs to be developed in clusters where we create walkable environments where your amenities are closer to where you live." (E6, 2020).

Therefore, when daily destinations (work, shop, school, and more) are within walking distance, why would one use a greenway for commuting purposes? Responding to such an argument requires understanding the greenway concept, types, and scales (see Chapters One and Three). For example, neighbourhood greenways like the ones in Portland, Oregon, facilitate access to schools, parks, and business districts (Portland Bureau of Transportation, 2015, 2021). Furthermore, the argument mentioned above assumes that all trips originate from home and all people will live in places where all their desired destinations are within walking distance. There lies the importance of greenways' contribution to multimodal travel.

The third argument is that speaking to bicycle enthusiasts (e.g., AT interest group leaders) may falsely assume people's perceptions about the need for greenways to function as ATCs. Interviewee E2 said,

"Bicyclists in Jeddah city are no more than 200 people. When you talk to them, they will undoubtedly ask for many things. However, you forgot the four million people who do not use bicycles and do not even have a desire for them." (E2, 2020).

This argument suggests that the need to enable and protect active commuters in Jeddah city is unwarranted. Simultaneously, it contradicts Aljoufie (2017) and Badawi and Farag (2021) empirical results, which indicated a positive attitude towards AT in Jeddah city. Nevertheless, interviewee E2 did not present evidence or refer to any studies substantiating such claims. Lastly, interviewee E2 assumed that this research only voices the needs of bicycle enthusiasts, which is contrary (see Section 5.3).

With that in mind, the thematic (inductive) analysis of experts' interview transcriptions identified four sub-themes for their recommendations (see Figure 8-4):

1. Approaches with planning, design, and management (PDM) dimensions as main considerations (see Table 8-3)
2. Approaches with policy dimensions as main considerations (see Table 8-4)
3. Approaches with economic dimensions as main considerations (see Table 8-5)
4. Approaches with regulatory dimensions as main considerations (see Table 8-6)

In the case of Tables 8-3, codes (or recommendations) had further subgroups. Specifically, the following subgroups were generated:

- Planning, design, and management dimensions that place transport as the main concern (referred to as "PDM-dim-transport").
- Planning, design, and management dimensions that place greenways as the main concern (referred to as "PDM-dim-GWs").
- Planning, design, and management dimensions that place both transport and greenways as the main concerns (referred to as "PDM-dim-integrated").
- Operation and maintenance of greenways (referred to as "PDM-dim-O&M").
- Planning, design, and management dimensions that focus on concerns aside from transportation and greenways (referred to as "PDM-dim-other").

As shown in Tables 8-3 to 8-6, some recommendations were mentioned by most of the interviewed experts, which suggests an agreement on their necessity. However, interviews with more experts might change those results. Therefore, those recommendations are prioritised based on their ability to simultaneously address several usage barriers of greenways and their underlying causes in Jeddah city (see Tables 8-1 and 8-2).

The linkage between experts' recommendations and the identified barriers via all data collection methods was based on the context experts discussed during the interviews. Moreover, the type and objective of a particular recommendation were also considered as an indication of association. The assigned codes for each barrier facilitated the linkage process. As shown in Tables 8-3 to 8-6, the far-right column references the codes assigned for the usage barriers and their underlying causes from Tables 8-1 and 8-2. Figure 8-2 illustrates that process, which helped prioritise those recommendations based on their ability to contribute to resolving multiple issues simultaneously (by counting the number of barriers/challenges a recommendation contributes to resolve). As a result, the highlighted rows (in yellow) are the interviewed experts' top ten recommendations for unlocking greenways' function as ATCs in Jeddah city (see Tables 8-3 to 8-6).

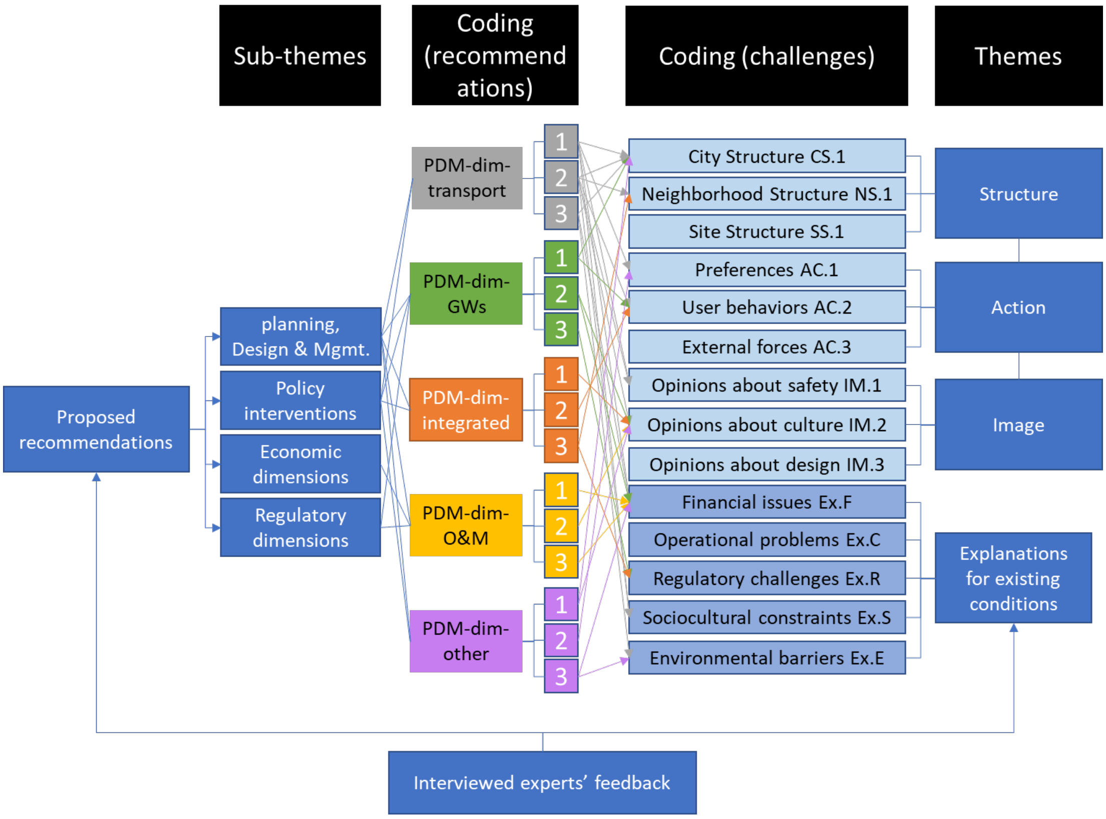


Figure 8-2. The thematic analysis linked the identified usage barriers of Jeddah's LPs and their underlying causes to the interviewed experts' recommendations.

Table 8-3. Approaches with planning, design, and management dimensions as main considerations.

Code	No.	Interviewed experts' recommendations (focus on planning, design, and management - PDM)	Interviewed experts							Codes (challenges—see Tables 8-1 & 8-2)
			E1	E2	E3	E4	E5	E6	E7	
(PDM-dim-transport)	1	Develop parcel and food delivery strategies to resolve long and short-term movement in a city.								AC.11.
	2	Encourage mixed-used and compacted developments.								CS.9, AC.4-7.
	3	Provide electric charging stations for electric bicycles and scooters.								CS.7, CS.9, SS.4.
	4	Any urban development should begin with the existing high urban density areas, which are found in central Jeddah city.								See Subsection 8.2.1.
	5	Implement traffic simulation studies to manage traffic flow and speed and consider alternative routes in case of accidents or emergencies.								AC.4.
	6	Ensure a wide availability of bicycle shops.								AC.8.
	7	Implement traffic calming measures, including road markings, signage, pavement materials, speed tables, and more.								AC.2, AC.4-5.
	8	Consider the length of pedestrian bridges (be within the acceptable walking distance).								NS.1.
	9	Redesign existing streets to consider the safety and accessibility for all users.								AC.2, NS.1-6, SS.1-3, SS.5, SS.10-11, IM.1, IM.6, AC.4, AC.5-7.
(PDM-dim-O&M)	1	Understand people's psychology instead of resorting to enforcement methods (i.e. provide blank canvases for spray painters to exhaust their frustrations).								AC.2-3.
	2	Install surveillance and security cameras to deter vandalism of public properties, theft, illegal vendors, and harassment of bicycle users.								AC.2-3.
	3	Create a mobile application that specifies the location of Jeddah's linear parks and its nearby facilities and amenities and informs potential visitors about the level of crowdedness.								AC.2.
	4	Implement periodic maintenance sessions where no visitors are permitted to enter until all maintenance tasks are completed to minimise disruptions and ensure quality.								AC.2.
(PDM-dim-integrated)	1	Implementation of Jeddah's transit-oriented development strategy, which aims to create seven urban clusters connected via rapid public transit as well as greenways.								CS.9, CS.8, NS.1, SS.3, SS.8, SS.11, AC.5-6.
	2	Review the building code to enable and protect active commuters.								CS.1-9, NS.1-6, SS.1-11, AC.6, AC.11.
	3	Produce design solutions that consider all linear park users and functions while reducing conflicts and interruptions.								SS.1-11, AC.2.
	4	Create a Jeddah metro network on viaducts and use the space below for walkways and cycleways.								CS.1-2, CS.8, NS.1, SS.3.
	5	Improve the microclimate by considering vegetation, wind, shade, pavement materials, and more in the design of physical networks for active commuters.								NS.1, SS.5, AC.5-7.
	6	Link existing linear parks to one another and other forms of green open spaces (creating a green network), as well as attractive/desirable destinations at both ends.								CS.1-2, CS.9, NS.1, SS.4, SS.7, SS.11.
(PDM-dim-greenways)	1	The ratio of softscape to hardscape elements should favour the former due to plants' multifunctional benefits.								CS.5, SS.5, AC.7.
	2	In addition to harvesting stormwater, collection and recycling of grey water to irrigate public parks are vital strategies in addressing the shortage of water resources.								CS.2, SS.5, Ex.F2, Ex.E1-2.
	3	LPs' access should be within walking distance from every household.								CS.2, AC.5, AC.7.
	4	Provide fire hydrants in public parks and other safety equipment.								AC.2.
	5	Use durable and resilient materials and furniture that can withstand damage (Addressing vandalism).								AC.3.
(PDM-dim-other)	1	Restore the Saudi identity in cities (learning from Al Balad, including temperature mitigation methods).								AC.7.
	2	Development of existing green spaces (aside from linear parks).								Ex.E2.
	3	Development of public spaces should prioritise ones located adjacent to mosques. Both could benefit from their proximity to one another. The mosque's facility management team would also extend their scope to the adjoining park.								Ex.E2.
	4	Activate the plan of implementing a hierarchy of public parks, each offering different levels and types of services and amenities | i.e., children's, sports, cultural, memorial, etc.								CS.3., Ex.E2.

Table 8-4. Approaches with policy dimensions as main considerations.

Code	No.	Interviewed experts' recommendations (focus on policy dimensions - P)	Interviewed experts							Codes (challenges— see Tables 8-1 & 8-2)
			E1	E2	E3	E4	E5	E6	E7	
P-Dim	1	Implementation of tax schemes such as CO_2 tax scheme in urban centres.								IM.2, AC.4-6.
	2	Workplaces/schools should advocate commuting via bicycles (e.g., bicycle-to-work schemes) by providing shower facilities, lockers, bicycle racks, and subsidies for bicycle ownership.								CS.7, IM.1-4, AC.5-6, AC.8.
	3	Provide free bicycle stations and rentals (suitable for all ages and abilities).								IM.9, AC.5-6, AC.8.
	4	Activate the role of the neighbourhood council in the process of administering and maintaining public parks.								SS.5, AC.2-3, Ex.F2.
	5	Classify and rank all contractors based on their good track record and performance. This list should be accessible and shared with all municipal decision-makers.								Ex.O2.
	6	Promoting active transportation usage should occur at multiple scales, which emphasises the importance of coordination and collaboration with stakeholders to minimise conflict and gain support (public participation).								CS.7, NS.5-6, IM.1-10, AC.1, AC.5-8, A.11, Ex.S.
	7	Achieving sustainable development goals should be the driver for change (consider, for instance, reducing the carbon footprint and livability).								See Subsection 8.2.1.
	8	Conduct public awareness campaigns about public manners (addressing vandalism)								AC.3.

Table 8-5. Approaches with economic dimensions as main considerations.

Code	No.	Interviewed experts' recommendations (focus on economic dimensions - E)	Interviewed experts							Codes (challenges— see Tables 8-1 & 8-2)
			E1	E2	E3	E4	E5	E6	E7	
E-dim	1	Attract investors and collaborate with businesses/agencies to bear some of the maintenance cost of greenways.								SS.5, Ex.F2, Ex.E1-2.
	2	Review budgets allocated for the operation and management of greenways and parks. For example, budget estimations should be based on technical grounds and not financial grounds.								SS.5, Ex.F2, Ex.E1-2.
	3	Generated income from investment opportunities should be fed back to the concerned authorities to sustain greenways' maintenance and operation programs.								SS.5, Ex.F2-3, Ex.E1-2.

Table 8-6. Approaches with regulatory dimensions as main considerations.

Code	No.	Interviewed experts' recommendations (focus on regulatory dimensions - R)	Interviewed experts							Codes (challenges— see Tables 8-1 & 8-2)
			E1	E2	E3	E4	E5	E6	E7	
R-dim	1	Review governmental projects' tendering process to ensure awarding contractors are not based only on the lowest bidder but on their ability to adequately complete the project tasks, past records, and performance.								Ex.O5
	2	Review the limitations placed on investment opportunities in public parks being classified as governmental projects to expand the revenue streams that could bear some of the maintenance and operation costs (e.g., access fees and advertisements).								SS.5, Ex.F1-2, Ex.E1-2.
	3	Regulate commercial activities within LPs to allow vendors to sell their merchandise and refreshments safely and legally. Licensing is one way.								AC.2.
	4	Enforce the laws and regulations against the individuals who vandalise public properties.								SS.4, AC.3.

As shown in Tables 8-3 to 8-6, many of the experts' recommendations for the complex and multidimensional barriers identified in Tables 8-1 and 8-2 are primarily goal-oriented and related. Furthermore, each requires an action plan that details the "how to implement" part, which is covered in Chapter Nine to a certain extent. Simultaneously, experts' recommendations are not a complete or comprehensive solution to the identified challenges. Instead, they must be interpreted as a foundation layer for future research and development to address those challenges, especially considering the multiplicity of variables influenced by time, project circumstances, and availability of resources. In short, without undermining other recommendations proposed by the interviewed experts in Tables 8-3 to 8-6, the highlighted ones' ability to address several barriers/challenges simultaneously made them a priority to activate the AT function of Jeddah's greenways.

Experts' recommendations emphasise the need for multidimensional treatments (e.g., urban design, education, and more) rather than just focusing on site-specific issues to activate walkways/LPs' AT function. Furthermore, forming a priority list helped structure their discussion in Chapter Nine, Section 9.1, which contextualises the barriers identified in the thesis and provides options for addressing them in the future. These options are discussed while relating to existing literature and global best practices.

8.3. Chapter Eight Summary

Chapter Eight primarily achieved three goals. First, it summarised the identified usage barriers of Jeddah's walkways/LPs as ATCs in Chapters Six and Seven. Second, based on the interviewed experts' feedback, it explained the challenges that contributed to their fragmentation, design, and existing conditions. Third, Chapter Eight also described the interviewed experts' recommendations for unlocking the AT function of greenways in Jeddah city. These recommendations were linked to the identified barriers in the thesis (see Tables 8-1 and 8-2).

Furthermore, a priority list of those recommendations was generated based on their ability to address multiple challenges simultaneously, hence, their importance. These recommendations stressed the importance of multidimensional interventions/treatments beyond addressing site-specific issues. Chapter Nine incorporates those recommendations in discussing activation strategies of greenways as facilitators of AT in Jeddah city.

CHAPTER NINE

DISCUSSION OF RESEARCH FINDINGS

9. Chapter Nine: Discussion of research findings

This thesis embarked on a significant challenge, determining how to activate greenways as facilitators of AT in Jeddah City, an automobile-dependent society. Chapters Six and Seven identified multidimensional barriers structured based on examinations of the physical characteristics (structure), opinions and experiences (image), and preferences and external forces (action). In Chapter Eight, those barriers were summarised and linked to the interviewed experts' recommendations for unlocking the AT potential of greenways in Jeddah city. Chapter Nine synthesises research findings across the thesis and relates them to existing scholarship and global best practices. From this evidence base, strategies are proposed to activate greenways as facilitators of AT in Jeddah city. These strategies are directed at adopting multimodal travel and extending greenways' contributions to sustainable transportation and liveability agendas in Saudi cities. Chapter Nine closes with a discussion of how the planning direction of greenways in SA is at a pivotal period due to SA's social and economic reform that began to stabilise its vision to overcome automobile dependence.

9.1. Activation strategies of greenways as facilitators of active transportation in Jeddah city

In Chapter Eight, interviews with experts revealed that greenway activation requires multidimensional and multilevel changes, ranging from site-specific improvements (e.g., improving thermal comfort) to integrating solutions. This Section proposes strategies for overcoming barriers identified in the thesis, informed by existing literature and global best practices. Discussion of these strategies is structured into three overarching and interconnected categories:

- Greenway planning, design, and regulation (Section 9.1.1).
- Personal, sociocultural, and environmental factors (Section 9.1.2).
- Participatory planning, funding, and evaluation (Section 9.1.3).

Each category encompasses several actions that collectively would accelerate the transition towards sustainable transportation in Saudi cities.

9.1.1. Greenway planning, design, and regulation

9.1.1.1. incorporate greenways into existing planning efforts

Chapters Six and Seven showed that motivations for and barriers to using greenways are multifaceted. Therefore, activating the potential of these greenways, including as facilitators of AT, requires comprehensive planning that links various sectors, priorities and plans because they are constituents of several planning initiatives (e.g., sustainable urban mobility plans, green infrastructure plans, tourism plans) (see Chapter Three). Hence, activating their transportation function must be aligned with these development goals. Doing so requires a comprehensive examination of the project area (e.g., natural and cultural resources) and public involvement at various stages (see Table 8-4). At the same time, it also requires increasing the capacity of institutional actors involved in planning for AT. Furthermore, when greenways aim to help businesses thrive, enable active lifestyles, and further the cause of many institutions and organisations (e.g., reduce carbon emissions), they will likely have more public support, translating to more funds for their implementation and maintenance. In conclusion, activating the transportation potential of greenways is linked to their success in performing other functions.

It was found that rarely do Jeddah residents use greenways as connecting conduits between different parts of the city (e.g., Jeddah's waterfront), instead treating them as destination sites (Section 6.1). Therefore, in order for greenways to function as connectors, there is a need for plans and policies that look at their potential on a city-wide scale. Doing so provides a variety of greenway scales and characteristics where, for instance, individuals seeking experiences away from bustling city life could be attracted to the greenway networks' naturalistic segments. These green connectors (at the city scale) offer opportunities to experience Jeddah city on foot, bicycles, and scooters of all types.

Discussion with the interviewed experts involved in decision-making regarding the planning strategy of walkways/LPs in Jeddah partially explained their fragmented nature (see Section 8.1.1). Current efforts aim to provide access to walkways/LPs within a walkable distance. However, proximity analysis of Jeddah's walkways/LPs revealed that most of Jeddah's built-up areas do not have access to them within walkable distance (see Section 6.1). Therefore, improving greenway accessibility via walking and bicycling will not happen overnight. Building Jeddah's green infrastructure, where greenways function as links to that system, requires integrated planning approaches. Then, the multi-phased implementation of such a plan would ultimately end with a connected and multifunctional greenway network. Therefore, activating greenways' AT function is not an afterthought but a part of setting landscape planning goals.

9.1.1.2. Integrate with public transportation planning and mobility management

Learning, praying, working, socialising, and more are all practices facilitated by transportation. Kent (2021) referred to them as the *bundling* of practices (from a social practice theory standpoint). Facilitating the transition to active commuting requires an understanding of those facilitated practices. In other words, AT policies must consider the spatial-temporal demands and needs for those practices (e.g., taking children to/from school). As explained in Chapter Seven, one of the major barriers to active commuting (via greenways or not) in Jeddah city is the distance between daily destinations, which is often time-restricted. Therefore, there is a need to improve travel options, experiences, and affordability. For example, the introduced greenways must consider bicycle and scooter share services by providing the necessary space and facilities to work efficiently, such as charging stations and different bicycle sizes and options (e.g., regular, electric, and cargo bikes). These services can be linked via smartphone apps for multimodal public transportation that facilitate their management and usage. Simultaneously, Jeddah’s future light rail transit and buses must allocate spaces for individuals with bicycles to support multimodal travel.

Urban development in Jeddah and other Saudi cities will be transit-oriented, as presented in several governmental reports (see Section 2.2), an approach supported by the interviewed experts (see Table 8-3). Therefore, greenways’ linkage to transit hubs will be one of their most important roles in Saudi cities, including Jeddah. These transit hubs are mostly located along arterial roads due to proximity to major points of interest (manage to travel demand), space availability, current and future population, and employment densities (AECOM, 2015). Access to the stations from surrounding neighbourhoods will depend on the bus and AT network. However, as evidenced by the environmental audits, sidewalk walkability is poor (see Section 6.2). Furthermore, depending on a person’s desired destination, the nearest greenways from their home address may or may not always be a part of their trip, emphasising the need to build greenway networks (rather than fragmented destinations) and integrate them with public transit. Thus, retrofit of Jeddah’s streets to support AT must occur at all scales (i.e., arterial, collector, and local streets) to facilitate access to those transit hubs and ultimately increase ridership.

However, public transportation must be fast and reliable (i.e., frequent and available 24/7). Enabling public transit (including bicycle-share) requires alleviating traffic congestion. This could be achieved partially by reducing the need for travel (e.g., distance learning and telecommuting) and alternative working schedules (Schiller and Kenworthy, 2017). Another method is providing dedicated routes that support only those modes. Alternatively, prioritisation could be controlled via signages/bollards that prevent automobile access at certain times of the day. Lastly, develop a parcel and food transportation strategy limiting neighbourhoods’ exposure to outside automobile traffic as recommended by interviewee E4 (e.g., using E-cargo bikes from last-mile distribution centres). The combined impact of these transportation demand management tools is greater than the benefits of their parts. They would partially free up road space to create greenways linked to public transit. Simultaneously, they would contribute to making alternative transportation modes (from automobiles) a safe, fast, and reliable choice to access facilitated practices (e.g., school learning).

Auditing sidewalks’ walkability in five neighbourhoods identified several barriers from people’s encroachments and building and management practices (see Table 8.1). Due to the variety and complexity of those barriers, solutions are case-specific. Thus, the assignment of multidisciplinary citizens and technical advisory committees is proposed to establish detailed action plans that facilitate the retrofit of streets. Steiner (2008) explained that advisory committees are techniques used in identifying problems, formulating objectives, assessing feasibility, and implementing plans. Ultimately, the advisory committees should collaborate with residents to achieve the typical redesign of every street type (MOMRAH, 2022a). Assessment of each case must consider alternatives and costs because each resident's decision had a reason (e.g., provide a driveway, improve safety, prevent property damage, and more). Some cases are easier to resolve than others (e.g., relocation of trees, lighting fixtures, and more). However, those related to building practices (e.g., inconsistent setback heights and walls that define lots) are believed to be the most challenging since they may require modifications to building structures. Therefore, residents and businesses must be open to the idea that the number of car parking spaces in front of their properties could be limited to improve walkability. Such an outcome could be a way of minimising interference with existing structures and reducing costs. Nonetheless, paid and secured parking options (including monthly subscriptions) within walking distance (preferably next to neighbourhood centres where jāmi/collective mosques are mostly located) can be provided as an alternative. In brief, multidisciplinary advisory committees are needed to establish detailed action plans addressing barriers to retrofitting streets in Jeddah city.

The provision of paid parking options within neighbourhoods must coincide with parking management by using permits and reconsidering parking requirements. These measures must coincide with several transportation demand management tools. The parking fees mentioned above are part of the disincentives to owning and using automobiles. However, residents must be incentivised to use other transportation modes via, for instance, transit passes, active commuting facilities, and amenities at daily destinations such as bicycle parking, storage units, shower rooms, and more. Furthermore, land-use management is vital to reducing travel distances/durations by providing neighbourhood facilities within walking distance. The abovementioned strategy about introducing paid parking spaces within neighbourhoods must be part of a mixed-use development. Therefore, it should incorporate missing or distant neighbourhood facilities such as nurseries, grocery shops, gyms, green spaces, and more.

9.1.1.3. Treat intersections with the grey network as opportunities

Building a greenway network will inevitably intersect with the street network, a barrier identified when the NDC was analysed (See Section 6.1.1). These intersections could be classified into two types: Ones where grade separation via bridges[24] is necessary (when intersecting highways and principal arterial thoroughfares) and unnecessary ones (all other road types). In the former case, current bridge design practices should be avoided for several reasons (see Figure 9-1). First, bridges must consider bicyclists and people with disabilities (e.g., ramps). Second, their design should be integrated with adjacent points of interest, providing various accessibility options. Third, their function should not be limited to connecting people to places. Bridges should be designed as LPs, providing multifunctional benefits to people and places. Doing so provides an opportunity to increase green space provision per capita. The Highline in New York, SkyGarden in Seoul, High Loop in Shanghai, Promenade Plantee in Paris,

[24] Tunnels should be avoided in Jeddah city due to high water table, high modification costs to existing utility infrastructure, lack of a strong visual impact, perceived as unsafe especially from vulnerable groups (e.g., women), invite trash and graffiti (Ashur and Alhassan, 2015; Rizati et al., 2013).

and Land Bridge in Vancouver are examples that successfully reimagined pedestrian bridges by applying the introduced strategies. As for other road types and sizes (the latter case), elements such as traffic signages/signals, pavement markings, refuge islands, curb extensions, and more are necessary road design components for a safe pedestrian crossing.

Figure 9-1. Pedestrian bridge on Al Madian Road, near Al Rawdah walkway.

9.1.1.4. Maximise greenways' diverse benefits

Chapter Five, Section 5.4 showed that most greenways in Jeddah city are oversized median islands (up to 40 m wide). As explained by the interviewed experts, reducing project costs was the primary motivator. However, creating exaggerated median islands should not be the default greenway design approach. Instead, greenways should be placed on roadsides, as explored below. Furthermore, streets with insufficient space should apply Kullmann's (2013) "asymmetrical boulevard" approach, which places an oversized road shoulder (i.e., greenway) in place of one or two traffic lanes on one side and a shared street on the other side (see Bell Street in Seattle, US is an example). De-centring greenways' placement differs from common development practices in Jeddah city.

Adopting such an approach is important for several reasons—first, the duplication of services and expenses. As shown in Section 6.1.1, creating a standalone destination at the street centre resulted in more parking spaces, driveways, pedestrian crossings, and curbs. The analysis of NDC has shown that an average of over one-third of walkways/LPs' total area is dedicated to automobiles (see Figure 6-8). Therefore, the placement of greenways on roadsides is spatially and financially more efficient than existing practices.

Second, the disassociation of abutting buildings limits the extent of greenways' benefits to them. Benefits of buildings' direct frontage to greenways include cooling and shading, especially during the summer season, a critical factor in the tropical hot climate of Jeddah city. Specifically, greenways' vegetative cover would save the buildings' energy requirements for air conditioning. Hsieh et al. (2018) and Tsoka et al. (2021) are among several studies that evidenced the energy savings from trees' reduction of buildings' solar heat gains via their continuous shading canopy, which could reach up to 54% as stated by the latter study. Other benefits of greenways' vegetative cover include reducing air and noise pollution (carbon sequestration and oxygen production), soil stabilisation, provision of privacy, regulating water runoff, and enhancing buildings' visual appearance (Ferrini et al., 2020).

Furthermore, greenways' juxtaposition from buildings facilitates greywater reuse as recommended by the interviewed experts (see Table 8-3) and evidenced by Bogis (2021) of its feasibility in the case of Jedda city to irrigate and vegetate the NDC. Simultaneously, buildings' shade maximises coverage of shaded areas along adjacent routes, reducing urban heat island effects. The use of buildings' shade was a primary strategy in Historic Jeddah (also known as Al Balad) to mitigate the impact of weather, as discussed by interviewees E6 and E7 (see Figure 9-2). That said, multidisciplinary involvement such as landscape architects, ecologists, arboriculturists, local authority planners, engineers and more is necessary to maximise benefits and minimise problems.

Figure 9-2. Narrow streets in Historic Jeddah benefit from buildings' shade that blocks direct sunlight exposure to alleviate discomfort (photo credit: Alejandro vn).

Third, spatial proximity between greenways and buildings has several mutual benefits. Greenways' proximity allows indoor activities (e.g., cafés) to spill outdoors, blending the gap between both spaces. Doing so helps businesses accommodate more customers, enhance exposure to pedestrian and bicycle traffic, and personalise edge spaces, which adds a unique street character. Furthermore, softscape elements such as trees make edge spaces more comfortable by providing shade that enhances the microclimate. Simultaneously, as Bently et al. (1985) explained, shade trees form small enclosures in outdoor spaces (equivalent to outdoor rooms) that invite people to claim such areas and interact with one another. The increased liveliness of buildings' edge spaces via the integration of greenways translates to more foot traffic and awareness of their contributions. Figures 9-3 and 9-4 are examples of methods to enhance the provision of facilities and amenities to redevelop inactive spaces and frontages. These design scenarios apply to main and commercial streets but respond to the identified barriers, including outdoor temperature and the lack of facilities and amenities.

Figure 9-3. The inactive frontage of BinDawood supermarket could be developed to add more facilities and amenities that benefit walkway/LP users.

Figure 9-4. Instead of overlooking a large parking space, repurposing an 8 m wide, as shown on the map, could be a way to enhance the visual quality and provide necessary facilities and amenities such as public toilets, greenspaces, and transit stops.

As for residential settings, the divide between private and public spaces should be maintained as an option due to culturally dependent notions of privacy (see Section 2.3 for more details). However, using blank walls must be discontinued to create visually interesting walking or bicycling experiences along edge zones that invite spontaneous social interaction. Thus, the wall itself must reimagined. They should not have a restricted form and function (e.g., straight line). The design of walls and fences needs to "*(1) help create a variety of spaces, (2) vary in height to provide different degrees of privacy, (3) include openings (windows) for defining special areas and views, and (4) support a number of furnishings (potted plants, sculpture, pictures, etc.) that provide additional character to each of the spaces.*" (Booth and Hiss, 2012, p.373). These spaces should be integrated with the design of greenways, blending the transition from private to public spaces. Blending should consider space form, the degree of overhead enclosure, shading structures, lighting, soft and hardscape materials, textures, rhythm, and colours.

These strategies partially address NS.5 and NS.6 in Table 8-1, where inactive frontages at buildings' ground floor are a main concern. Nevertheless, securing land

and regulation is a concern with such development strategies (see Section 9.1.1.5). Therefore, negotiating an easement agreement with adjacent property owners is necessary to avoid misuse of edge spaces and conflict with building codes. In short, instead of the oversized median islands, the placement of greenways at roadsides is spatially and financially more efficient and beneficial to buildings, businesses, and people.

9.1.1.5. Secure and regulate land for greenways

Building a greenway network in Jeddah city would require securing and regulating land for greenways. Flink and Searns (1993) defined four ways to secure a property: *"(1) Management agreements, leases, permits, and licences; (2) easements or partial rights to a specific piece of property; (3) purchase or donation of the title or all the rights a parcel of land from a willing seller or donor; (4) land regulation that prohibits or encourages certain uses"* (Flink & Searns, 1993, p.101). They further mentioned that selecting the best approach will *"depend upon the type of land ownership, your relationship with the landowner, your financial resources, your strategy for securing land, regulatory tools, the degree of threat to the resource, and future greenway uses proposed for the land"* (Flink & Searns, 1993, p.101-102). These challenges will multiply when a particular greenway traverses through multiple jurisdictions. In many cases, they will, like the East Coast Greenway, United States, the RAVeL in Wallonie, Belgium, Vancouver City greenways' network, and Sydney's Green Grid. Therefore, the interviewed experts stressed the importance of stakeholders' participation as a strategy to overcome such challenges in each phase of greenways' project lifecycle (see Section 9.1.3 for its discussion in further detail). Doing so could provide options and reveal opportunities that may not be clear or known.

As discussed in Section 3.5, there were many efforts, from both local and national levels, to address issues of AT in SA, which included the introduction of greenways. However, these efforts were mainly introduced as plans and guidelines, missing the indispensable legal component (see Section 3.5). Based on research findings, planning, implementing, and maintaining greenways in Jeddah city require updates of policies, laws, decisions and practices in public participation, street design standards, contract tendering process, land regulation, and more for existing and proposed ones. Therefore, there is a need to (I) define the legal gaps in every phase of a greenway project lifecycle, (II) identify the involved stakeholders, (III) develop legal frameworks to overcome these challenges, (IV) test their applicability, and (V) propose an implementation strategy of these urban laws in Saudi cities including Jeddah (UN-Habitat, 2016 influenced these proposed steps). For instance, how should using greenways adjacent to storefronts, residential properties, natural areas, and more be regulated in Jeddah city? In addition to the points listed earlier, answering that question should (I) consider various greenway types, scales, and goals, (II) specify permitted and prohibited uses/activities, and (III) create standards that govern each usage.

9.1.1.6. Consider all greenway user types and activities

In response to the identified barriers to greenways' usage as ATCs (see Table 8-1 for a summary), greenway design must consider all user types. Addas (2015) and Maghrabi (2019) classified public park users based on their socioeconomic characteristics (e.g., gender or age) and activities (e.g., recreation or physical activity) in SA. However, the classification of walkway/LP users in Saudi cities based on their movement patterns and speed has never been discussed. Local bicycle groups refrain from using Jeddah's walkways/LPs to prevent collision with site users, whose movement can be unpredictable due to differences in their movement pattern, speed, and perceptual, cognitive, and motor abilities. Therefore, users could be classified as fast and ambling, which differs from Gehl and Svarre's (2013) description of users based on optional and necessary activities. However, the proposed categorisation was influenced by Loukaitou-Sideris's (1993) recommendation for designing streets, which stressed the need to provide *place* and *link* qualities.

That said, fast users such as active commuters and runners treat walkways/LPs as thoroughfares. Their movement speed and pattern are not an indicator of their engagement in optional or necessary activities. However, a common denominator is their low engagement with site activities and other users. Therefore, protected bicycle lanes must be a standardised design treatment for thoroughfare AT traffic in Jeddah's walkways/LPs.

Amble users walk and bicycle at a slower pace. Their movement pattern engages with site activities and other users more than fast users. Furthermore, they are likely to meander and frequently change in movement directions. Both fast and amble users can engage in stationary activities (i.e., sitting and standing). Therefore, considering stationery and movement activities is important throughout the greenway design to mitigate conflict among site users and enhance accessibility and comfort.

In Jeddah and other Saudi cities, greenway design must also consider universal design practices because people with limited mobility are part of the site users. According to Flink and Searns (1993), impairment could be temporary (e.g., pregnant women or person carrying a heavy load of groceries), visual (e.g., blind), mobile (e.g., wheelchair users), hearing (i.e., communicate only via visual means), age-related (e.g., elderly residents), and learning (e.g., inability to navigate the environment). Environmental audits revealed non-conformity to Saudi standards for pedestrian and bicycle facilities. Therefore, improvement in project delivery and assessments is needed to ensure conformity to universal design standards.

Auditing of several sites revealed that wayfinding signages are inadequate, especially in Al Rehab and Al Rawdah (Tahlia) walkways (see Section 6.3). However, considering children, foreigners (who cannot understand the Arabic language), and people with disabilities in their design strategy is missing from all sites. Taking children into account means the use of colour, textures, signages, and more to improve the safety, visibility, accessibility, and legibility of the urban environment. For example, routes leading to schools could have visual cues (e.g., signages, landmarks, and public art) that intuitively create memorable places while notifying other road users to take extra precautions (NACTO, 2020). In addition, translations to several languages and consideration of people with disabilities increase accessibility to wayfinding signages (e.g., considering audible cues, various heights, and tactile features). In short, mobility-driven designs, policies, and programs are needed to create safe, accessible, and enjoyable active commuting experiences for children (with and without caregivers), foreigners, and people with disabilities.

Doing so partially requires updating design standards and legal frameworks for pedestrian and bicycle facilities. For example, it was not until June of 2022 that MOMRA's minimum width for sidewalks was problematic (MOMRA, 2001, 2005b, 2019a, 2019b). Specifically, a pedestrian sidewalk zone of 0.7 m needed to be replaced with a minimum of 1.5 m (even in extreme circumstances) because walking is a social activity (see Figure 9-5). A 1.5 m width would allow two people to walk side by side or two individuals walking in opposite directions (FHWA, 2006). Furthermore, a width of 0.7 m is not enough for a wheelchair user who requires a minimum of 0.9 m (MOMRA, 2019b). In addition, the width dedicated to the frontage zone is often interrupted by a building's doors, windows, façade elements (e.g., columns, architraves, and awnings), planters, signages, or steps (see Figure 9-6). Therefore, they are often not effective widths for pedestrian traffic movement. This issue was addressed in MOMRA's National Urban Design Guidelines (MOMRAH, 2022a). Nonetheless, highlighting it explains existing conditions, recognises existing efforts, and stresses the need to update those standards continuously.

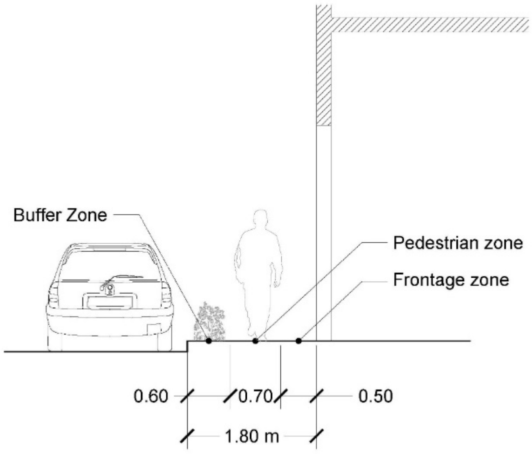


Figure 9-5. The Ministry of Municipality and Rural Affairs' minimum sidewalk dimensions for Saudi cities (MOMRA, 2019d) (drawn by the researcher).

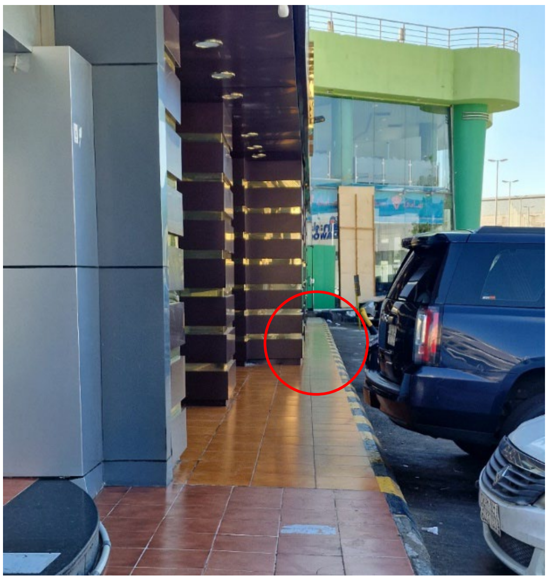


Figure 9-6. Façade columns affect the walkability of sidewalks (in Palestine Street Walkway).

Another area of great importance is the facilities and amenities needed for different user types and activities. As expressed by several questionnaires and interview participants (see Chapter Seven), public toilets, bicycle lanes, vegetation, stalls/kiosks, and more can be motivators and deterrents (when unavailable) to using Jeddah's walkways/LPs. Assessment of five walkways/LPs revealed that these facilities and amenities are lacking (see Section 6.3). Therefore, the development of Jeddah's walkways/LPs would benefit from their provision in a manner that considers users of all ages and abilities (e.g., different sizes of bicycle racks and wheelchair-accessible public toilets).

Notwithstanding, the provision of these facilities and amenities based on predefined design templates must be discontinued (see Section 8.1.2 for more information). Instead, they must be context-sensitive, which means responsive to the current physical, biological, cultural, and regulatory conditions (LaGro, 2013). Considering these factors informs the greenway objectives, physical characteristics, how it supports ecological functions and meets stakeholders' needs. Therefore, facilities and amenities' location, shape, dimensions, frequency, materials, colours, and more must be based on a comprehensive assessment of existing on-site (intrinsic) and off-site (extrinsic) conditions/factors. For example, the placement and type of vegetation must consider existing site conditions (e.g., structures), aesthetics, functions (e.g., stormwater management), and management (e.g., maintenance).

Another example is regarding lighting fixtures. The current illumination of spaces for pedestrians would benefit from various forms, intensities, and directions of illuminations (e.g., accent lighting) in an integrated manner with the surrounding streetscape and building designs. Additionally, installations of motion sensor lights would save energy expenses, especially when walkways/LPs are unoccupied. Consideration of these factors would contribute to defining the site's character (alleviating monotony). In short, practices of designing walkways/LPs via predefined templates must be replaced with problem-solving processes that respond creatively to the site's existing conditions.

9.1.1.7. Focus on neighbourhood greenways as building blocks for sustainability transitions

Dependence on automobiles for daily commutes is still prevalent in Jeddah city. The modal shift to bussing, bicycling, and walking is not about eliminating the usage of automobiles but rather reducing reliance on them. Therefore, starting with the low-hanging fruit should be first. Have people go to neighbourhood facilities such as mosques, grocery stores, schools, and more using AT modes. Then, redevelopment should extend/scale up outward. Such a strategy is like the "3 S" movement, which focuses on designing cities for *Short*-distance travel via *Slow* transportation modes while exploiting *Smart* technologies (e.g., bicycle sharing schemes, e-scooters and bikes, license plate recognition, radio-controlled retractable bollards) (Cervero et al., 2017).

To do so, the contraction[25] of existing streets via the integration of greenways should focus on collector roads of all neighbourhoods in Jeddah city for several reasons (see Figure 9-7). First, most neighbourhood facilities are located along those roads. Second, most lead to arterial roads, where stations for the light rail transit and buses will be located (see Section 2.2). Third, the contraction of all collector roads will provide access to the greenway network within five minutes (a key issue, as shown in Section 6.1). Fourth, their width (between 20 and 40 m) allows the creation of protected bicycle lanes on both sides of the road. Such a factor is critical, especially in the Saudi context, because it reinforces individuals' confidence, providing an incentive to adopt such modes. For these reasons, transportation-led greenways or ATCs would be prominent in Saudi cities. In short, focusing most of the resources on the contraction of collector streets first is a culturally driven strategy that (I) gradually reduces reliance on automobiles to access neighbourhood facilities and (II) aligns with future public transportation plans in Jeddah city.

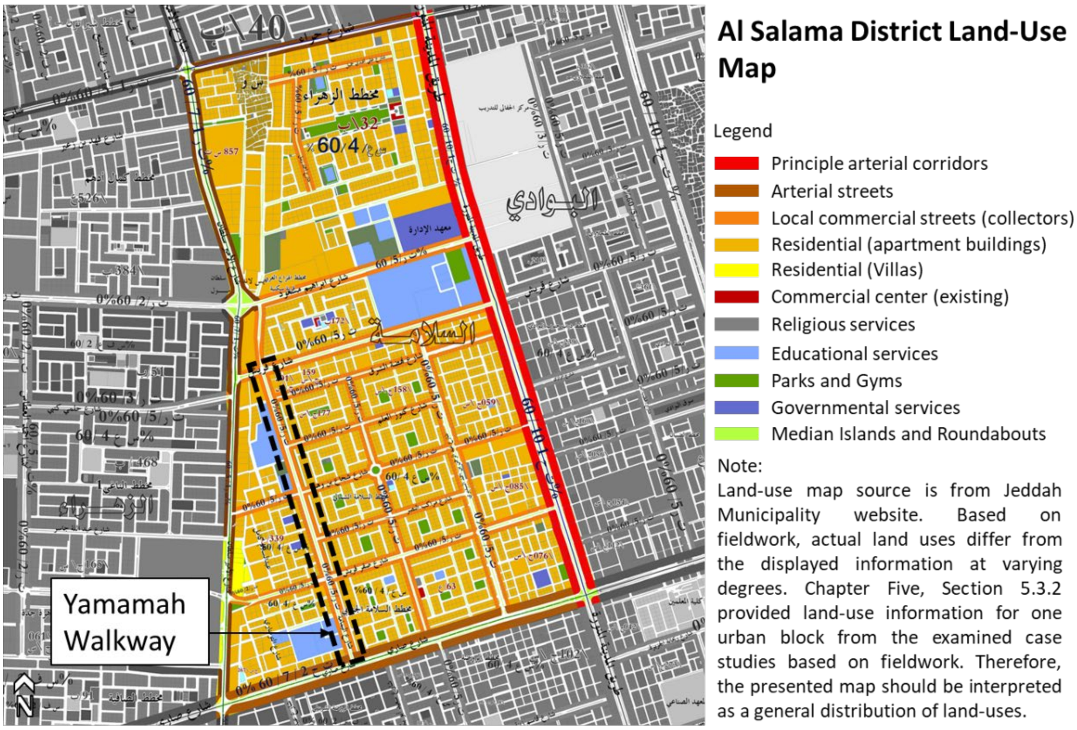


Figure 9-7. The land-use map for Al Salama District displays the location of collector roads (Orange-coloured Street network) and their relationship to other street hierarchies (typical urban form).

Meanwhile, local roads should apply tactical urbanism approaches, which are flexible, inexpensive, and scalable (Lydon and Garcia, 2015). Doing so focuses available resources on the contraction of collector roads. Those tactics aim to make local roads safe and accessible for active commuters via road dieting (a lesser intervention to

[25] Road contraction is "a form of land reclamation, which […] involves reassigning land for place-making and green mobility purposes." (Crevro et al., 2017). It also involves greywater reuse from adjacent buildings and stormwater management to vegetated the reclaimed lands.

existing systems than road contraction). This is because of the prevalent unavailability of sidewalks within neighbourhoods, as evidenced by the assessment of five neighbourhoods (see Section 6.2). As Lydon and Garcia (2015) explained in their case study of Broad Avenue in Memphis, Tennessee, efforts began by temporarily defining bike lanes and vehicle parking spaces using road markings. Once those collaborative efforts gained wide traction, they attracted further investments, transforming the temporary tactics into permanent street reconfigurations. In the case of Jeddah city, a much wider road marking scope is needed to address existing conditions. Specifically, they should be used to define pedestrians and bicycle lanes, vehicle parking spaces, pedestrian crossings, directions, edges, hazards, and more. These efforts must be combined with traffic calming strategies. For instance, traffic speeds on local roads must be < 30 km/h to protect active commuters (see Section 9.1.2.1). Placement of regulatory signages, especially at all neighbourhood entry points, could be a way to enhance safety within neighbourhood cores. In short, space and traffic management via flexible, inexpensive, and scalable tactics (e.g., road markings) is a strategy to concentrate resources on the contraction schemes of collector roads.

As for arterial roads, public transportation plans have not yet been implemented[26]. Thus, their contraction schemes should align with the public transit implementation plan to enhance their integration with the greenway network. This is because the actual form will likely differ, at varying degrees, from typical designs, adapting to existing physical, biological, cultural, and regulatory conditions. For example, the actual location and physical dimensions of transit stops/stations and lanes, intersections, infrastructure, views, and more would affect the greenway's form, functions, and appearance. Moreover, As Flink and Searns (1993) recommended, funding for greenway projects should be secured from transportation, tourism, and other departments/institutions because they support their causes (e.g., facilitate access). In short, the retrofit of arterial roads (of all sizes) via the integration of greenways should be aligned with the implementation phases for public transportation in Jeddah.

9.1.2. Personal, sociocultural, and environmental factors

9.1.2.1. Protect active commuters

Research findings explained that reckless drivers and outdoor temperature are primary impediments to active commuting in Jeddah city. The following are strategies to protect active commuters. First, slow down traffic speeds via regulations and design (e.g., narrowing automobile traffic lanes). The adapted PEAT gave traffic speed and calming measures a fair score for all examined walkways/LPs because speed bumps were implemented. Additionally, despite the unavailability of traffic speed signs, a traffic speed of 50 km/h was assumed as stated in the Saudi traffic law[27] (specifically,

[26] However, an announcement is anticipated soon given the recent demolitions unplanned settlements (see Section 2.1.1).
[27] Latest amendment date in that government document was 2022/08/10.

Chapter Five, Article 50/9/5/1) since all case studies were within urban areas (General Traffic Department, 2020). Interestingly, the previous version of the Saudi Traffic law permitted traffic speeds up to 70 km/h within residential areas if no traffic signs indicated otherwise (General Traffic Department, 2008), which is a safety hazard for pedestrians and bicyclists. With that in mind, since schools border Al Rehab, Tahlia, and Al Yamamah walkways, a 50 km/h traffic speed is a safety hazard near such locations. As a rule of thumb, bicycle lanes must be protected whenever automobile traffic speed exceeds 30 km/h. Thus, a traffic speed of 30 km/h near what NACTO (2020) defined as “slow zones” (i.e., areas near schools, parks, senior areas, and mosques) needs to be considered in future Saudi traffic law revisions to enhance safety for road users.

Second, address accessibility problems. Assessment of pedestrian crossings had poor results (see Section 6.3). They need to conform to national standards and be more frequent. After all, a core function of greenways is connecting people to places (see Section 1.3). A further improvement would be integrating with adjacent spaces (see discussion about context-sensitivity in Section 9.1.1.6). For example, greenways adjacent to a school entrance could incorporate bicycle racks, drinking water fountains, and shaded seating areas for parents waiting to pick up their children (see Figure 9-7). In brief, safe access to adjacent buildings and spaces is one of the most important improvement areas for greenways in Jeddah.

Figure 9-7. A typical example of an opportunity to create a wide pedestrian crossing that forms a safe physical link between walkways/LPs and nearby destinations.

Third, improve outdoor thermal comfort. Based on FOs, most LP users prefer using LPs during the late afternoon and evening hours partially to avoid the hot air temperature. Even though gauging the tolerance rate of weather adversity was qualitatively examined, research in Chicago, Illinois, showed that anything below 4°C and above 32°C resulted in sharp drops in daily greenway usage (Gobster et al., 2017). If these measures were to be applied in the case of Jeddah city, active commuting via greenways would only be tolerable and safe for five months of the year based on the mean daily maximum temperature (32°C), specifically from November until March. Hegazy and Qurnfulah's (2020) thermal comfort assessment of four streets in Jeddah city confirms such a theory. Nonetheless, such a period may extend if temperatures outside peak heat hours were to be considered (e.g., late-night hours). Therefore, implementing the proposed strategy that maximises the shaded areas along walkways/LPs (Section 9.1.4) is needed along with other solutions to overcome such a formidable challenge (e.g., solar-reflective materials, decreasing travel distances and durations, integration with public transit – see Section 9.1.1.2).

9.1.2.2. Respond to the sociocultural context

Dependence on automobiles is ingrained in Saudi society's culture, passing such behaviour from generation to generation ever since the introduction of automobile-centric town planning in the 1940s (See Section 3.2). As Kent (2021) explained, for a practice (i.e., active commuting) to exist, it needs *recruitment*, a cohort of practitioners giving a reference point for other individuals and increasing awareness.

However, religious beliefs, fear of public judgement, adhering to what socially constitutes acceptable behaviour, and formal Saudi attire are all unique sociocultural impediments to cycling for transportation in Saudi cities (see Section 7.5). Interviewee E2 and some questionnaire participants viewed the concept of active commuting with doubt and pessimism. They characterised these modes in a city like Jeddah as impractical and unsafe, considering the contemporary urban conditions (see Chapter Six) and both culture and traditions (see Chapter Seven). According to Nyborg et al. (2016), policy can support social norm changes by providing "*reasons for people to change their expectations. This is different from attempting to persuade people to change normative values.*" (p.43). Thus, policies that induce social norm change include, but are not limited to, ones that support investment in pedestrian and bicycle facilities (e.g., protected lanes). Changes in social norms around AT are accelerated when reinforced by policies that further the cause of AT (e.g., policies for providing end-of-trip facilities and deterring harassing conduct).

Increasing visibility is another way to change social norms (Nyborg et al., 2016). One of the strategies current bicycling groups use is training in several locations in Jeddah city to normalise the bicycling scene (for women as well) in the streets of Jeddah. They also use social media channels to maximise their reach (increasing recruitment). Their videos incorporate various messages about health and fitness. Thus, although such groups represent a very small minority of city residents, they are performing an important role in changing cultural perceptions of AT behaviours and acting as social innovators. Communication strategies could be strengthened via policies that increase their visibility, supported by collaboration with other organisations (e.g., the Saudi Arabian Cycling Federation) and businesses that would benefit from increased active commuters (e.g., advertisements and school programs). Moreover, most interviewed experts recommended the creation of public awareness campaigns to promote active commuting in Jeddah city. Communicating the AT benefits via these campaigns should be evidence-based (see Section 1.1). When enough supportive social feedback is received, the new behaviour (i.e., active commuting) reaches its tipping point and eventually becomes cool and normal.

However, at the current stage and as reported by the interviewed AT interest groups (see Section 7.6), the large turnouts to bicycle training sessions and events signify a changing attitude towards bicycling, though not necessarily for transportation (see Figure 9-8). However, Aljoufie (2017) and Badawi and Farag (2021) found that most of their participants have a positive attitude towards AT, which is a significant predictor of potential active commuters via greenways (Chen et al., 2019; Dill et al., 2014). Nonetheless, the representation of their questionnaire sample to Jeddah's population is a limitation, necessitating further research. In short, supporting these grassroots efforts could overcome many public attitudes and perceptions towards bicycling as a transportation mode.

Figure 9-8. World Bicycle Day, Riyadh, June 2022. Photo Credit: Saudi cycling (@Saudi_Cycling, 2022).

Another contentious subject needing further examination is women's bicycling in Saudi cities like Jeddah. Research findings explained that there were two primary arguments raised against it. First, women's bicycling allegedly entails revealing or defining parts of their bodies in public, which is forbidden in Islam. As reported by the interviewed women cyclists group leaders (see Section 7.5), such an issue is addressed via Islamic clothing covering a woman's body without restricting movement. However, their availability, as explained by Al-Tayyar and Al Dabbagh (2021), is an issue.

Nevertheless, according to interviewed group leaders, most of the participating women in bicycling do not adhere to the hijab principles, creating a public image that could be stigmatised by those who do, which is the mainstream culture. The growing trend of such phenomenon could be linked to SA's Crown Prince Mohammed bin Salman's statement in 2018, where he specified wearing the traditional Abaya as optional (Anderson, 2018). Therefore, women's cyclists' identity should be inclusive (inviting to all women, irrespective of religious or cultural views), especially considering that social identity influences people's policy support (Allert and Reese, 2023; Mackay et al., 2021). In other words, policies supporting bicycle usage as a transportation mode in Saudi cities must consider all social groups to maximise the engagement in collective action that facilitates the sustainable mobility transition (e.g., address the expectations of veiled women).

Second, since bicycling in Saudi cities is rare, women's bicycling in public spaces can draw unwanted attention, increasing their risk of being harassed. To alleviate such risks, women ride their bicycles in groups and within specific locations such as walkways/LPs (see Section 7.5). Such reported behaviour is like Almahmood et al. (2018), Addas & Rishbeth (2018), and Maghrabi's (2019) conclusion about women's preferences in public urban spaces, which is the presence of other women. It reinforces their sense of safety. However, a broader social change is needed in order for women to feel safe to cycle. Since women's bicycling in Jeddah city is confined and socially accepted within designated locations (e.g., Jeddah's walkways/LPs), it can hinder the effectiveness of any proposed greenway network in the future. Therefore, increasing visibility and awareness, as mentioned in earlier paragraphs, could be a way of normalising women's participation in bicycling.

Harassment was not the only identified sociocultural barrier to AT in Jeddah city. Anti-social behaviours (e.g., littering, vandalism acts, and theft), as well as conflict among users (e.g., from crowdedness and usage of children's toy cars/scooters), could be mitigated via the placement of regulatory signages at walkways/LPs' main entrances and zones with a high concentration of people. Based on environmental audits, regulatory signages are either unavailable or lacking. The displayed information must communicate usage regulations (i.e., what, where, how, when, and more). Equally important is the description of penalties and legal proceedings in case of misconduct (e.g., littering or illegal parking).

Furthermore, the contact information of facility managers must be included in case walkway/LP users require assistance. The periodic security guard patrols and surveillance cameras observed in Jeddah Waterfront Park (see Figure 9-9) support these measures. Even though the latter has research, safety, and security applications, ethical concerns such as privacy and users' identity require further research to understand users' protection policies. In short, regulatory signages are a means to educate users, maintain site conditions, and alleviate safety hazards.

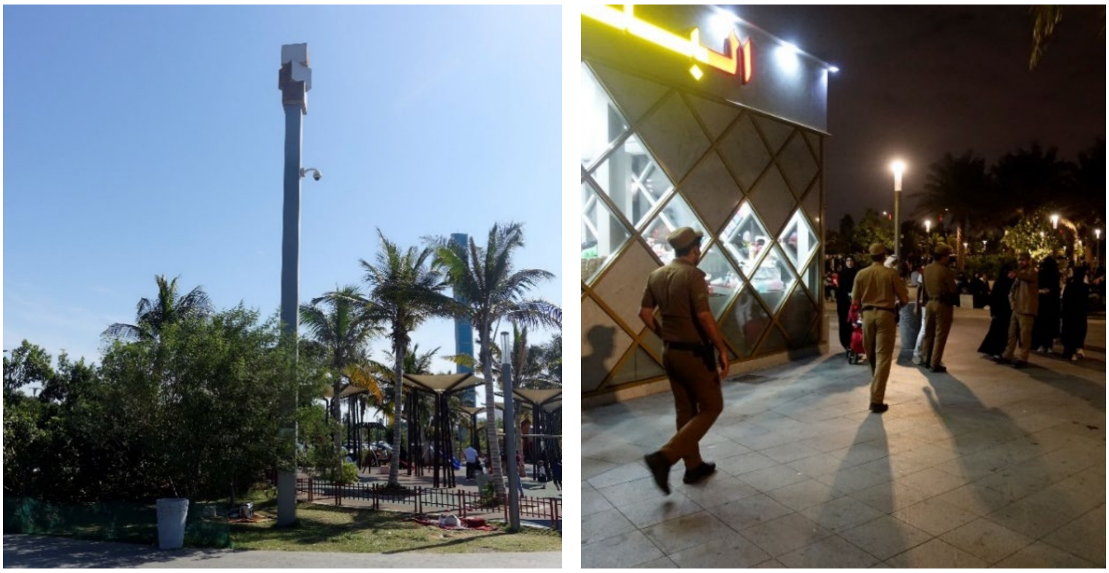


Figure 9-9. Security measures in the Jeddah waterfront walkway are additions that deterred many acts of vandalism, according to the interviewed participants.

Nonetheless, enforcement should not be the default resolution. Some practices signal unmet needs, as expressed by interviewee E6. Since using children's toy cars/scooters places other users, especially other children, at risk of collision, space or time dedication could be a way to manage safety hazards. The same concept applies to damaging fences at walkways along drainage channels. They could suggest a need to create shortcuts. Furthermore, blank walls dedicated to graffiti enthusiasts allow them to express themselves. Therefore, it is important to understand and monitor users' impact over time, manage usage, and respond to their needs (Ahern, 2003). In brief, certain anti-social behaviours could be accounted for via, for instance, space/time dedication, site development, and education instead of enforcement.

On another note, non-users of greenways were a subject of interest to many scholars worldwide (Evenson et al., 2005; Sims-Gould et al., 2019; Wolch et al., 2010), including this PhD research given its emphasis on activating the latent potential of greenways. Factors contributing to the non-usage of greenways in Jeddah city were similar to those identified internationally. Specifically, results explained that distance, temperature, absence of facilities (e.g. public toilets), lack of intrinsic motivation, and time were the top reasons, which is similar to several international experiences (Auchincloss et al., 2019; Guttenplan and Patten, 1995; Hankey et al., 2012; Mundet and Coenders, 2010; Sims-Gould et al., 2019; Wolch et al., 2010). Moreover, findings also revealed that female participants are affected by those barriers more than males (see Section 7.2.1). Since access to Jeddah's walkways/LPs is only safe and convenient via automobiles (see Sections 6.2 and 6.3 for neighbourhood and site assessments), those who do not own a vehicle or cannot drive are constrained by such limitations. Such a factor is of significance in the Saudi context since women's right to drive an automobile was granted in June 2018, a subject Badawi and Farag (2021) explained in further detail.

9.1.2.3. Invest in education and motivation programs to enable active commuting

Even though the reasons for not using greenways are numerous, lack of time and interest stood out as the top unique personal factors (see Section 7.2). These personal reasons align with the 2019 Household Sports Practice Survey findings, which explained that the predominant physical inactivity in Saudi Arabia (80%) is due primarily to Saudi residents' lack of desire and time (The General Authority for Statistics, 2019a). Since studies have shown that healthy individuals are more likely to commute via greenways (Wolch et al., 2010), the prevalence of obesity in SA is a crucial hurdle. Althumiri et al. (2021) found that the national weighted prevalence of obesity (BMI ≥ 30) was 24.7% in 2020. Therefore, the Quality-of-Life 2020 program aims to create built environments enabling active lifestyles ("Quality of Life Program," 2018). Regeneration of urban environments to address issues of active travel duration (lack of time) may not be a sufficient response to the Saudi residents' lack of interest in AT. Being interested in leading an active lifestyle, specifically via AT, is a personal choice, and understanding the incentives that could influence Saudi residents' mindsets is needed. To conclude, balancing commuting time and the rewards of using greenways as ATCs (e.g., PA) is a challenge beyond improving greenway accessibility because it depends on an individual's valuation of both (time vs. perceived benefits).

Nonetheless, e-bicycles and e-scooters (also known as micromobility vehicles) overcame many challenges associated with traditional bicycles, such as distance, gradients, duration, physical ability and weather (Fyhri et al., 2017; Simsekoglu & Klöckner, 2019). Introducing them in Jeddah city as shared services while providing the necessary facilities (e.g., charging stations) could be a way to address many of the barriers mentioned in the earlier paragraphs. In short, increasing greenway usage is a formidable challenge in Jeddah city and internationally.

Equally important, research findings partially attributed the rare active travel behaviour also to the widespread inexperience about riding a bicycle and lack of confidence to ride in traffic. As explained in Section 4.5, from the perspective of social cognitive theory, self-efficacy, confidence, and skills to engage in bicycling for transportation are directly related to the engagement in that behaviour (Bopp et al., 2018). The same applies to a social practice theory where a modal shift to bicycling, for instance, partially needs *competence*, which is the knowledge of riding a bicycle, navigating the environment, adapting to different weather conditions, dealing with traffic, and more (Cass and Faulconbridge, 2016; Kent, 2022). Interviews with local AT interest group leaders described their efforts to overcome those challenges via training sessions. However, these voluntary efforts, while admirable, are fragmented and narrow in scope.

One way to address these concerns is by incorporating bicycle training sessions in educational and encouragement programs. In other words, make riding bicycles part of the education system at all levels, including learning about traffic rules, situational awareness, etiquette, and safety equipment. Workplaces could pay for free bicycle training sessions for their members to support the culture shift towards sustainable transportation. Simultaneously, equip schools/universities and workplaces with bicycle facilities (e.g., secured bicycle parking, storage rooms, and more). Furthermore, incentives enable such a process and partially address the reported lack of interest via the questionnaire participants. Specifically, create incentives for institutions/employers (e.g., tax reductions) and active commuters (e.g., subsidies to own and maintain bicycles). In short, education and encouragement are essential strategies to overcome inexperience and lack of confidence in riding bicycles as a mode of transport.

9.1.3. Participatory planning, funding, and evaluation

9.1.3.1. Adopt a systems' perspective

The multidimensional factors influencing the use of greenways as ATCs require an integrated approach that transcends disciplinary boundaries. Systems thinking focuses on *"the dynamic interrelationships of different elements shaping complex sustainability issues. It takes a systemic view of sustainability issues rather than breaking them down into a series of discrete elements that can be addressed separately."* (Abson et al., 2017, p.31). Therefore, it is vital to understand greenway's stakeholders. Who is or would be interested in the success of this project? Who are the landowners? Who are funding bodies (public or private or both) and individuals (e.g., volunteers) in the short and long term? Who regulates the planning of greenways? Who would benefit from this project? Who are the designers and constructors of this project? Who will maintain this project? The answers to these questions are case-specific. However, understanding the dynamic interrelationships between stakeholders or "*the multi-actor network*" (Geels, 2002, p.1260), including power dynamics, is a system-oriented approach that can aid the realisation and sustainability of greenways.

In the pursuit of bringing about change in the context of a complex system, understanding how knowledge is produced, shared and used can influence the system's goals, methods, interactions, and parameters. Technological advancements should not be limited to hardware (e.g., physical infrastructure, bicycles, and more) and software (e.g., bicycle-sharing systems/apps, traffic laws, and more) but also to knowledge production, as Abson et al. (2017) asserted in their research about developing sustainable approaches to transformational change. The empirical research results revealed how knowledge from the perspectives of local residents (users and non-users) as well as experts is essential for understanding greenways and AT in Jeddah city. If one were to only look at international guidelines or principles, there would not be the same nuanced understanding of barriers and opportunities. Therefore, advances in how knowledge is produced, integrated, verified, assessed, communicated, transferred, and generalised for building greenway networks for AT substantiate the role of research and development. For example, input received from public involvement, inventory, and analysis of community and resources can influence greenway goals and the methods used to build them (Flink & Searns, 1993; Hellmund and Smith, 2006; Ndubisi et al., 1995; Ryan et al., 1993). To conclude, research and development in how knowledge is produced and used (in SA and globally) can help identify gaps, assess limitations, and refute socially constructed beliefs in activating greenways' AT function.

Stakeholders' participation (e.g., public-private partnerships), although recommended by the interviewed experts (see Section 8.2), is complex due to greenways' scale (could traverse jurisdictional boundaries), variations in landscape contexts (e.g., urban to rural and vice versa), and co-occurrence of multiple functions along the same route (e.g., preservation vs recreation). Nevertheless, one study in the 1990s and early 2000s showed that citizen's participation in five European cities (Zurich, Basle, Amsterdam, Groningen, and Freiburg) had a key role in redirecting policies, investments, planning, and the public adoption of transit and non-motorised modes of transport (Schiller & Kenworthy, 2017). Therefore, as stressed by several interviewed experts, while challenging, public participation plays an important role in the transition towards sustainable urban mobility, partially facilitated by greenways (see Section 1.3).

9.1.3.2. Establish sustainable financial resources

The interviewed experts unanimously attributed limited budgets as a primary barrier to existing conditions regarding walkways/LPs. Many of their proposed solutions revolved around enhancing collaborations with the concerned authorities to minimise oversights, exchange knowledge and expertise, improve responsiveness to obstacles, and align objectives (see Tables 8-4 to 8-6). For example, an invitation for tender must consider a project's lifecycle: its initiation, planning, construction, maintenance, and closure. Current practices of implementing a project based on predefined templates will often lead to unanticipated obstacles and expenses. As explained by the interviewed experts, this has led, in many instances, to conflict and waste of resources. These issues emphasise the design process and collaboration between a multidisciplinary group of experts from all the concerned authorities. Doing so makes calculated estimations rather than predictions of project expenses.

Nonetheless, decision-makers may not allocate sufficient budgets that meet expectations, which seems to be a regular occurrence. In other cases, budgets could be cut or inconsistent. As reported by the interviewed experts, insufficient funds have partially led to the production of poorly designed and maintained walkways/LPs (e.g., without vegetation). Such development practices must be discontinued because they lead to undesirable places, as shown in Section 7.2, which thwart the purpose behind their creation. Therefore, the interviewed experts suggested seeking funds via alternative resources, specifically from wealthy individuals and investment opportunities (i.e., access fees, advertisements, and kiosks). The former case (i.e., wealthy individuals) is unreliable because it is inconsistent. The latter case risks residents' rejection because walkways/LPs are public spaces, and advertisements may not suit a park's atmosphere. As for allocating spaces for entrepreneurs to sell refreshments/food via kiosks/restaurants, it may work in places (e.g., Al Corniche) but not in others, such as a walkway/LP within a neighbourhood. This is because entrepreneurs are expected to favour locations with high and consistent foot traffic. As a result, dependence on such income sources may lead to unequal delivery (quality) between public parks since some locations may not be attractive to investors. Exacerbating existing practices is that the collected funds are not directly fed to the projects of concern. They go through several bureaucratic channels, and many never find their way back, and when they do, it would have been too late (e.g., plants die if not watered regularly) (see Section 8.1.2 for more information).

The raised arguments against experts' suggestions should not be interpreted as a detraction of their solutions. Offering investment opportunities via kiosks/food trucks is a brilliant strategy when the conditions are met (e.g., good location). However, balancing between public and private interests must be considered to avoid gentrification, leading to social segregation. For example, the documented increase in property values after implementing a greenway (Kang & Cervero, 2009; Majors & Burow, 2015; Suzuki et al., 2013) could unintentionally make these areas only livable for those who can afford it. In addition, introducing entrepreneurial opportunities should not be the only way to secure funds for public parks. It should be a mixture of strategies that reduce projects' expenses (e.g., use of water-tolerant plants, greywater reuse, and usage regulations to minimise damage) and increase sustainable income streams (e.g., endowments and land-value capture).

9.1.3.3. Enable stakeholders' participation

Another way to secure financial resources to build and maintain walkways/LPs (and public parks in general) is via fundraising and collaboration initiatives that engage individuals, businesses, institutions, government agencies, and more (Flink and Searns, 1993). However, unlike regular fundraising projects, those for public parks should be continuous (live projects). For example, maintenance and inventory schedules should be posted and updated regularly via a dedicated online platform. An interested individual or party would visit the online platform, select the walkway/LP of interest, and then contribute to a specific cause/task/opportunity (e.g., fill a water tank, purchase materials, equipment, and more). Alternatively, an individual or party could volunteer personally in site maintenance (e.g., litter collection). In such cases, information about the time slot and tutorials would be presented. With that in mind, charitable donations should only fill funding gaps and not devolve the stewardship responsibility to individuals and businesses.

The definition and specification of projects/tasks should originate from stakeholders' collaboration that reflects the community and site needs. Therefore, projects/tasks/opportunities could be nested under multiple categories, such as site design/development, maintenance, and events. The collected funds must be documented, displayed publicly, and spent directly. However, the administration of such live projects is challenging. It requires full-time employees, skills training, development and maintenance of the online platform, and more. Therefore, reactivation of the neighbourhood council's role in managing public parks, as suggested by interviewee E7 (see Table 8-4), is vital. The success of such a strategy depends largely on its promotion, execution efficiency, transparency, and stakeholders' participation and education. In short, the proposed online fundraising and collaboration platform would enhance community involvement in improving their immediate urban environments.

The proposed collaboration strategy among stakeholders is different from existing practices. Unlike the current centralised governance approach in the design, implementation, and maintenance of public parks (Mandeli, 2011; MOMRA & UN-Habitat, 2019a), the proposed strategy decentralises communication and participation of stakeholders at the residential district level, producing smaller units that are managed by neighbourhood councils. Such decentralisation aims to enhance participatory governance and community empowerment to facilitate sustainability transitions (e.g., building pedestrian and bicycle facilities). Determination of site program, design, budgets, maintenance, and more is another area where the proposed strategy differs from existing practices. The former is specified by centralised government bodies such as MOMRA (an issue explained by the interviewed experts; see Sections 8.1.2 and 8.1.3), whereas the latter would originate from stakeholders' collaboration. Therefore, interactive communication with the public about their immediate spaces (about their plans, budgets, maintenance, and more) would become localised. According to the Organisation for Economic Co-operation and Development (OECD), the benefits of decentralisation include, but are not limited to, tailoring services to local needs, improving the efficiency of public service delivery, strengthening public participation, and enabling experimentation and policy innovation (OECD, 2019). Simultaneously, it risks increasing the urban development disparities between residential districts, partially driven by the differences in financial, administrative, and technical capacities. Therefore, more interdisciplinary research is needed to design and implement the decentralised participatory system while resolving legal, political, financial, and administrative conflicts with the existing system of designing, implementing, and maintaining public parks (including greenways).

9.1.3.4. Measure greenways' multifunctional contributions

Measuring greenways' contributions is important to create a case for policy-makers, provide evidence to the public of their benefits, and inform their design. As discussed in Chapter Two, key performance indicators of AT in SA are absent from the Quality-of-life Program implementation plan 2020-2023. For example, measuring AT behaviours (e.g., via automated counters or crowdsourced data), their frequencies, durations, and modes are important indicators of greenways' contributions to surrounding neighbourhoods. These numbers could be correlated with physical activity rates, happiness, body mass index, economic returns at the individual (e.g., savings) and community levels (e.g., revenue from bicycle share services), and more.

Then, these results could be stratified based on sociodemographic characteristics such as gender, age, household income, and more. Many of these correlations were already conducted for several greenways internationally (Auchincloss et al., 2019; Burbidge and Goulias, 2009; Dill et al., 2014; Evenson et al., 2005; Frank et al., 2021; Hirsch et al., 2017; Krizek and Johnson, 2007; Wolff-Hughes et al., 2014). These studies were systematically reviewed in Chapter Four. However, none were performed in SA. Therefore, it is important to establish strategic performance indicators for greenways at the national and local levels, especially their contributions to changing travel behaviours.

Even though implementing a greenway network via the lens of systems thinking is recommended (see Section 9.1.3.1), starting at a city-wide scale increases challenges, risks, and time to see results; thus, radical, challenge-driven, feasible, strategic, and communicative/mobilising experimentation is key (Bertolini, 2020; Lydon and Garcia, 2015). Flink and Searns (1993) described a pilot project as the *"best way to build a greenway constituency."* (Flink & Searns, 1993, p.71). Pilot projects can help potential users, funders, decision-makers, and surrounding businesses see and measure the impact of a greenway. Simultaneously, it can help the bodies involved in the planning process evaluate implemented measures, learn from users' experiences, and build a case for future developments (Flink, 2020; Flink and Searns, 1993). In short, experimentation is a key sustainability transition strategy to build a greenway constituency, minimise both challenges and risks, evaluate implemented measures, and inform future development practices.

9.2. A pivotal period for the development direction of greenways in SA

Based on the review of academic literature and governmental reports (see Section 1.4 and Section 3.5) and the examination of existing greenway types in Jeddah city (see Section 5.4), frameworks for planning and managing greenways in SA framed the function of greenways narrowly. They did not provide accommodation for more multifunctional uses and associated development trajectories. Only recently, such development direction changed, as evidenced in the National Public Realm Design Manual (MOMRAH, 2022b), where greenways' contribution to multimodal mobility is emphasised in their definition (see Section 2.4.1). Based on the identified barriers in the thesis, translating such qualities into existing conditions is a complex process due to its multidimensionality. Nonetheless, such a pivotal point places the walkways/LPs created ever since the 21st century in SA as a first generation. Second-generation greenways, within (sub)urban contexts in Saudi cities, are ones that would partially consider sustainable transportation as a motive for their (re)development. In short, the recent political acknowledgement of greenways' contribution to multimodal transportation is a pivotal period for their development direction in SA.

Greenways' typology in SA is unique to its cultural and environmental context, making it different from international examples. The identification of existing walkways/LPs types in Jeddah, as presented in Section 5.4, should be interpreted as a first step toward identifying the variations of existing types. However, recent efforts to provide a typology for greenways in SA are based on an examination of existing conditions and functions without questioning whether those types are indeed greenways and without comparing those types to globally established greenway typologies (Ahern, 1995; Fabos, 1995; Hellmund & Smith, 2006; Horte & Eisenman, 2020; Kullmann, 2011; Liu et al., 2020; Little, 1990; Turner, 1995). These scholars primarily classified greenways based on their settings and purposes, which often overlap. Moving from generic to specific classifications could be more beneficial in setting minimum requirements regarding the quality, project program, and range of services and facilities. For example, ATCs could have subcategories based on scale/size (i.e., road hierarchies). Simultaneously, these requirements should be flexible enough to consider existing conditions such as topography, property ownership, land-use types, regulations, and more. In short, movement from generic to specific categorisation of greenways could be a way to enhance project programming and give prominence to their differences among various nations.

If Jeddah's urban milieu is unsupportive of AT, how could its greenways be any different? As the questionnaire and interview participants explained, outdoor temperature, urban sprawl, lack of public transportation, unavailability of sidewalks, and more contributed to creating an auto-centric lifestyle (see Chapter Seven). These conditions exemplify Copenhagen, one of the world's most bikeable cities, in the 1950s and 1960s (Colville-Andersen, 2018). So, what drove such change? According to Colville-Andersen (2018), the two oil crises in the 1970s made commuting via automobile expensive, resulting in thousands of public demonstrations to improve bicycling infrastructure. Equivalently, the Saudi Vision 2030 could be viewed as a future disrupter to automobile-centric systems. Specifically, the vision's quality of life program pledged to enhance the urban landscape (e.g., greenways) and quality of services (e.g., public transportation) by 2030, creating momentum at all levels to reclaim Saudi cities for people (see Section 3.5 for more information). Social and economic reforms drive urbanism and societal change in both cases (Denmark and SA); however, at different timelines and circumstances. Nonetheless, will Saudi Vision 2030 succeed in destabilising existing systems and industries (i.e., regime resistance) to accelerate the transition towards sustainable urban mobility? Only time will tell.

Since 68% of SA's population is under 40 years old (General Authority for Statistics, 2021), the adoption of multimodal travel at a rapid pace has an increased likelihood. As concluded by the systematic review (see Section 4.4), active commuters via greenways are likely to be ≤ 40 years old (Chen et al., 2019; Hirsch et al., 2017). Saudi Arabia could capitalise on such an opportunity to accelerate the transition towards public and active transportation.

9.3. Chapter Nine Summary

The discussion of research findings primarily aimed to provide strategies to activate greenways as facilitators of AT in Jeddah city. Considering the identified barriers in

Chapters Six and Seven, the proposed strategies were guided by existing literature, global best practices, and the interviewed experts' recommendations (see Section 8.2). Due to the multidimensionality of the identified barriers, the synthesised discussion of strategies extended beyond site-specific improvements (e.g., improving thermal comfort). Understanding the interrelationships of different components that shaped those complex barriers and the extent of their impact is key to addressing them. In other words, actions to resolve the identified barriers must be addressed comprehensively, collaboratively with stakeholders, and simultaneously rather than discrete tasks. Therefore, a systems-thinking approach to researching, planning, implementing, maintaining, assessing, and integrating greenways with other planning initiatives (e.g., transit-oriented development) is needed to activate their AT function.

What must greenways be to accelerate the transition towards sustainable urban mobility? As explained in Sections 9.1.1 to 9.1.3, their activation needs to make them multifunctional, connected, accessible, comfortable, safe, enjoyable, and contributors to sustainable development. Simultaneously, the degree of success in achieving such characteristics depends on the quality and performance of public transportation, landscape management, urban governance, technological innovations (e.g., in communications, infrastructures, and mobility), and more. Therefore, a whole system reconfiguration is needed to enable active and public transportation. However, as Geels (2019) explained, the existing automobile-centric systems have lock-in mechanisms (e.g., investments in skills, businesses, factories, and infrastructure), which have become embedded in people's lifestyles. Inducing a cultural change, in part, requires policies that support investments in pedestrian and bicycle facilities, bicycle education programs, public awareness campaigns, incentives, and increasing the capacity of institutional actors involved in planning for AT. Implementing these policies would benefit from phasing to minimise challenges and risks and measuring their contributions.

With that in mind, Saudi Arabia's social and economic reform began to stabilise its vision to overcome automobile dependence, especially via its quality-of-life program. Such change is partially observed in the redefinition of greenways, which acknowledges their contribution to multimodal transportation. Therefore, urban greenways in Saudi cities that consider sustainable transportation as a motive for their (re)development would be considered second-generation. However, movement from generic to specific in categorising greenways is needed to enhance project programming and give prominence to their differences among various countries.

CHAPTER TEN

RESEARCH CONCLUSION

10. Chapter Ten: Research Conclusion

Chapter Ten concludes this PhD research. Firstly, it reviews the main research aim and questions and summarises key findings. Secondly, it recaps the key contributions to scholarship the research has made. Finally, it discusses the research limitations and provides future research opportunities.

10.1. Summary of research findings

This research aimed to explore the barriers and strategies associated with activating greenways' function as AT facilitators in SA, using Jeddah City as a case study. This was pursued via mixed research methods (web-based questionnaire, environmental audits, field observations (FOs), interviews with local and international experts as well as leaders of stakeholders' groups) and informed by the review of existing literature (Chapters Two to Four). The empirical findings of this PhD research followed the integrated knowledge generation approach in landscape architecture research (Bruns et al., 2016). Thus, exploration of the activation barriers encompassed studies of the physical environment (structure), opinions and experiences (image), and preferences and behaviours (action). Furthermore, interviews with participants revealed various underlying causes of the existing structure and function of Jeddah's greenways and informed proposed strategies to activate their AT potential.

The physical environment was assessed on three levels: city, neighbourhood, and site. At the city scale, findings showed that Jeddah's walkways/LPs are fragmented, lack variety in scale and design characteristics, are rarely accessible within walking distance from residents' homes, and are frequently interrupted via intersections with high-speed arterial roads. Interviewed experts identified numerous underlying causes of these barriers. These barriers included the lack of green spaces, planning strategy of open spaces (lacking connectivity, variety or flexibility in adapting to different contexts, environmental considerations, and community involvement), fragmentation of responsibilities among the concerned authorities, high modification costs of utility infrastructures, conflicts in land-use regulations, the presence of competing urban development priorities, acts of vandalism, and people's unwillingness to cooperate in enhancing their shared urban environment.

Furthermore, design paradigms of walkways/LPs were found to reinforce the automobile-dependent lifestyle. For example, on average, NDC's walkways/LPs have one-third of their total area dedicated to vehicle parking, driveways, and narrow median islands that function only as traffic lane separators. Simultaneously, using high curb heights (to deter reckless driving and parking) and road-like lighting design are other areas that manifest the influence of automobile-centric planning on walkways/LPs' design. As discussed in Chapter Nine (Section 9.1.4), one way to reduce the duplication of services (e.g., parking spaces) and maximise greenways' benefits is by placing greenways on roadsides, which differs from the common development practices in Jeddah city.

At the neighbourhood scale, street intersection density and sidewalk walkability assessments were conducted within 400 m of five walkways/LPs in Jeddah city as case studies. Results showed that all these neighbourhoods achieved the local (and global) minimum standards, suggesting they have a well-connected street network. However, sidewalk walkability was unsafe due to unavailability or obstructions caused by building and management practices and residents' encroachments. These issues apply to 91% of sidewalks, on average, in the examined case studies (i.e., forcing pedestrians to walk along with vehicle traffic). Simultaneously, inactive frontages at the ground floor level, inappropriate location of street utilities, and differences in buildings' setback elevations were identified as additional barriers to reclaiming streets for people (via, for example, neighbourhood greenways).

At the site scale, the selected five case studies also had route-level assessments using an adapted PEAT, which examined walkways/LPs' design, amenities, and maintenance. The assessment had 33 indicators (19 were at the segment level) and used a four-point rating scale. Even though several indicators had fair and good scores (e.g., pavement surface condition and site distance), the potential of these sites to support active transportation is thwarted by many other impediments. These were primarily attributed to inaccessibility (e.g., lack of pedestrian crossings) and unavailability of several facilities and amenities (e.g., public toilets). These impediments were consistent across all sites and resulted in none conforming to national standards and guidelines. At the same time, interviewed experts underscored limited budgets, water scarcity, lack of integration with the concerned authorities, and limitations enforced by governmental contracts as underlying causes of the identified route-level barriers. These issues were shown to be legacies of past planning regimes that remain embedded within legal frameworks.

The questionnaire respondents and interview participants confirmed many barriers that emerged from examining the physical environment. They reported additional, yet important, insights about Jeddah's walkways/LPs and AT. Research findings showed that Jeddah's walkways/LPs were created and valued as destinations that facilitate physical, leisure, and social activities but rarely for commuting. Since linking people to places is one of greenways' primary functions, their activation as facilitators of AT in Jeddah city is needed. Influences on such usage preference are numerous but could be classified under route (or site), contextual/environmental, sociocultural, and personal factors. Results showed that these factors are related to one another in complex ways.

As reported by the questionnaire and interview participants, site-related factors such as facilities, amenities, crowdedness, water features/bodies, accessibility, and maintenance act as motivators or deterrents to using Jeddah walkways/LPs, including as ATCs. Because of differences in the design and maintenance of Jeddah's walkways/LPs, findings revealed preferences for distant walkways/LPs (mostly Al Corniche Parks) rather than/instead of the one nearest to their home addresses.

Furthermore, walkways/LPs with good facilities and amenities were shown to attract a wide range of companion preferences, resulting in longer periods of time spent in them. Analysis of the questionnaire's open-ended responses also showed that the attraction of individuals' family and friends to a particular walkway/LP also influenced their own choices. However, high turnouts to a particular walkway/LP commonly resulted in challenges, such as conflict among users and usage regulation. This emphasised the need to provide Jeddah's greenways with place and link qualities (i.e., consider different usage purposes such as commuting, recreation, and socialisation).

Since Jeddah's urban milieu is unsupportive of public and active transit, addressing contextual/environmental factors is essential to unlocking walkways/LPs' potential as ATCs in Jeddah city. Research findings showed that outdoor temperature, distance between destinations, lack of public transit, bicycle share services, pedestrian and bicycle facilities, and policies encouraging AT are major concerns. These barriers (in addition to route-related ones) affected women's visitation frequencies to Jeddah's walkways/LPs more than men's due to a range of cultural, historical and practical factors. Therefore, findings suggest that in a city like Jeddah, where travel options are mostly limited to automobiles, access to opportunities (in this case, greenways) is unequal.

So far, the identified barriers are similar to many international experiences but develop uniquely in Jeddah city. The same conclusion could also be applied to many sociocultural and personal barriers. However, reliance solely on physical greenway networks does not suffice to address them. Specifically, research findings revealed that anti-social behaviours (e.g., harassment, motorists' behaviours, bicycle theft), social norms, perceptions about the bicycle culture, unawareness of traffic rules and regulations for bicyclists, Saudi formal attire, and religion were sociocultural barriers to bicycling for transportation in Jeddah city. Many of these impediments (in addition to the contextual barriers) are linked to several personal factors, which include lack of time and interest (intrinsic motivation), habit, health state, bicycle ownership, bicycling self-efficacy, knowledge, and skills. However, unique to the Saudi context is how religion and social norms influence women's participation in bicycling (see Section 9.1.1.2 for the discussion about such an aspect). Interviews with local AT interest groups explained the nature of those challenges and their ongoing efforts to address many of them via their regular training sessions and events. Their voluntary social support is a gateway to changing travel behaviour, similar to many international experiences.

As shown, activating greenways as facilitators of AT in Jeddah city requires addressing barriers related to AT, which are multidimensional. Interviews with experts revealed the underlying causes of such barriers and offered recommendations to address them. These recommendations stressed the importance of action across social, environmental, technological, economic and legal domains. Key barriers to greenway activation were synthesised in Chapter Nine, along with strategies for addressing them in the future.

These strategies included but were not limited to improving stakeholders' participation, integrating with public transportation, maximising greenways' diverse benefits, and responding to the sociocultural context. Ultimately, greenways' activation as ATCs requires them to be multifunctional, connected, accessible, comfortable, safe, enjoyable, and contribute to sustainable development. Yet, the degree of success in achieving such characteristics depends on the quality and performance of public transportation, landscape management, urban governance, technological innovations (e.g., in communications, infrastructures, and mobility), and more. Therefore, identified barriers must be addressed comprehensively, collaboratively with stakeholders, and simultaneously rather than discrete actions.

10.2. Contributions to knowledge

This PhD thesis has contributed to scholarship on urban greenways in a number of ways. The review of literature on greenways' forms and functions, divided into five time periods (Chapter Three), provided an updated literature review of greenways' evolution while stressing its role as transportation corridors in planning initiatives, policies, and case studies worldwide (mainly in English-speaking countries). Doing so encompassed interdisciplinary research that connects with and contributes to various scholarly communities. Furthermore, it defined a fifth-generation (2006-present) that viewed greenways as infrastructure, a new typology of greenway development from an explicitly international focus. This chronological review provided both urban scholars and practitioners with a temporal lens on greenway planning and a novel framework to understand international trends in greenway development. Simultaneously, it connected greenway scholarship to urban and open space planning in Saudi cities. Doing so built an understanding of the past, present, and potential future of greenways and AT in SA in relation to international experiences, which is a novel contribution to the greenway planning literature.

Another significant contribution of this thesis is establishing an empirical evidence base of factors that influence greenways' usage for AT based on a systematic review of internationally published peer-reviewed journal articles from 1991 until 2021[28] (Chapter Four). The results improved the understanding of greenways' usage by, for the first time, bringing together evidence in a form that allows decision-makers to recognise international experiences and shape practice. Such an understanding can maximise greenways' potential. Simultaneously, clarifying the state of existing literature about greenways' usage as ATCs helped identify knowledge gaps in this area, strengthen its knowledge base, and improve the accessibility of available evidence to decision-makers.

This PhD thesis is the first study to examine the challenges associated with using greenways as ATCs in Saudi cities. Doing so addresses the need for more research on greenways in SA, as highlighted by the systematic review. Empirical research emphasised the importance of context (historical, political, sociocultural,

[28] The systematic review has been published in the journal *Sustainability* (Zawawi et al., 2023).

environmental) when seeking to activate greenways' function as ATCs. There is a wide availability of resources that explain how to design greenways (e.g., international standards), but little knowledge on how to move an automobile-dependent city towards AT via greenways. In identifying influences on greenway usage, this research underscored key factors that must be overcome, including automobile-centric lifestyles, planning systems, social norms, lack of bicycling skills and knowledge, outdoor temperature, and more. These barriers cannot simply be 'fixed' through good design; they must be directly factored into an integrated and multifunctional strategy.

This PhD research extended existing knowledge on the influences of sociocultural factors on women's usage of public open spaces in Saudi cities (Addas, 2015; Almahmood et al., 2017, 2018; van Geel, 2016; Maghrabi, 2019; and Maneval, 2019). Specifically, research findings explained how, where, when, why, and with whom women bicycle in Jeddah city (see Section 7.5). Analysis and interpretation of results directly linked religion to women's cyclists' identity and social and personal norms (see Section 9.1.2.2 for further details). These results provide additional insights into existing research from other societies about religious and gender norms' influence on women's participation in bicycling (Hayhurst et al., 2022; Ravensbergen, 2022; Song et al., 2018). Understanding such complexities is important because it can affect social support for policies supporting bicycle usage in Saudi cities. Simultaneously, since women's bicycling in Jeddah city is confined and socially accepted within designated locations (e.g., Jeddah's walkways/LPs), it can hinder the effectiveness of any proposed greenway network in the future. These contributions to knowledge also respond directly to Aljoufie's (2017) conclusion about the need to explore the challenges of bicycle usage in Jeddah city and planning for its infrastructure.

Equally important to the contextual influences are the route or greenway-specific factors such as proximity, accessibility, comfort, safety, and more. This PhD research contributed to existing AT theories (e.g., Alfonzo, 2005; Panter et al., 2008; Saelens et al., 2003; Schneider, 2013) by explaining the influence of situational and temporal factors at the route level (e.g., conflict between site users, anti-social behaviour, and crowdedness) on where and when residents of Jeddah city walk or bicycle. Results showed that these factors are associated with route or greenway attributes. Therefore, their influence on one's routine choice to actively commute via greenways emphasises the importance of greenways' design, regulation, and management.

Even though many of the identified barriers (e.g., unavailability of sidewalks) in Jeddah city have previously been reported by several scholars in SA (Addas, 2015; Addas and Alserayhi, 2020b; Alhajaj, 2014; AlShareef and Aljoufie, 2020; Maghrabi, 2019), this PhD research identified the size and extent of those issues using reliable auditing tools (i.e., adapted MAPPA and PEAT) and focused on factors related to AT, which had not previously been applied in Jeddah city. Using assessment frameworks resulted in high precision and transparency, which enabled direct comparison of Jeddah's urban form with local and global standards.

Furthermore, the environmental audits comprised factors unexamined by previous studies. These include, but are not limited to, frontages at the ground floor level, regulatory and wayfinding signages, path slops, road markings, traffic speeds, public transit stops, and bicycle racks. Exploring such influences is important since they are associated with the safety, accessibility, and comfort of active commuting. Furthermore, examining several sites in Jeddah city indicated the consistency and variability of the identified barriers. In short, even though some of the identified barriers in the thesis were reported in existing literature, the applied research methods and tools enhanced the accuracy of results and generated nuanced insights.

The proposed strategies that resulted from the discussion of research findings (including the interviewed experts' recommendations) suggest a departure from existing greenway planning, design, and management practices in SA. In brief, these strategies partially shift Jeddah's greenways from being standalone and fragmented destinations into multifunctional and connected infrastructures that contribute to sustainable transportation and livability agendas (see Chapter Nine). These agendas include enhancing access to opportunities, especially for disadvantaged groups who are unable or unpermitted or cannot afford an automobile in Saudi cities. Enablers of such transition are stakeholders' participation, the quality and performance of other services and infrastructures (e.g., public transit), policies that enable and incentivise AT, institutional actors' capacity to plan for AT, bicycle education programs, public awareness campaigns, and more. Therefore, in response to the identified barriers in the thesis, the proposed set of actions enhanced the understanding of interrelationships of different components and opportunities in the planning, design, and management of greenways, offering strategies that collectively facilitate sustainable transitions. The proposed strategies are of value to academics, practitioners, and decision-makers involved in creating and managing greenways.

10.3. Research limitations and future directions[29]

Many empirical research findings should be considered in light of some limitations. Since the scope of work was limited to Jeddah's greenways, any extrapolation of the research findings to other locations should be done cautiously. Topography, for instance, despite being a factor that could influence a trip's active travel distance, was not raised as an issue in the case study of Jeddah since the city enjoys mild slope changes. However, topography could be a major deterrent to AT in cities such as Taif or Makkah, further emphasising the need to cover other regions in SA. The selection criteria of a potential case study in SA could also consider drawing comparisons between greenway users in urban, peri-urban, and rural areas.

[29] The systematic review, presented in Chapter Four, discussed future research directions (see Section 4.5.1). Therefore, the content of this Section is focused on the empirical research results.

Although the questionnaire sample provided useful insights into the attitudes and behaviours of Jeddah residents, sample size limited the ability to perform some statistical tests and comparative statistical analyses among Jeddah's walkways/LPs. What exacerbated such limitation is the imbalanced number of questionnaire responses for each of the 18 LPs (out of 24) because of the decision to use convenience sampling. Therefore, the ability to statistically compare usage between LPs was limited to a certain extent. Future studies could build on these results and adopt purposive or stratified sampling approaches to ameliorate these issues.

The questionnaire and FOs adopted a cross-sectional design, introducing a temporality bias. For example, inter-seasonal variability in users' behaviours could not be explored. However, to overcome such limitations, multiple methods (i.e., interviews and environmental audits) were used to validate the questionnaire and FOs findings and gain additional insights. Nonetheless, future research could consider longitudinal study designs to understand the influence of factors over time. Given the proposed strategies to transition Jeddah towards greater uptake of active commuting, longitudinal research would be worthwhile to investigate the dynamics of such a change over time.

Perceived distance from home address was used because of the importance of residents' perceptions of their local environment. However, such perceptions may not align with objective measurements. Thus, future research could explore how residents understand and navigate their local environment and how this corresponds with geographical attributes. However, to put matters in perspective, issues regarding distance were two out of 35 questions in the questionnaire that each participant had to answer to qualify as a complete response. Moreover, proximity analysis via GIS was used to triangulate with other data about distance, thus overcoming such limitations to a certain extent.

Nonetheless, future research can adopt means to accurately measure the distance of participants' home addresses from a greenway. An example of such means would be geolocating participants' home addresses anonymously using GPS. Another method would be to narrow the research scope of work to home addresses located at varying distances from a single greenway to improve the accuracy of research results that incorporate distance as one of its variables.

This PhD research has evidenced that active commuters via greenways in Jeddah city are rare. While it was important to document both users and non-users and to understand barriers to greenway use, the low number of questionnaire participants who stated that they walk or cycle for transportation via greenways in Jeddah city limited the ability to draw statistical comparisons of those user types with international case studies. Furthermore, it also limited the ability to compare the behaviour of different user types (e.g., active commuters vs. recreational users). Therefore, future research could purposely target active commuters via greenways to conduct comparative analysis studies that shed more light on their behaviours and needs, especially in SA, when AT gains more traction.

The sidewalk walkability audit of five neighbourhoods using adapted MAPPA and greenway assessments using an adapted PEAT were based on local and global standards and best practices. Such well-established methods provided objective quantitative results, facilitating comparisons between the examined sites and summarising results. However, future research could develop those methods further by considering additional assessment criteria for each indicator/factor (though it could complicate the assessment process). These include, but are not limited to, aesthetic quality, comfort, variety, efficiency, and more.

To elaborate on such points, width and seating in the examined walkways/LPs are lacking from a qualitative design perspective. While width scored well across all sites, the assessment did not consider the walkway/LP's width's appropriateness to the context and existing pedestrian traffic volumes. As for seating, the adapted PEAT assessment measured their availability, frequency, and maintenance. It did not consider the design and comfort of those amenities. Figure 10-1 shows that seating across all case studies is similar (i.e., concrete benches). Future designs may consider different seating options. Alternatives that encourage social interactions, consider different seating/relaxing positions, incorporate arm and backrests, and reflect the site design theme. In short, there is merit in undertaking qualitative assessments of greenway design (i.e., how design elements are perceived and utilised) rather than focussing on measurement and adherence to global standards.

Figure 10-1. Similar seating designs across the examined case studies.

While a large number of factors influencing greenway use were assessed in this research, not everything was studied. Future research could build on the findings by exploring unexamined dimensions such as economic conditions, delays in adult life stage milestones, a shift in attitudes, increased driver's licence restrictions, especially for young people (e.g., more training), and car ownership costs (including fuel, maintenance, insurance, taxes, depreciation, parking). These deterrents and factors gradually influence people's living preferences and travel behaviours (Delbosc et al., 2019), especially millennials (Bobb et al., 2018; Urban Land Institute, 2016). That said, discussing such deterrents would not be a call to deliberately make the ownership and usage of automobiles expensive and difficult in SA. Instead, it would call for social inclusion, reduced health inequalities and costs, decreased commuting duration, safer streets, enhanced air quality, and improved real estate values and revenues for local businesses, as evidenced by Bobb et al. (2018).

The same applies to the proposed strategies that resulted from the discussion of research findings that provided directions for activating greenways in Jeddah city as facilitators of AT (see Chapter Nine). These directions require further interdisciplinary research to implement them because they encompass dimensions beyond the scope of this PhD research. For instance, stakeholders' participation, as recommended by the interviewed experts, is key to addressing many of the identified barriers in the thesis (e.g., lack of vegetation due to limited financial resources). However, too much is yet known about the legal, political, financial, and administrative conflicts in implementing the proposed strategies (e.g., decentralised participatory system) that resulted from relating to existing literature and local and global best practices. Simultaneously, testing and measuring the effectiveness of those strategies is necessary before widescale implementations. Furthermore, detailed designs and implementation procedures will (and should) vary depending on existing conditions and the decisions from stakeholders' participation in response to the community and site needs. In short, the proposed actions to activate greenways' function as ATCs provided future research directions for the (re)development of greenways in Jeddah city.

Finally, the imposed lockdown and travel restrictions during COVID-19 (nearly two years) constrained the data collection methods and duration. Exacerbating such an unprecedented circumstance was unpredictability. It was unclear when the imposed restrictions would end. The same applies to the measures that controlled the spread of COVID-19, which varied in strictness, duration, and timing between the UK and SA. Furthermore, people's behaviours in public open spaces before and during COVID-19 changed when restrictions were relaxed (e.g., social distancing). Therefore, methods such as FOs were significantly impacted. Please read Chapter Five for more details on the impact of COVID-19 on the amount and type of data that could be collected.

10.4. Conclusion

Due to the existing automobile-centric systems in Jeddah city that have lock-in mechanisms embedded in people's lifestyles, activating the AT function of greenways in Jeddah requires multidimensional changes across sectors and among diverse sets of actors. First, change must follow a systems-thinking approach. In other words, the identified greenways and AT barriers in the thesis must be addressed comprehensively, collaboratively with stakeholders, and simultaneously rather than as sequential, discrete tasks. Thus, it is vital to understand the dynamic interrelationships of the different components that shaped those challenges and the extent of their impact.

Second, change must consider how knowledge is produced, shared, and used for building a greenway network for AT. The role of research and development, such as that presented in this thesis, is vital. Description of design patterns and features is necessary, yet understanding history, culture, behaviour, and the inclusion of residents' perspectives, in addition to expert voices, is critical. Third, change must start small by phasing in change gradually. Given the manifold challenges to AT in Saudi Arabia, an experimentation strategy is needed to build a greenway constituency, minimise challenges and risks and evaluate implemented measures. Fourth, change must consider equity, diversity, and inclusion as a primary lens in its decisions to avoid gentrification and social segregation. Fifth, change must be accompanied by reforming governance processes, including legal instruments, to enable, sustain, regulate and protect AT (e.g., via greenways). Sixth, change must increase the capacity of institutional actors involved in planning for AT. Lastly, change must be measured and monitored to support a long-term commitment to change.

In conclusion, the success of activating the AT function of greenways is not exclusively dependent on building physical AT networks; other social, cultural, legal, and contextual factors are also key. Enablers of such activation include, but are not limited to, the quality and performance of public services and infrastructures (e.g., public transit), policies that enable and incentivise AT, bicycle education programs, and public awareness campaigns. Therefore, greenways' support and integration with planning initiatives is vital (e.g., transit-oriented development and tourism plans). At the same time, greenways must gain public support from, for example, helping businesses thrive, enabling active lifestyles, and furthering the cause of institutions and corporations involved in sustainable development. Doing so requires greenways to be multifunctional, connected, accessible, comfortable, safe, enjoyable, and contributors to sustainable development. Achieving these qualities must also apply to all user types (e.g., different ages and abilities) and usage purposes such as active commuting, exercising, socialising, and learning. As such, adopting sustainable travel patterns becomes a desired rather than a needed practice.

Even though the investments in greenway projects as a solution to the impacts of automobile dependence in SA are still in the early stages, the Saudi Vision 2030 signify a positive change and growth. Planning greenways as infrastructure in SA represents a promising step towards a sustainable and healthier future.

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APPENDICES

12. Appendix A: Data from Jeddah Municipality

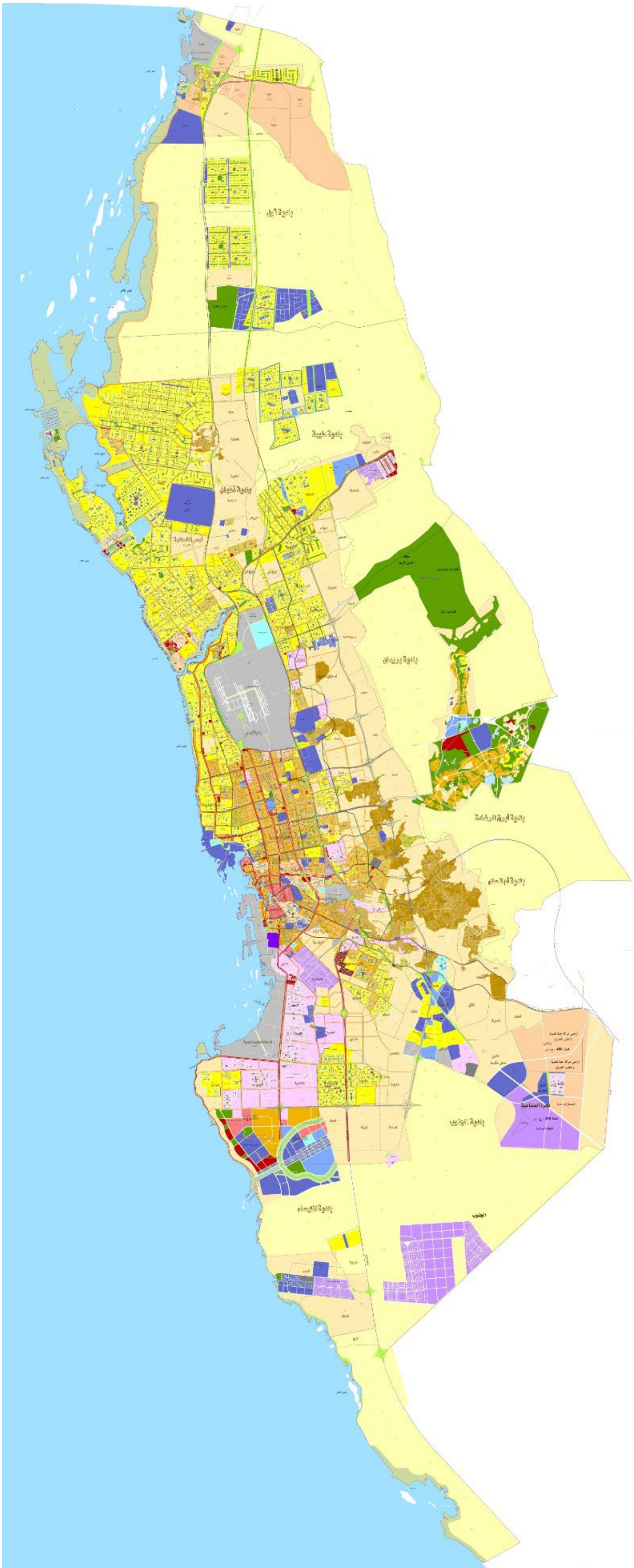


Figure A1. Land-use map of Jeddah city in 2019 (raster image).

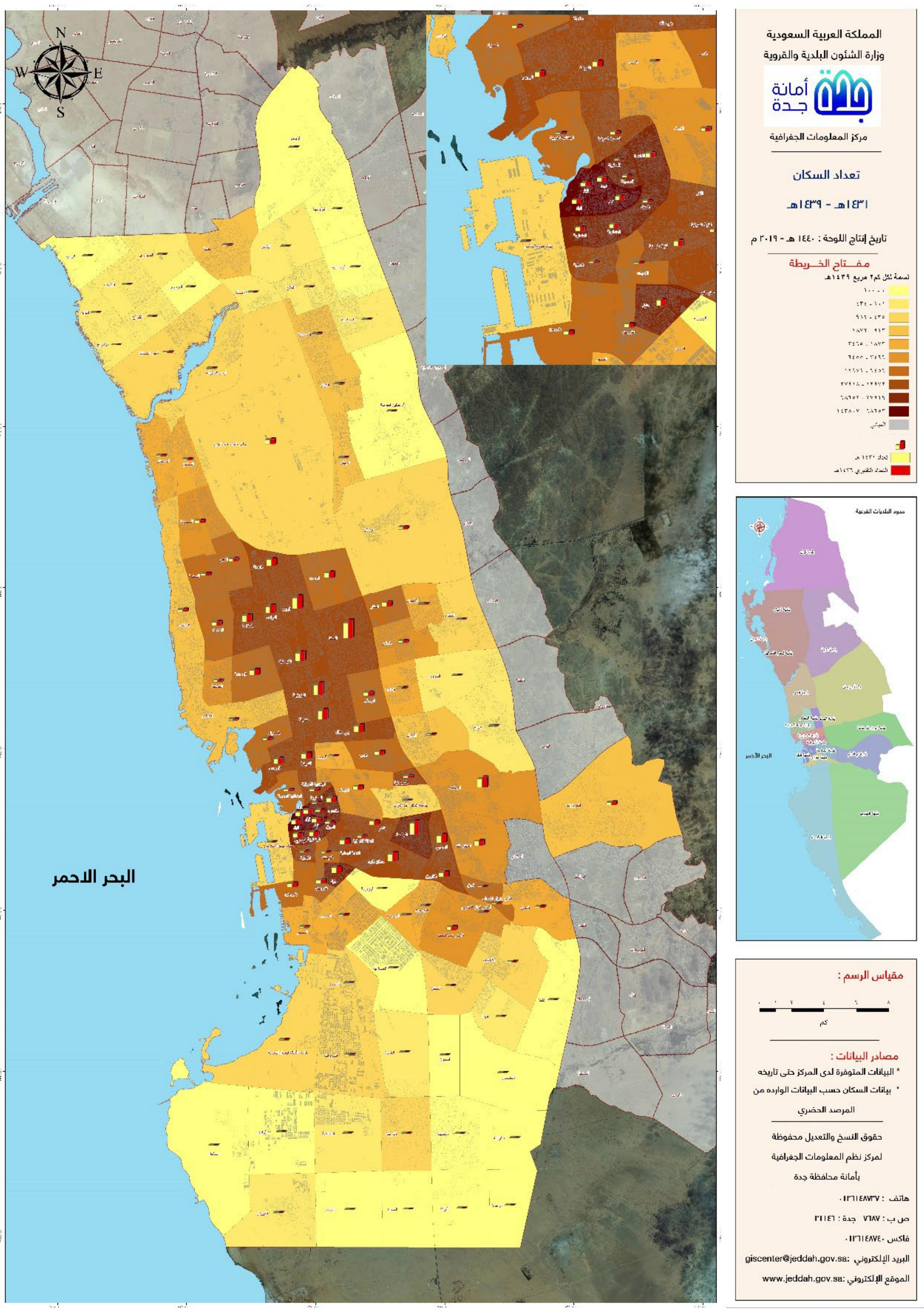


Figure A2. Jeddah’s population density 2019 (raster image).

13. Appendix B: Ethics Committee Reviewer Decision

This form must be completed by each reviewer. Each application will be reviewed by two members of the ethics committee. Reviews may be completed electronically and sent to the Faculty ethics administrator (Jo Deeley) from a University of Nottingham email address, or may be completed in paper form and delivered to the Faculty of Engineering Research Office.

Applicant full name Abdulrahman Zawawi - Resubmission

Reviewed by:

Name DE13

Signature (paper based only) ………………………………………………………………

Date 01/11/2019

- [x] Approval awarded - no changes required
- [ ] Approval awarded - subject to required changes (see comments below)
- [ ] Approval pending - further information & resubmission required (see comments)
- [ ] Approval declined – reasons given below

Comments:

Please note:

1. The approval only covers the participants and trials specified on the form and further approval must be requested for any repetition or extension to the investigation.
2. The approval covers the ethical requirements for the techniques and procedures described in the protocol but does not replace a safety or risk assessment.
3. Approval is not intended to convey any judgement on the quality of the research, experimental design or techniques.
4. Normally, all queries raised by reviewers should be addressed. In the case of conflicting or incomplete views, the ethics committee chair will review the comments and relay these to the applicant via email. All email correspondence related to the application must be copied to the Faculty research ethics administrator.

Any problems which arise during the course of the investigation must be reported to the Faculty Research Ethics Committee

14. Appendix C: The questionnaire

The University of Nottingham

Informed Consent Document for Research (The Arabic version is available upon request from the researcher)

Principal Researcher: Abdulrahman A. Zawawi
Study Title: "Greenways and Sustainable Urban Mobility Systems: The case study of Jeddah, Saudi Arabia."
Institution: University of Nottingham

This message is an open invitation to voluntarily participate in a PhD. research web-based questionnaire. The targeted audiences are residents of Jeddah city who are above 18 years old. This research is funded by King Abdulaziz University. The results of this PhD. research will only be used for educational and research purposes.

The questionnaire's questions aim to inquire about your perceptions, preferences, and the factors that influence your use (or non-use) of Jeddah's greenways. However, this questionnaire focus on your use experience of Jeddah's greenways for commuting purposes. This means that the greenway is not the destination, but rather a medium that enables you to reach desired points of interests in the city whether for business or pleasure (i.e. place of work, or study). Simultaneously, the author will ask you about the public amenities and services (i.e. public transport) in proximity to those greenways. Thus, the questionnaire will specifically examine whether the greenway near your home address and its nearby public amenities and services facilitates access to your desired destinations on foot or using a bicycle.

Please note that the term "greenways" is a word used internationally to describe corridors of land and water or linear parks that serve multi-functional purposes. The local term used by Jeddah Municipality is "walkways." Examples of Jeddah's walkways include, but not limited to, Jeddah waterfront walkway, Al Jamiaa walkway, and Al Tahlia walkway.

Your participation in this questionnaire is anonymous by default in all its stages. However, at the end of the questionnaire, you will be asked to voluntarily provide your contact information (name, email, and phone number) to further participate in this PhD. study. Provision of such information will be considered as a consent to have the author contact you personally. The main purpose is to give you the opportunity to elaborate on the choices you made in the questionnaire and gain a deeper understanding of the various factors the influence your use experiences of Jeddah's greenways. The collection of such information is solely for reaching out to participants who are interested and willing to be interviewed by the author via the phone or Skype. The collected contact information and responses will be stored in a designated private digital directory that is password protect and located in a secure server. It will be kept securely for seven years following the research publication in accordance with the Data Protection Act. After that, all the collected data will be permanently deleted.

Providing your contact information does not necessarily mean that the author's correspondence with you is guaranteed. The selection of participants in the second phase of the Ph.D. research inquiry is random. The author will use digital randomizer to select potential participants. If you happen to be selected by the software, the author will send you an invitation letter via email. This email will include all the information needed for participation. It will answer all your questions regarding the nature and procedure of the in-depth interview. However, your consent then is important. The author will not set the interview until he receives your consent. You will still have the option to accept or reject to be interviewed prior to or during the session.

Completing the questionnaire will take approximately 15 minutes. Please share the participation invitation web-link with your family, friends, and professional acquaintances. This questionnaire is available in both Arabic and English languages. Please click the icon above to change the displayed language at any time.

For further information, please contact the PhD. researcher via the listed email address.

Kind Regards,
Abdulrahman Ayman Zawawi
Abdulrahman.zawawi@nottingham.ac.uk

Web-based Questionnaire Consent Page: (The Arabic version is available upon request from the researcher)

Q1| Do you agree to participate in this PhD research questionnaire as described in the informed consent document?

- Yes, I agree.
- No, I do not agree.

Q2|Do you agree with the following statement or not?

"I understand that providing my contact information at the end of this questionnaire is voluntary."

- Yes, I agree.
- No, I do not agree.

Q3|Are you a resident of Jeddah city?

- Yes.
- No.

Q4|Are you 18 years old or more?

- Yes.
- No.

To eliminate any confusion regarding the term Jeddah's "walkways," which is the focus of this questionnaire and overall research. Please examine the picture below and then click next.

Walkway Definition:

"A passage for walking."

Merriam-Webster Dictionary

Q5| Which of the following walkways (or linear park) is nearest to your home address?

- ○ Northern Corniche walkway. Address: Al Shatee District, Corniche Street. (From Border Guard station to Nawras roundabout).
- ○ Jeddah waterfront walkway. Address: Al Shatee District, Corniche Street. (From Al Nawras roundabout to Al Corniche first lake).
- ○ Middle Corniche Park. Address: Al-Hamra'a District, Corniche Street.
- ○ Al Shatee Garden walkway. Address: Al Shatee District, Corniche Street.
- ○ Prince Faisal bin Fahad street walkway (Al Hilton Walkway). Address: Al Shatee District, Prince Faisal bin Fahad street.
- ○ Taibah Walkway. Address: Al Frosyah District.
- ○ Al Yamama Walkway. Address: Al Salama District, Al Yamama Street.
- ○ Al Samer walkway. Address: Al Samer District, Omaire Bin Al Habab Street.
- ○ Prince Al Fawaz district walkway. Address: Prince Al Fawaz district, Anas Bin Quatada Al Ansari street (Peace be upon him).
- ○ Zahrt Al Waha walkway. Address: Zahrt Al Waha District, Fakhr Aldeen Shalah Street.
- ○ Al Safa walkway. Address: Al Safa District, Mamoon Bre Street.
- ○ Al Safa 2 walkway. Address: Al Safa District, Sahal Bin Rafie Al Khazargi Street.

- ○ Al Nakheel walkway. Address: Al Nakheel District, Mohammad Bin Ibrahim Al Mubarak St.
- ○ Al Nakheel 2 walkway. Address: Al Nakheel District, Saleh Bin Mohammad Al Tuwajiri St.
- ○ Shatee Al Safe walkway. Address: Southern Corniche District Southern Corniche Street.
- ○ Al Jamiaa walkway. Address: Al Fayha'a District, Zaid Bin Amro Street.
- ○ Al Waha walkway. Address: Al Waha District, Mohammad Bin Sulaiman Al Bassam Street.
- ○ Al Faisalia walkway. Address: Al Faisalia District, Al Saieeda Khadija Street.
- ○ Al Rehab walkway. Address: Al Rehab District, Amer Bin Slamah Street.
- ○ Al Shabab lake walkway. Address: Al-Baghdadiyah Al-Gharbiyah District, Ibrahim Bin Ahmad AL Raqui Street.
- ○ Al Rawdah walkway (Al Tahlia Walkway). Address: Al Rawdah District, Al Nahdah Street.
- ○ Other. Please specify.

Q6| How often do you visit the selected walkway (in Q5)?

- ○ Never visited. (move to Q7)
- ○ Once every couple of months. (move to Q39)
- ○ Once a month. (move to Q39)
- ○ Once every two weeks. (move to Q39)
- ○ Once a week. (move to Q39)
- ○ Multiple times a week. (move to Q39)
- ○ Everyday. (move to Q39)

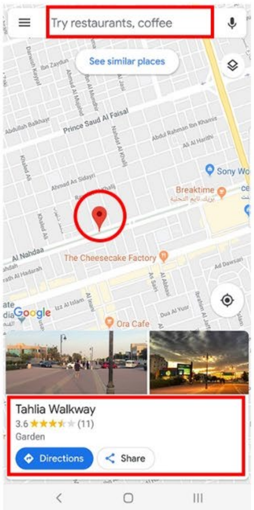
Scenario A (nonuse)

Q7| Why haven't you used the selected walkway (in Q5)? (Please select all that apply).

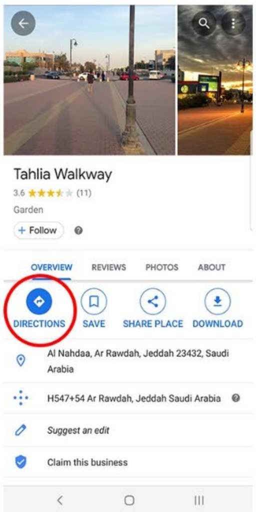
- ☐ The walkway is difficult to access by walking or bicycling.
- ☐ The walkway is far from my home address.
- ☐ Walking or bicycling consumes a lot of time and energy compared to using a car.
- ☐ There is no dedicated bicycle lane.
- ☐ I have multiple destinations.
- ☐ I have children 0-8 years of age.
- ☐ Outdoor air temperature.
- ☐ No public transport services are nearby.
- ☐ The quality of available public transport is poor.
- ☐ Lack/insufficient water features and fountains
- ☐ Lack/insufficient restrooms
- ☐ Poor maintenance.
- ☐ I have a disability.
- ☐ I have medical conditions that prevent me from walking or bicycling.
- ☐ Lack of information signs
- ☐ Afraid of crime along the walkway
- ☐ No one to go with.
- ☐ Don't have enough info about the walkway
- ☐ Lack of time/too busy
- ☐ General lack of interest
- ☐ Lack of shops and stores nearby the linear park.
- ☐ Distance to my regular destinations are far from the walkway.
- ☐ Other (please specify).

Q8| Approximately how far is the selected walkway or linear park (in Q5) from your home address? (Please use google maps to provide an accurate estimation of the distance – see Figure below).

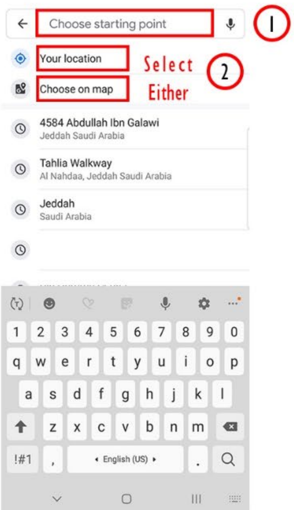
- o Less than 0.5 km (< 500 m).
- o Between 0.5 and 1 km.
- o Between 1 and 2 km.
- o Between 2 and 5 km.
- o Between 5 and 8 km.
- o Between 8 and 11 km.
- o Between 11 and 14 km.
- o More than 14 km.



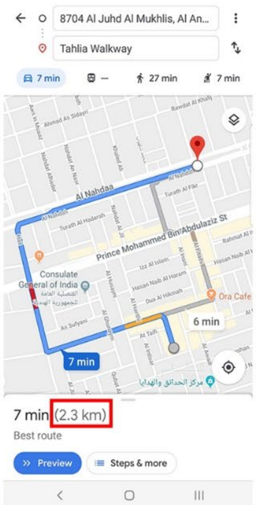
1- Begin by selecting (or typing the name) of the nearest linear park to your home address. Then, tap on the large red box.



2- Click the "Directios" icon as show in the red circle.



3- Choose either "your location" if you are currently at home or select "choose on map" to identify the location of your home address.



4- Use the generated number you see in the red box to answer to distance question in the online survey. Thanks!

Q9| Please select your residential district: (leave empty if you prefer not to say).

Al Basateen	Al Ajwad	Al Qryniah
Taiba	Al Montazah	Al Wadi
Al Firdous	Ash Shorooq	As Sahil
Al-Zumorrud Al Shera'a Al Yaqoot Al Amwaj	Al Sharafeyah Al-Rawabi Al Thaghr Al Jami`ah	Al Qwizain Al Moulysaa Ad Dahiah Abruq Ar Rughamah
Al Sawari	Al-Baghdadiyah Al-Sharqiyah	Al Farooq
Al Riyadh	Al-Baghdadiyah Al-Gharbiyah	Al Sabeel
Al Lulu Al Rahmanyah Al Bashaer Al Frosyah	Al Sulaymaniyah Bani Malik Aziziyah Al-Ruwais	Al Adean Kilo 14
Al Falah	Al Nakheel	
Al Hamadaniyyah	Al Kandarah	
Al-Salehiyah Al Khalidiyyah Ash Shati Al Murjan Al Kausar	Al Jawharah Um Hableen Al Adel Prince Abdulmajeed Al-Ammariyah	
Al Asalah	Al Amir Fawwaz Al Junoobi	
Al Safa Al Marwah Al Bawadi An Nuzhah Ar Rabwah	Al Amir Fawaz Ash Shamaly Al Mahjar Al-Thaalba Al-Suhaifah Petromin	
Ar Rawdah	Al-Qurayat	
As Salamah	Al-Hindawiya	
Al Naeem An Nahdah Al Mohammadiyyah Bryman	Al-Wazeeriyah Mada'en Al-Fahd Al Muntazahat Ajaweed	
Al Faisaliyyah	Al Waha	
Abhur Al Junoobiyah	An Nazlah Al Yamaniyyah	
Obhur Al-Shamaliyah Al Fayha'a An Naseem Al Warood	Al-Nazlah Al-Sharqiyah Al-Manar Al Samer Ar Rayaan	
Al Rehab	Al Sanabel	
Al-Balad	Khumrah	
Al-Hamra'a Al Andalus Mishrifah	As Sarawat At Taawon Al Fadeylah	

Q10| To what degree would the factors mentioned below influence your decision to use (or not use) the selected walkway (in Q5) for commuting purposes? ('commuting' meaning to travel, by walking or bicycling, from home to work / study or vice versa via the walkway)

Highly not influential - Somewhat not influential - Neutral - Somewhat influential - Highly influential

- Outdoor temperature
- Availability of a pedestrian pathway leading to the walkway.
- Availability of a dedicated bicycle lane leading to the walkway.
- Distance from my home address.
- Availability of electric bicycles and scooters in the market.
- More shops and services within proximity to the walkway.
- Shading structures.
- Presence of vegetation.
- Availability of nearby public transport services.
- Availability of water bodies and features.
- Availability of restrooms.
- Well-maintained walkways.
- Availability of disability infrastructure for all walkway facilities and amenities.
- Availability of seating structures.
- Information signs for all users and activities
- Security from crime and theft.
- Availability of periodic, organized, and on-site social programs and activities.
- Marketing campaigns that provide updates about the walkway (programs and activities)

Q11| How regularly do you use the following types / modes of transport as part of your daily travel in/around Jeddah city? (i.e. reach your place of work/study/recreation)

Everyday – Few times a week – once a week – Once a month - Never

- Walking
- Bicycles
- Scooters
- Motorbikes
- Taxis or Ride-hailing services
- Private cars
- Ridesharing or Car-pooling services
- Buses
- Trains

Q12| Do you visit other walkways which are further away from your home address more often the selected in Q5?

- Yes. (move to Q13)
- No. (move to Q26)

Q13| Which of the listed walkways is the one you visit the most?

Same list as Q5 except the one the selected by the participant.

Q14 | Why do you visit the selected walkway in Q13 and <u>not</u> the one selected in Q5? (open-ended question)

Q15| What are the factors that would influence your sense of safety using the selected walkway (in Q13) for transport purposes? (Multiple choices)

- ☐ Automobile speed.
- ☐ Traffic density.
- ☐ Lack of personal safety.
- ☐ Conflict between users.
- ☐ Crowdedness.
- ☐ Rude users.
- ☐ road intersections.
- ☐ threat of crime.
- ☐ the degree of neighborhood civility or order (affected by poverty, limited education, racism, and gangs).
- ☐ Other (please specify).

Q16| As a pedestrian, to what degree do you feel safe using the selected walkway (in Q13)?

- o Safe
- o Somewhat safe.
- o Neutral
- o Somewhat unsafe.
- o Unsafe

Q17| As a cyclist, to what degree would you feel safe using the selected walkway (in Q13)?

- o Safe
- o Somewhat safe.
- o Neutral
- o Somewhat unsafe.
- o Unsafe

Q18 | What are your purposes for visiting/using the selected walkway (in Q13)? (Multiple choices)

- ☐ Health and well-being (Reduce weight/ Reduce stress/ Reduce the risks of high blood pressure and cardiovascular disease).
- ☐ Recreational activities (walk or ride a bicycle/ play sports/ Children playgrounds)
- ☐ Leisure (Enjoy my free time such as getting fresh air or reading a book).
- ☐ Social well-being (Hangout with friends and family/ Engage in activity with family and children/ meet new people).
- ☐ Events (Attend a specific event or an organized celebration).
- ☐ Commute purposes (to reach specific destinations for business or pleasure).
- ☐ Other reasons. Please specify:

Q19| How do you use the selected walkway (in Q13)?

- Mostly, circling back and forth.
- Mostly, remain in one location.
- Mix between circulating the linear park and remaining in one location.
- I mostly just pass by and don't use its facilities.
- Other, please specify:

Q20| What is the mode of transport do you usually use to reach the selected walkway (in Q13)?

- Walking
- Bicycles
- Scooters
- Motorbikes
- Taxis or Ride-hailing services
- Private cars
- Ridesharing or Car-pooling services
- Buses
- Trains

Q21| Approximately, how many minutes do you spend in the selected walkway (in Q13) per visit?

- <15 min.
- 15–30 min.
- 30 min to 1 h
- 1–2 h
- >2 h

Q22| With whom do you usually visit the selected walkway (in Q13)?

- By myself.
- With a close friend.
- With a group of friends.
- With my spouse.
- With my children.
- With my spouse and children.
- With family relatives.
- With a domestic animal (i.e. cats and dogs).

Q23| Have you ever bicycled in/to/from the selected walkway (inQ13) for commuting purposes (reach desired destinations whether for business or pleasure)?

- Yes (move to Q24)
- No (move to Q25)

Q24| From where did get the bicycle?

- I own it.
- I borrowed it from a friend or a family member.
- I rented it for a bicycle shop.
- I rented it from a nearby bicycle share service.
- Other. Please specify:

Q25| Why haven't you used the bicycle before in/to/from the selected walkway (in Q13) for commuting purposes? (multiple choices)

- ☐ I do not own a bicycle.
- ☐ There are no bicycle share systems.
- ☐ I do not know how to ride a bicycle.
- ☐ I do not feel confident enough to ride a bicycle for commute purposes to/from my desired destinations.
- ☐ I have a medical condition that prevents me from riding a bicycle.
- ☐ I have a disability that prevents me from riding a bicycle.
- ☐ Wearing a helmet makes me look silly.
- ☐ My attire hinders riding a bicycle comfortably.
- ☐ The desired destinations are too far from the linear park.
- ☐ No public transit stops are nearby or less than 1 km.
- ☐ Unfavorable or uncomfortable weather conditions
- ☐ My time is short. I need a fast commuting option to reach my desired destination.
- ☐ My journey usually involves carrying groceries or bags.
- ☐ The pathway from/to the desired destinations lack bicycle amenities such as racks and repair shops.
- ☐ The pathway from/to the desired destinations does not feel safe.
- ☐ The pathway from/to the desired destinations has no dedicated bicycle lane (or separated from traffic).
- ☐ The bicycle lane from/to the desired destinations lack quality and needs maintenance or improvements.
- ☐ I usually travel with my family members.
- ☐ Other reasons, please specify:

Q26| What is your gender?

- o Male
- o Female
- o Prefer not to say.

Q27| How old are you?

- o 18-24 years old
- o 25-34 years old
- o 35-44 years old
- o 45-54 years old
- o 55-64 years old
- o 65-74 years old
- o 75-48 years old
- o 85 and older
- o Prefer not to say.

Q28| What is your marital status?

- Single.
- Married
- Divorced
- Widowed.
- Separated
- Never Married.
- Prefer not to say.

Q29| Do you have children 0-8 years of age?

- Yes
- No
- Prefer not to say.

Q30| Do you own car?

- Yes.
- No.
- Prefer not to say.

Q31| What is your current employment status?

- Employed
- Employed part-time
- Self-employed
- Unemployed looking for work
- Unemployed not looking for work
- A student
- Retired
- Disabled
- Prefer not to say.

Q32| What is the total household monthly income?

- Less than 3000 SAR.
- 3000 SAR to less than 6000 SAR.
- 6000 SAR to less than 10,000 SAR.
- 10,000 SAR to less than 15,000 SAR.
- 15,000 SAR to less than 20,000 SAR.
- 20,000 SAR to less than 25,000 SAR.
- 25,000 SAR to less than 30,000 SAR.
- More than 35,000 SAR.
- Prefer not to say.
- 30,000 SAR to less than 35,000 SAR.

Q33|How many years have you lived in Jeddah city? please enter a numerical value in English (0 means less than one year)

Q34| How many years have you lived in your current address in Jeddah city?

- Less than one year
- 1-5 years
- 5-10 years
- 10-15 years
- 15-20 years
- 20-25 years
- More than 25 years
- Prefer not to say

Q35| If there are any experiences or thoughts that you would like to share about Jeddah's walkways (or linear parks), please feel free to use the space below. (optional open-ended question)

Q36| Would like to participate by a telephone or SKYPE interview so that issues raised in previous questions could be examined in greater detail from your own point of view?

- ☐ Yes (move to Q35).
- ☐ No (end of questionnaire).

Q37| Thank you very much for your interest to further participate in this Ph.D. research study. Could you please write your name, email or phone number so that the researcher can contact you to arrange for an interview. (leave all fields empty if you prefer not to say)

Q38| Preferred interview call time:

- ☐ Morning (9-12 pm)
- ☐ Afternoon (1-6 pm)
- ☐ Evening (6-9 pm)

End of questionnaire for Scenario A (thank you message)

Scenario B (A User)

Q39| Is the selected walkway (in Q5) the one you visit the most?

- Yes. (move to Q42)
- No. (move to Q 40)

Q40| Which of the listed walkways is the one you visit the most?

Same list as Q5 except the one the selected by the participant.

Q41| Why do you visit the selected walkway (in Q38) more the one selected in Q5? (open-ended question)

Q42| Approximately how far is the selected walkway (in Q5) or linear park from your home address? (please use google maps to provide an accurate estimation of the distance – see Figure Below).

See Q8 for the answer options and Figure.

Q43| Please select your residential district: (leave empty if you prefer not to say).

See Q9 for the answer options.

Q44| Mainly, why do you visit the selected walkway or the linear park (in Q5)?

See Q18 for the answer options.

Q45| This question is only displayed if commute purposes is not a selected choice in Q44. What were the constraints that prevented or limited you from using the selected walkway (in Q5) for commuting purposes? ('commuting' meaning to travel, by walking or bicycling, from home to work / study or vice versa via the walkway) (multiple choices)

See Q7 for the answer options.

Q46| How do you use the selected walkway or linear park (in Q5)?

See Q19 for the answer options.

Q47| What mode of transportation do you usually use to arrive to the selected walkway (in Q5)?

See Q20 for the answer options.

Q48| Approximately, how many minutes do you spend in the selected walkway (in Q5) per visit?

See Q21 for the answer options.

Q49| Have you ever bicycled in/to/from the selected walkway (inQ5) for commuting purposes (reach desired destinations whether for business or pleasure)?

- Yes (move to Q50 and skip 51)
- No (move to Q51)

Q50| From where did get the bicycle?

See Q24 for the answer options.

Q51| Why haven't you used the bicycle before in/to/from the selected walkway (in Q5) for commuting purposes? (multiple choices)

See Q25 for the answer options.

Q52| With whom do you usually visit the selected walkway (in Q5)?

See Q22 for the answer options.

Q53| What are the factors that would influence your sense of safety using the selected walkway (in Q5) for transport purposes? (Multiple choices)

See Q15 for the answer options.

Q54| As a pedestrian, to what degree do you feel safe using the selected walkway (in Q5)?

See Q16 for the answer options.

Q55| As a cyclist, to what degree would you feel safe using the selected walkway (in Q5)?

See Q17 for the answer options.

Q56| How regularly do you use the following types / modes of transport as part of your daily travel in/around Jeddah city? (i.e. reach your place of work/study/recreation)

See Q11 for the answer options.

Q57| To what degree would the factors mentioned below influence your decision to use (or not use) the selected walkway (in Q5) for commuting purposes? ('commuting' meaning to travel, by walking or bicycling, from home to work / study or vice versa via the walkway)

See Q10 for the answer options.

Q58| What is your gender?

See Q26 for the answer options.

Q59| How old are you?

See Q27 for the answer options.

Q60| What is your marital status?

See Q28 for the answer options.

Q61| Do you have children 0-8 years of age?

See Q29 for the answer options.

Q62| Do you own car?

See Q30 for the answer options.

Q63| What is your current employment status?

See Q31 for the answer options.

Q64| What is the total household monthly income?

See Q32 for the answer options.

Q65|How many years have you lived in Jeddah city? please enter a numerical value in English (0 means less than one year)

Q66|How many years have you lived in your current address in Jeddah city?

See Q34 for the answer options.

Q67| If there are any experiences or thoughts that you would like to share about Jeddah's walkways (or linear parks), please feel free to use the space below. (optional open-ended question)

Q68| Would like to participate by a telephone or SKYPE interview so that issues raised in previous questions could be examined in greater detail from your own point of view?

- ☐ Yes (move to Q69).
- ☐ No (end of questionnaire).

Q69| Thank you very much for your interest to further participate in this Ph.D. research study. Could you please write your name, email or phone number so that the researcher can contact you to arrange for an interview. (leave all fields empty if you prefer not to say)

Q70| Preferred interview call time:

See Q38 for the answer options.

End of questionnaire for Scenario B (thank you message)

15. Appendix D: Permit to conduct fieldwork 2023

KINGDOM OF SAUDI ARABIA
Ministry of Education
KING ABDULAZIZ UNIVERSITY
Faculty of Architecture and Planning
Department of Landscape Architecture

Ref.:
Date:
Encl.:

المملكة العربية السعودية
وزارة التعليم
جامعة الملك عبدالعزيز
كلية العمارة والتخطيط
قسم عمارة البيئة

الرقم: ٩٦٧٥٧
التاريخ: ٢/٩/١٤٤٤هـ
المرفقات:

الى من يهمه الأمر

السلام عليكم ورحمة الله وبركاته،،،

نفيدكم بأن المبتعث عبدالرحمن ايمن زواوي ورقمه الوظيفي: ٠٠٠١٥٨٥٦ وهو محاضر بقسم عمارة البيئة - كلية العمارة والتخطيط - جامعة الملك عبدالعزيز، ويقوم برحلة علمية ضمن متطلبات بحث رسالة الدكتوراه وتتطلب الدراسة جمع المعلومات لدعم البحث العلمي، فيما يلي الوسائل المستخدمة لجمع المعلومات:-

١- التصوير في حدائق مدينة جدة الطويلة.

وعليه نرجو منكم مشكورين التكرم والسماح للمبتعث عبدالرحمن زواوي بجمع المعلومات بالطرق المذكورة أعلاه علما بأن هذه المعلومات ستستخدم للأغراض العلمية والبحثية فقط.

وتفضلوا بقبول خالص تحياتي وتقديري،،،

رئيس قسم عمارة البيئة

د. أحمد عبدالرزاق مغربي

جامعة الملك عبد العزيز
كلية العمارة والتخطيط
قسم عمارة البيئة
Faculty Of Architecture and Planning
KING ABDULAZIZ UNIVERSITY

ص.ب: ٨٠٢٠٠ جـدة: ٢١٥٨٩
P.O.Box:80200 Jeddah: 21589

فاكس: ٠١٢٦٢٩٢٠٣٩
Fax : 0126292039

☎: ٠١٢٦٤٠٢٠٠٠ - ٦٤٧١٣
☎:0126402000 - 64713

16. Appendix E: Permit to conduct fieldwork 2019/20

KINGDOM OF SAUDI ARABIA
Ministry of Education
KING ABDULAZIZ UNIVERSITY
Faculty of Architecture and Planning
Department of Landscape Architecture

Ref.: ....
Date: ....
Encl.: ....

المملكة العربية السعودية
وزارة التعليم
جامعة الملك عبد العزيز
كلية العمارة والتخطيط
قسم عمارة البيئة

الرقم: ....
التاريخ: ....
المرفقات: ....

الى من يهمه الأمر

السلام عليكم ورحمة الله وبركاته،،،

نفيدكم بأن المبتعث عبدالرحمن ايمن زواوي ورقمه الوظيفي: ٠٠٠١٥٨٥٦ وهو محاضر بقسم عمارة البيئة - كلية العمارة والتخطيط - جامعة الملك عبدالعزيز، ويقوم برحلة علمية ضمن متطلبات بحث رسالة الدكتوراه وتتطلب الدراسة جمع المعلومات لدعم البحث العلمي، فيما يلي الوسائل المستخدمة لجمع المعلومات:-

١- التصوير في حدائق مدينة جدة الطويلة.
٢- توزيع دعوات لتعبئة استبيانات خاصة بالدراسة.

وعليه نرجو منكم مشكورين التكرم والسماح للمبتعث عبدالرحمن زواوي ولمساعديه الباحثين بجمع المعلومات بالطرق المذكورة أعلاه علما بأن هذه المعلومات التي يجمعها المحاضر و مساعديه الباحثين ستستخدم للأغراض العلمية والبحثية فقط.

وتفضلوا بقبول خالص تحياتي وتقديري،،،

رئيس قسم عمارة البيئة المكلف

د. أحمد عبدالرزاق مغربي

جامعة الملك عبد العزيز
كلية العمارة والتخطيط
قسم عمارة البيئة
KING ABDULAZIZ UNIVERSITY
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P.O.Box:80200 Jeddah: 21589

فاكس: ٠١٢٦٢٩٢٠٣٩
Fax : 0126292039

☎: ٠١٢٦٤٠٢٠٠٠ - ٦٤٧١٣
☎:0126402000 - 64713

17. Appendix F: Experts interview invitation, consent form, and questions

Greenways and Sustainable Urban Mobility: The case study of Jeddah, Saudi Arabia

Research Interview with Key local and international experts

Invitation Email letter (The Arabic version is available upon request from the researcher)**:**

Dear [invitee],

I hope this email finds you well. My name is Abdulrahman Zawawi, and I am a PhD student at the University of Nottingham, Department of Architecture and Built Environment. This email is an invitation to an in-depth interview that focus on my PhD research project titled “Greenways and Sustainable Urban Mobility Systems: The case study of Jeddah, Saudi Arabia.” This research is funded by King Abdulaziz University.

The main purpose of this PhD. research is to examine the factors that affect the use of greenways as a constituent of sustainable urban mobility systems in Jeddah, Saudi Arabia. With this intention, this research strives to understand how the contemporary urban condition influences the use of greenways (or as locally known walkways) in Jeddah city for non-motorized transport. Given your professional work experience related to this subject, it would be a great opportunity to learn from you and enrich the discussion of my PhD. research findings.

The interview will talk place over Zoom (software platform). Once the author receives your consent to voluntarily participate, he will contact you on the time frame you specify in the following page via email or message providing an invitation web-link and a password. If for some reason the interview did not take place at the specified time, a follow-up email or message will be sent to you to arrange for another suitable time frame. Please note that the interview will take approximately 30-45 minutes of your time to complete. You can accept or reject the invitation. If you accepted the invitation and changed your mind at a later time or during the interview, all the collected data from you will be permanently deleted.

It is important to note that the interview will be audio recorded only. If you do not wish to be audio recorded, please answer the questions displayed in the following page accordingly. The audio recording will be transcribed and translated (if needed), then analyzed for education and research purposes. The digital files (consent forms + recordings) will be stored in a password-protected and secure server. It will be kept securely for seven years following the research publication in accordance with the Data Protection Act. After that, all the collected data will be permanently deleted. Your identity information, specifically your name and position, will be quoted in the PhD research. However, if you wish to have your participation as an anonymous, please indicated so by answering the questions accordingly in the following page.

For further details or questions, please contact the author via the email address or phone number below.

Thank you very much for your time to consider the interview request, I hope I can hear from you soon.

Kind Regards
Abdulrahman Ayman Zawawi
Lecture (On leave to pursue a PhD. degree from The University of Nottingham, UK)
Department of Landscape Architecture
King Abdulaziz University
Abdulrahman.zawawi@nottingham.ac.uk

Key local and international experts Consent Form (The Arabic version is available upon request from the researcher)

Please answer the following statements:

"I have read the paragraphs in the previous page and wish to voluntarily have an interview with the author about his PhD research via Zoom (software platform)."

- Yes, I agree.
- No, I do not agree.

"I consent to have my voice recorded during the interview only for research and educational purposes."

- Yes, I agree.
- No, I do not agree.

"I consent to have my identity information, specifically my name and position, to be quoted for educational and research purposes."

- Yes, I do not mind quoting my name and position in this Ph.D. research project.
- No, I do mind, and want to have my participation as anonymous.

Please select a suitable day for the interview by filling the blanks with the appropriate information (keeping in mind that the 30th of September 2020 would be the last day for interviews).

Month …………………………………………… Day …………………………………………………………

Please select a suitable timeframe in that day: Between …………….. and ……………. (Please specify AM or PM)

Please type your name (leave empty if do not wish to reveal): ……………………………………………

Your Job title (leave empty if do not wish to reveal): ………………………………………………………………

Name of your city………………………………… Name of your country …………………………….

Your preferred contact method (only to send you the Zoom invitation web-link and password)

- Email
- Phone number

Please type the preferred contact method:

Thank you very much for taking the time to consider this invitation and willingness to participate in this Ph.D. research project.

For further details or questions, please contact the author, Abdulrahman Zawawi via the email address or phone number below:

Abdulrahman.zawawi@nottingham.ac.uk

Interview topics and questions (The Arabic version is available upon request from the researcher)**:**

Topic 1: Strategies to influence travel behaviour in Saudi Arabia

How can planners and designers and policy-makers encourage people to walk and cycle for commute purposes in Saudi Arabia or specifically Jeddah city?

Topic 2: Greenways as a constituent of sustainable urban mobility systems

1. Based on my PhD research questionnaire findings, most of Jeddah's residents drive their cars to the nearest linear park from their home addresses. How can we encourage other modes of transport such as walking or bicycling?
2. Based on my PhD research questionnaire findings, the use of Jeddah's greenways as transport corridors is almost non-existent (meaning greenways are means to reach points of interests rather than a destination). What are the short and long term strategies to transform Jeddah's greenways to function as non-motorized transport corridors?

3. Keeping in mind the continuous development of the public transport network in Jeddah city, do you believe its linkage with a proposed greenway network would influence how and where residents travel? In other words, would the integration of greenways with public transport affect how and where residents travel in Jeddah city? Or are greenways irrelevant in terms of how and where would Jeddah residents commute for their daily destinations? Please explain your response.

Topic 3: Use of Jeddah's greenways

1. Aside from Al-corniche parks, most of Jeddah's walkways or linear parks share more or less the same design and materials. Why is this the case?
2. Many of Jeddah's walkways are occupied by food trucks, illegal vendors offering goods and scooter rental services for children, as well as bicycle rental shops who collectively change dramatically how linear parks are used and experienced. Nonetheless, those groups fill-in a much-needed gap via the services they provide for visitors of those parks, while at the same time causing several issues such as the conflict between site users, and illegally using public spaces for personal gains.
    - To what extent should commercial activities take place in linear parks? Why?
    - How can we regulate the use of Jeddah's linear parks while offering those groups the opportunity to provide those needed services?
3. Based on my PhD research questionnaire findings, outdoor temperature was a reoccurring constraint for using Jeddah's linear parks, what has been done to address this issue and how can we further attenuate its impact in the future?

4. Based on my research findings, maintenance is a very influential factor that influences participants' use of Jeddah's linear parks. My site inventory of Jeddah's linear parks revealed that many of them are not vegetated. Some are intentionally not vegetated by design while others as a result of negligence. Why is this the case? And how can future linear park developments treat this problem?

5. Based on site-observations, acts of vandalism such as inappropriate wall and floor paintings, breaking of light bulbs, throwing litter, and many more are witnessed in most of Jeddah's linear parks. Those acts deter not only users, but also public and private investors. Aside from law and order, how would planning and design interventions help resolve those problems?

Topic 4: Bicycle use culture

1. Describe the evolution of bicycles' use culture in Jeddah city or Saudi Arabia in general.
2. Aside from the personal and religious reasons, distant daily destinations, safety, comfort, outdoor temperature, no bicycle ownership, lack of bicycle shops and amenities, and lack of dedicated bicycle lanes are all reasons flagged in my PhD research as obstacles for bicycle use. How can we (as planners and designers) address those concerns, which are hindering wider and faster adoption of bicycles as a mode of transport in Jeddah city today?
    a. What is your opinion about bicycle share services as a commute option in Jeddah city? How would they contribute in addressing some of the concerns mentioned in the previous question?

Topic 5: Technology' potential in redefining the use and use-potential of greenways in Saudi Arabia or specifically Jeddah city.

Given the technological advancements and the benefits of both electric bicycles and scooters, please answer the following questions:

- When would the use of electric bicycles and scooters become a successful alternative to the use of cars for daily commuting purposes in Jeddah city?
- Do you believe that the availability of those technologies would enable greater use of Jeddah's linear parks to reach daily destinations and why?

Topic 6: Conclusion

Would you like to add or provide more insights about the interview topic?

18. Appendix G: Interview invitation, consent form, and questions for active transportation interest groups' leaders

Greenways and Sustainable Urban Mobility Systems: The case study of Jeddah, Saudi Arabia

Research Interview with active transportation interest group leaders

Invitation Email letter (The Arabic version is available upon request from the researcher)**:**

Dear [invitee],

I hope this email finds you well. My name is Abdulrahman Zawawi, and I am a PhD student at the University of Nottingham, Department of Architecture and Built Environment. This email is an invitation to an in-depth interview that focus on my PhD research project titled "Greenways and Sustainable Urban Mobility Systems: The case study of Jeddah, Saudi Arabia." This research is funded by King Abdulaziz University.

The main purpose of this PhD. research is to examine the factors that affect the use of greenways as a constituent of sustainable urban mobility systems in Jeddah, Saudi Arabia. With this intention, this research strives to understand how the contemporary urban condition influences the use of greenways (or as locally known walkways) in Jeddah city for non-motorized transport. Given your leadership role in a local community that care about walking and bicycling, it would be a great opportunity to learn from you and enrich the discussion of my PhD research findings.

The interview will talk place over Zoom (software platform). Once the author receives your consent to voluntarily participate, he will contact you on the time frame you specify in the following page via email or message providing an invitation web-link and a password. If for some reason the interview did not take place at the specified time, a follow-up email or message will be sent to you to arrange for another suitable time frame. Please note that the interview will take approximately 30-45 minutes of your time to complete. You can accept or reject the invitation. If you accepted the invitation and changed your mind at a later time or during the interview, all the collected data from you will be permanently deleted.

It is important to note that the interview will be audio recorded only. If you do not wish to be audio recorded, please answer the questions displayed in the following page accordingly. The audio recording will be transcribed and translated (if needed), then analyzed for education and research purposes. The digital files (consent forms + recordings) will be stored in a password-protected and secure server. It will be kept securely for seven years following the research publication in accordance with the Data Protection Act. After that, all the collected data will be permanently deleted. Your identity information, specifically your name and position, will be quoted in the PhD research. However, if you wish to have your participation as an anonymous, please indicated so by answering the questions accordingly in the following page.

For further details or questions, please contact the author via the email address or phone number below.

Thank you very much for your time to consider the interview request, I hope I can hear from you soon.

Kind Regards
Abdulrahman Ayman Zawawi
Lecturer (On leave to pursue a Ph.D. degree from The University of Nottingham)
Department of Landscape Architecture
King Abdulaziz University
Abdulrahman.zawawi@nottingham.ac.uk

Consent Form for interviewing active transportation interest group leaders (The Arabic version is available upon request from the researcher)

Please answer the following statements:

"I have read the paragraphs in the previous page and wish to voluntarily have an interview with the author about his PhD research via Zoom (software platform)."

- Yes, I agree.
- No, I do not agree.

"I consent to have my voice recorded during the interview only for research and educational purposes."

- Yes, I agree.
- No, I do not agree.

"I consent to have my identity information, specifically my name and position, to be quoted for educational and research purposes."

- Yes, I do not mind quoting my name and position in this Ph.D. research project.
- No, I do mind, and want to have my participation as anonymous.

Please select a suitable day for the interview: (dropdown list will show up). Please select a suitable day, keeping in mind that the 18th of September 2020 would the last day for interviews.

Please select a suitable timeframe in that day: Between ………….. and …………

Please type your name (leave empty if do not wish to reveal): ……………………………………………

Your Job title (leave empty if do not wish to reveal):
………………………………………………………………

Name of your city………………………………… Name of your country ……………………………

Your preferred contact method (only to send you the Zoom invitation web-link and password)

- Email
- Phone number

Please type the preferred contact method:

Thank you very much for taking the time to consider this invitation and willingness to participate in this Ph.D. research project.

Interview topics and questions (The Arabic version is available upon request from the researcher)**:**

Topic 1: About the community

Q1: Please describe your community. i.e. goal and objectives (top 3 at max).

Q2: Why have you set those goals and aspirations?

Q3: What type of support, if any, have you received from governmental entities or institutions or businesses?

Topic 2: About the training sessions' route location

Q1: Where does your community walk or bicycle in Jeddah city (Please define a start and end point)?

Scenario 1: If the route does not pass through any of Jeddah's linear parks

1. Explain why?
2. What were the criteria for selecting a suitable location for your community's training sessions?
3. Define the risks (i.e. health or safety) your community is currently taking in every training session? How do you alleviate those risks?
4. What makes the location you mentioned a more suitable route for your community's training sessions than any of Jeddah's linear parks?
5. What would Jeddah's linear parks need to have to qualify as suitable grounds for your community's training sessions?

Scenario 2: If the route passes through any of Jeddah's linear parks

1. Why this location and not the other linear parks? In other words, what are the qualities that made this location favorable compared to other linear parks or even other locations in Jeddah city?
2. Define the risks (i.e. health or safety) your community is currently taking in every training session? How do you alleviate those risks?
3. As a community leader, at what level have the linear park (the one you mentioned in previous responses) delivered in terms of comfort, enjoyment, maintenance, and quality of pedestrian or bicycle amenities for your community and why?

Topic 3: time and length of training sessions

Q1: When does your community usually gather and walk or bicycle together and why?

- Would you consider other times of the day? Why?

Q2: How many times a week/month does your community walk or bicycle in Jeddah city and why?

Q3: On average, how far (distance) do your community members walk or bicycle in a single training session? Why?

Topic 4: About the community members

Q1: Which mode of transport does most of your members use to reach the training session's starting point and why?

Q2: How do you define groups within your community? Is it by members' home distance from the training session's starting point or fitness level or gender or age or other factors?

- Would consider a mixed group of males and females (families) and why?

Q3: Which age group do you believe has the highest number of members in your community and why?

- Would you consider other age groups to join your community (i.e. very young or very old? Please explain your answer.

Q4: How many members do you usually have in a training session? Why?

Q5: Ever since the establishment of your community, what have your members complained about?

- Which of those complaints have been resolved and which have not yet been resolved? Why?

Topic 5: Active living vs. training sessions

With health being one of the main focuses of your community, how do you feel about walking or bicycling to daily destinations (i.e. work or grocery shop) in Jeddah city instead of dedicating a training session to walk or bicycle with or without a group?

Topic 6: Bicycle culture

Q1: Describe the evolution of bicycles' use culture in Jeddah city.

Q2: Aside from the planning and design reasons, religious reasons (i.e. hijab), physical abilities, safety, comfort, no bicycle ownership, usually travel with my family members, and lack of confidence to use bicycles for transport purposes are all reasons flagged in my PhD research as obstacles for bicycle use in Jeddah city. How can we (as community leaders) address or attenuate those constraints, which are hindering wider and faster adoption of bicycles as a mode of transport in Jeddah city today?

Q3: What is your opinion about bicycle share services as a commute option in Jeddah city?

- Would bicycle share services be a better option for your members to join your training sessions (if it involved riding a bicycle) than purchasing and storing a large number of bicycles?

Topic 7: Conclusion

Q1: Would you like to add or provide more insights about the interview topic?