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SPATIAL LOGIC OF PARK ACCESS IN QATAR

BY

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ABSTRACT

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Urban parks unite communities and enhance livability. Spatial distribution of parks, however, does not always adhere to people's needs. Using the established and new methodologies, this paper identifies the green park distribution pattern in Greater Doha, Qatar using two approaches, (a) using walkable service areas to highlight zones underserved by parks, and (b) identifying park need zones using variables such as population density, housing type and population subgroup. Walkability levels in selected park service areas are assessed using audits. Results show that about 22% of the zones, majorly housing the expatriates and low-wage migrants in Doha municipality are underserved by parks. Need based analysis shows actual park need both in Doha and suburbs. Walkability analysis highlights lack of street-level policy regulations that confound pedestrian access. Findings provide insight into drafting policies on planning parks based on the need to ensure equitable access to different demographic sections.

Keywords: Green parks, spatial equity, need score, accessibility

DEDICATION

This thesis is dedicated to my parents

for their endless love.

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CHAPTER 1 : INTRODUCTION

Public parks have evolved over the years and transformed in their design and significance. From informal cattle grazing commons and landscaped urban oasis to public reservation sites, they have changed with the societal as well as cultural needs and demands (Low, Taplin, & Scheld, 2005). Earliest parks began as utilitarian measures to meet the open outdoor space needs of people living in squalid conditions. Over time, they became recreational and leisure spots. The impacts of parks in improving psychosocial and ecological health are well documented. Parks are avenues for social interaction, community strengthening and forging a strong sense of place (Chiesura, 2004). They unify people from diverse backgrounds through different activities, including cultural expression and socializing. Park environments relax and rejuvenate users, ease stress by imitating natural landscapes and provide opportunities for play (Kaplan & Kaplan, 1989; Ulrich, 1981). Some of these parks establish a global image of emerging cities and serve as locations for festivities, national celebrations, and other cultural projects.

Ecologically, parks aid in stormwater retention, provide unfragmented habitat patch, act as urban oasis and cool intraurban temperature. From an economic sphere, parks increase adjacent property prices and footfall for adjacent business activities given they are well maintained, safe and free of acts of crime. Thus, their influence in civil, social, economic and ecological spheres reflect their indispensability in the present days.

Parks connect people from all ethnicities and socioeconomic classes which is of prime significance in the globalized world. As important cost-free public resources, they act as tangible reflection of livability and quality of life. Yet parks can forge strong

cultural diversity only if their access and usage are equitable to different communities. To ensure that the majority of the citizens enjoy the benefits of a park, it should be sited based on multiple socio-economic and socio-cultural factors. Typical park distribution focuses on a narrow lens of park size, people it seeks to serve, and the extent of facilities provided in each of these parks. In such a distribution, a park of certain size is planned relative to population density standards alone, irrespective of the distance required to access the park or the actual needs of the users. Parks are also classified based on the facilities present. Most of these park distribution studies belong to the domain of regional science and economics and often involve statistical approach. This contrasts with the distribution that identifies and acknowledges the social and cultural urban context of a neighbourhood based on empirical data. This thesis studies the distribution pattern of urban parks in Greater Doha and Al-Daayen, Qatar based on socio-spatial accessibility goals using open source demographic data and observation studies.

The introduction chapter contains eight sections, as shown in Figure 1. The first section introduces the evolution of green parks and the need for emphasizing equitable access to park related public resources. The second section discusses the problem statement, and the third section discusses the significance of the study. The fourth and fifth sections clearly propose the research questions, hypothesis and possible limitations related to the study. The sixth, seventh and eighth sections deal with the methodology, overall structure of the thesis and contribution of the thesis in knowledge advancement and its practical implications.

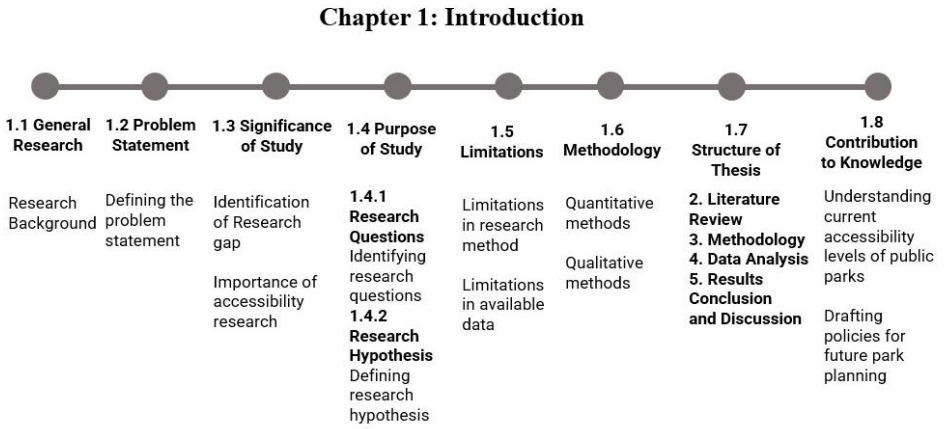


Figure 1. Summary of the introduction chapter.

1.1. Research Context: Greenspace Accessibility

Early landscaped urban parks in America were a result of romanticism that arose from the difficult conditions under industrial capitalism. The philosophy of romanticism idealized green parks imitating natural country sides as places of refuge against the grim conditions of overcrowded, plagued and polluted industrial cities (Low et al., 2005). Over time, the social goals evolved from public health and social reform to that of a place for pleasure, a place of relaxation, and a place where people could forget their woes (Cranz & Boland, 2004). In the current times, green parks are fundamental urban design elements that augment the health of its residents and enhance the livability of cities. Even in the face of the recent pandemic, parks have remained resilient and multi-functional. Therefore, they deserve the status of particularly important public goods in planning discourse that can alter the quality of lives of citizens. Especially of concern is the quantity, quality and the spatial and social accessibility of these goods through the lens of social justice. Amount of green area per inhabitant, quality of the green area, ease of access to different sections of society (based on gender, age, cultural and economic constraints), cost-benefit tradeoff and

need factors are important in deciding the efficacy of a park system.

Urban public services such as the distribution of public parks fall under 'public goods' enjoyed by many users together. Since green parks are fixed public goods, residents must be able to access these goods to ensure efficient use of parks. Broad population subset surrounding a park can fall in multiple cultural identities, ethnicities, races or income classes. Such demographic diversity and economic characteristics of the resident population confound the simple notion of equal distribution of green parks.

Initial measures of deciding park distribution and their accessibility were based on geographical theories such as Location theory and Central Place theory (DeVerteuil, 2000; Hass, 2009). These distribution measures used cost-benefit analysis where the emphasis was to increase efficiency and reduce operational costs, disregarding other complex socio-economic variables (Gillespie & Marten, 1978; Nicholls, 2001). Typically, a recreational standards approach is used to plan greenspace where it is expressed quantitatively as a target area per population (m^2/person) (Boulton, Dedekorkut-Howes, & Byrne, 2018), distance from residents, or both and in other cases, the adequacy and provision of facilities within greenspace (Boulton et al., 2018; Jansson & Persson, 2010; Lee & Hong, 2013; Lo & Jim, 2012; Ravenscroft & Markwell, 2000). In general terms, spatial distribution systems of parks are guided by park size, their catchment area and the projected population it seeks to serve.

Such planning approaches, however, rule out the socio-demographic characteristics such as sex, age, race, income and choice variables nor the extent of need for green parks among the surrounding residents. Therefore, emphasizing only on typical service distribution techniques cannot fulfil an equitable distribution system since equity of resource placement is largely guided by public need for the resources (Jones & Kaufman, 1974). Moreover, these measures consider the public realm as a

service or good to be distributed, based on the perceived need in the urban fabric rather than on the analysis of empirical field data. While standards can help in minimizing the negative effects of chaotic distribution systems, a more nuanced approach with clear emphasis on important variables can deliver better distribution networks and use of parks. Hence, there is a need to compare the actual urban data of these areas to the standards stipulated by the planning agencies through routine data collection and analysis.

Park proximity, park amenities and park acreage are regarded as important elements defining park efficiency and usage (Rigolon, 2016). When it comes to proximity, parks insert a walkable area of influence, usually called the service area. The amount of people within the service area are assumed to have walkable access to parks as opposed to the people outside the service area. Using the service area analysis, previous studies have concluded that low-income people of color have limited access and poor facilities in parks (Byrne, Wolch, & Zhang, 2009; Wolch, Byrne, & Newell, 2014), making the study of park distribution a social justice issue in academic research. Color, race and ethnicity have been the basis of unfair placement of parks in most of the studies conducted in the Global North. Current park distribution practices selectively exclude certain sections of the society from park access causing a decline of social and cultural diversity. Therefore, equitable park distribution has an important role in bridging the selective lack of access to the public realm and in optimizing need based access to parks.

In the Middle Eastern setting, the number of parks has increased with population growth, influx of foreign workforce and government policies. In the oil rich Gulf Cooperation Council (GCC) countries such as Qatar and the United Arab Emirates, independence from the colonial powers and the discovery of oil reserves disrupted the

gradual transition and assimilation of cultural and social identities, resulting in a unique social landscape (Khalaf, 2006). Several factors contributed to the development of the current urban landscape in Qatar. The most important factor was the liberalization of the 1970's and the resultant relaxation in investor policies in real estate. This led to an increase in the construction projects and a consequent influx of migrants of various cultural backgrounds due to the limited number of nationals and their professional experience (Khalaf, 2006). This in turn resulted in an increased demand for housing of the expatriate workforce and the growth of private developers. Other factors such as welfarism strategy by the Qatari Government, high pay for the locals, growing consumerism, petrodollar capital and expatriation of the Arab money post 9/11 all boosted the growth of investor led urbanism (Adham, 2011). Service sectors and the growing tourism industry coupled with good pay and provision of general security encouraged further migrant flow.

Qatari cities adopted universal standards of urban planning with respect to street width and plot configurations with an influx of idealized Western principles of city planning and town making, particularly reductionist in its understanding of the regional climatic and cultural idiosyncrasies (Khalaf, 2006). It also resulted in a spatial configuration typical of Gulf oil countries with segregated housing patterns of the migrants, detached villa housing of the nationals, luxury island housing, technical parks and energy hubs. A part of this urban growth was the development of green parks, claimed to be adopted from Western cities. In addition to parks, Qatar is investing heavily in preparing the country for the upcoming FIFA 2022 including investments on street beautification.

Despite being at odds with the understanding and implementation of sustainable dimensions of park design, park visitation is an important aspect of Qatari culture.

There is a lack of academic studies and research on park accessibility and its role in influencing park visits in the Middle Eastern context. In a report by Masdar (2020) concerning the role of urban green spaces in UAE, 87.4 percent of the population were seen to visit public green spaces, ranging from daily to once a month.

Even though the number of parks is on the rise in Qatar, a well distributed park system is essential to achieve urban sustainability goals. With their significant role in improving livability of a neighbourhood, this study analyzes the current distribution system with respect to proximity and need-based goals. It further studies the micro-accessibility aspects surrounding the parks. This research narrows its focus on the Greater Doha and Al Daayen areas which include most urbanized and populous cities and urban areas in Qatar.

1.2. Problem Statement

Earlier studies have found that well located parks lead to higher park use and social cohesion (de Vries, van Dillen, Groenewegen, & Spreeuwenberg, 2013; Kim & Kaplan, 2004; Sugiyama, Leslie, Giles-Corti, & Owen, 2008). Attributes such as population density, housing unit density, land use diversity, a pleasant walking experience and an overall need for the park are also important factors in measuring its efficiency (Talen, 2010; Wang, Brown, & Liu, 2015). Parks designed and distributed without considering these attributes result in social disconnect, exclusive access to certain sections and alienation of certain other sections of the society. Earlier studies have used equity mapping as a planning tool to analyze distributional fairness of public amenities among people of diverse sections and needs (Talen, 1998). For instance, in a review of park quality, quantity and proximity in Global North, Rigolon (2016) found

that whites and communities with higher socioeconomic status have higher walkable access to park quality and quantity. In studies from the Global South, Rigolon, Browning, Lee, and Shin (2018) found that similar inequities were consistent at a higher rate in park quantity and proximity and in lower rates in park quality. Spatial analysis of ten US cities on the distributional fairness of urban green space uncovered bias in green space planning. Higher income people and people with higher education were found to enjoy greater access to greenspaces as opposed to others (Nesbitt, Meitner, Girling, Sheppard, & Lu, 2019). Such shortage and inequity in the distribution of urban green spaces can also lead to ethnic segregation, poor health conditions of certain sections of society and psychological disturbances due to unequal or no access to recreational public realm. These problems can be symptomatic of bigger social justice issues such as environmental racism, absence of distributive and procedural justice, ethnic/race bias and income bias (Florida, 2019; Scott & Lee, 2018).

In addition to equity mapping, understanding park provision based on the community need is also an important aspect of fair distribution system. Social needs, especially of the underprivileged class or lower income sector can also affect park location efficiency. Therefore, the population subset of a neighbourhood, their physical and social characteristics and their overall need for green parks must be studied to propose equitable park distribution. Additionally, street-level accessibility including urban design factors determine park access and use to a great extent.

Usually, resources like public parks are distributed based on predefined standards such as 1 acre per 1000 people or on proximity standards such as service area, with little attention to distributional fairness (Talen, 1998). In the Qatari context, the current distribution system favors the default standards introducing a potential for lack of distributional fairness concerning different sections of the society. Therefore, there

is a need to study the equity mapping of urban parks in Qatar to uncover the presence, if any, of such distributional biases. More specifically, there is a need to understand the current distribution system and its beneficiaries. Therefore, this research studies the equity mapping of green parks in Greater Doha and Al-Daayen from a pedestrian perspective. It also identifies areas with higher need for public parks using three variables namely population density, presence of low skilled migrant concentration and residential typology. In addition, it also assesses the micro-accessibility levels surrounding the parks in chosen neighborhoods.

1.3. Significance of Study

The research measures the distributional equity of public park distribution in Qatar based on park acreage, park proximity (closeness to parks) as well as demographic density. Additionally, it identifies areas with higher need for public parks. Moreover, street-level accessibility surrounding the parks are also studied.

The study is significant for urban designers, planners, academicians and the community alike. At the planning level, the results can inform the present status of public park distribution. Park disadvantaged communities can be identified and necessary planning guidelines can be adopted. Planning professionals can benefit by identifying newer park locations in need based areas to ensure fair green space distribution. They can also make use of the novel and non-resource intensive methodology to address timely concerns regarding public park allocation. The methodology can also be extended to include other public service allocations to measure their distributional equity and identify need based areas.

Micro-accessibility studies in the research compares social variables such as

walkability in the immediate surrounding of parks in different neighbourhoods. At the community level, results from the micro-accessibility study can inform policy makers to deduce required urban characteristics to improve walkability, usage and place making of parks. The insights from the micro-accessibility study can be used to set up a bottom-up approach of launching community redressal programs and spreading general planning awareness.

The research also adds valuable insight to the accessibility research literature of Qatar and the extended GCC, which has similar social, political and economic setup. While there is a wide gap in the practice of landscape architecture and academia in these countries, this research can also be a step towards partnering with the planning authorities for bridging the theory-practice gap. The study is also significant in achieving a sustainable social structure under the social development goals of Qatar National Vision 2030.

1.4. Purpose of Study

The purpose of this research study is to explore the equity mapping of urban green parks in Greater Doha and Al-Daayen to understand the pattern of park distribution and its efficiency from the standpoint of spatial and social urban goals. It seeks to explore resident proximity, social need as well as pedestrian accessibility in the spatial arrangement of urban parks in Qatar. Geographic Information System (GIS) mapping is used for spatial macro analysis of all the parks in Greater Doha and Al-Daayen. Additionally, it studies the micro-accessibility factors surrounding the parks at neighbourhood level. This is done to study the effectiveness of park locations with respect to pedestrian accessibility. Urban design characteristics of a walkable buffer of

400 m is thoroughly analyzed using GIS data and observation studies. Walkability is analyzed using variables such as density, diversity of uses, housing typology, street characteristics and subjective assessments.

1.4.1. Research Questions

Based on the equity mapping and need based study of parks in Greater Doha and Al-Daayen, the study will address the following questions:

1. How are parks spatially distributed in Greater Doha and Al-Daayen with respect to the population density?
2. How are certain population subgroups, especially low-wage migrants and expats affected by the current distribution pattern?
3. How do factors such as population density, housing type(apartments) and population group(labour gatherings) affect park need and how has it been addressed in Qatar?

Additionally, from observation studies and walkability audits, the following question will be answered.

4. How does the current walkability level encourage/discourage pedestrian accessibility to neighbourhood parks?

1.4.2. Research Hypotheses

The basic hypotheses of the research are as follows:

1. Present park distribution system in Qatar has led to inequitable resource allocation, thereby subjecting certain sections of society into recreational

disadvantage.

2. Low-income people, immigrants and visible minorities have disproportionate access to park resources than high-income natives in Qatar.
3. Street level accessibility around parks is higher in older neighbourhoods than newer neighbourhoods.

1.5. Limitations

Constraints in obtaining data from relevant sources have limited the scope of the research in this thesis. Due to the lack of demographic data to a finer scale, open-source data in a coarser range was used for analysis. Socio-economic data were substituted with proxies for need-based analysis. The COVID-19 pandemic has also limited the ability to carry out qualitative analysis in terms of user's behavioural patterns and opinions in parks. Other limitations include exclusion of variables that affect walkability such as climate variables and perceptual qualities associated with park access. Limitations are explained in detail in section 5.6

1.6. Methodology

Methodology identifies key variables that are important in analyzing accessibility to parks namely park proximity, park need and walkability around parks (Figure 2). Park proximity measures the amount of people falling within the walkable access to the parks. Park need identifies areas in need of parks using variables such as population density, housing subtype and population subgroup (proxy for income level and ethnic class). To study micro-level accessibility, selected neighbourhoods are audited to gain observational insights on the current street character and urban design

characteristics that encourage or impede walkability. These steps are described in detail below.

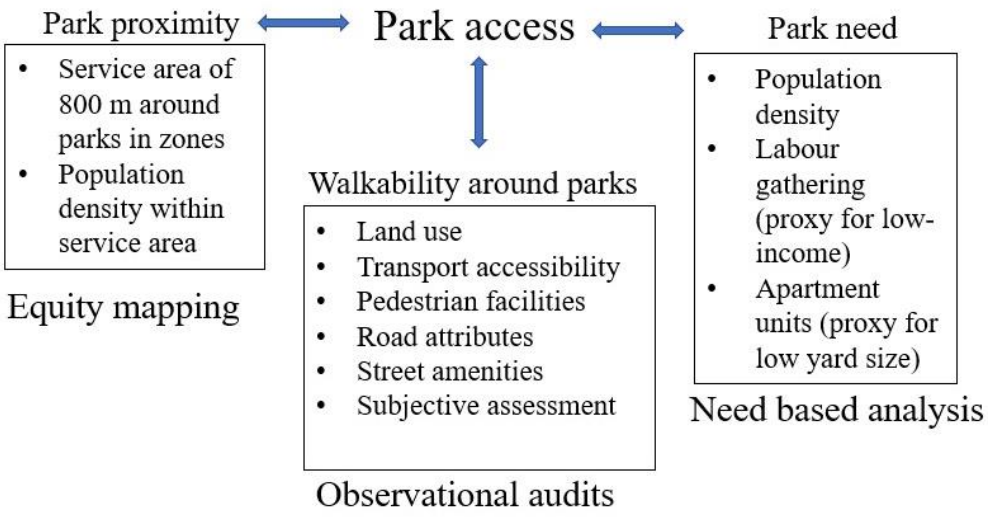


Figure 2. Methodology framework used in the study.

The methodology involves three key steps used in analyzing and identifying park access, park distribution pattern and the current level of walkability around parks in Greater Doha and Al-Daayen Municipalities in Qatar. The first step involves identifying the percentage of the population within walkable access to the parks based on minimum distance analysis (Talen, 1998) which forms the basis for equity mapping of parks. 'Radius' method is used in the analysis wherein residents are assumed to be covered by a service if they fall within the stipulated distance around the parks. Such minimum distance analysis in park accessibility research has been followed in earlier research on park distribution (Boone, Buckley, Grove, & Sister, 2009; Nicholls, 2001; Talen, 2010). In this study, 800 m radius is chosen as the maximum distance that can be accessed by foot.

The second step involves understanding park needs of the population based on spatial and socio-spatial goals. Variables analyzed in the study include population

density, housing subtype and population subgroup. In the study, housing subtype includes the number of apartment units within the service area since apartment dwellers are at a greater need for greenspace as opposed to residents in individual villas. Population subgroup includes the number of large and small labour gatherings. According to the census data of Qatar, a group of 2 to 6 persons of same gender living together, at the same time not fulfilling the conditions of a normal household family is categorized as a labourer's group of small gatherings whereas more than 7 members is considered a large gathering (Planning and Statistics Authority, 2010). In the study, small and large gatherings are used as a proxy for income level and ethnic class.

The third step includes a micro-level analysis of the immediate surrounding of parks (service area of 400 m) in two chosen neighbourhoods namely, Madinat Khalifa South and New Al-Rayyan. Pedestrian walkability levels are analyzed using self-audit studies, observation studies and GIS mapping. Pedestrian Audit Scan (PEDS) is used to carry out the walkability audit after dividing the road network in the service area into 300 m segments. PEDS uses four broad classifications for data analysis namely macroscale environment (land use and segment type), pedestrian facilities (sidewalk continuity and obstructions), road attributes (road width and crossing aids), and the microscale features of walking environment (street amenities like lighting). In addition, subjective evaluative questions are also added for an overall judgement of the pedestrian environment.

1.7. Structure of Thesis

The thesis is structured as follows:

Chapter 2, "Literature Review," includes two sections: 1) Studying the

evolution of urban open spaces with a particular emphasis on greenspaces 2) Reviewing the accessibility measures in public goods allocation, namely parks and understanding the current literature on accessibility research in parks. It also examines the critical variables in accessibility research, equity mapping and need based analysis to identify the gaps in literature.

Chapter 3, "Methodology," addresses the research methodology and the approach used in the study. It describes in detail the collection and analysis of GIS data used in equity mapping. It also outlines the steps used in assessing park need index. Walkability audits and observation studies used in determining pedestrian accessibility are also discussed in detail. Other methodologies also include site visits, observation studies, photographs, maps, and plans.

Chapter 4, "Data Analysis," presents the outcome of equity mapping based on park proximity and identifies park need zones based on need index. Population density, housing type and population type are used to identify park disadvantaged zones. It further analyses the park land use and pedestrian walkability around the parks in two neighbourhoods to gain insights on the current walkability level around parks.

Chapter 5, "Results, Discussion and Conclusion," chapter revisits the research question and discusses the findings in the light of park planning regulations in Qatar. It also proposes guidelines for a better logic for park distribution in Qatar including design recommendations and policy regulations at a macro and micro scale.

1.8. Knowledge Contribution and Advancement

The research contributes to knowledge by innovating the existing methodology of equity mapping by introducing the use of open source population data in the absence

of Census data. It also contributes to accessibility literature and equity mapping of parks in a Middle Eastern perspective, especially of Qatar, which is not well documented at present. The study proposes a rationale for the need-based budgeting on park funding and provides a guideline for future park planning. Future research should include other critical variables concerning park need, such as children below age 15 to identify need-based areas with higher accuracy. The need study should also be supplemented with a detailed inventory of the parks, detailed survey of demographic characteristics including age, gender, ethnicity and needs. Population data at a finer resolution should also be used to corroborate the accuracy of the findings of the present study.

CHAPTER 2 : LITERATURE REVIEW

Chapter 2 critically examines the background literature to highlight important knowledge gaps that this thesis investigates. It synthesizes data on accessibility research, planning standards and distributional justice aspects of accessibility with a special focus on greenspace planning. The aim of the literature review is to understand the recent and past research that addresses equity mapping and needs based assessment in greenspace planning. Different methodologies used for equity mapping and need-based assessment within walkable access of urban parks are studied. In the review we also discuss in detail the social and spatial variables influencing park placement such as proximity, density, land use diversity, walkability and the interrelationship between these factors. The ultimate purpose is to identify the gap in accessibility research in the Qatari planning scenario and identify a suitable methodology to carry out equity mapping and need based assessment within the data constraints. The review includes research papers, published government reports, books, interviews and a detailed search of electronic databases.

The review is structured into two main sections, Section 2.1 dealing with urban green space research and section 2.2 dealing with park accessibility measures (Figure 3). Section 2.1 presents the background research on the benefits of urban parks as a public resource, their evolution over time with a particular emphasis on the park typology in Gulf countries and Qatar.

Section 2.2 reviews the accessibility measures used in public resource distribution and its shift from earlier geometric and territorial distributional theories to include more need based measures. The review also highlights micro-accessibility measures such as walkability and urban design characteristics in informing park

distribution and design. Section 2.2.1 provides a planning context to understand key social and spatial variables that must be considered in park design. Section 2.2.2 critically evaluates the planning standards used throughout the world and what it means to accessibility research. Sections 2.2.3 and 2.2.4 emphasize on distributional justice discussions in public resource distribution and the need for compensatory distributional principles after identifying relevant variables from a pedestrian perspective. These sections inform the gaps in literature in Qatari spatial planning of parks and form the basis for further research.

Section 2.2.5 discusses micro-accessibility aspects such as walkability concerning the street network and urban design characteristics immediately around the park. Self-administered walkability audits are analyzed and mapped to understand the elements that contribute or hinder park access at neighbourhood level.

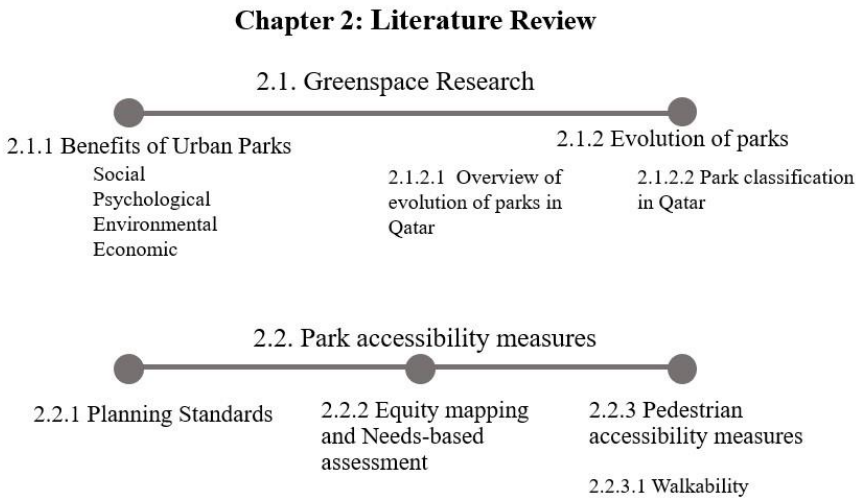


Figure 3. Summary of the literature review section.

Parks form an integral public resource in cities, usually for free use by any section of the society. While it is an equalizer in terms of its role as a recreational space for all, park access determines the quantity of people positively impacted by it.

Accessibility as a broad term can mean the opportunity to enjoy a utility by the merit of its easily approachable location and the absence of social , economic or cultural barriers. Accessibility measures have evolved over the years to convey distributional justice, ensuring equitable access for everyone. While some users have difficulty in accessing parks due to its distance, some others find the pedestrian experience of walking till parks cumbersome. Planners, policy makers and administrators, therefore, play the most important role in upholding normative principles of what a distribution system ought to be as opposed to the current scenario.

This review begins by understanding evolution, benefits and typology of green parks. It proceeds to understand accessibility research and related literature that cover the following key focus areas: (i) understanding variables enhancing park access (ii) identifying and defining equity mapping and need based areas; and (iii) understanding pedestrian accessibility.

2.1. Greenspace Research

Greenspace research has increased drastically since the turn of the century. Research on greenspace is carried out in multiple disciplines such as environmental sciences, leisure and recreation, medical and health sciences, economics, earth sciences and urban planning. However, a comprehensive definition of the term, acceptable to different disciplines, is absent. A recent review of the greenspace literature yielded two common interpretations of the word. The first explicitly comparing greenspace to nature and the second where greenspace included urban vegetation (Taylor & Hochuli, 2017). The latter included parks, gardens, yards, urban forests and urban farms, where human interaction was expected. Since an overarching rigorous definition is absent, in

this research, greenspace includes publicly accessible green parks, excluding stadiums, green areas in private backyards, private gardens, street sides and medians. The literature review section, however, includes articles falling into both definitions, with a particular emphasis on urban green areas with human intervention.

Greenspaces such as urban parks are more than optional utilities in the long term vitality of cities. Cities are particularly emphasized since vacant lands are limited, and they are under pressure in the face of rapid development. Urban parks are linked to improved mental and physical health along with other ecological benefits. In the face of the climate crisis and the uncertainty induced by pandemics, these spaces are found to be adaptive, flexible and resilient to the challenges.

While urban parks provide multiple benefits for all, people challenged by economic or social constraints are the most important benefactors of parks. Therefore, providing easy access to these communities is an important aspect of accessibility research, especially in the light of social and environmental justice movements. Accessibility to urban parks is affected by multidimensional aspects such as spatial proximity, transport connectivity, socioeconomic barriers, cultural barriers as well as perceived proximity and safety. Spatial distribution patterns including the level of dispersion of parks, presence of easy access points and the integration of walkable urban design features immediately around the parks also influence park use (Simon, 2016). In this review, our discussion is limited to the socio-spatial park accessibility measures.

2.1.1. Benefits of Urban Parks

Parks and other greenspaces provide a setting for civil, social, cultural, political and economic activities in cities. Metrics such as “amount of public green spaces per inhabitant”, “public parks” and “recreation areas” serve as useful yardsticks in measuring the livability of cities (Chiesura, 2004). Socially, parks bind diverse cultural groups by bringing people together. They unite people for different activities, including relaxation, recreation, cultural expression, and socializing. They act as meeting grounds for cultural and national events and forge a sense of place identity and belongingness (Relph, 1976). While all parks display certain common characteristics, they also display differences that distinguish each as a unique setting. Among the distinguishing characteristics include area, spatial configuration, planting proposals, amenities offered, as well as the ambience of the setting.

Successful urban parks lift the economic and aesthetic value of an area, whereas a poorly designed and maintained park negatively affects the area. Parks tend to increase the property prices of adjacent lands. In addition to social and economic benefits, parks have ecological importance. Huge parks protect a wide range of flora and fauna. Even small parks provide ecological benefits such as large edge habitat, exotic species and altered nutrient cycle (Forsyth & Musacchio, 2005). Biodiversity preservation helps in clean air, fresh water, climate and disease regulation, carbon sequestration and even in upholding spiritual values. The biodiversity cost associated with natural vegetation and vegetation with human influence is a field of study gaining traction in recent years. The value addition of ecosystem services, including that of urban parks to the Gross Domestic Product (GDP) and to welfare of human beings is usually taken for granted and not accounted for (Sukhdev, 2009). Figure 4 briefs the

importance of parks.

Figure 4. Social, economic and environmental benefits of urban parks.

There are certain unique characteristics that generally promote the use of a park and attract residents. These include attributes such as features available, condition of the park, accessibility, aesthetics, and safety (Bedimo-Rung, Mowen, & Cohen, 2005). McCormack, Rock, Toohey, and Hignell (2010) also note that park attributes overlap, reinforcing each other in positive as well as negative ways. Jacobs (1961) has also observed that public spaces that are surrounded by diverse functions have a greater diversity of users and a tendency to be used for longer periods of the day. Unused parks and deserted places play a negative role in people's outlook of public places. Deserted places that invoke perceptions of crime and vandalism were found to elicit insecure emotions amongst residents (Chiesura, 2004). Research has also shown that the lack of cleanliness, vandalism and poor maintenance discourage park use (Gobster, 2002).

2.1.2. Evolution of Parks

Over the years, urban parks have evolved to act as recreational avenues than its initial role as a public necessity. A brief overview of the park types and their changes over time is discussed both from the United Kingdom and the American perspective.

In the United Kingdom, the Victorian public health reforms of the 1830's gave rise to the Public Parks Movement where open spaces were created as a respite from industry related air pollution, unsanitary conditions and overcrowding. "Physically parks helped cleanse cities by opening them …. to air, dissipating the airborne contagion early Victorian medicine blamed for the cholera" (Malchow, 1985, p.99). Public health was not the only motive behind park creation. Declining morals of the Industrial town and the idealism associated with pastoral countryside also motivated park creation (Dreher, 1993). Based on the study by Malchow (1985), the first period of park movement saw parks created along the Industrial North on lands given up as 'private benevolence'— as gifts and public subscriptions by the elite. In the second period, preservation of parks and commons were also prioritized under the Commons Preservation society in the middle-class suburbs where commons were under the threat of continuous building and development. The third rise of public parks movement emphasized on providing facilities for the workers in the most crowded parts of the city, in areas where the need for parks were higher either due to density or crowding. Park creation in England was hand in hand with policy regulations and acts such as the Metropolitan Open Spaces Act of 1881 which allowed church burial grounds to be transferred to local authorities for conversion to parks. Together, with the help of park supporters, private elites and public efforts, numerous parks opened nearly in every British city by the end of nineteenth century. By the end of the century, planned green

spaces were also provided alongside factories to promote health as well as to project parks as an essential aspect of civilized community (Grant, 2014). Such initiatives are regarded as the pre-cursors to Garden City Movement popularized by Ebenezer Howard.

From an American perspective, the earliest parks were unimproved commons, or public open ground used for grazing cattle (Low et al., 2005). Rather than being well-defined areas with park-like features, these were the extensions of the public place, with further additions of trees and benches for relaxation. It was followed by the design of landscaped parks (Central Park in New York in 1853) which essentially mimicked the serene countryside and was designed solely for relaxation (Low et al., 2005). Landscaped parks were followed by the establishment of reservation lands, a network of natural green land, preserved and linked by parkways and boulevards. It was followed by recreational parks which provided more opportunities for direct and indirect forms of recreation, rather than a passive contact with nature.

In addition to these changes, parks differed in the social goals they set to achieve in each period. Cranz and Boland (2004) note that the parks in America gradually shifted its social significance as avenues for social reform to that of ecological health. Table 1 shows the gradual evolution of the social goals of the parks from 1850 onwards.

Table 1. A comparison of the social goals of parks over the years. Adapted from "Defining the sustainable park: A fifth model for urban parks" by G. Cranz and M. Boland, 2004, *Landscape Journal*,*23*,p. 103.

Park Typology	Pleasure Ground 1850-1900	Reform Park 1900-1930	Recreation Facility 1930-1965	Open Space System 1965 onwards	Sustainable Park 1990-2004
Social Goal	Public health and social reform	Social reform; Children's play; Assimilation	Recreation service	Participation; Revitalize city; stop riots	Human health; ecological health
Recipients	Upper middle class	Working class children and immigrants	Suburban family residents	Lower and upper middle class youth and children	People and planet
Relevance	Social justice	Environmental justice	Social justice	Environmental justice	Environmental justice and climate crisis

2.1.2.1. Overview of Evolution of Parks in Qatar

The development of parks in Qatar began with the establishment of a central administration system in early 1970's after declaring its independence from colonial rule (Zahlan, 1979). Even though the Ministry of Municipality was established in Doha as early as 1963, planning regulations were enforced only in 1971 under the Ministry of Municipal Affairs. The major objectives of the Ministry under the town planning section were Qatar's urbanization, standardizing the building process, garden and overall health of people (Buainain, 1999). In 1974, British planner Llewlyn Davis was appointed to prepare the Master plan of Doha and to provide a structure plan for the stress areas in Qatar. In 1979, Shankland Cox Partnership was introduced to further review existing planning policies. Each of these plans had green park ideals obtained from Western principles. The idea of greening the city arose from the liberalization and transformation of Doha as a service hub when the decision makers realized the need for providing urban amenities beyond the necessities (Wiedmann, Salama, & Mirincheva,

2014).

The Doha Landscape Masterplan of 1983 by Hellmuth, Obata and Kassabaum Architects proposed open space planning guidelines for Doha municipality. It provided a blueprint for the green space development pattern that has impacted the current open space layout in Doha. As per the Masterplan report, issues affecting open space development were identified in different areas of Doha. Figure 5 shows the parks, plazas and recreational lands of Doha municipality in 1983.

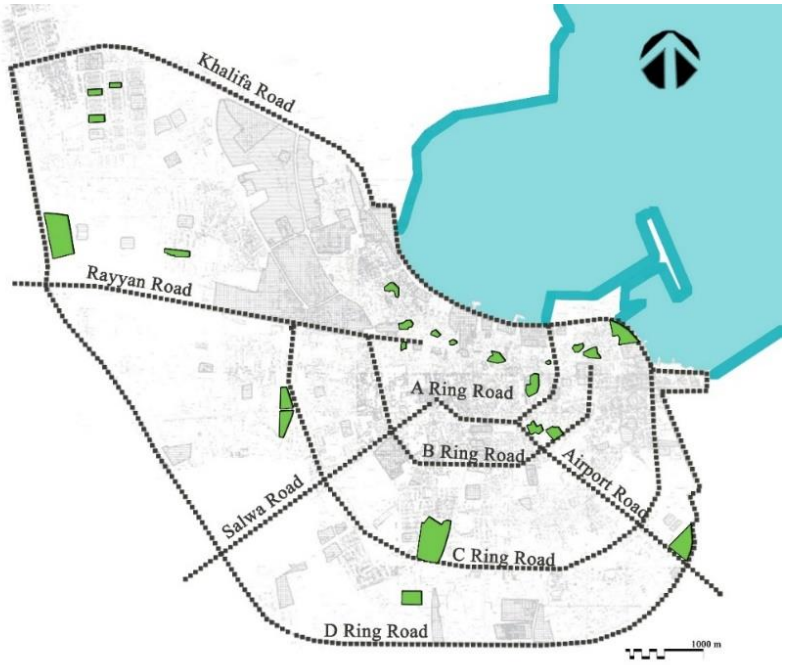


Figure 5. Parks, plazas and recreation land in Doha municipality. Adapted from "Doha Landscape Master Plan Report" by Hellmuth, Obata and Kassabaum Inc, 1983,p. 5.

The report divided Doha municipality into city core, central city area, the corniche and outskirts based on the land use, circulation, public development projects and government land ownership. Relevant planning and design guidelines were proposed for each of these areas for street beautification and open space development. These recommendations are briefed in Figure 6. The major recommendations were to improve

recreational activities and pedestrian accessibility to the Corniche and develop neighbourhood parks and pedestrian pathways in the central city and outskirts.

Doha has limited arable land due to its arid conditions and water scarcity. However, the number of public parks and landscaped area increased, due to urban development, population growth and urban greening efforts by the Government . Availability of water from treated sewage effluent, government policies on street beautification and religious components of Islamic planting also aided the growth in landscape (Lockerbie, 2020a).

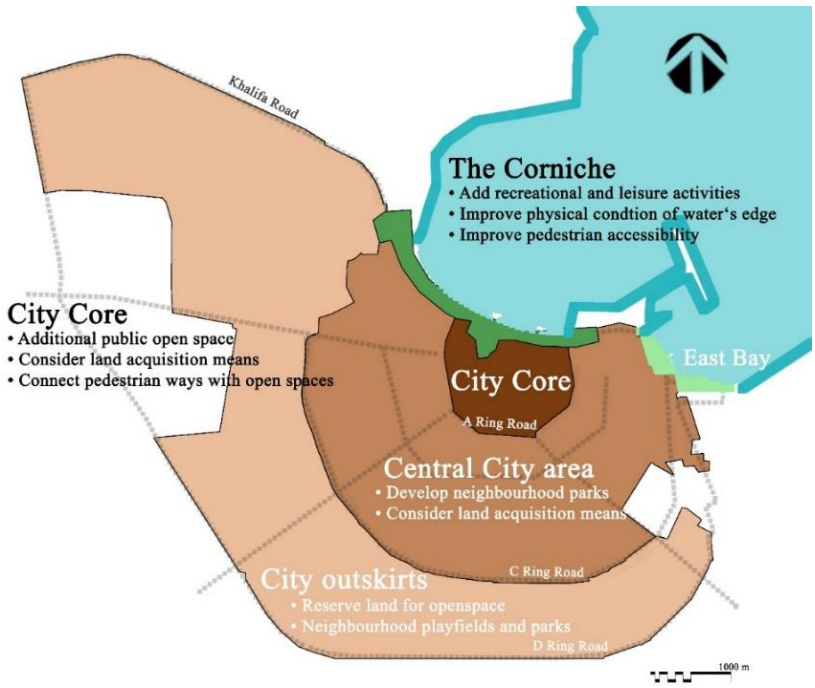


Figure 6. Doha Landscape Master plan recommendations. Adapted from "Doha Landscape Master Plan Report" by Hellmuth, Obata and Kassabaum Inc, 1983.

The first public garden — Al Muntazah Garden — was established between the B and C ring roads of Doha in the 1970's (Lockerbie, 2020a). Most of the other public parks in inner Doha were also established before 2000. Figure 7 shows the gradual changes in public green parks in Inner Doha area.

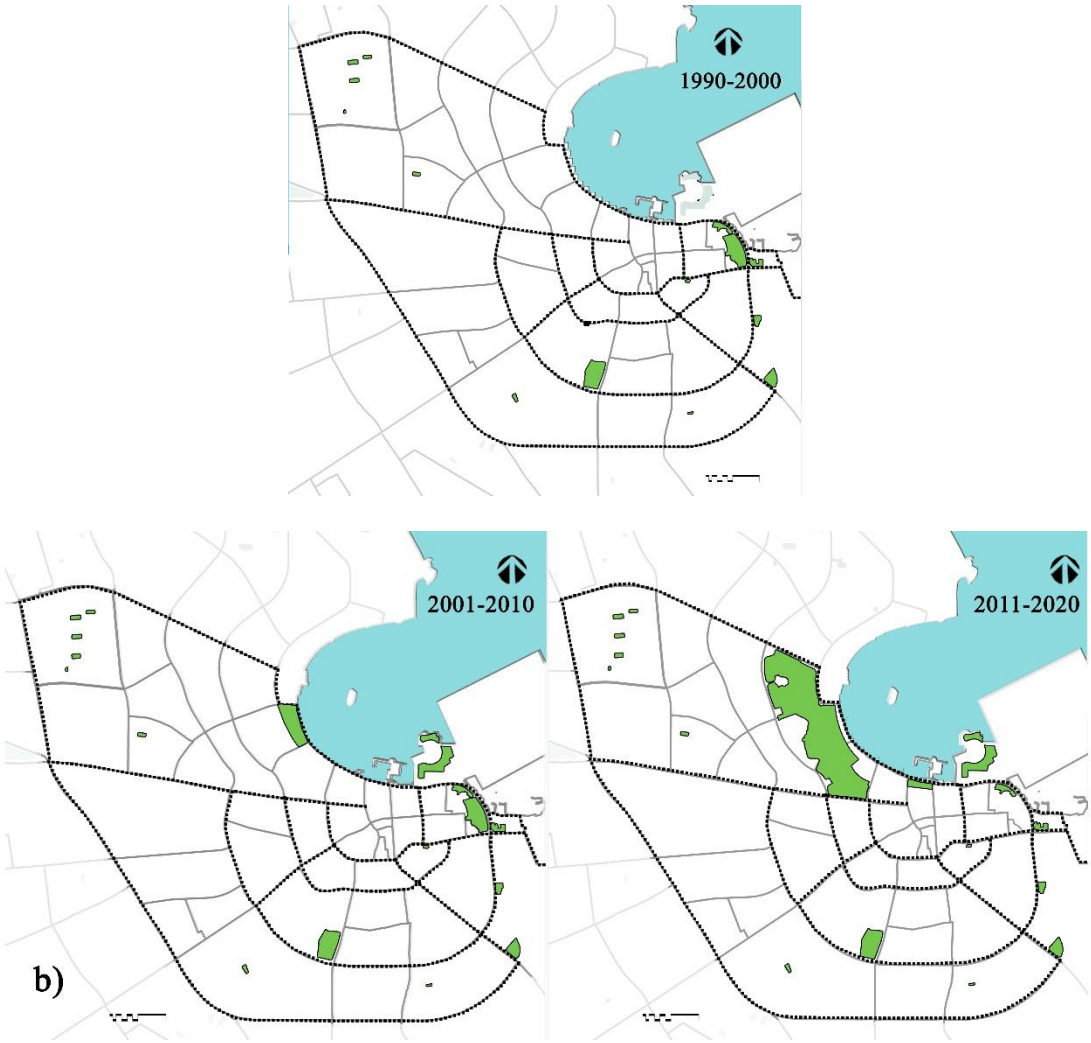


Figure 7. a) Park development in inner Doha from 1990-2000 b) Park development in inner Doha till the year 2020. Green represents public parks.

Figure 8 shows the park locations that were developed before and after 2000 in Greater Doha and Al Daayen area, the most populous and densely populated parts of Qatar. The area comparison of the parks shows an increase of 128% before 2000 through to the present with an increase in park area from 34.2 hectares to 439 hectares. Other studies carried out to analyze the green area growth using land use landcover changes of Doha revealed an annual growth of 2.57% from 1990-2000 and 9.38% after 2000 (Shandas, Makido, & Ferwati, 2017). A similar study carried out in 2017 also

found an increase in vegetation from 11.19 km^2 in 1987 to 22.01 km^2 in 2013 (Abulibdeh, Al-Awadhi, & Al-Barwani, 2019). Though the area boundaries considered for analysis in the studies were different, both studies showed an increase in green area over the last two decades. In these studies, green areas included agricultural land and farms in addition to parks and street landscapes. Recently, ambitious landscaping plans such as planting one million trees around Qatar, using the treated sewage water were also introduced by the Ministry of Municipality and Environment (Ataullah, 2019).

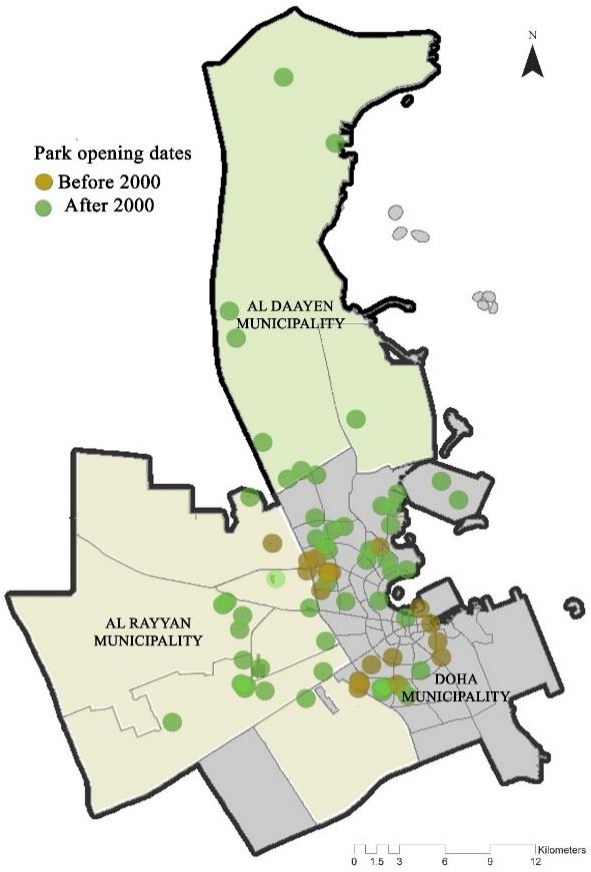


Figure 8. Map showing Doha municipality, parts of Al Rayyan municipality and Al Daayen municipality with parks opened before and after 2000 in brown and green respectively.

Despite an increase in the amount of green area, the extent of integration of public realm with planning policies for an effective use by public is under question. Some planners attribute this decline in the development of public realm to the misconception that climatic extremes and a cultural preference of privacy in Doha would deter people from using public open spaces (Qaddumi & Ahmadi, 2017). A recent study by Tannous, Major, and Furlan (2021) using space syntax on park accessibility and park size found that there is no discernible logic between park location, park size and degree of accessibility for parks lesser than 20 acres in size in Metropolitan Doha.

In Qatar, the process of designing a neighborhood park starts with choosing a location and studying the surrounding land use and users (Eribi, 2017). At the neighbourhood level, park locations are commonly nominated by local municipalities and some other times by citizens (Qaddumi & Ahmadi, 2017). Municipalities decide the location mainly on a precursory study of land use of a neighbourhood and the feasibility of turning nearby vacant areas into parks (Eribi, 2017).

Various organizations work together to create public spaces in Qatar; Ashghal (Public Works Authority) focusses on urban beautification, the Public Parks Department on the design and execution of parks, Urban Planning Department of Ministry of Municipality and Environment on spatial planning of parks and the Local Councils on community redressal (Figure 9). The present park classification system adopted in Qatar identifies and arranges existing and new parks based on their size and catchment population to non-administrative units such as national, metropolitan, town, district, local and neighborhood parks based on projected population (M. Noureleddin, personal communication, June 4, 2021). This system is contingent on the land already acquired by the Government since land acquisition in brownfield areas are not recommended at present due to market pressures. Therefore, urbanized high density

zones are at a disadvantage because of land scarcity and real estate pressure. However, the Ministry enforces that in the upcoming projects involving developers, a percentage of land must be allocated for community development in the form of green open spaces or schools.

Figure 9. Participants and drivers of the public realm. From " Scaling down planning in Doha towards the neighborhood and its public realm" by D.Qaddumi & A.Ahmadi, 2017, *QScience Connect, 2017*.

In Qatar, a vast range of differences in the population composition and structure has led to challenges in defining the real benefactors of public realm planning. Expatriates compose 88 percentage of the population structure resulting in a dilemma over the desired planning principles and policies. The population structure has also favored exclusionary planning regulations exacerbating low density sprawl to the suburbs, longer commuting distances, traffic congestion and an overall fragmented urban space (Catalán, Saurí, & Serra, 2008; Qaddumi & Ahmadi, 2017). A lack of public private coordination (except through a Municipal Council elected every four years) and a lack of communication to engage in consultation and participation with the

natives and urban residents further exacerbates the public impetus in planning decisions (Qaddumi & Ahmadi, 2017). This also provides very less opportunity to the expatriate population to voice their demands or to appropriate public places.

2.1.2.2. Types of Parks in Qatar

Among public realm greenspace typologies, public parks are defined as landscaped areas owned by the Government or by community groups. Six major distinctions of parks are identified as per the Open Space, Recreation and Sport Facilities Development Guidelines under Qatar National Master Plan. The National Level Park, Municipality Park, City Park, District Park, Local Park and Neighbourhood Park are defined based on the population it seeks to serve as well as the size of the park (Figure 10). Table 2 shows the park classification in Qatar based on their size and population served.

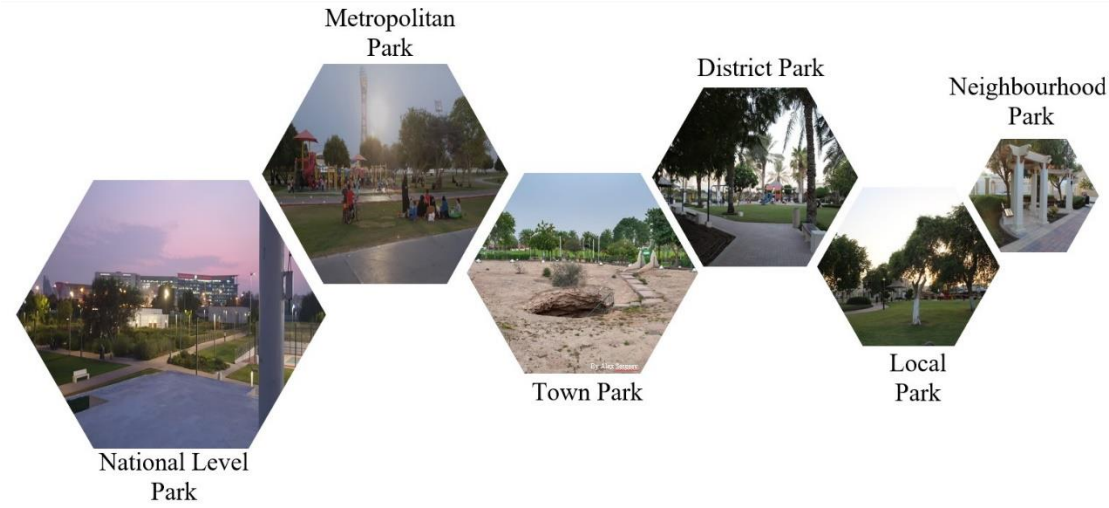


Figure 10. Park typology in Qatar based on size and catchment population.

Table 2. Park distinction in Qatar based on population served and site area. Adapted from "Open Space, Recreation and Sport Facilities Development Guidelines, Qatar" by Ministry of Municipality and Environment.

Catchment Level	National	Metropolitan	Town	District	Local	Neighborhood
Facility	National Level Park	Metropolitan/ Municipality Park	Town Park	District Park	Local Park	Neighborhood Park
Population served	Over 2 million	100000-300000	50000-100000	30000-50000	3000 with r <400 m	1200 with r <250 m
Site area range (ha)	NA	60-200	5-15	2-5	0.4-2	0.1-.25
Parks (Greater Doha and Daayen)	-	1	11	8	39	15

Based on the guidelines report, a national park is used to define a large park primarily of national interest. Below the national parks are the metropolitan parks that emphasize the regional characteristic of the place. Metropolitan parks follow a distinct theme in each of the identified Municipalities (Table 3). Town parks are community-based parks with multiple amenities that hold cultural events for community use. District parks have recreational amenities unavailable in neighbourhood parks and are designed to serve 2-3 neighbourhoods. Local parks are fenced parks that serve a buffer area of within 400 m of residences. Neighbourhood parks are those parks which fall within 200- 250 m distance from residential units in a neighbourhood, for use by people within the neighbourhood.

Table 3. Themes identified for Metropolitan parks in Qatar. From "Open Space, Recreation and Sport Facilities Development Guidelines, Qatar" by Ministry of Municipality and Environment.

Region	Recommended Theme
Al Doha	Cultural, Capital city theme parks
Al Shamal Municipality	Port, Archeological Places, Sea Turtle, Eco Parks
Al Khor Municipality	Port, Mangrove, Marine Diversity
Al-Rayyan Municipality	Hills Landscape, water-based recreation
Al Wakra Municipality	Dune, Fishing Village
Al Daayen	Passive / Traditional farming –based recreation

In addition to the green parks, Qatar has been investing heavily in urban beautification (Figure 11). These include street beautification — planting street trees, beautifying intersections, introducing hardscape elements along street edges as well as preparing jogging and biking tracks — along major highways. However, earlier studies have claimed that landscape architecture is simplified to urban beautification in the Middle East, disregarding the ecological landscape perspective which honors landscape as the stage for other lived-in functions and experiences (Makhzoumi, 2016). This kind of 'cosmetic beautification', aims to showcase the country as an avenue for growth and prosperity, while it may have an exceedingly small impact on people and their well-being, or satisfy the park need of the populace. While planning bodies appear to prioritize both green park creation and urban beautification through streetscape and hardscape, the latter is found to take precedence owing to the upcoming FIFA world cup. The concept of landscape planting simply in beautifying the region ignores the fundamental ecology and natural processes taking place in maintaining the equilibrium of biodiversity.

Figure 11. Urban beautification in cloverleaf intersection pits in Qatar.

Other aspects of green parks in the Middle East are the “verdant landscape as a symbolic recreation of the Islamic paradise”(p. 6) in park design and an assertion to put the country in the global limelight through interesting landscape designs (Bolleter, 2009; Ouis, 2002). Numerous landscape projects within Qatar such as the Aspire Park, Museum of Islamic Art park, Oxygen Park and the recent addition of expanded and refurbished Al Bidda Park create an image of the latter aspect; a modern, progressive Islamic nation. Parks such as Al Bidda park (covering 205 hectares) draw many users due to the presence of various recreational facilities such as biking tracks, jogging trail, splash pads, barbecue spots and private gazebos (Figure 12).

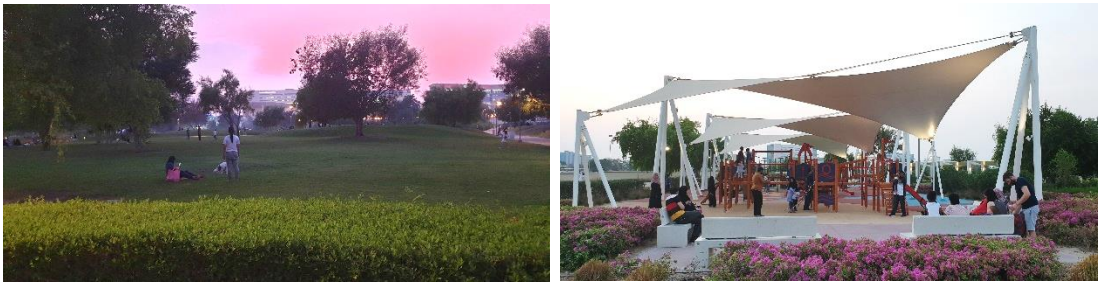


Figure 12. Park visitors relaxing at Al Bidda Park.

Green areas have different connotations for different population groups in the Gulf. Where palm groves are recreational sites for elites; roundabouts and streets are

the sites of migrant labourers (Doherty, 2017). At present, certain parks have exclusive ‘ladies’ days’ to promote the interests of women and children and to provide a safe and private environment sensitive to the local culture. However, single male workers — colloquially known as bachelors — are not allowed in certain parks, especially in various neighbourhood family parks, unless accompanied by children or women. Neighbourhood and municipality parks are often fenced off from the surrounding streets for surveillance and to ensure entrance to the families. Similarly, sport based dress code is mandated in a few parks such as Aspire park further dissuading certain sections of the society.

2.2. Park Accessibility Measures

Accessibility in public good distribution is important to maximize use and provide equal opportunities for all. Hence, it is closely related to social and spatial equity of goods. Though accessibility can have multiple definitions in the scale of its impact, it is generally understood as the ease of opportunities for all with an emphasis on proximity of amenities, needs of diverse users and other cultural barriers. In other words, accessibility measures the availability of services in terms of distributional distance, affordability and appropriateness (Simon, 2016). The premise of accessibility is equality in opportunities irrespective of socioeconomic, cultural, educational or personal differences. Owing to the multiple benefits related to greenspace, park access is considered as one of the important markers of urban livability (Byrne et al., 2009).

Even though traditional accessibility measures relied on geometric theories with a notion of ‘origin’ and destination distance as the primary markers, the concept has evolved over the years to include space-time constraints. Space-time measure of

accessibility was defined by Pirie (1979) as a measure ‘which was sensitive to adaptive behavior—to the fact that accessibility is always created and is not just something to be had by virtue of one's locale’ (Wang, 2015). Over the last two decades, a further shift was observed in the conceptual definition of accessibility from that of the sole spatial ability to reach the public good to the inclusion of ‘non-spatial’ aspects such as socio-economic characteristics, communication constraints, public need and other cultural barriers. This shift created the need for an integrated accessibility measure that can measure multiple variables (Figure 13). However, spatial-physical dimensions are the most researched aspects of accessibility (Bisht, Mishra, & Fuloria, 2010). In this research, accessibility is confined to spatial and non-spatial variables such as proximity to parks and demographic profile including population and housing subtype.

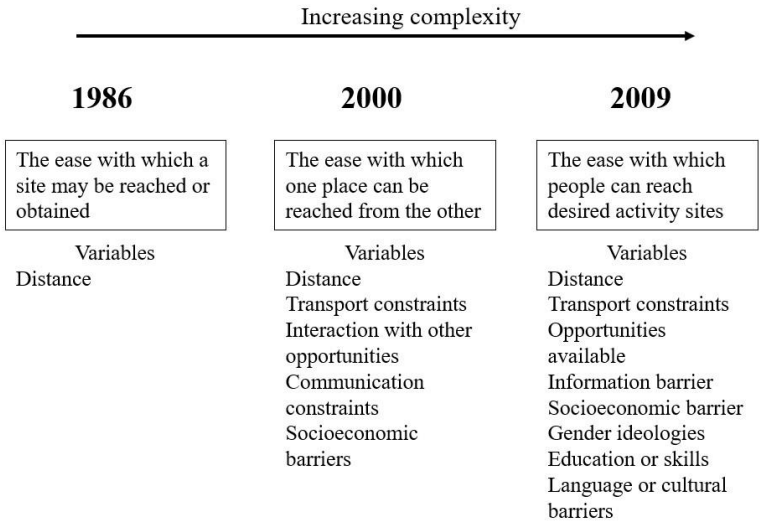


Figure 13. Introduction of non-spatial variables in defining accessibility. Adapted from “Rethinking planning for urban parks: accessibility, use and behavior” by D. Wang, 2015.

From a planning perspective, a compact city rather than a sprawl, is accessible since facilities tend to be within suitable distance (Ewing, 1999). The study of access

is hence closely attached to the study of urban form (Talen, 2002). Higher density urban forms support social equity by increasing access to transport facilities, reducing social segregation and providing better access to facilities (Burton, 2000).

2.2.1. Green Parks and Planning Context

Planning for park provision constitutes answers to innumerable concerns ranging from public health, urban sustainability and social sustainability. In the sphere of social sustainability, a distribution pattern that includes one group and excludes the other accounts for environmental injustice. Such distributional injustice is prevalent both in Global North and Global South cities with community wide variations in access to park acreage and park proximity (Rigolon, 2016; Rigolon et al., 2018).

Park distribution approaches around the world rely on per capita green area standards to meet the minimum green area required for the inhabitants. Some scholars claim that the World Health Organization stipulates a standard of 9 m^2/person (Morar, Radoslav, Spiridon, & P curar, 2014). However, the origin of the data is not clear and seems to be cited from an Italian study (Salbitano, 2020). Per capita green park standards vary from country to country. In the United States of America, National Recreation and Park Association (NRPA) has recently scrapped the earlier standard of 40 m^2/person within 400 m distance of parks, citing the inadequacies of standards in satisfying different geographic areas (May, 2019). Instead NRPA uses park metrics which includes a comprehensive data of the park standards and insights for recreation agencies based on comparison with peer agencies. In Germany, for instance, the minimum green area requirement is 20 m^2/person (Grunewald, Richter, Meinel, Herold, & Syrbe, 2017) whereas in Italy, it is 13.5 m^2/person (Hashem, 2015). In Queensland,

Australia, park standards are between 40-50 m^2/person (Byrne & Sipe, 2010). However, Park Provision Ratio (PPR) based on the actual park provisions in Melbourne, Stockholm and New York were found to be 48, 74 and 18 m^2/person respectively, far higher than the stipulated standards (Tan, Wang, & Sia, 2013). Using land use land cover analysis in Qatar and by comparing them with other Middle Eastern countries, Hashem (2015) proposed 8 m^2/person as the per capita green park standard for Qatar. Table 4 shows the green park standards considered in other Gulf countries.

Table 4. Green park standards in Middle Eastern countries. From "Assessing spatial equality of urban green spaces provision: a case study of Greater Doha in Qatar" by H. Nadeem, 2015, *Local Environment, 20.*

Country	Urban Green Space (ha/1000 people)
Bahrain	0.58
Oman	0.95
Abu Dhabi	0.85
Dubai	0.77

Erkip (1997) has noted that multiple factors can contribute to public service distributional patterns. The number of resources available or the amount of land that can be converted to parks, the distribution and composition of population, political demands and needs of the citizens together determine the park distribution pattern. Green area standards alone do not guarantee park accessibility and usage. Previous research has clearly demonstrated park inaccessibility faced by communities due to multiple socio-economic factors such as race, gender, ethnicity and age (Boulton, Dedekorkut-Howes, & Byrne, 2018). Therefore, it is necessary to study other variables that impact spatial and non-spatial accessibility.

2.2.1.1. Proximity

Park proximity refers to the spatial distance of a park from any other geographical unit in the neighbourhood. Proximity, in equity mapping studies, explores the possibility of walking to a park, especially from one's residential unit. Residential proximity, along with mobility is found to be an important indicator of access to many amenities (Haugen, 2012). Earlier studies have found a connection between proximity and park acreage to improved walkability, neighbourhood quality, positive resident outcomes and increased park visitation (Chiesura, 2004; García & White, 2006; Giles-Corti & Donovan, 2002; Harnik & Simms, 2004; Talen, 2010). Park proximity was also found to ensure improved physical health (Sallis & Hovell, 1990). Conversely, studies have found that an inequitable distribution pattern which hinders park access reduces physical activity levels in people of low socioeconomic class (Giles-Corti & Donovan, 2002; Macintyre, Maciver, & Sooman, 1993). Park visitation is strongly correlated to park proximity despite the size or status of parks, meaning that neighbourhood parks nearby are equally likely to be visited as much as a regional park nearby (Giles-Corti & Donovan, 2002). The increased visitation can be attributed to the concept of 'distance decay effect' where people are more likely to make multiple shorter trips and fewer longer distances (Wilson, Sister, & Wolch, 2008).

2.2.1.2. Density

Density is the number of units in a given area. There are many measures of density depending on the unit that is measured. Population density is the number of people living per unit area. Density can also be a mix of housing and the actual resident

population (Whitehead, 2008). Some researchers suggest density is a means to achieve urban sustainability goals such as connectivity, social vitality and convenience facilitated by gridded streets, mixed-use diverse neighbourhoods and easy access to transit (Simon, 2016).

However, theorists are divided when it comes to densification (urban consolidation), where the proponents believe that it can lead to efficient use of public amenities, reducing sprawl and pollution and protecting valuable land in the suburbs (Byrne & Sipe, 2010). Less dense and fragmented development pattern with segregated land use makes it difficult to access amenities since they tend to be far from each other (Talen, 2010). Therefore, population and residential densities play an important role in urban greenspace use.

It is argued that areas with higher population density have higher greenspace need to account for the loss of private green yards (Byrne & Sipe, 2010). In areas with higher residential density, people of lower socioeconomic status have higher need for green parks since they cannot afford other forms of leisure due to mobility, cultural or income related constraints (Azzali & Tomba, 2018; Scott & Munson, 1994; Wolch, Wilson, & Fehrenbach, 2005). Similarly, children too have greater need of green parks for their social and psychological development (Erkip, 1997). Despite their developmental needs, several studies in the United States have suggested that children living in poverty have lower levels of physical activity and consequent obesity-related health problems, due to the absence of freely accessible recreational spaces that promote physical activity (Gilliland, Holmes, Irwin, & Tucker, 2006; Romero, 2005; Talen, 2001; Talen & Anselin, 1998).

Similarly negative effects have also been attributed to density. For example, high density neighbourhoods are seen to have smaller parks which are of lower quality and less used due to perceived safety concerns and lack of maintenance (Dempsey, Brown, & Bramley, 2012; Simon, 2016). These discussions necessitate that park design in denser areas must consider the socioeconomic characteristics, cultural and age related needs of the surrounding demographic profile.

2.2.1.3. Diversity

Diverse areas provide opportunities for interaction by allowing people belonging to different race, ethnic or socioeconomic conditions to sustain together (Sarkissian, 1976). They also present a microcosm of human complexity despite the differences in their physical, social and cultural beliefs (Talen, 2008). Earlier theorists have all agreed that social diversity is integral for urban vitality since it promotes human interaction, favors distributional equity and enforces inclusive societal values (Jacobs, 1961; Talen, 2008). Mixed- use is a measure of different people or activities and is used in maintaining diversity. In addition to the equity factor, other advantages of mixed-use include improved aesthetics of streetscape, increased safety due to informal policing and increase in footfall. Diverse communities can also foster a sense of shared responsibility, accelerating the funding for the design and upkeep of public assets such as parks.

Since public parks are free services, they play an important role in successfully mixing diverse people and creating a sense of shared responsibility (Talen, 2006). Park provision in diverse areas is also linked to increased park visitation and perceived safety (Jacobs, 1961). Diverse land use and social mix around parks are found to provide a

constant flow of people and complex pool of use depending on the time of the day. On the contrary, some studies have suggested the prevalence of crime in mixed-use neighbourhoods with higher residential density due to the influx of outsiders, primarily due to the need for policing than the effect of diversity itself (Stucky & Ottensmann, 2009).

Catering to a diverse group of people requires a nuanced approach in tackling park design. Diverse groups of people also appropriate public spaces based on their preferences. Hence providing options for flexibility and adaptation are important in park design. Therefore, greenspace requirements in socially diverse communities suggest a need for an understanding of the population profile of the surrounding neighbourhood.

2.2.1.4. Social Variables

Other social variables that ascertain park access are the socio-economic and cultural differences including race, gender, ethnicity and income levels. Religious beliefs and practices, for instance, shape user's engagement in parks. In a study of Muslim park users in Birmingham, users were seen to avoid parks with dog-walkers or parks where people were not clothed modestly in summers. They tended to congregate with people speaking the same language, forming gender based groups observing their kids and staying away from parks that were perceived as unsafe due to hate crimes or other illicit activities (Keshavarz, 2013). Study on parks in Qatar has shown the need for family parks and ladies only parks considering the gender based segregation practiced in Qatari culture (Eribi, 2017). While such policies are sensitive to cultural needs, low-wage migrant labourers, usually employed in the construction sector, are

kept away from such facilities. In Dubai, exclusionary mechanisms such as labour dominated enclaves are mandated to certain migrant communities who are also subjected to segregation and diminished access to public open spaces promoting social exclusion along ethnic and socio-economic lines (Elsheshtawy, 2013).

Within the structured society of Qatar, migrants and nationals enjoy different levels of privileges on social, economic and spatial spectrum. Public planning for welfare is skewed towards the rich nationals from which migrants and expatriates are excluded. Labour laws and other judicial policies emphasize on the 'temporariness' of the expatriate and the inability to form an indelible bond with their country of migration. For an expatriate, employment designation — private sector with non-labour designation and a minimum salary of QR 7000-10000, housing contract and medical insurance are mandatory to bring family members to Qatar (Hukoomi, 2021). Economic and cultural barriers, therefore, limit the access to green parks to such low-wage migrant communities.

2.2.2. Equity Mapping and Need Analysis of Parks

According to the World Bank (2005), equity refers to fairness facilitated by equality in opportunities and an absence of absolute deprivation, arising from membership in a certain group (e.g., a certain race, gender, ethnic group etc.). In social sciences, equity and equality are used interchangeably, however the difference between the two lies in the fact that in achieving equality, equal opportunities are presented before people whereas in equity, fairness and justice is ensured (Jones, 2009).

Accessibility is a means of achieving equity since ease with which a public amenity is approached spatially or socially determines the equity of these amenities for

its users. Even though absolute equity in terms of accessibility of urban spatial network is an elusive goal since some locations are more integrated than the others, equity based on proximity or within walkable distance can be achieved. Spatial disparity in public good distribution can hinder equitable access to certain sections of society. The converse is also true. A park located evenly from a spatial point of view, but far from a residential neighbourhood or in an area where the population density does not efficiently serve the park need not contribute to the 'equity' factor. Therefore, other factors determining social need such as demographic profile, income levels, residential typology and culture together dictate spatial equity of parks. Parks where cultural barriers and gender separation are mandated due to religious or cultural factors decreases fair access.

Park distribution can either be equitable, compensatory, demand-based or market based (Byrne & Sipe, 2010). Equitable distribution ensures equal access to all sections of society irrespective of need whereas compensatory distribution emphasizes on locating accessible parks closer to high need/ park disadvantaged communities. The other two types of park distribution are based on public demand and their financial ability to pay for these amenities. In rich Gulf- oil countries, however, a growing trend is the exhibitionistic distribution of public parks to make the cities more attractive to global capital (Bolleter, 2009). These distribution types can cause selective access to certain sections of society if planning from a normative stance is not considered.

Spatial equity is measured through distance (Talen & Anselin, 1998) whereas social accessibility requires demographic variables that measure income, ethnicity, age and gender. Equity mapping as a term was initially used by Emily Talen to describe the spatial distribution of public amenities to understand the level of distributional equity amongst different demographic groups and diverse needs. Spatial metrics such as park

counts, park acreage, park provision per capita and park quality are studied in equity mapping literature (Boone et al., 2009; Rigolon, 2016; Vaughan et al., 2013; Wolch et al., 2005). Park acreage is measured by the number or size of parks in a study unit. Park quality assessment includes park amenities, actual and perceived safety and park maintenance levels (Wang, 2015). In earlier research by Larson, Jennings, and Cloutier (2016), park quantity (percentage of parks in cities) was found to be a strong contributor of community wellbeing, followed by park quality (per capita park spending) and park accessibility (percentage of people within 800 m of parks).

Over the last two decades, the concept of environmental racism is highlighted in accessibility literature. It discusses the inequitable distribution of enjoyable amenities to selective communities. Equity mapping studies also have highlighted spatial distribution injustice and poor park quality suffered by socially underprivileged communities. Several studies have discussed the presence of fewer park acreage and park facilities in underprivileged communities than that enjoyed by the well-off sections of society (Boone et al., 2009; Vaughan et al., 2013; Wolch et al., 2005). In a study on Baltimore, disadvantaged African American communities had lower park acreage within the service area, even though they had better accessibility (Boone et al., 2009). Park access was found to be disproportionately higher in areas with white high-income individuals as opposed to low-income Black-African population in South African context (Venter, Shackleton, Van Staden, Selomane, & Masterson, 2020). An exhaustive review on park access, park acreage and park quality found that while Latino and African American communities had greater access to neighbourhood parks, park acreage and quality were less than their wealthy counterparts (Rigolon, 2016). Rigolon's review of park accessibility in global south and north cities shows that inequity in green space acreage was common for both (Rigolon et al., 2018). While the

global north had inequity in park quality, global south cities had unequal proximity (Rigolon et al., 2018). In Ankara, Turkey park use was correlated to income levels in addition to park proximity (Erkip, 1997).

Similarly, Nicholls (2001) in her study on park accessibility in Bryan, Texas found that park distribution was spatially equitable to high-need communities while reaching to the park was not equitable due to physical barriers such as highways and poor walkways. She employed a 'network analysis' tool with an acceptable maximum distance of 800 m to draw service areas around the parks (Chen, Christensen, & Li, 2019). In a study of parks in Los Angeles, Wolch et al. (2005) found low park acreage in disadvantaged communities such as African Americans, Asian Pacific Islanders and Latino dominated neighbourhoods. While these disadvantaged communities had less than 1.7 park acres per 1000 people, predominantly White communities had as much as 31.8 park acres per 1,000 residents. Partly, this result is because the white dominated areas are located on the suburbs where the residents are close to large regional parks. She also found higher or equal funding for parks in affluent suburban areas than the neediest areas in terms of poverty, higher number of children and below average accessibility to parks. Table 5 reviews studies that adopted the radius approach (2008 onwards) in park distribution analysis and their results in relation to equity mapping.

Table 5. A list of empirical studies measuring recreational open space equity and access utilizing radius technique. Methods employed and unit of analysis define the area considered around the study site. Results briefly mention distributional equity from a lens of proximity and acreage to different communities.

Author(s)	Public amenity/ Study site	Methods employed	Unit of analysis	Results
Boone et al. (2009)	Parks in Baltimore, USA	Thiessen polygons drawn around parks	400 meters (=0.25 mile)	High access in park proximity, low access in park acreage to low-income communities.
Cutts, Darby, Boone, and Brewis (2009)	Parks in Phoenix, Arizona	Euclidean radius buffer around parks	400 meters (=0.25 mile)	High access in park proximity, low access in park quality to low-income communities.
Johnson Gaither (2011)	Parks in Hall county, Georgia	Thiessen polygons around parks	400 meters (=0.25 mile)	Low access in park acreage to low-income communities.
Chen et al. (2019)	Parks in Cache County, Utah	Network analysis service area around parks	800 meters (=0.5 mile)	High access in park proximity, low access in park acreage to low-income communities.
Weiss et al. (2011)	Parks in New York city, USA	Euclidean radius buffer around parks	400 meters (=0.25 mile)	Low access in park acreage & high access to park amenities to low-income communities, (Latinos, poor, African Americans, migrants)
Rigolon and Flohr (2014)	Park, school ground and community garden in Denver	Weighted spatial network analysis	400 meters (=0.25 mile)	Low access in play area acreage to low-income communities, (Latinos, poor, African Americans, migrants)

In the preceding section, equity mapping studies from the Global North, specifically the United States have been reviewed due to scarce literature from Middle Eastern perspective. The rationale is to understand the approach employed in each study area. While there is considerable distinction and nuances in the market structure and population composition in Qatar, this distinction is acknowledged, for instance in employing the service area measures and assessing inequity in the demographic composition while employing the methodology in Qatari context. While the ethnic

minorities in the United States and the low-wage migrant population have clear distinctions in their socio-economic standing, the latter like the former are considered a vulnerable population group due to their status in the social hierarchy.

Wilson et al. (2008) states that equity mapping can be analyzed using two approaches: (1) the container approach; and (2) the minimum distance approach (Table 6). The container approach is further classified as a coverage approach whereas minimum distance includes the radius approach. In the container approach, the total count or area of amenities inside a geographical unit is summed (Lindsey, Maraj, & Kuan, 2001; Nicholls, 2001; Smoyer-Tomic, Hewko, & Hodgson, 2004; Talen & Anselin, 1998). In the container approach, an amenity distribution is considered equitable if a higher number of amenities coincides with disadvantaged communities (for e.g., low-income, minority, migrants). While the container approach is simple in understanding the distributional density of amenities with respect to demography, it can be miscalculated if the container boundaries are not clearly defined (Nicholls, 2001). For instance, people living next to the container boundary will have access to nearby amenities on both the containers or might be nearer to the amenity in the other container and therefore the results from this approach need not accurately measure the distributional fairness based on access. Presence of park, park acreage or park provision per capita alone does not ensure park use. Therefore, a minimum distance approach, with an emphasis on service area, was incorporated in recent studies.

In the minimum distance approach, access is measured using the distance metrics from origin to destination such as the service area buffer radius, driving distance or indirect estimate such as travel time. In this approach, equity is achieved if parks are located closer to the disadvantaged communities (for e.g., low-income, minority, migrants). People living within a shorter distance or service area are deemed to have

higher accessibility. A variation of the minimum distance approach is the radius approach in which inequity is measured if a lower presence of disadvantaged communities within the buffer radius (usually 800 m) is detected as opposed to the other communities. To measure the coverage or service area around individual parks, two common metrics for measuring the distance are used: network distance and Euclidean distance. Network distance is the length of the facility through the shortest available street network. Radius approach is implemented by comparing the percent of disadvantaged groups (percent ethnic/ minority) within the service area to those outside of the service area. Service areas are measured either as 'crow-flies' distance or the distance based on the directions and layout of the street network. The following paragraph describes the service area in detail and proceeds with the discussion on equity mapping.

Table 6. Accessibility measurement techniques, their approaches and their source. From "Measuring accessibility of regional parks: A comparison of three GIS techniques" by K. Hass, 2009.

Type	Approach	Definition	Source
Service Area Measures	Container	Number of facilities contained within a given unit.	Talen & Anselin, 1998
	Cumulative Opportunities	Count of the opportunities reached within a given travel time or distance	Handy & Niemeier, 1997
Travel Impedance Measures	Minimum Distance	Distance to the nearest facility	Talen & Anselin, 1998
	Travel Cost	The average distance between each point of origin and all destinations	Talen & Anselin, 1998
Gravity and Potential Measures	Potential	The sum of all facilities (weighted by size) is divided by the 'frictional effect' of distance.	Handy & Niemeier, 1997, Skov-Peterson, 2001
Utility Based Measures	Utility	The probability of an individual making a particular choice depends on the utility of that choice relative to the utility of all choices	Handy & Niemeier, 1997

While the minimum distance approach assumes people within the service buffer to have higher access to those outside the service buffer, other measures such as the travel impedance, gravity, and utility measures uses multiple measures to calculate accessibility, including travel cost (Hass, 2009).

2.2.2.1. Service Area

Generally, service area is defined by the time taken to complete the distance to the nearest amenity, by the pedestrians. Park service area determines the zone of influence exerted by individual parks (Guo et al., 2019; Lancaster, 1983). In accessibility research, park service area refers to the maximum walkable distance of a resident from the nearest park. Different estimates for distance such as one tenth of a mile (150 m), a quarter mile (400 m), a half mile (800 m) buffer around parks or six walkable block distance standards are employed in service area measurements (Harnik & Simms, 2004; Leccese & McCormick, 2000). These standards vary from place to place based on the geographic and economic constraints as well as political realities such as funding and land availability, climatic extremes as well as street grid patterns.

However, an amenity farther than half mile (approx. 800 meters), which roughly equals a 10-minute walk is considered a 'formal destination' and hence people are more likely to use other means of transport than walk. Half a mile distance to the nearest park has been analyzed in earlier studies as an effective distance to be covered in 10 minutes (Lindsey et al., 2001; Nicholls, 2001). Hence, half a mile has been used as the maximum threshold for placing parks in a neighbourhood.

2.2.2.2. Needs-Based Assessments

Need index is used in earlier studies to identify user need relative to their socio-economic conditions (Murray & Davis, 2001). Other than the social goals, social need determines equity to a larger extent. A just park distribution must therefore consider such public needs. Public needs may depend on various social and urban variables of the surroundings. Population density, residential typology, demographic mix and climatic factors are some of the factors determining park need.

Past studies have used the need index to determine the extent of demand in the social and economic spheres such as public transport need and need for schools (Murray & Davis, 2001; Talen, 2001). Apartment dwellers have different green park needs than those living in huge single-family homes (Talen, 2001). It is often noted that neighbourhoods with tall apartment buildings with lower per capita green area in their residences will have higher preference for public parks in contrast to large villas with ample green gardens. Therefore, public parks can replace needs for greenspace in apartment residents and not necessarily in single-family homes since the latter can make use of the private yards for recreational purposes (Talen, 2010). In a study to understand park quality and park need, Chen et al. (2019), found that rental homes with lower yard space and higher park need lack equal park quality services to other communities. Similarly, the demographic mix of the household can also be a determinant of public park need. In addition to all these factors, cultural and climatic factors play a role in providing or hindering the ease with which any amenity can be enjoyed. Especially in the case of Qatar, it is observed that hot humid summers deter the movement of people in public open spaces, specifically at noon. Thus, equity as a concept can only be ensured if multiple variables of park access are met simultaneously.

Ethnic/race minorities lack private yards for play in addition to having poor affordability to private recreational amenities (Wolch et al., 2005). The inequity is prominent in such ethnic neighbourhoods since they have more children per family (Wilson et al., 2008). Due to low personal mobility, children and elderly people are found to be more green space-dependent (Boulton et al., 2018; Loukaitou-Sideris & Stieglitz, 2002). People from lower socio-economic strata, migrant workers, people living in apartments with limited green areas and those belonging to higher block density need higher access to green neighbourhood parks.

An index can be linear or non-linear depending on the variables used. The weight is attributed to each of these variables based on their importance in meeting the need and the scale used for distinction. Equally weighted variables with the same number of scales can be combined linearly and used as a basic index to determine the need index. For need analysis of public transport in suburbs, Murray and Davis (2001) used indicators such as number of people per sq.km, people aged 65 years and over and those with an income below 300 dollars per week.

2.2.3. Pedestrian Accessibility Measures

As people contribute to the vitality of cities, studying the ways in which cities can accommodate more pedestrian friendly design is of vital importance. Public spaces act as fundamental social centers leading to neighbourhood placemaking, healthy living and increased quality of urban life. Therefore, understanding the degree to which pedestrian accessibility is encouraged or discouraged by urban planning as well as urban design characteristics is significant. Zoning regulations, land use diversity, street network and urban design characteristics are attributes that contribute to walkability.

2.2.3.1. Walkability

Walkability has been defined in multiple ways, but the most common definitions in planning literature combine safety, comfort and the usefulness of the walk. Talen and Koschinsky (2013) defined walkability as a physical aspect of the neighbourhood that makes walking a positive experience aided by well-designed streets, sidewalks and paths. New Urbanism, Transit Oriented Development and Traditional Neighbourhood Planning theories have all proposed walkable neighbourhoods as important elements of urban design. Convivial spaces — open, public locations where citizens can gather, linger or wander through — are built on the foundations of a walkable environment (Shaftoe, 2008). Seminal articles on urban public places state that good public places are the ones that increase access.

Proponents of these theories attribute economic revival and increase in footfall to the level of walkability in cities. The general theory of walkability, consolidated by Speck (2012) in his book '*Walkable City : How Downtown can save America, one step at a time*' states four essential elements for designing a walkable neighbourhood; the walk should be useful, safe, comfortable and interesting. Although these factors are important individually, they are often interconnected, and a successful walk should include all the four elements together (Speck, 2012).

Usefulness of the walk refers to a healthy land use mix and the presence of transit in a walking stretch. Urban zoning ordinances that govern land use diversity promote vitality in streets and provide interesting destinations for people to walk to (Jacobs, 1961). Proper land use mix excludes blank facades, huge parking lots or back of the buildings overlooking important streets.

While the social and economic conditions of people determine their choice to

walk, urban design features can persuade or dissuade people from choosing smaller walking destinations (Oakes, Forsyth, & Schmitz, 2007). This falls in the realm of safety which can be easily manipulated in a city setting. Sidewalks are regarded as 'the vital organs' of a city where social and functional interactions are reinforced (Jacobs, 1961). They are conduits of movement in a street that add vitality and character to the space. Since street edges are under the ownership of public authorities, any change relating to edge character can be easily implemented within a realistic budget. Physical urban design characteristics include multiple variables such as street grid system, sidewalk condition, sidewalk obstructions, tree canopy, traffic volume, land use, street lighting, crossing aids and the presence of benches and other shading devices. Small block size and grid like street networks are attributed to increased choice of routes. Grid networks with multiple connections encourage physical activity, enhance pedestrian permeability and provide opportunities for optional interactions than those with fewer connections (Gehl, 2010; Jacobs, 1961). Small block sizes with higher street density are also seen as predictors of successful walkable neighbourhoods (Frank, Schmid, Sallis, Chapman, & Saelens, 2005; Ledraa, 2016). They also improve social interaction, increase footfall and decrease vehicle accidents due to lower speed limits (Stangl, 2015). Conversely, longer distances and unattractive pathways are likely to push people to switch walking for cars (Byrne & Sipe, 2010).

The third aspect of walkability is comfort. Researchers have studied the influence of perceptual qualities in enhancing the walkability of a neighbourhood (Ewing & Handy, 2009). These include imageability, transparency, complexity, enclosure and human scale all of which indirectly capture a person's perception of the environment while walking down a street and provide a sense of comfort. Streets that act as outdoor living rooms with a defined spatial containment offer comfort to

pedestrians. In streets where one side has low-rise buildings and the other has huge parking lots, a visual enclosure is not attained and therefore not comfortable to walk in (Ewing, 1999). Similarly street trees that shield the roads on either side have been found to slow down the drivers and provide a sense of comfort to pedestrians. According to the Pedestrian and Transit-Friendly Design report submitted by Ewing in 1999, a total of 10 essential features are required for a pedestrian and transit friendly environment. These include healthy density and diversity, street factors such as continuous sidewalks, safe crossing aids and buffers, easily accessible transit, smaller roads (2-4 lanes), street oriented buildings and safe waiting places (Ewing, 1999).

The final aspect of walkable streets is the presence of interesting elements along the walk. Jan Gehl refers to this as 'sticky' edges where a pedestrian has consistent cues to slow down and interact with the public life around (Gehl, 2010). Ground floor retail, interesting cafes, awnings, patios or performers that amuse the crowd contribute to 'stickiness' in a street. Benches under shady trees, street hedges, proper signages and a consistent design language contribute to an interesting edge design.

While most of the planners are proponents of walkability, some criticisms against walkability include the excessive automobile reliant cultural attitudes prevalent amongst certain societies despite the presence of public amenities in proximity (Haugen, 2012). Some researchers argue that walkable infrastructure can be helpful only if accompanied by "like-minded residents" or management systems that promote street life (Brower, 2011 as cited in Talen & Koschinsky, 2013). This poses the question on how to strike a balance between people's preference and an overall desire for sustainability.

Another important aspect of pedestrian accessibility, especially in Middle Eastern countries is a need to consider the thermal comfort aspects in the public open

spaces. Studies argue that the claims of summers and relative heat as causes of disregard in public realm investment are baseless and that summers are not deterrents in pedestrians frequenting public areas (Peca Amaral Gomes, Al-Ragam, & AlShalfan, 2021; Qaddumi & Ahmadi, 2017). These studies have cited a consistent presence of users in Souq Waqif, a marketplace in inner Doha, Corniche and adjacent Bidda Park, even in the evenings of the summer months. Despite hot summers, daytime walking is pleasant for six months of the year, from October to March or April (Doherty, 2017).

Thoughtful urban street design can improve the thermal comfort of the pedestrian microclimate (Pinelo Silva, 2017). Street orientation and the width/height aspect-ratio of buildings relative to street are effective in mitigating microclimate (Ali-Toudert & Mayer, 2006). *Sikkak* or narrow alleyways, an original urban design strategy of the Arab towns to provide direct pedestrian routes, are found in the superblock design in Middle Eastern cities like Abu Dhabi, Kuwait and Bahrain (Scoppa, Bawazir, & Alawadi, 2018). Within the superblocks, they are spaced out evenly between two plots and form a thermally regulated pedestrian environment due to their small width (not more than 3 m) and easy through access. In the Qatari context, except for a few articles examining the 'street-level' urban design characteristics that impact walkability (AlSadi, 2016; Salama & Azzali, 2015; Shaaban, 2019), an understanding of the pedestrian environment particularly around the parks is absent. By understanding the urban morphology of the service area including land use, accessibility, sidewalk conditions and other urban design features in selected neighbourhoods, this study discusses the pedestrian accessibility around the parks.

CHAPTER 3 : METHODOLOGY

The first two chapters have discussed the importance of equitable spatial distribution of parks and the various methodologies employed in earlier studies. This chapter outlines the research design, study area selection and the research design employed for data collection and analyses (Figure 14). This study uses multiple research methods that include geospatial analysis, statistical analysis and observation studies. The selected methods are both quantitative and qualitative. This chapter starts by delineating the study area followed by a detailed description of the methodologies used in equity mapping, need score index analysis and walkability analysis respectively.

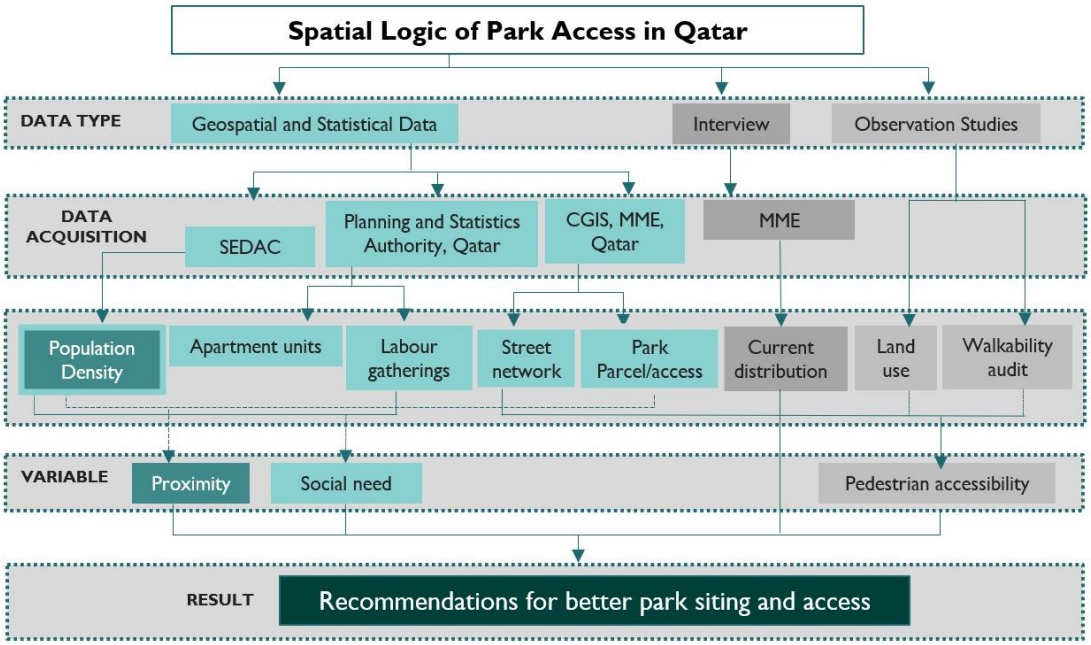


Figure 14. Methodology of the thesis.

3.1. Study Area

The administrative boundaries in Qatar are demarcated as municipalities, zones, districts and blocks in a decreasing hierarchy of their size. Qatar consists of a total of seven municipalities of which Doha municipality has the highest population of roughly 1 million people in a 203 km^2 area. Greater Doha area refers to multiple zones within and outside Doha municipality characterized by faster population growth (Hashem, 2015). A total of 65 zones and 74 parks were considered for analysis (Figure 15a). Figure 15b shows 800 m walkable buffer around the access points of each of these parks.

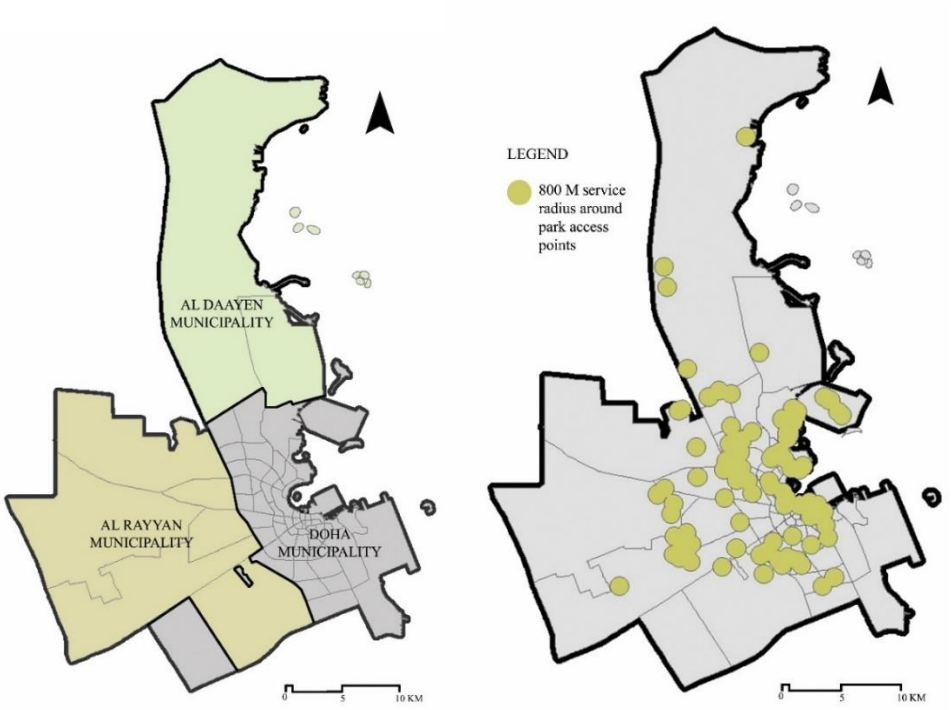


Figure 15. (a) Study boundaries considered in the research, (b) Greater Doha and Al-Daayen parks with 800 m service radius around each park.

Greater Doha includes Doha municipality, six zones in Al-Rayyan, five urban centers of Umm Salal Muhammad, Umm Salal Ali, Al-Daayen, Al-Khuraitiat and

Umm Al-Afa'i. It covers an area of 866 sq.km with a combined population of 1.6 million residents as per 2015 census. In this study, the entire extent of Al-Daayen municipality is also considered since the analysis is based on zonal geospatial and statistical data. The study area is referred to as Greater Doha in the research, henceforth.

3.2. Equity Mapping

3.2.1. Software

The research used spatial data in ESRI ArcGIS 10.2 software for spatial mapping of zone wise population within a walkable access of 800 m around the parks (acceptable maximum service distance used in accessibility research). This method closely follows the earlier studies on park distribution (Boone et al., 2009; Nicholls, 2001). Unlike the earlier studies, population density data were obtained from the SEDAC open source database. This approach improves efficacy by identifying density patterns at a finer grain. Instead of assuming an even distribution of population in a zone, each grid cell is assigned with a density value.

3.2.2. Data Acquisition

A variety of data sources were used for data collation (Table 7)

Table 7. Data type and their sources used in spatial analysis of green parks in Greater Doha.

Data type	Source
Street Network of service area (800 m around park)	Center for Geographic Information System, Qatar
Park parcels	Center for Geographic Information System, Qatar, self-drawn over satellite image
Park points	Center for Geographic Information System, Qatar, self-drawn over satellite image
District and zone boundaries	Center for Geographic Information System, Qatar
Population data	Socioeconomic Data and Application Center (SEDAC)
Population subtype, housing type	Planning and Statistics Authority, Qatar

3.2.3. Data Preparation

To analyze the population served by all parks within a service area of 800 m radius in the study area, park access points and park parcel data were obtained from the Center for Geographic Information System (CGIS), Qatar. Park parcel data and access points obtained from CGIS were cross verified with aerial imagery (Google Earth) to update omitted or erroneously plotted parks and access points within the study area. Additional park parcels and access points opened until 2020 were digitized to include in the study. Green areas that did not meet the research criteria such as stadiums, green areas in private backyards, private gardens, street sides and medians, promenades and plazas, sports club and golf club were excluded from the study since the emphasis was on public parks with opportunities for equal access and use to everyone. Seventy four different parks and their access points were identified in Greater Doha. It was then cross-referenced by location with census zones to allocate parks and their area

characteristics to zones. Both larger and smaller parks are included in the park service area.

The unit of analysis chosen for the study is the census zones (n=65), the geographic extent of which differs based on the municipality. Zones were chosen as units of assessment since most of the data, openly available for analysis were enlisted zone wise. Geo-spatial analyses using ESRI ArcGIS 10.2 was carried out for assessing spatial accessibility to parks. Euclidean or the radius distance measures a buffer of a given distance around the facility. The rationale for using a Euclidean distance is the assumption that pedestrians use informal and straight park routes (Cutts et al., 2009). A service radius of 800 m (metric for a 10-minute walk), acceptable maximum walking distance from the park access points was measured using the buffer function in ESRI ArcGIS 10.2. Half a mile (800 m) was used as the maximum threshold for placing parks in the neighbourhood based on the earlier studies (Nicholls, 2001).

Even though the service radius must be lesser for Qatar, which has a hot desert climate (BWh) according to the most updated Köppen-Geiger climate classification (Beck et al., 2018), 800 m buffer radius was used for equity mapping assuming that the parks are used mostly used after day fall in pleasant weather and therefore, the walkability radius is comparable to 800 m. Moreover, parks in Qatar rely on energy intensive irrigation facilities and year round maintenance. Hence, strategic park location within the above considered 800 m radius is more important from an environmental sustainability perspective.

Since block level population data could not be obtained, population data were obtained from the fourth version of Gridded Population of the World (GPWv4) 2020, an open source data from Socioeconomic Data and Application Center (SEDAC) of the University of Columbia (Center for International Earth Science Information Network -

CIESIN - Columbia University, 2018). GPWv4 maps the distribution of human population (counts and densities) on a continuous global raster surface. GPW contains the density distribution of the global human population collated at the most detailed spatial resolution available from the results of the 2010 round of national censuses and population registers. The input data are extrapolated to produce population estimates for the years 2000, 2005, 2010, 2015 and 2020. GPWv4 uses areal weighting method to disaggregate census population data into grid cells at 30 arc-seconds resolution (approximately 1 km resolution at the equator) (Lloyd, Sorichetta, & Tatem, 2017). GPWv4 was projected with the Qatar National Grid Reference Coordinate System and tile size lowered to10 x10 m. The mean of the value within the area under consideration can then provide adjusted population density. This method takes care of inconsistent results obtained from the 'container approach' used in park access calculation where only facilities within a specified boundary (such as census tracts) are used for analysis even if it is near to residents in the next unit (Maroko, Maantay, Sohler, Grady, & Arno, 2009).

Zonal statistics tool was used to derive population density data per tile. The output of zonal statistics uses measures of central tendency and dispersion such as maximum, minimum, range, mean and standard deviation to accurately depict the results. The mean value of all the tiles within the zone was used to get the final population density both for the zones as well as for the service area within each zone.

The following basic calculations were used to obtain the percentage of population served by parks in each zone.

Total population of the zone = Area of the zone x Mean population density of the zone – (Eq. 1)

Population of service area = Service area of the zone x Mean population density of the

service area – (Eq. 2)

Percentage population served = Population of service area/ Total population of the zone – (Eq. 3)

3.3. Need Score Analysis

Need score index was also calculated to identify the zones where the potential need for parks is higher. Due to data constraints, the study was limited to three variables namely, population density, population type (number of labour gatherings) and housing type (number of apartment units) obtained from the Planning and Statistics Authority, Qatar. These three variables, although interlinked, contribute independently to the need score analysis. A detailed discussion on the importance of these three variables in determining the need for parks is presented in the literature review section. A brief rationale for the choice of these three variables are discussed here. Higher the population per sq.km, greater is the need for park access. Similarly, housing unit types such as that of labour gatherings (Qatari census term for a group of men, 6 or more in a single accommodation) have a greater need for green areas in general. Since many neighbourhood parks in Qatar are open only to families, these migrant men who are usually from lower socio-economic classes have limited access to public parks. They are mostly single men, residing without families, either in labour camps or cramped living spaces. Hence, their need for access to outdoor spaces is more pronounced. Therefore, understanding labour gathering clusters and numbers are important in determining the zones where the need for park access is higher. Residents in apartments or high-rise residential buildings have fewer opportunities to access green areas for relaxation compared to detached villas with private green yards. Hence, residents in such units have a higher need compared to the others.

Following Murray and Davis (2001), mathematically, explanation of need index should include: (i) Enlisting variables, (ii) Detailing the use of processed or interpreted data, (iii) Using linear or nonlinear methods to combine variables, and (iv) Explaining any weightings used in combining variables.

Variables included can be listed as:

i = index of geographic areas

j = index of indicators or variables

w = importance weight of indicator j

Rij = derived value of indicator j in area i

Φi = measure of relative need

Therefore, potential need for parks Φi = U (Ri1, Ri2, …)

To make the need index (Φi) meaningful, it is important to either provide adjusted weights to each indicator or standardize the indicator scale. Since determining the relative weights can be complex, the indicators are interpreted in equal interval scales within a value of 1-5. The value assigned to the attribute falling into the quantile with higher need is taken as 5 and for those falling into the lowest need is taken as 1. For example, in deciding population density scoring, the quantile statistics of the population density attribute was obtained from ArcGIS 10.2 and then a score from 1 to 5 was allotted to the values falling in each of the quantile groups. Earlier studies have used interval values in assigning classes based on equal size, standard deviations, quantiles, natural breaks and so on (Boone et al., 2009; Murray & Davis, 2001; Talen, 2003). All three variables were then standardized to obtain need scores with higher scores showing greater need for parks. Need score data was then overlaid with actual park access (park proximity) to obtain the actual gap zones (zones with park need) using a basic query generator in ArcMap.

3.4. Walkability Analysis

To understand the nuances of street characteristics that form micro-accessibility aspects of park accessibility research, qualitative analysis was done on park neighbourhoods. The intention of the analysis was to obtain insights on the current walkability aspects of two distinct study areas.

The primary data were collected from two neighbourhoods with different socio-cultural backgrounds: Madinat Khalifa South and New Al-Rayyan. Each of the neighbourhoods are predominantly residential and has the highest number of neighbourhood parks (5 in Madinat Khalifa South and 4 in New Al-Rayyan). For analyzing walkability, 2 different parks were chosen both in Madinat Khalifa and Al-Rayyan municipality. The selected neighborhoods differ in their socioeconomic status, population density, from older development to newer development and from inner-Doha neighborhoods to suburban neighborhoods. An underlying assumption that streets in higher density old development will increase walkability underpins these neighbourhood choices.

Socio-spatial characteristics of both case study areas were first mapped, which helped in understanding the urban characteristics of these neighbourhoods. This includes mapping the land parcels, building footprints and land use data in ArcMap software. Layer files (.lyr) obtained from the Center for Geographic Information System were used to draw the land parcels. Since land use data required for a fine grain analysis could not be obtained, observation analysis was carried out in the two neighbourhoods. Land use of the units were observed and fed in five major land-use classes (villa residential, apartment residential, mixed-use/ commercial, institutional and parks). Land use data was then fed to the parcel shapefile. The data is used to find

the land use diversity. After updating site-specific information, the study used the surveys developed by researchers at Pedestrian Environment Data Scan or (PEDS) (Clifton, Livi Smith, & Rodriguez, 2007) (see Appendix A for details of the field work). Audits were conducted in the two neighbourhoods with varying socio-economic and spatial urban patterns to gain insights on the current accessibility level. Observation, surveying, note taking, photography, videography and walking along the pathways allowed for a detailed study of street characteristics of the two neighbourhoods. The collected data were then analyzed for patterns using mapping techniques in ArcMap.

Following Lee and Talen (2014), walkability audits were carried out using a self-reported audit method developed from Pedestrian Environment Data Scan (PEDS). PEDS uses four broad classifications for data analysis namely macroscale environment (land use and segment type), pedestrian facilities (sidewalk continuity and obstructions), road attributes (road width and crossing aids), and the microscale features of walking environment (street amenities like lighting). In addition, subjective evaluative questions are also added for an overall judgement of the pedestrian environment.

To undertake PEDS walkability audit, a service area of 400 m was obtained around desired parks using the network analyst tool which uses the actual street network around the parks to come up with a service polygon. Service area obtained through the network analyst option in ArcMap approximates the actual pathway taken by the pedestrians along the street network. After obtaining the service areas, street networks obtained from the Center for Geographic Information System (CGIS) were divided into segments either to the nearest intersection or falling into less than 300 m to ensure better analysis of variation along longer roads and pathways (Clifton et al., 2007). Audits were conducted on either side of the road in case of high volume roads with heavy traffic

since each of these roads are equally important for pedestrian access. A total of 375 segments were audited both by foot and by vehicle. Audits were carried out multiple times in the same street to ensure reliability. Where the street characters looked typical, videography of the entire street was done instead of walking along the path. In some instances, streets were observed by driving slowly down the street and parking along the side and taking photos and videos. Audits covered about 45 hours in observation, note taking, photography, videography and answering self-audits. Majority of the audits were done after 4 PM in the evening when some sort of activity was expected in the streets. Audits were carried out in January 2021 and again in March 2021 covering a total of 15 days. Where audits were not answered on site, they were marked and rated at the end of the day using videos and photographs. Both objective and subjective data were obtained. Subjective data were used to understand and reinforce objective data.

Audit questions were created in Microsoft forms in mobile phone to allow ease in answering and transporting the analysis. Audit answers were fed directly into the system using Microsoft forms survey tool. Eighteen variables were adopted in this study: (1) segment type; (2) sidewalk continuity; (3) sidewalk condition; (4) sidewalk elevation; (5) sidewalk width; (6) obstructions present; (7) on street parking; (8) buffers present; (9) shade trees; (10) number of traffic lanes; (11) traffic volume; (12) land use; (13) active frontage (14) street lighting; (15) pedestrians observed; (16) crossing aids; (17) attractive for walking; and (18) safe for walking (Ledraa, 2016). Relevant scores were given to each of the survey answers and the sum of the scores were used as the walkability score of that segment in the street. Each walkability indicator was given a numeric score ranging from 1 as the least desirable to 2, 3, or 4, depending on the scale range, as the most desirable. Table 8 shows the variables and the scoring values used in the walkability audit.

Table 8. A list of variables used in the walkability audit along with the point scores.

No	Variable	Scores
1.	Segment Type	
	Low volume road – audit both sides	2
	High volume road – audit this side only	1
2.	Sidewalk continuity	
	No sidewalk along both sides	1
	No sidewalk along one side	2
	Sidewalk missing in some sections	3
	Sidewalk missing in few sections	4
	Continuous	5
3.	Sidewalk Condition	
	Very good	5
	Good	4
	Average	3
	Fair	2
	Poor	1
4.	Sidewalk elevation	
	Less than 15 cm	1
	15 cm	2
	More than 15 cm	1
5.	Sidewalk width	
	Less than or equal to 150 cm	1
	More than 150 cm	2
6.	Obstructions present	
	Vehicles parked on one side	-1
	Vehicles parked on both sides	-1
	Utility poles	-1
	Tree trunks	-1
	Garbage bins	-1
	Hoardings	-1
	Shop encroachment	-1
	Step/ramp	-1
	Obstructive curbs	-1
	Fencing	-1
	Unused objects	-1
	car porch	-1
	None	0
7.	On street parking	
	None	2
	On one side	1
	On both sides/ median	0
8.	Buffers present	
	Trees	1
	Car porches	1
	Shading device	1
	None	0
	Other	1
9.	Shade trees	
	None or Very Few: the path is not shaded by any trees (or only one tree) along the segment	1
	Some: the path is covered between 25 and 75% of the way.	2

No	Variable	Scores
	Many/Dense: more than 75% of the path is shaded by trees.	3
10.	Number of traffic lanes	
	1	5
	2	4
	4	3
	6	2
	8	1
11.	Traffic volume	
	Very low	5
	Low	4
	Moderate	3
	High	2
	Very high	1
12.	Land use	
	Majority recreational	5
	Majority residential	4
	Majority mixed-use	3
	Majority institutional	2
	Other	1
13.	Active frontage	
	Yes	4
	No	0
14.	Street lighting	
	Pedestrian oriented lighting on both sides	5
	Pedestrian oriented lighting on one side	4
	Road oriented lighting on both sides	3
	Road oriented lighting on one side	2
	No lighting	1
15.	Pedestrians observed during survey	
	Less than 5	1
	More than 5	2
16.	Crossing aids	
	Road markings	1
	Pedestrian signal	1
	Median/traffic island	1
	Curb cuts	1
	Speed bumps	1
	Other traffic calming measures	1
17.	Attractive for walking	
	Strongly Agree	5
	Agree	4
	Neutral	3
	Disagree	2
	Strongly Disagree	1
18.	Safe for walking	
	Strongly Agree	5
	Agree	4
	Neutral	3
	Disagree	2
	Strongly Disagree	1

After obtaining street segments, walkability audit and scores were fed into the segment shapefile in ArcMap and spatial mapping was done to observe any insights and patterns on the walkability characteristics of the two neighbourhoods.

CHAPTER 4 : DATA ANALYSIS

The previous chapters discussed the importance of ensuring social, spatial, temporal and cultural accessibility to achieve distributional fairness of public goods, especially parks. Some of the methods employed to analyze distributional fairness were also discussed. This chapter will discuss the park accessibility aspects from two different scales, the macro scale and the micro scale. Macro-accessibility section discusses the overall spatial distributional pattern of public parks in Greater Doha with an emphasis on current distributional setup, its influence on the demographic profile and identification of need-based zones in the study area. This sets the scene for policy recommendations at zonal level pertaining to land use and administrative policies. Micro-accessibility section discusses the aspects of walkability, urban design and street-level planning with an emphasis on user experience in walking to the parks. The analyses from micro-accessibility studies can be used to enhance pedestrian access and experience in arriving at the park. These two sections are further dissected for a finer delineation of accessibility observations.

4.1 Macro-accessibility to parks depicts the equity mapping findings in Greater Doha area. This section consists of five parts. The first two parts deal with the current distribution pattern and its spatial meaning and the per capita park provision per zone. The last three chapters include quantitative data on the percentage of population served by parks, potential need areas and actual need areas at zonal level.

4.2 Micro-accessibility to parks includes walkability studies of two neighbourhoods, Madinat Khalifa South and New Al-Rayyan to gain insight on the current accessibility levels around parks. This section consists of three parts. The first part explains the study neighbourhood with a detailed analysis of the demographic mix,

accessibility and land use. The second and the third part deal with the findings of the walkability audit carried out in the two neighbourhoods. Figure 16 shows the summary of the data analysis chapter.

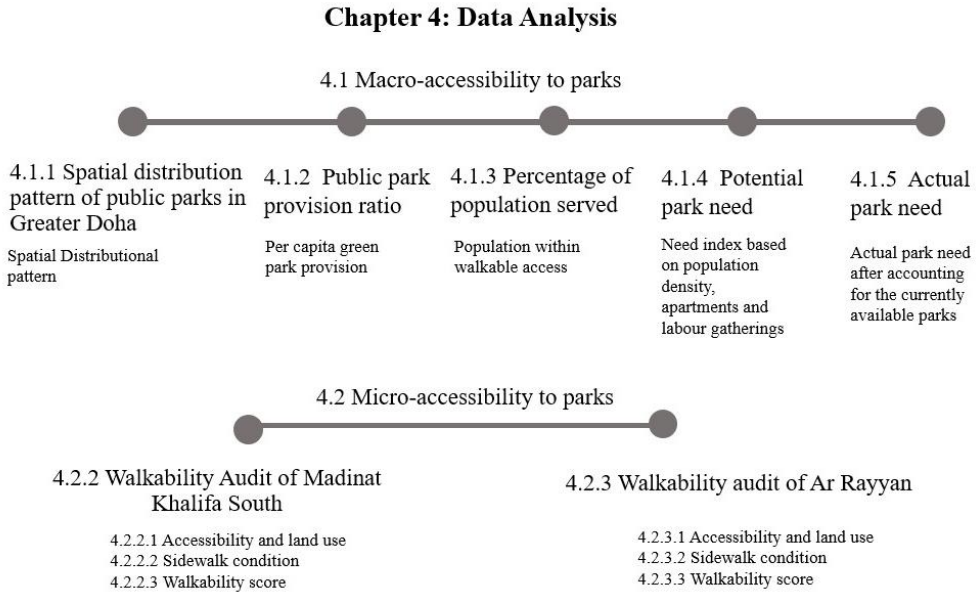


Figure 16. Summary of the data analysis chapter.

4.1. Macro-Accessibility to Parks

The previous sections have reviewed the importance of accessibility in determining park use both from a distributional/planning perspective (macro-analysis) and urban design perspective (micro-analysis). This section analyzes the findings of the macro-analysis perspective in the Greater Doha area and Al-Daayen in Qatar. It discusses the park distribution scenario in Qatar and the causal effects of policies in these distribution patterns, if any. It also analyzes the demographic reach of parks, need-based park distribution and identifies potential and actual park need zones. The findings employ spatial analysis of park access points from open source data using GIS.

Specifically, section 4.1.1.1 discusses the spatial distribution of parks in Greater Doha and Al-Daayen. Section 4.1.1.2 studies park provision ratio or per capita green provided in each of the zones. Last three sections discuss the importance of compensatory distribution and identify zones with potential and actual immediate need for parks.

4.1.1. Spatial Distribution Pattern of Public Parks in Greater Doha

The study was carried out in Greater Doha after obtaining GIS data, including parks, parcels and access points from the Center for GIS (Figure 17a and 17b). The data were updated for errors with the parks open until 2020 by referring to aerial images from Google Earth. The dataset consists of a total of 74 parks, which excludes trails, golf courses, stadiums, corniche promenade and private gardens (Table 9). ArcGIS was used to enumerate the parks contained within the zone boundary and the park areas were summed within the zones to find the total park acreage as shown in Figure 18.

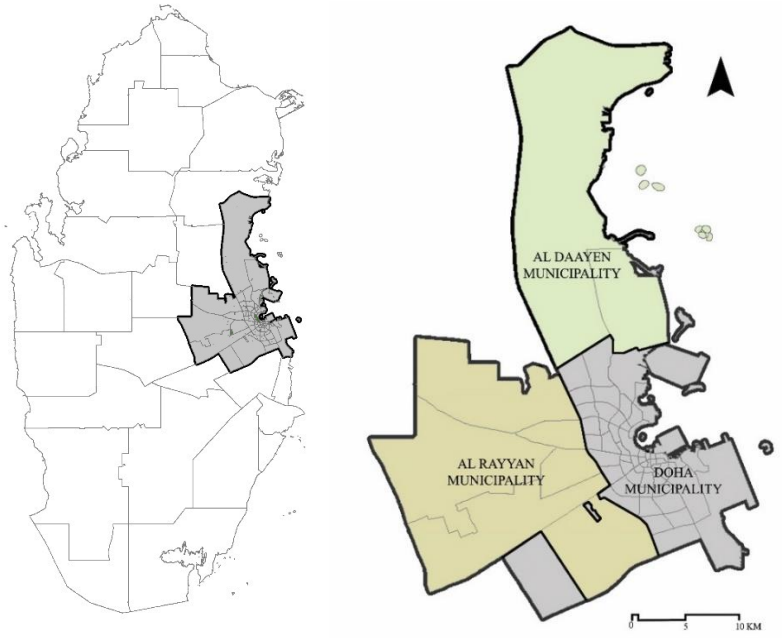


Figure 17. (a) Map of Qatar showing Greater Doha and Al-Daayen municipality considered in the research , (b) Study boundaries considered in the research

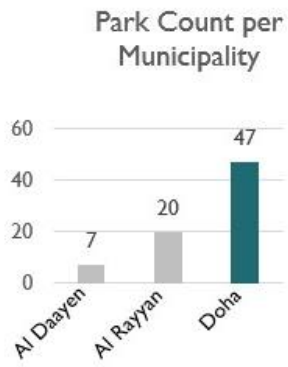
Table 9. List of parks in Greater Doha and Al-Daayen considered for analysis in increasing order of park hectarage (Corniche promenade and MIA park excluded). Park classification is based on MME park distinction in Qatar where parks are distinguished as neighbourhood, local, district, town and metropolitan park for park hectares between 0.1- 0.4, 0.4-2, 2-5, 5-60, 60 and above respectively. Source: Center for Geographic Information System (CGIS), Qatar.

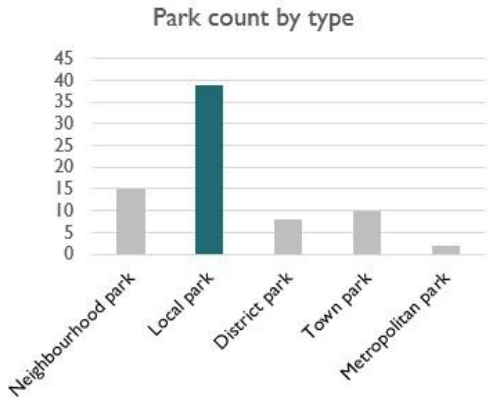
Sl. No	Area (in ha)	Park Name	Park classification	Park District	Zone	Municipality
1	0.1	Abu Hamour Park	Neighbourhood park	Al Maamoura 56	56	Al-Rayyan Municipality
2	0.2	Fereej Al Ali Family Park (East)	Neighbourhood park	Nuaija 43	43	Doha Municipality
3	0.2	Al Yousufiya Park	Neighbourhood park	Madinat Khalifa South	34	Doha Municipality
4	0.2	Abu Sidra Park	Neighbourhood park	Fereej Al Manaseer	55	Al-Rayyan Municipality
5	0.2	Izghawa 51 Garden	Neighbourhood park	Izghawa 51 Garden	51	Al-Rayyan Municipality
6	0.2	Jeryan Nejaima Park	Neighbourhood park	Jeryan Nejaima	68	Doha Municipality
7	0.2	Muaither Park	Neighbourhood park	New Al-Rayyan	53	Al-Rayyan Municipality
8	0.2	Al Azizia Park	Neighbourhood park	Al Aziziya	55	Al-Rayyan Municipality
9	0.2	Fareej Al Ali Family Park (West)	Neighbourhood park	Nuaija 43	43	Doha Municipality
10	0.2	Al Hilal Park	Neighbourhood park	Al Hilal	42	Doha Municipality
11	0.3	Um Al khaba Park	Neighbourhood park	Umm Lekhba	31	Doha Municipality
12	0.3	Al Waab Park 1	Neighbourhood park	Al Waab	55	Al-Rayyan Municipality
13	0.3	Nuwaija Park 1	Neighbourhood park	Nuaija 44	44	Doha Municipality
14	0.3	Muaither Public Park 2	Neighbourhood park	Muaither 55	55	Al-Rayyan Municipality
15	0.3	Old Al Ghanim Park	Neighbourhood park	Old Al Ghanim 16	16	Doha Municipality
16	0.4	Ain Khaled Park	Local park	Ain Khaled	56	Al-Rayyan Municipality
17	0.4	Nuwaijah Park 3	Local park	Nuaija 44	44	Doha Municipality

Sl. No	Area (in ha)	Park Name	Park classification	Park District	Zone	Municipality
18	0.4	Muaither Family Park No, 1	Local park	Muaither 55	55	Al-Rayyan Municipality
19	0.4	New Garden Nuaija Family Park	Local park	Nuaija 44	44	Doha Municipality
20	0.4	Thumamah Doha Group 2 Park	Local park	Al Thumama 46	46	Doha Municipality
21	0.4	Wasit Park	Local park	Dahl Al Hamam	32	Doha Municipality
22	0.4	Al Soudan Park 1	Local park	Fereej Al Soudan 54	54	Al-Rayyan Municipality
23	0.4	Fereej Al Ali Park	Local park	Nuaija 43	43	Doha Municipality
24	0.4	Al Ghariya Park	Local park	Dahl Al Hamam	32	Doha Municipality
25	0.5	Lebaib Park	Local park	Leabaib	70	Al-Daayen Municipality
26	0.5	Thumamah Park	Local park	Al thumama 47	47	Doha Municipality
27	0.5	Al Abraj Park	Local park	Onaiza 63	63	Doha Municipality
28	0.5	New Al-Rayyan Park 2	Local park	New Al-Rayyan	53	Al-Rayyan Municipality
29	0.5	Al Sailiya Park	Local park	Al Mearad 55	55	Al-Rayyan Municipality
30	0.5	Lejbailat Park	Local park	Lejbailat	64	Doha Municipality
31	0.6	Alebb Garden	Local park	Al Ebb	70	Al-Daayen Municipality
32	0.6	North Al Sakama Park	Local park	Al Sakhama	70	Al-Daayen Municipality
33	0.6	Al Mamoura Family Park	Local park	Al Maamoura 43	43	Doha Municipality
34	0.7	Duhail Park	Local park	Duhail	30	Doha Municipality
35	0.7	Madinat Khalifa Park No 1	Local park	Madinat Khalifa South	34	Doha Municipality
36	0.7	Gharafa Park	Local park	Al Gharrafa	51	Al-Rayyan Municipality
37	0.7	North Khalifa City Park	Local park	Madinat Khalifa North	32	Doha Municipality
38	0.7	Al Hitmi Park	Local park	New Al Hitmi	37	Doha Municipality
39	0.7	New Slata Park	Local park	New Slata	40	Doha Municipality

Sl. No	Area (in ha)	Park Name	Park classification	Park District	Zone	Municipality
40	0.7	Qatar Green Centre Park	Local park	Hazm Al Markhiya	67	Doha Municipality
41	0.8	South Al Sakhama Park (Unused)	Local park	Al Sakhama	70	Al-Daayen Municipality
42	0.9	Al-Rayyan Park 11	Local park	New Al-Rayyan	53	Al-Rayyan Municipality
43	0.9	Muntazah Al-Rayyan Family Park	Local park	New Al-Rayyan	53	Al-Rayyan Municipality
44	0.9	Al Huwaila Park	Local park	Madinat Khalifa South	34	Doha Municipality
45	0.9	Simaisma Garden	Local park	Semaisma	70	Al-Daayen Municipality
46	1.0	Al Luqta Children's Park	Local park	Al Luqta	52	Al-Rayyan Municipality
47	1.0	Al Khulaifat Park for Women (North)	Local park	Al Maamoura 43	43	Doha Municipality
48	1.0	Busamra Park	Local park	Al Maamoura 44	44	Doha Municipality
49	1.1	Al Marwab Garden	Local park	Madinat Khalifa South	34	Doha Municipality
50	1.1	Al Marroona Park	Local park	Madinat Khalifa South	34	Doha Municipality
51	1.3	Onaiza Park	Local park	Onaiza 65	65	Doha Municipality
52	1.4	Hazm Al Markhiya Park	Local park	Hazm Al Markhiya	67	Doha Municipality
53	1.5	Izghawa Family Park	Local park	Izghawa 51	51	Al-Rayyan Municipality
54	1.9	Public Nurseries Park	Local park	Doha International Airport	48	Doha Municipality
55	2.2	Onaiza Park	District park	Onaiza 65	65	Doha Municipality
56	2.3	New Onaiza Park	District park	Onaiza 63	63	Doha Municipality
57	2.4	Doha Club Park	District park	Al Khulaifat	28	Doha Municipality
58	2.8	Al Qassar Park	District park	Legtaifiya	66	Doha Municipality
59	2.9	Al Muthaf Park	District park	Slata	18	Doha Municipality
60	3.7	Al Mannal Garden	District park	Leabaib	70	Al-Daayen Municipality

Sl. No	Area (in ha)	Park Name	Park classification	Park District	Zone	Municipality
61	3.8	Souq Waqif Park	District park	Al Jasra	1	Doha Municipality
62	4.7	Airport Park	District park	Doha International Airport	48	Doha Municipality
63	7.9	Al Dafna Park/ Sheraton Hotel Park	Town park	Al Dafna 61	61	Doha Municipality
64	8.8	Crescent Park	Town park	Al Kharayej	69	Al-Daayen Municipality
65	9.0	Al Dafna Park	Town park	Al Dafna 60	60	Doha Municipality
66	9.2	Dahl Al Hammam	Town park	Dahl Al Hamam	32	Doha Municipality
67	9.3	Al-Rayyan Park	Town park	Old Al-Rayyan	52	Al-Rayyan Municipality
68	13.0	Pearl Qatar	Town park	Pearl	66	Doha Municipality
69	13.1	Oxygen Park	Town park	Old Al-Rayyan	52	Al-Rayyan Municipality
70	14.0	Rawdhat Al khail Garden	Town park	Rawdhat Al khail	24	Doha Municipality
71	21.5	5/6 Park	Town park	Al Gassar 61	61	Doha Municipality
72	57.0	Katara Hills	Town park	Al Gassar 66	66	Doha Municipality
73	79.6	Aspire Park	Town park	Baaya	54	Al-Rayyan Municipality
74	174.4	Al Bidda	Metropolitan park	Rumaila 12, Wadi Al Sail 12 and Al Bidda 12	12	Doha Municipality





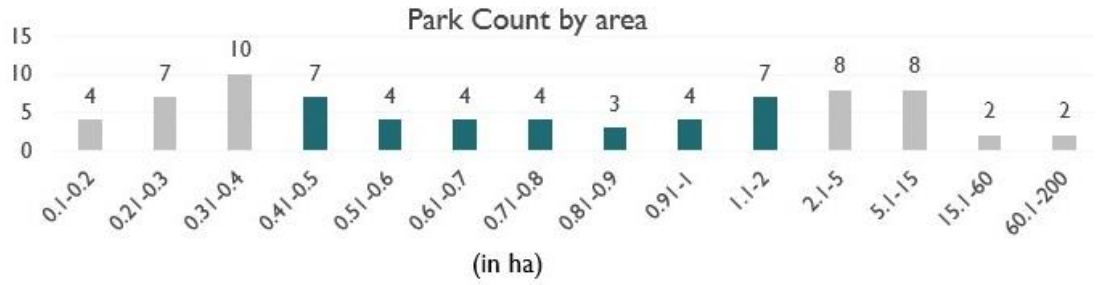


Figure 18. (a) Park count per municipality, (b) Park count by park type c) Park count based on area.

The total land area of the study boundaries including Greater Doha and Al-Daayen is 889 sq km, about 8% of the area of Qatar. Green park area and the service area of 800 m around these parks account for 1% (5 km^2) and 14% (123 km^2) of the study area respectively. Figure 19a and Figure 19b shows the parks in the study area with a service radius of 800 m.

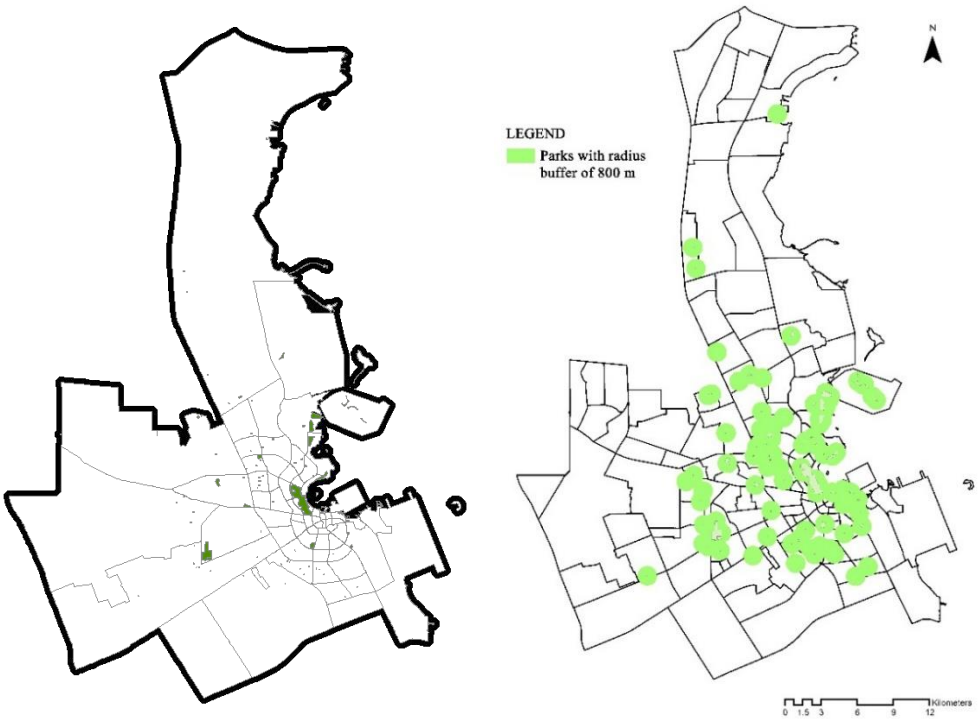


Figure 19. (a) Greater Doha and Al-Daayen parks park distribution shown in green (b) Service area considered around the parks within a buffer of 800 m radius.

4.1.2. Public Park Provision Ratio

The following section tabulates the parks considered in the study, their percentage area per zone and per capita park provision ratio. Percentage green area is calculated by dividing the green area to the zone area. Per capita park provision is obtained by dividing the whole population of the zone by the amount of green area.

Doha municipality has the highest number of green parks (47 counts) followed by Al-Rayyan and Al-Daayen Municipalities. Only 34 zones in the study area contain parks. Distributional equality in terms of park acreage and park provision ratio varies zone by zone. However, an inverse correlation with population density and per capita park area confirms a poorly planned distribution pattern that does not consider population count as an important marker for park acreage. As seen in the park provision ratio, the majority of these zones have less than 8 m^2/person standard specified in earlier studies (Table 10). Zones with the highest park provision ratio are the ones with lower population density, discrediting the importance of population density in planning public parks. These are residential and commercial zones catering to high-income working populations of different nationalities. Al Dafna, Al Qassar, Lusail and Onaiza are characterized by high rise modern apartments, hotel units and other luxury amenities including the planned cities of the Pearl and Lusail. These parks are designed as choice destinations to attract people from different parts of the city rather on the basis of neighbourhood need. Park provision ratio in zones such as Old Al Ghanim, Hamad Medical City and Madinat Khalifa South (population density from 10,000 to 39,000 no. per sqkm) , with a higher concentration of migrant workers, fall well below 1.5 sqm. Figure 20 shows an inverse relationship between per capita green cover by zone and population density.

Table 10. Percentage green park cover and park provision ratio of zones in Greater Doha, arranged in decreasing park provision ratio. Other zones without green parks have been excluded. Similarly, zones with very low residential populations as per Census 2015 data such as Al Bidda (zone 12), Al Dafna (zone 60) and Al Jasrah (zone 1) have been excluded. Source: Population Density (PSA, Qatar)

Zone No	Zone Name	Percentage green park cover by zone	Park provision ratio (m^2 per person)	Population Density (no. per km^2) based on 2015 census
61	Al Dafna, Al Qassar	7.35	73.14	1005
69	Jabal Thuaileb, Al Kharayej, Lusail, Al Egla, Wadi Al Banat	0.17	65.70	26
18	Al Salatah, Al Mirqab	4.61	41.90	1100
48	Doha International Airport	0.57	35.40	160
66	Onaiza, Leqtaifiya, Al Qassar	2.79	33.06	843
54	Fereej Al Amir, Luaib, Muraikh, Baaya, Mehairja, Fereej Al Soudan	4.43	32.53	1362
28	Al Khulaifat, Ras Abu Aboud	2.58	14.01	1843
52	Luqta. Lebday, Old Al- Rayyan, Shagub and Fereej al Zaeem	1.74	12.66	1377
32	Madinat Khalifa North, Dahl Al Hamam	4.43	8.67	5111
24	Rawdat Al Khail	8.41	7.69	10933
63	Onaiza	1.43	3.69	3872
65	Onaiza	1.22	3.27	3742
67	Hazm Al Markhiya	0.51	2.39	2121
43	Nuaija	0.51	1.67	3075
44	Nuaija	0.67	1.54	4367
70	Al Ebb, Jeryan Jenaihat, Al Kheesa, Rawdat Al Hamama, Wadi Al Wasaah, Al Sakhama, Al Masrouhiya, Wadi Lusail, Lusail, Umm Qarn, Al-Daayen	0.03	1.33	222
64	Lejbailat	0.37	1.27	2940
34	Madinat Khalifa South	1.51	1.04	14525
30	Duhail	0.10	0.85	1125
46	Al Thumama	0.11	0.46	2282
40	New Salatah	0.21	0.45	4634
51	Al Gharrafa, Gharrafat Al-Rayyan ,Izghawa, Bani Hajer, Al Seej, Rawdat Egdaim, Al Themaid	0.03	0.42	692
68	Jelaiah, Al Tarfah, Jeryan Nejaima	0.02	0.41	567
47	Al Thumama	0.14	0.37	3933

Zone No	Zone Name	Percentage green park cover by zone	Park provision ratio (m^2 per person)	Population Density (no. per km^2) based on 2015 census
53	New Al-Rayyan, Al Wajbah, Muaither	0.02	0.32	702
37	Hamad Medical City	0.29	0.28	10383
31	Umm Lekhba	0.08	0.22	3791
42	Al Hilal	0.14	0.21	6629
16	Old Al Ghanim	0.82	0.21	39662
55	Fereej Al Soudan, Al Waab, Al Aziziya, New Fereej Al Ghanim, Fereej Al Murra, Fereej Al Manaseer, Bu Sidra, Muaither, Al Sailiya , Al Mearad	0.02	0.07	3443
56	Fereej Al Asiri, New Fereej Al Khulaifat, Bu Samra, Al Mamoura, Abu Hamour, Mesaimeer ,Ain Khaled	0.01	0.04	2109

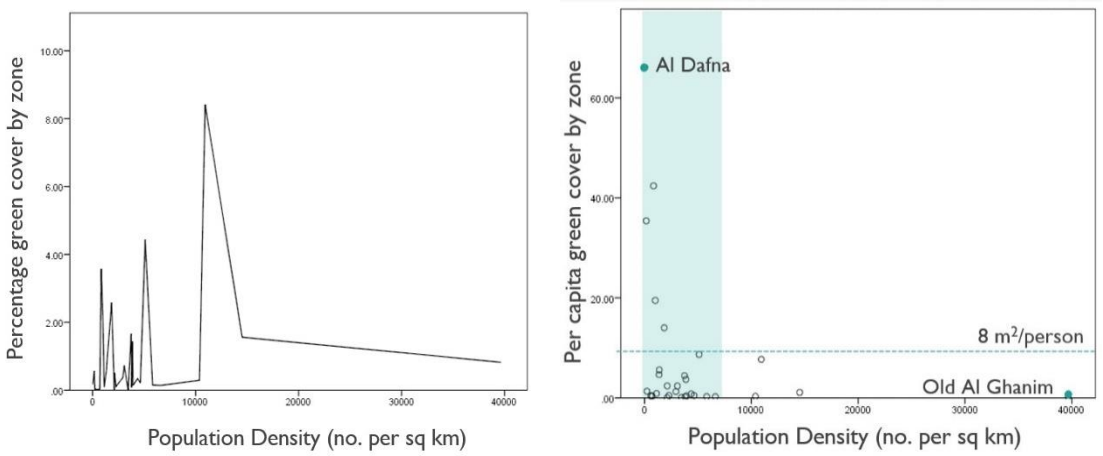


Figure 20. Relationship between population density, percentage green cover and per capita green cover by zone in the study area.

An explicit relationship between population density and percentage green cover cannot be seen from the graph (Figure 20). Some zones with fewer percentage of green cover have larger population density (such as Al Ghanim), whereas zones with more green cover have fewer residents (such as Dafna) with the rest of the zones falling in between these two levels.

Figure 21 shows the park distribution in area (hectares) of districts in the study area. More area distribution is seen along the waterfront area stretching from Al Bidda to Pearl Qatar. This clearly demarcates the development of parks along the waterfront zones probably due to higher land acquisition costs in the densely populated parts of Inner Doha within the C- Ring road and strategic location of parks overlooking the Gulf.

Figure 21. a) Park area mapped as graduated colors in districts based on area in hectares. Park parcels are superimposed in each district b) Park provision ratio (m^2 per person) per zones in study area

4.1.3. Percentage of Population Served

In this section, we analyze the distribution pattern of green parks in Greater Doha area with particular emphasis on the percentage of population served within walkable access in each zone. Percentage of population served is defined as the population count falling within the service area in a zone to the whole zone population. Correlating the percentage population served with the ethnic composition of the zone can uncover biases in the distribution system, if any. Figure 22 shows the percentage of people served by all the parks in each zone of the study area.

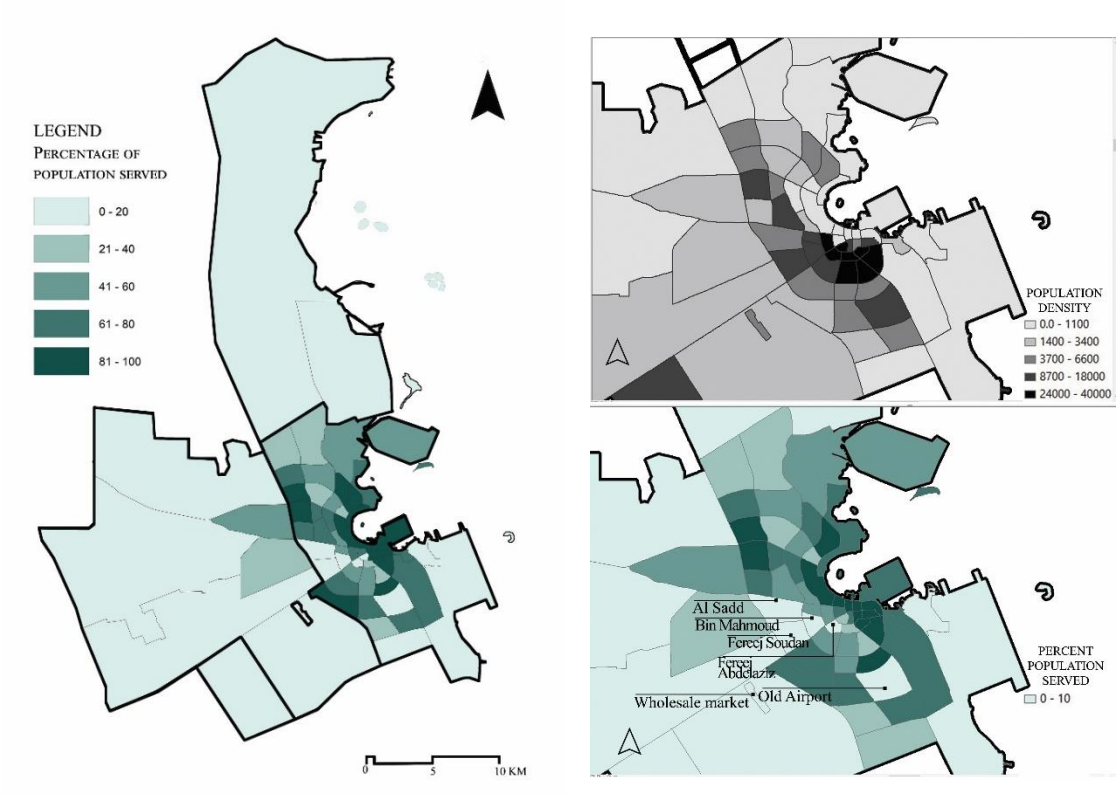


Figure 22. a) Percentage of population served within walkable access around each park in zones of Greater Doha and Al-Daayen. b) Population density of zones in Greater Doha c) Zones with less than 10 percent of the total population within walkable access to parks in Doha municipality (clockwise from left).

Percentage of population served is obtained using The Gridded Population of the World (GPWv4) 2020, an open source data from Socioeconomic Data and Application Center (SEDAC). GPWv4 contains the density distribution of the global human population collated at the most detailed spatial resolution available from the results of the 2010 round of censuses.

This section deals with the results of the zone wise population advantaged by proximity to parks in the study area. Only 8 zones (12% of the zones) in the study area have parks that serve the entire zone population (Figure 22a). Nearly half of the zones have less than 50% of the people within walkable access to parks. Zones with the least park access based on proximity, where less than 10% of people are within the walkable access, are found in 14 zones (22% of the zones) spread across Doha, Ar-Rayan and Al-Daayen municipalities (Table 11). These findings are more significant in Doha municipality since it has the highest population density (Figure 22b). Out of the 14 zones with less than 10 percent people served, ten of these zones fall under Doha municipality. It is notable that the migrant population, largely low wage Asian workers reside in the seven zones in Doha municipality that serve less than 10 percent of its people (Figure 22c).

Table 11. Zones with less than 10% population within walkable access to parks in Greater Doha and Al-Daayen. Darker rows show the six zones in Doha municipality with higher migrant population. Predominant land use, number of small and large gatherings are obtained from the Census data 2015 of Planning and Statistics Authority.

Zone No	Zone Name	Population served (%)	Municipality	Predominant Land use	No of small labour gathering units (2015 census)	No of large labour gathering units (2015 census)
14	Fereej Abdel Aziz	0	Doha	Residential	527	214
23	Fereej Bin Mahmoud	0	Doha	Residential	495	140
29	Ras Abu Aboud 29	0	Doha	Government owned		-
49	Hamad International Airport	0	Doha	Commercial	8	7
57	Industrial Area	0	Doha	Commercial	683	3186
58	Wholesale Market	0	Doha	Commercial	52	15
39	Al Sadd, New Al Mirqab, Fereej Al Nasr	1	Doha	Residential	653	93
38	Al Sadd	3	Doha	Residential	485	114
69	Lusail 69, Al Egla, Jabal Thuaileb, Al Kharayej	3	Doha	Recreational	12	2
70	Al-Daayen	5	Al-Daayen	Residential	60	319
53	New Al-Rayyan, Al Wajbah, Muaither	6	Al-Rayyan	Government owned	1062	696
45	Old Airport	7	Doha	Residential	692	304
51	Al Gharrafa, Gharrafat Al-Rayyan ,Izghawa, Bani Hajer, Al Seej, Rawdat Egdaim, Al Themaid	7	Al-Rayyan	Residential	290	224
56	Fereej Al Asiri, New Fereej Al Khulaifat, Bu Samra, Al Mamoura, Abu Hamour, Mesaimeer ,Ain Khaled	9	Al-Rayyan	Residential	863	1163

These seven zones are Old airport, Fereej Abdel Aziz, Bin Mahmoud, Al Nasr (combined with New Al Mirqab), Al Sadd, Industrial area and Wholesale market. The Old Airport area, originally designed in the Dar Al Handasah plan as the capital of Qatar, is a significant retail market in Qatar. It is inhabited largely by non-nationals and has land use fragmentation without a characteristic planning principle (Al-Thani, Amato, Koç, & Al-Ghamdi, 2019). Fereej Bin Mahmoud is a mixed-use neighbourhood largely with high rise commercial and residential buildings. Al Sadd, the commercial centers of Doha fall under zones with constant activity due to diverse demographic mix, largely belonging to the working migrants, mixed land use and higher density (Eiraibe, AL-Malki, & Furlan, 2016). Similarly, Fereej Abdul Aziz is predominantly inhabited by male Asian migrant workers, with a building typology of mid to high-rise apartment buildings surrounded by retail activities (Ibrahim, Salama, Wiedmann, Aboukalloub, & Awwaad, 2020). Wholesale market, popular for fresh produce, is predominantly a retail market with a majority of migrant workers. Industrial area has the highest concentration of labour housing units, otherwise known as 'labour camps', where majority of the low-income unskilled foreign workers reside (Nagy, 2006). Relaxations in the planning regulations in 2016 allowed labourers working in industrial units to reside in newly built garages or scrap shops further increasing their number in Industrial area (Lockerbie, 2020b).

Due to data constraints on obtaining numerical breakdown of population type based on median income or median housing value of the population in identified zones, statistical correlations could not be obtained. However, earlier research studies on these neighbourhoods, as described in the above paragraph, show a dominance of migrant workers, especially belonging to the low-income category in underserved zones. The same results can be observed by overlaying the 'distribution of labour gatherings' map

(Planning and Statistics Authority, 2010) over the population served map. Figure 23 clearly shows the presence of higher labour gatherings in the underserved zones of Doha and Rayyan municipality. Such underrepresentation of vulnerable population group of low-wage migrants jeopardizes their recreational avenues, especially since they are at higher need for parks in walking distance due to socioeconomic barriers.

Like Doha, Al-Rayyan municipality has fewer parks serving the zone population. However, since the zone includes a higher concentration of both natives and migrants, it can be argued that natives are also underserved by the current park distribution network in Qatar. The extent of lack of recreational ability in Al-Rayyan due to spatial inaccessibility from proximity perspective, however, can only be ascertained after a detailed study of the housing layout of the native Arabs given that Arabic villas are attached with landscaped yards providing opportunities for relaxation and play.

Several possibilities might explain these findings. First, the identified zones have higher population density, resulting in a bureaucratic difficulty of acquiring new lands for park development. Land acquisition process is slow and expensive; often involving valuation and estimation of due compensation value. Another aspect is the practical difficulty of obtaining vacant land since zones in Doha municipality are highly urbanized. Moreover, park and public recreational spaces take a backseat when it comes to funding in general. Secondly, the Government is unwilling to spend on areas with higher labour population where the economic return of investment is low. Although we can only speculate without additional data, the current results clearly show that migrants are the receiving end of this distributional bias. Moreover, an anecdotal review of the park creation date shows that the majority of the parks planned in inner Doha (except Al Bidda Park and few other parks in the West Bay area) were before 2010. Therefore,

it is plausible to assume that the park growth after 2010 has been towards suburban areas, neglecting the inner areas further, resulting in underrepresentation in the above mentioned zones.

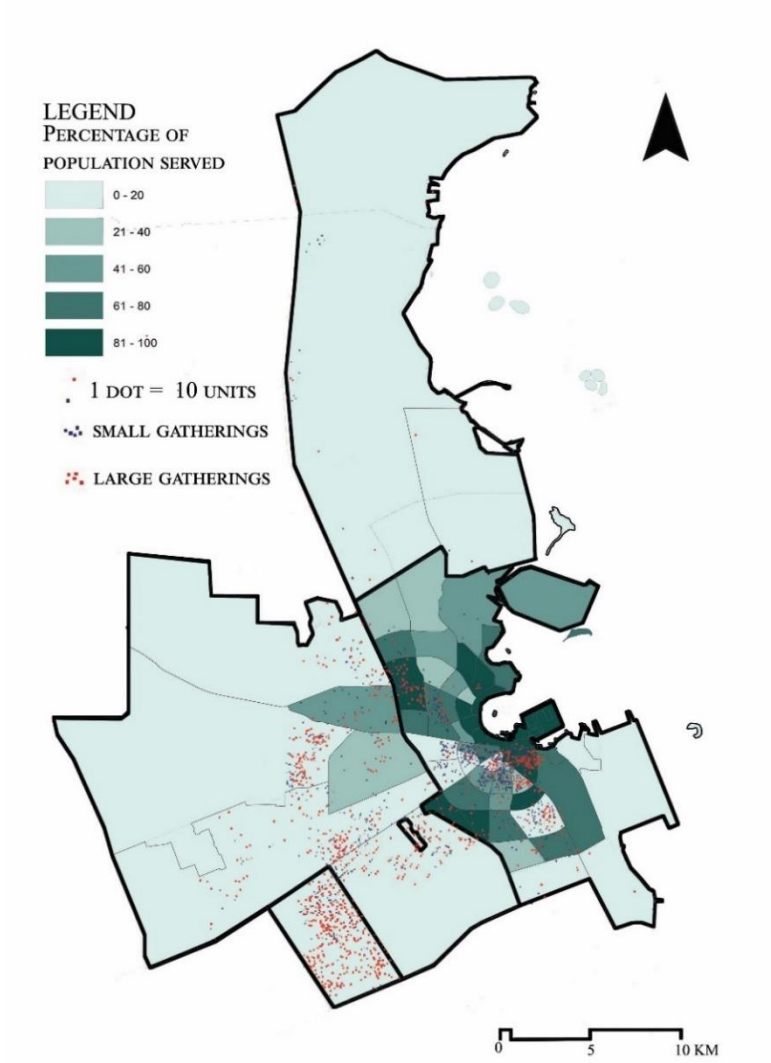


Figure 23. Map showing the concentration of labour gatherings in underserved zones in Doha and Rayyan municipalities. Red and blue dots show large and small labour gatherings respectively obtained from Qatar Development Atlas 2010.

Overall, only 29% of the population in Greater Doha and Al-Daayen have access to parks within 800 m buffer radius leaving 71% of the population underserved. All municipalities in the study area are equally underserved. However, fewer people residing around parks in zones with higher migrant population points towards a

distributional bias, worsened by higher population density and fewer recreational opportunities.

4.1.4. Potential Park Need

In this section , zones with greater need for parks, where the need is defined by three critical attributes namely: population density, population subgroup (labour gathering) and housing type (apartments) are identified. Earlier research has used need index to determine the extent of demand based on identified variables in the social and economic spheres. Murray and Davis (2001) have approached the design of need index by identifying the relevant variables, deriving related empirical data and weighting each data for a linear or non-linear index.

From the analysis based on the three variables considered in the research, the following need index map is generated (Figure 24). It indicates the zones with higher need considering the population density, the extent of labour gathering as well as the sum of apartments.

The area with higher park need is spread across Greater Doha with a cluster of zones closer to Old Doha and Al-Rayyan. This clearly reflects the residential population density data meaning that highest need zones have higher population density. The highest need zone (with need index > 9) is Zone 25. Zone 25 comprises residential districts mainly, Fereej Bin Durham and Al Mansoura. Ten other zones also fall in high need zones (with need index > 6), 8 of which are in Doha municipality. These zones are Umm Ghwailina (Zone 27), Old Al Ghanim (Zone 16), Al Doha Al Jadeeda (Zone 15), Msheirib (Zone 13), Najma (Zone 26) followed by Fereej Abdelaziz (Zone 14), Old Airport (Zone 45) and Industrial Area (Zone 57). These are primarily residential

zones with higher migrant populations, including low-wage migrant concentration. All these zones fall within the periphery of the third ring road (C-Ring road) around old Doha. Since our analysis included apartment building numbers irrespective of their occupancy as one of the indicators, zone 66 including the planned city of the Pearl shows up in the moderate need zone. This may not fully reflect the current housing occupancy in the Pearl, where a considerable number of apartments are vacant. However, our analysis identifies a potential need at a later stage when the apartments are fully housed.

In Al-Rayyan municipality, zones 55 and 56 are in greater need when compared to the rest of the zones. These zones include districts such as Fereej Al Asiri, New Fereej Al Khulaifat, Bu Samra, Al Mamoura, Abu Hamour, Mesaimeer, Ain Khaled as well as Fereej Al Soudan, Al Waab, Al Aziziya, New Fereej Al Ghanim, Fereej Al Murra, Fereej Al Manaseer, Bu Sidra, Muaither, Al Sailiya and Al Mearad. Overall, the need index map points towards a greater potential need for green parks both in Al-Rayyan and Doha municipality.

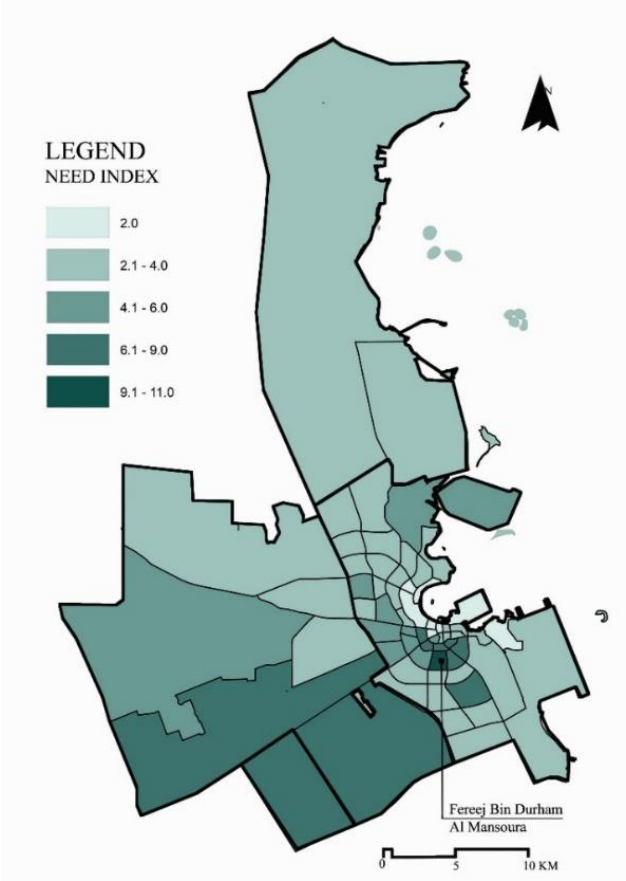


Figure 24. Need index of zones showing potential need for green parks in Greater Doha and Al-Daayen. Potential need does not account for the actual park provision in these areas.

4.1.5. Actual Park Need

Potential need for neighbourhood parks does not reflect the actual need provision, vital in equitable park distribution. The latter can be assessed only by analyzing the actual number and extent of green parks currently open and accessible to the residents. Need index integrated with actual park provision can help us determine explicit need areas and compare the areas served by the present park distribution pattern. Combining the percentage of population served by these parks (potential park users) with the need index can be used for the same. This is achieved by a simple query function in ArcMap where threshold values are input to find the park need zones. These

threshold values are lower park service areas (percentage population served less than 50%) and zones with highest park need (need index greater than 6). The highlighted areas in Figure 25 show zones in Doha municipality with greater need for parks based on the actual park provision. These zones are also listed in Table 12.

Table 12. Zones with actual park need and land use. Dominant land use is obtained from Census data (2015) of Planning and Statistics Authority, Qatar

Zone No	Zone name	Dominant Land use
14	Fereej Abdelaziz	Residential
15	Al Doha Al Jadeeda	Residential
25	Fereej Bin Durham, Al Mansoura	Residential
26	Najma	Residential
45	Old Airport	Residential
57	Industrial Area	Commercial
55	Fereej Al Soudan, Al Waab, Al Aziziya, New Fereej Al Ghanim, Fereej Al Murra, Fereej Al Manaseer, Bu Sidra, Muaither, Al Sailiya, Al Mearad	Residential
56	Fereej Al Asiri, New Fereej Al Khulaifat, Bu Samra, Al Mamoura, Abu Hamour, Mesaimeer, Ain Khaled	Residential

As can be seen from Figure 25, zones with higher potential need (with need index > 6) are not sufficiently supplied with parks making these areas park-disadvantaged zones in Greater Doha. It includes zones in both Doha and Rayyan municipalities. Zones within Doha municipality, however, must be prioritized for new park interventions as these zones with limited land area are currently experiencing rapid urban growth and population density. These zones can be rank ordered based on land availability and community consensus for park design.

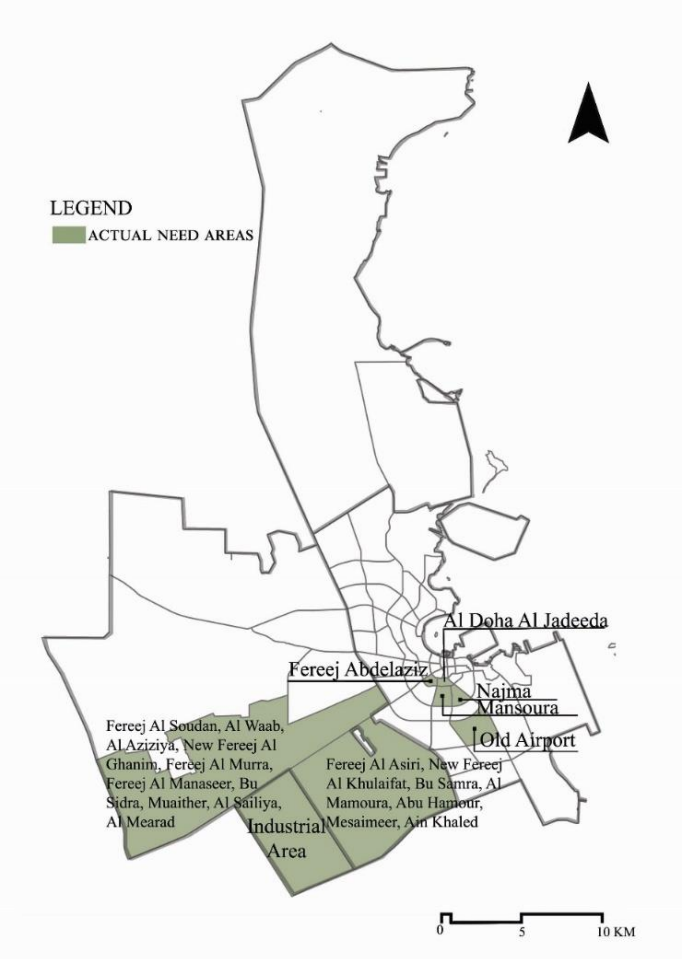


Figure 25. Zones with greater need for parks based on the actual park provision. Actual park provision refers to the actual number of usable parks.

Similarly developing towns on the edges (Al-Rayyan) must be considered after suitable interventions in inner Doha, which are overpopulated with rapid urbanization. Since Al-Rayyan municipality has a higher percentage of vacant undeveloped land, neighbourhood parks can be proposed within the catchment area with due consideration to diverse community needs. In neighbourhoods with predominantly Qatari nationals and low-density urban form, these parks must be targeted to the needs of the neighbouring community. The results of potential and actual park need also show that the study area lack park and recreation resources in an absolute sense, with a lack in the distribution relative to the needs of the surrounding residents.

4.2. Micro-Accessibility to Parks

The earlier sections analyzed park distribution at a macro level and identified zones where people are underserved, and user needs are not met. However, park provision alone does not ensure park use. Ease of pedestrian access to the park is another important variable that determines park use. The following paragraphs describe the micro-accessibility to parks in two neighborhoods, Madinat Khalifa South and New Al-Rayyan where features such as street network and pedestrian accessibility to individual streets are assessed.

The first section discusses the background analysis of two study areas. For the background analysis, land parcels, land uses, and public transportation system were mapped. The second section describes the Pedestrian Environment Scan walkability audit of the neighbourhoods. About 16 variables were chosen in the audit relating to sidewalks, the extent of barriers present, traffic volume, land use, safety and subjective measurements such as perceived safety and attractiveness of the street segment for the audit.

4.2.1. Madinat Khalifa South Neighbourhood

Madinat Khalifa South covers an area of 650 acres (2.6 sq. km) and is predominantly a residential zone catering mainly to the expats. Madinat Khalifa is one of the earliest neighbourhoods in Doha municipality. It was designed for housing indigenous Qataris after the introduction of land policies that offered them 30 m x 30 m plots and interest free construction loans (Nagy, 1997). The zone includes population from Southeast Asia and other Arab expats from African countries such as Sudan, with a stark lower number in native Arab population. Historical images of Doha show the

development of Madinat Khalifa neighbourhood by the mid-1970's (Figure 26).

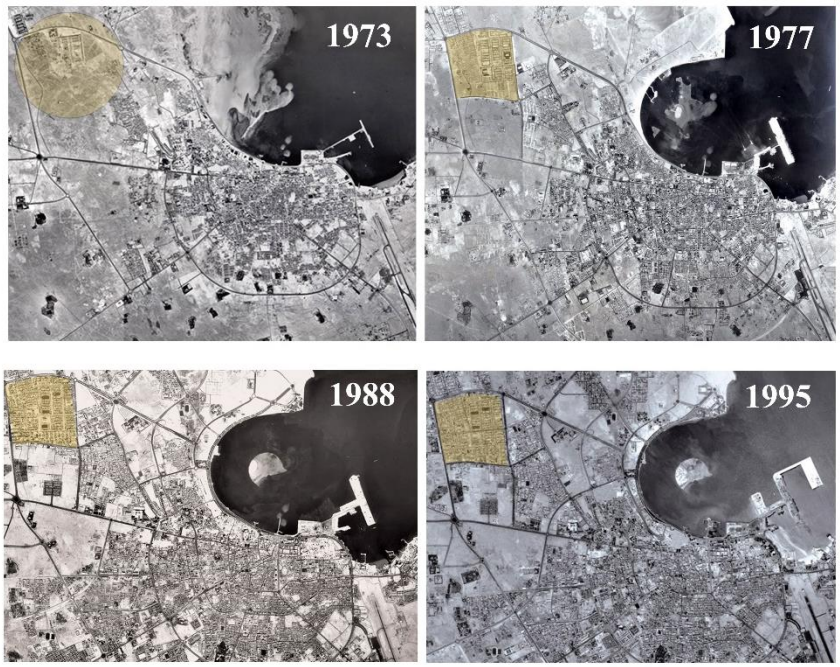


Figure 26. Map of Madinat Khalifa South neighborhood showing the development of parks over the years. In the year 1997, the road network and park parcels can be seen. All the five parks can be seen in the year 1988 (Ashraf & Sadiq, 2013).

Currently, the neighbourhood consists of five family parks namely Al Huwailah, Al Maroona, Al Yousufiya, Al Marwab and Madinat Khalifa South Park (Figure 27). Most of the parks have standardized park design with lawns, native and non-native trees, seating areas and children's play amenities.

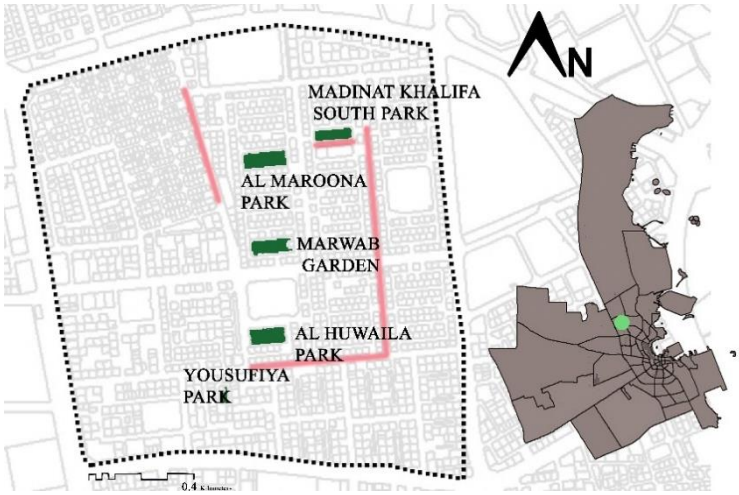


Figure 27. Parcel map of Madinat Khalifa South neighbourhood showing five parks in green and major commercial/ mixed-use streets in red. Parcel map obtained from Center for Geographic Information System modified by author.

Most prominent residential typologies in the zone are low-medium and medium density residential zones (R2 and R3 with 61-240 persons/hectare) as per the municipality Spatial Development Plan designation. The area has multiple building types: detached villas, villas with accessory structures such as garages and *majilis,* apartment units. Since the neighbourhood was established as early as 1970's, most of the buildings have worn out facades and lower heights. It has a finer grain with smaller plot sizes (30 m x 30 m) and a permeable street network system. With mainly residential street fronts, the zone includes clusters of commercial units such as groceries, clinics, supermarkets, bakeries, cafes catering to the majority Asian population, public schools, multiple parks, traffic police headquarters and other neighbourhood amenities. Majority of the retail units are suburban, designed to cater to middle class to lower middle class families. Census data of 2015 by the Ministry of Planning and Statistics show population density in Madinat Khalifa South as 14524/km^2 with an overall population of 38247 (Planning and Statistics Authority, 2015). Percentages of housing unit types and establishment types are shown in Figure 28a and b respectively. The higher

population density can be explained by the prevalence of small and large labour gatherings within these smaller and crowded building footprints, despite lower height density. With 81% of housing units as flats/apartments , 8% of establishments as large labour gatherings and 4% as small labour gathering, the neighbourhood has mixed residential typology with a dominance of apartment units. The most important commercial streets in the neighbourhood are Al Faihani, Amr Ibn Alas street and Al Zubara street with various cafeterias, grocery shops, salons, tailors and other neighbourhood amenities on either edge of the road.

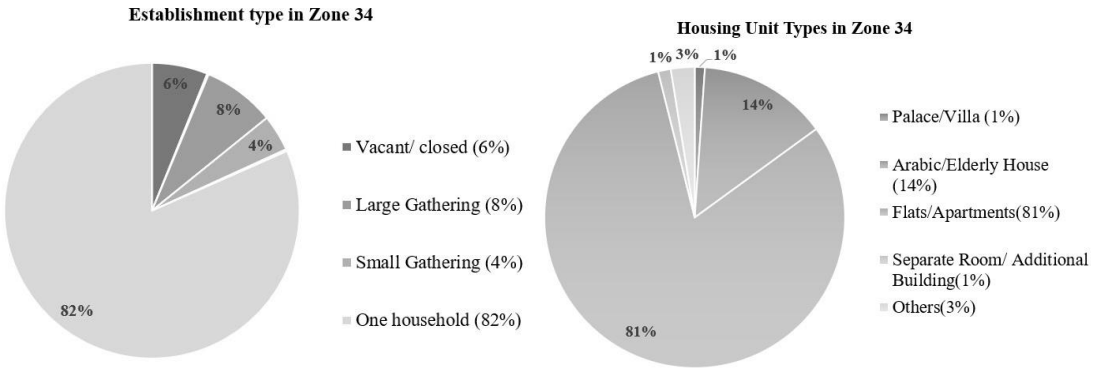


Figure 28. a) Establishment types in Zone 34 showing 12% of establishments as labour gatherings b) Housing unit type in Madinat Khalifa South showing major residential typology of flats/apartments obtained from Planning and Statistics Authority, 2015.

This paragraph describes the neighbourhood parks in Madinat Khalifa South (Figure 29). Al Huwailah park, with an area of 2.7 acres was opened in 2005 and is designated as a family park with a children's play area and basketball court. Al Maroona Park, opened in 1982 has an area of 2.7 acres. It is one of the residential gardens that has been designated as a youth playground. With minimal trees, the park has green turf that is maintained for standing games with balls. Al Yousufiya park is also one of the oldest parks which opened in 1982 and reopened in 2004. The park is smaller compared

to other neighbourhood parks and covers an area of 0.4 acres. The park is equipped with a children's play area and is located next to the mosque in a cul-de-sac. Al Marwab garden was opened in 1982 and covers an area of 2.9 acres. It includes a green lawn with trees on either side mainly intended as a play area for young adults. Madinat Khalifa South Park, one of the active parks in the neighbourhood, occupies an area of 1.7 acres. It was opened in 1982 and is equipped with a children's play area and shaded seating areas. It is located opposite Al Meera supermarket and mosque.

Figure 29. Neighbourhood parks in Madinat Khalifa South neighbourhood

4.2.1.1. Land Use and Accessibility

Previous sections provided a background analysis of the whole of Madinat Khalifa South zone. The following sections detail out the land use analysis, accessibility and walkability mapping within the 400 m service area obtained using ESRI ArcMap network analysis (Figure 30). The study area considers the actual street network to delineate the service area.

Figure 30. Area considered for Pedestrian Environment Data Scan (PEDS) walkability audit in Madinat Khalifa South neighbourhood within 5 minutes' walk around neighbourhood parks. Service area boundaries are obtained using network analysis tool in ArcMap within 400 m

Land use analysis of the study area shows a higher number of residential units, especially villas and apartment units (Figure 31). In addition to housing units, it also includes local commercial units such as cafes, restaurants, grocery stores, salons, tailor shops and meat sellers, intended for use by neighbourhood residents. Another characteristic of the land use division is the prevalence of these commercial outlets in smaller single-unit rooms, typically as extensions of the garage in residential streets

(Figure 32). Such land use sub-plotting helped the owners to economically gain from introducing a commercial use (Lockerbie, 2020b). It was scrapped, however, in 2013 owing to multiple traffic issues. Such land sub-plotting introduces liveliness and vitality to the neighbourhood despite leading to heavy traffic during peak hours. A common typology is the development of these commercial units along a single street turning them into commercial streets.

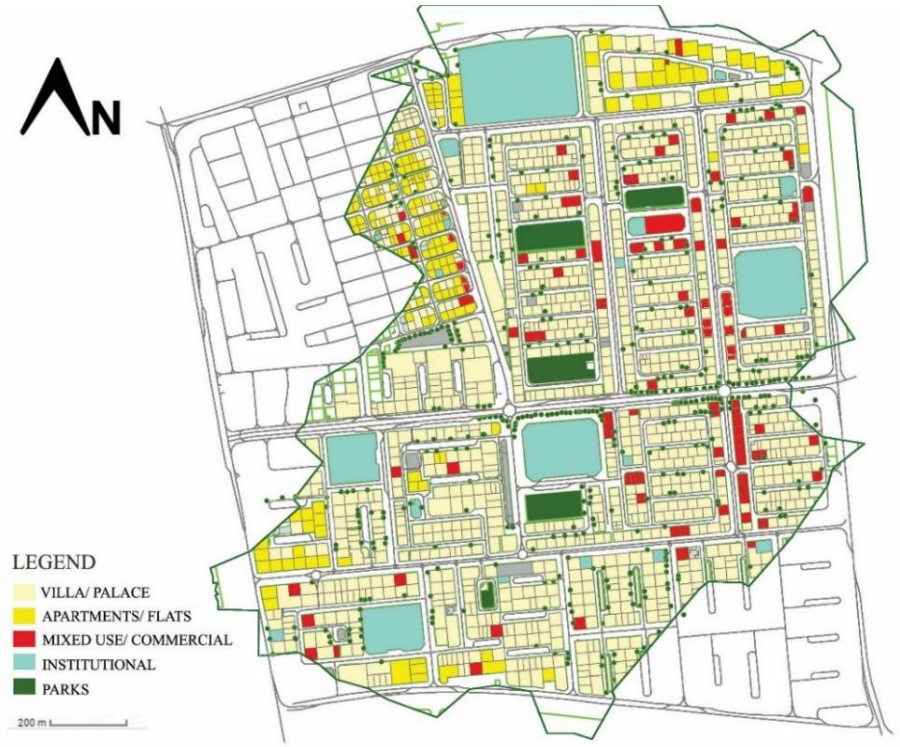


Figure 31. Major land uses in Madinat Khalifa South.

Figure 32. Typical commercial units seen in the residential neighbourhood. These are either accessory units or garages repurposed as commercial units.

The study area prominently has housing units which makes it easier for families to access neighbourhood parks. Most of these units, however, are low density units with a fewer mix of land uses which are not desired around park surroundings. Except for Madinat Khalifa South Park, a healthy diverse mix of activities are not found around the park to activate the spaces to ensure a constant flow (Figure 33). Madinat Khalifa South park has a supermarket across it which tends to be more active in the early morning hours as well as at night. Huwailah park has school frontage which essentially acts as a dead space across the street especially during the evening, which is when parks are mostly used. However, the use of the park as a continuation of the academic space or as multi-functional space could not be ascertained due to the COVID-19 pandemic and related school closure. In other cases, uses and needs are not met by the parks due to governance policies and cultural differences. For instance, the majority of the buildings surrounding Maroona Park and Marwab garden are run down older buildings inhabited by labourers. With the parks exclusively designated as family parks, they are not accessible to the migrant labourers in the area who stay without families. Figure 33 and Figure 34 show the immediate surroundings of parks in Madinat Khalifa.

Madinat Khalifa South Park is designed as part of the *furjan* concept in Qatari neighbourhood planning where a mix of mosque, commercial units and parks sit within a residential area. Al Meera, a popular supermarket, located opposite the park draws customers from different parts of the neighbourhood (Figure 33). While Madinat Khalifa South enjoys pedestrian traffic from people visiting this store, a cultural aspect of the Qatari culture acts as a barrier in an overall positive use of the space. Most frequent users of the neighbourhood parks are families with children who need to be taken out for play activities in the evening. Most of the time, a woman or a group of women accompany these children. In a setting where female park goers would like

privacy from male gaze, this park does not provide enough privacy through its grill fences. Another aspect of the area surrounding the park is the prevalence of low-wage labour housing and their constant presence along the grocery store and the related shops located close to it. Some of these men cannot afford private transport to reach the grocery store and hence use walking as the preferable means of access. Some can be seen unwinding after their day job in the few cafeterias located across the park. While this diversity may activate street frontage as described by Jane Jacobs, its effect on the use of parks in a Qatari setting needs to be studied. Especially since bachelors loitering around the park spark concerns of ogling at the females in the park. Since most of these parks are family parks, single males are often not allowed inside the parks. Park is secured by multiple guards of both genders throughout its working time of 2 PM to 11 PM.

Figure 33. Immediate surroundings of Al Maroona and Madinat Khalifa South Park in Madinat Khalifa South neighbourhood.

Figure 34. Immediate surroundings of Al Merwab Garden, Al Huwaila Park and Yousufiya Park in Madinat Khalifa South neighbourhood.

The neighbourhood has largely maintained its street network system established in the early 1970's. While it has a compact road network with an average block size of 738 sqm, some parts of the neighbourhood are overcrowded, run down and without any street side amenities. These streets are predominantly occupied by low wage labourers from India, Bangladesh and Sri Lanka even in the absence of basic street safety characteristics (Figure 35). Figure showing low-income expatriates taking a walk with no street pathway facility.

Figure 35. Run-down public realm in Madinat Khalifa South neighbourhood used by low-income expatriate populace.

The study area is very well connected through public transportation systems including *karwa* buses (state owned bus network system) and metrolink buses. Though the neighbourhood does not have a metro station currently, the core areas are well fed by the metrolink buses. Bus stops are also strategically placed to include institutions, grocery shops and parks. Since the street design includes a grid network system, accessibility to the parks is easier and straightforward. Roads with a speed limit of 30-50 km/hr surround these parks. In some cases, narrow often shaded alleys or *sikkak* border one of the sides of the parks. These *sikkak* (sing. *sikka*), if planned strategically, can provide short and efficient route pathways for pedestrians. Figure 36 shows a typical section with the *sikka* located next to the park within the study area.

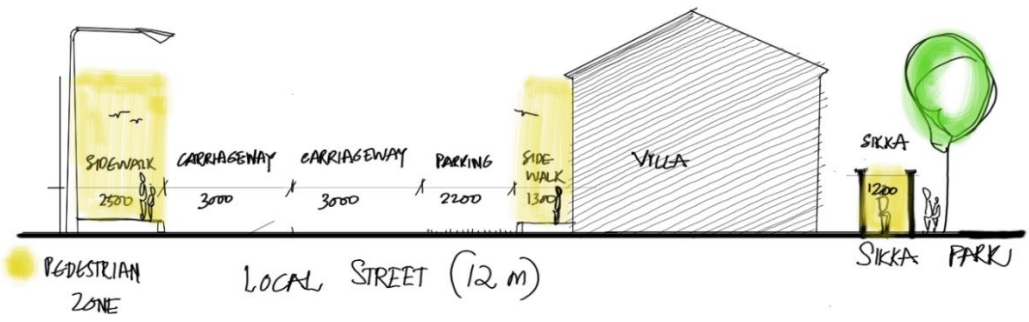


Figure 36. Typical section of *sikkaks* found in Madinat Khalifa south neighbourhood ranging from 1.2 m in width.

Figure 37 shows the bus stops and metrolink stops in the neighbourhood. The network system varies over the north and south of Omar Bin Khattab Street. While the road network is a simple grid system to the north, cul-de-sacs are found to the south of Omar Bin Khattab Street.

Figure 37. Bus stops and metrolink route and stops in Madinat Khalifa South neighbourhood.

With smaller block size than the suburban newer developments, Madinat Khalifa South has higher number of street connections. The average plot area is 642 sqm. Typical street connectivity is found after eight plots with an average block size of 200 m x 65 m.

4.2.1.2. Sidewalk Condition and Barriers

Pedestrian accessibility is facilitated in the neighbourhood with sidewalks along either side of the roads, most of which are in good condition. Major walkability

impediments are the presence of obstructions in the pathways (Figure 38). Most common obstructions are multiple cars parked on the pathways forcing the pedestrian to walk through the roads. Even in streets where on-street parking spots are clearly demarcated, cars are parked on sidewalks. Basement parking is absent in the neighbourhood except in some of the newly constructed apartments. Even outside the apartments, uncontrolled parking can be seen. This excessive reliance on cars has made the street car-centric, rendering pedestrian infrastructure less efficient and very less used. Excessive car parking on sidewalks has also turned them into parking spots where the only walkable paths are along the roads. Multiple cars also mean covered porches extending out of the compound walls. The sidewalks also lack shaded seating areas and plant canopy shade.

Due to the lack of clear demarcations on easement, property line and pathways, some residential units have narrow green lawns jutting into the pathways making it inaccessible to differently abled people. In some cases, the sidewalks are sloped at an angle rendering it difficult to walk through. In some streets, the absence of pavement hinders safe and pleasant walking experience. The landscape is dominated by male figures, often discouraging female users from accessing park by walk. Despite the presence of sidewalks, most of the people arrive in cars, majority with small kids and women.

Figure 38. Some of the obstructions found along the sidewalks a) Streetlight mast and palm trunk b) Parked bikes, construction works c) Green lawn along the sidewalk, sidewalk with a slope making it difficult to walk in d) Steps jutting out in the sidewalk.

4.2.1.3. Walkability Mapping

The following section analyzes the walkability scores of individual sections of Madinat Khalifa South neighbourhood based on the PEDS audit. The visual mapping of scores in seen in Figure 39.

Most of the roads in Madinat Khalifa South have continuous sidewalks except along the roads with infrastructural upgradation. Conditions of the sidewalks were fair to good with occasional holes, undulations and loose paver tiles. Sidewalk width and elevation were fairly consistent; 1.5 m width in most cases and a single step height. The most common difference in walkability scores to the north and south of Omar Bin Khattab Street was the presence of obstructions along the sidewalks. In areas with

higher labour gatherings, streets have multiple obstructions in the form of cars, garbage bins, flower beds, steps and unused objects (Figure 39). Overall walkability scores were higher in cul-de-sacs compared to older blocks due to fewer obstructions and cleaner sidewalks. The scoring is suggestive of the need for fewer obstructions in sidewalk rather than implicating the design of cul-de-sacs which is attributed to low dense neighborhoods and suburban sprawls. Similarly steps and urban elements such as water fountains provide respite and enliven the streets. However, these elements must not hinder pedestrian access. The central Omar Bin Khattab street which connects east-west of the neighbourhood has a pleasant and well maintained public realm for walking (Figure 40). More people were observed on streets where there was a higher migrant population concentration, possibly due to their limited transportation choices or a cultural need for using streets as realms for interaction. They tend to walk, especially to different cafes and stores that cater to their needs even in the absence of sidewalks or poor and broken pavers.

Figure 39. Highest walkability scores are seen in central streets and cul-de-sacs mainly because of the diversity of land use, sidewalk landscaping and the presence of fewer obstructions respectively.

Figure 40. Shaded pathways along the stretch of Omar Bin Khattab street.

4.2.2. New Al-Rayyan Neighbourhood

New Al-Rayyan is one of the newly-formed neighbourhoods in the suburbs of Qatar. It has low-density residential zone (R1) designation as per Municipality Spatial Development Plan under the Ministry of Municipality and Environment. The neighbourhood includes both denser apartment dwellings as well as detached villa units. These standalone villas cater mainly to native Arabs. With larger parcel size and a conventional suburban residential typology, these houses have huge compound walls with newly formed streets and sidewalks.

As per spatial development plan, the neighbourhood should maintain a low scale residential development with a density of 1-60 persons/ha. Anticipated building typology includes detached dwelling, courtyard house, villa compound, semi-detached, palace with a maximum anticipated height of 13m with a provision of up to 17 m with architectural features for Palace Development, ancillary buildings, G (4m): majlis (up to 5m). Permitted building use in the neighbourhood are residential, mosques, open space, transit stations, residential compound retail. Most of the buildings fall within two storey heights. Zoning bylaws allow a frontage of 5 m with a side and rear offset of 3

m. The land use diversity is minimal with a dominance of residential typologies. Schools, kindergartens and parks are also seen.

New Al-Rayyan district covers an area of 1905 acres (7.7 sqkm) more than three times the area of Madinat Khalifa South neighbourhood. The most important commercial street along the site is Al Shafi street cutting north-south across the neighbourhood. It has multiple cafeterias, *abhaya* (cloak worn by Muslim women) shops, carpentry, upholstery and other commercial establishments on both sides. Historical photographs of New Al-Rayyan district show a gradual development of the street network and residential units along the top left of Shafi Street (Figure 41).

Figure 41. Google Earth historical archive image of New Al-Rayyan district showing the study area in 2005 and 2006. Development of newer residential zone to the left of Shafi Street is marked in black (Source: Google Earth).

This paragraph gives a brief account of the parks in New-Al-Rayyan study area. Based on the 2015 census by the Planning and Statistics Authority (PSA), New Al-Rayyan zone (Zone 53) including the districts of New Al-Rayyan, Al Wajbah and Muaither had a population of 77,875. New Al-Rayyan district has four parks namely New Al-Rayyan family park 11, Muntazah Al-Rayyan park, Muaither park and New Al-Rayyan park 2 (Figure 42 and Figure 43). New Al-Rayyan family park 11 was opened in 2010 and is designated as a residential park. It covers an area of 8683 sqm, contains children's play area, outdoor court and shaded seating areas and other public

amenities. New Al-Rayyan family park 2 was opened in 2014 with an area of 4927 sqm designated as a family park with children's play area and soccer fields. Muaither park (New Al-Rayyan family park 4) was opened in 2004 with an area of 4927 sqm. It is a residential park with a children's play area, a variety of fruit trees, shaded seating and other public amenities such as toilets. Muntazah Al-Rayyan park was opened in 2004 with an area of 8807 sqm and is designated as a family park with children's play area, shaded trees and seating. It is the biggest neighbourhood park in New Al-Rayyan and includes palms and nearly 17 types of trees. It is located across a mosque. All these parks are exclusively designated as family parks.

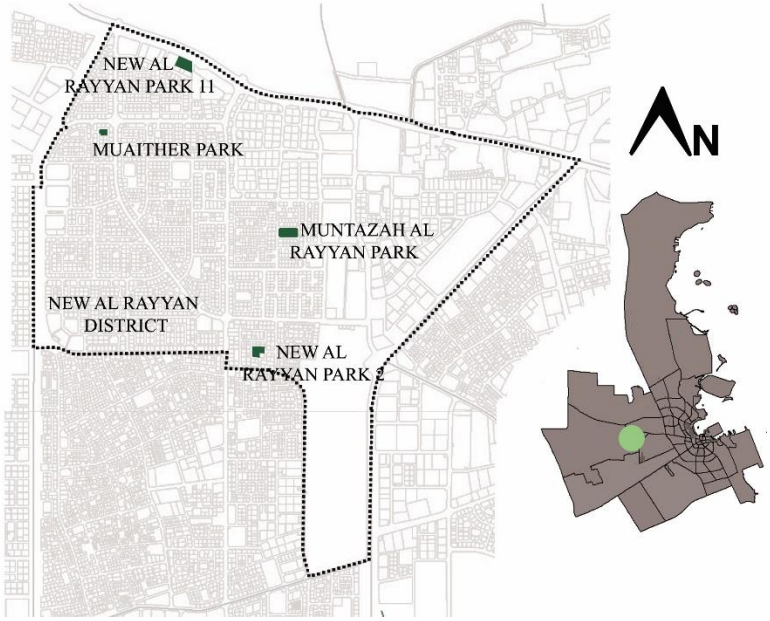


Figure 42. Parcel map of New Al-Rayyan District showing four parks in green. Parcel map obtained from Center for Geographic Information System modified by author.

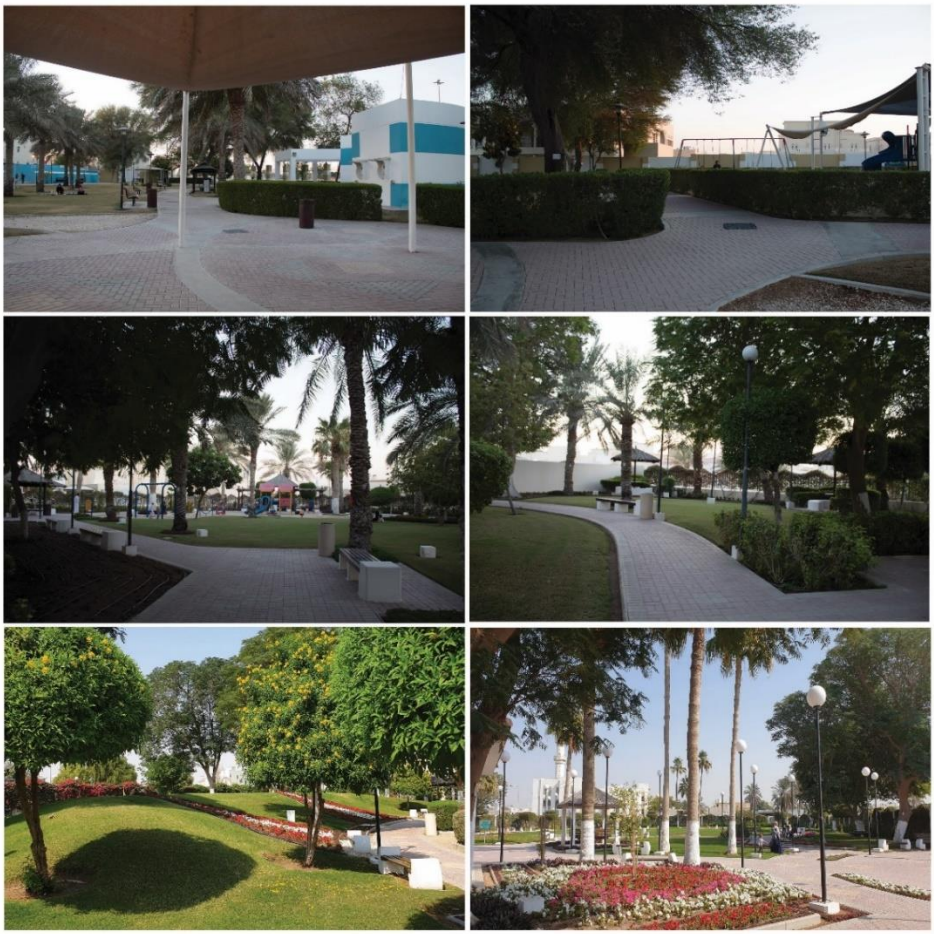


Figure 43. Neighbourhood parks in New Al-Rayyan neighbourhood.

4.2.2.1. Land Use and Accessibility

The following sections detail out the land use analysis, accessibility and walkability mapping within the 400 m service area around three parks in New-Al Rayyan neighbourhood (Figure 44).

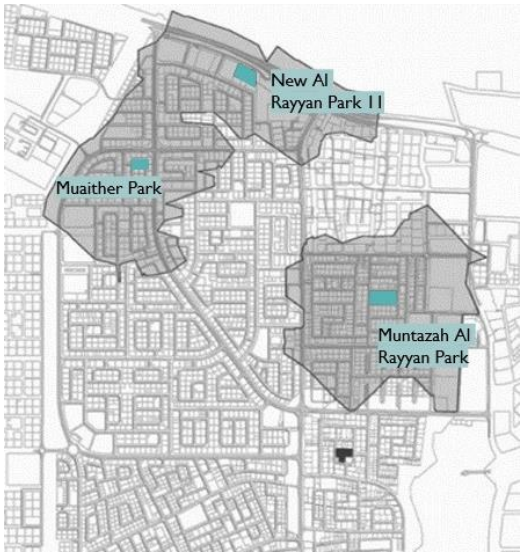


Figure 44. a) Area considered for Pedestrian Environment Data Scan (PEDS) walkability audit in Al-Rayyan neighbourhood within 5 minutes' walk of neighbourhood parks. Service area boundaries of 400 m around the parks are obtained using the network analysis tool in ESRI ArcGIS 10.2.

Land use analysis of the study area shows a stark contrast to the east and west of Al Shafi Street (Figure 45). For ease of analysis, the study area to the west of Al-Shafi street is marked as area 1 and to the east is marked as area 2. While the newer development in area 1 is largely detached villas up to two storeys high, the older settlement in area 2 is diverse in its land use (Figure 46). Villas in area 1 have huge compound walls as street front boundaries, providing little to no street activation. Cafés and other daily need supermarkets are absent as seen in the land use map, except along the highway where school, supermarket and petrol pump are found. Such mono-functional zoning practices where native people settle in large, detached villas and expats in 'compound villa' or apartment buildings are a common scene in Qatari residential landscape. Land use regulations limit the development of rental properties in neighbourhoods designated for Qatari low-density housing (Nagy, 1997). These preferences are culturally driven and perpetuated by planning regulations. New Al-Rayyan and Muaither park (parks in area 1) have larger parcel size of an average of

1492 sqm. Most of the park users are families from the neighbourhood. Since the zoning around the park is monotonous, the required density necessary for activating park frontage is not achieved.

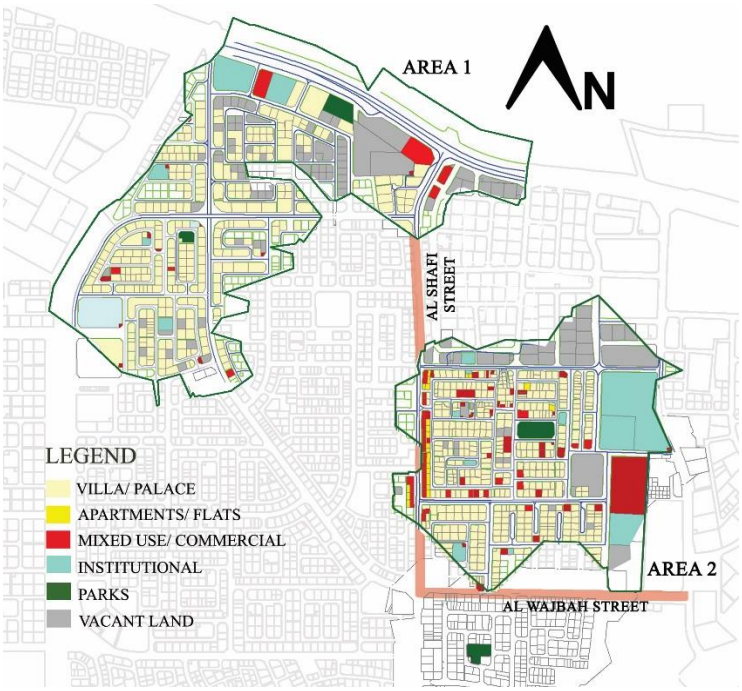


Figure 45. Land use map of the study area in New Al-Rayyan neighbourhood.

Figure 46. Villas in area 1 of New Al-Rayyan neighbourhood.

Muntazah Al-Rayyan park in area 2, on the other hand, has a higher diversity and a larger population mix including expatriate population (Figure 47). Higher number of people were observed walking outside the parks in area 2 due to the presence of commercial units such as cafes, supermarkets, salons and poultry stalls, components of

sticky edge proposed by Jan Gehl. Like Madinat Khalifa South, these parks do not cater to the bulk of migrants in the neighbourhood since they are designated as family parks and are exclusively open to people with families. Such governance measures present a missed opportunity of assuring park accessibility to people with higher park need. Another aspect of locating family parks in areas with higher migrant population, majority of which are men, is the decreased park use by female visitors due to cultural bias, an example of how the western ideals of activating a space can mean intrusion in Qatari culture. Therefore, understanding the demographic profile and cultural nuances is beneficial before designating parks as family only or public parks.

Figure 47. Typical street character of area 2 in New Al-Rayyan neighbourhood b) Neglected public realm in southern part of area 1.

The study area is relatively well connected by the public transportation system including *karwa* buses even though the neighbourhood does not have a metro station. Bus stops are also strategically placed to include institutions, grocery shops and parks (Figure 48). Newer developments in area 1 have bigger plot size to that of area 2. The average plot area is 1189 sqm, higher than that of Madinat Khalifa south neighbourhood.

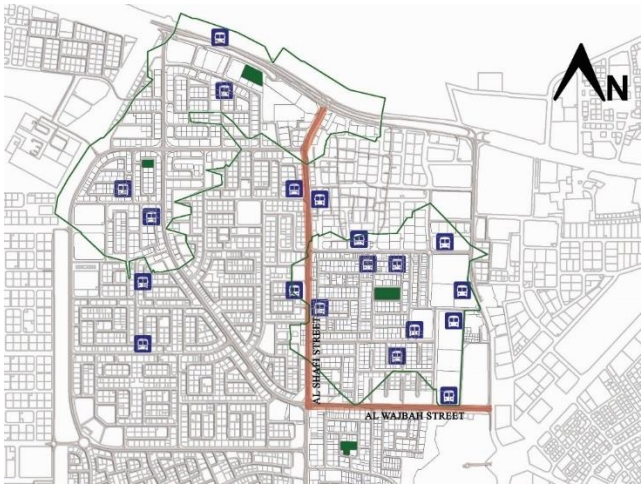


Figure 48. Bus stops in New Al-Rayyan neighbourhood.

4.2.2.2. Sidewalk Condition and Barriers

Sidewalk conditions differ in the study area. While area 1 has the majority of the sidewalks in good condition, the southern part of the neighbourhood is still under development and hence has streets where sidewalks are yet to be installed. Sidewalks, however, are usually kept cleaner and well maintained in area 1 possibly using domestic help available in the majority of larger Arab homes. Despite having larger parcel size and bigger individual villas, cars dominate the landscape and occupy sidewalks outside the homeowner's property line in the public setback. Another aspect of the sidewalk condition is the increased conversion of sidewalks as outdoor gardens or private space by the residents. Such annexation of public realm is prevalent and seen throughout residential neighbourhoods (Figure 49). It can be assumed that as these practices do not generally get penalized, they encourage profligate encroachment into the public realm, especially in the neighbourhood level walkways. This behavior can also be noted in other Gulf countries such as Kuwait (Peca Amaral Gomes et al., 2021). While landscaping and shop encroachment elements along the street frontage can add interest to the pedestrians, a synergy must be obtained between planning for walkability and

interest either by dedicated sidewalks or dedicated through areas.

Figure 49. An outdoor green area and a temporary seating space made out of screens set up in the public realm in the newer development to the west of the study area.

In area 2, sidewalk condition is fairly good with occasional damages due to infrastructural upgradation such as laying of utility lines below them. In some cases, pavers are loosened due to poor workmanship. Sidewalk obstructions observed in area 2 are similar to the ones seen in Madinat Khalifa South neighbourhood. Overall, densely populated inner roads of area 2 are scattered with multiple wastes and are not well maintained. Some of the most common obstructions along the pavement are shown in Figure 50. Garbage bins, step encroachment on sidewalks, narrow green areas, centrally placed streetlights and signposts, general rubbish and car porches are seen throughout the area. Some of these residential blocks with cul-de-sacs are relatively safer and easier to navigate (Figure 51b).

Despite sidewalk encroachment by cars, pedestrians observed in the streets were higher than in area 1, mainly migrants of South Asian, African and Arab origin, due to the presence of multiple commercial units. Figure 51a shows a group of people walking from the mosque after evening prayers, essentially turning the road into a shared street.

Figure 50. Some of the obstructions found along the sidewalk a) Cars parked along sidewalk on either sides b) Temporary mobile toilet along sidewalk c) Palm trees along sidewalk d) Steps jutting out in the sidewalk (clockwise from top left).

Figure 51. a) People seen walking on the roads in area 2 after attending the evening prayers b) Cul-de-sacs which are quieter, safer and has narrow single lanes making it easier to cross.

4.2.2.3. Walkability Mapping

The following section presents walkability mapping based on the walkability scores of the audit (Figure 53).

Compared to Madinat Khalifa South, area 1 of New Al-Rayyan has a lower residential density, fewer land use mix and fewer sidewalk obstructions. The street dynamics on either side of Al Shafi Street is different due to the differences in land use diversity. While the newer neighbourhood consists of predominantly villa and apartment compounds without any commercial establishments, the streets have very low traffic and are comparatively safer. At the same time, they are uninteresting and not pleasing to walk by. This is mainly due to the presence of large compound walls without any visual/environmental permeability to the street frontage. Even when these villas are street facing, these walls block off the permeability and define a street character that is neither pleasing nor engaging to walk by (Figure 52). Street frontage shown below can make the walk more interesting by revealing the character of the house while providing the required privacy.

Figure 52. Desirable vs undesirable street character in Al-Rayyan. Examples of residents attempt at beautifying the public realm within the property line and outside the property line resulting in land annexation and uncomfortable sidewalks.

Figure 53. Walkability mapping in New Al-Rayyan study area.

The major difference in walkability scores of the study area are mentioned in Figure 53. Area 2 with smaller lot size, higher street density and a healthy mix of diverse uses has higher potential for walkability. The presence of cars and other on-path obstructions, however, deter easy access to pedestrians resulting in lower walkability scores. The area also scores lower in the subjective analysis of the level of attractiveness and safety of the streets. To the west, area 1 with recent subdivision regulations have favored disconnected monofunctional zones over a healthy mix. The walkability scores are on the higher side since the sidewalks are obstruction free to a larger extent. To the south of area 1, sidewalks are yet to be developed. Hence the walkability scores are lower.

CHAPTER 5 : RESULTS, DISCUSSION AND CONCLUSION

Urban parks are important recreational magnets that improve the livability of cities. Equitable spatial distribution of urban parks is linked to their success in maximizing utility and involving diverse communities. This study analyzed the following important aspects of spatial distribution of parks in Greater Doha and Al-Daayen municipality: 1) Identify the current spatial distribution pattern based on demography and proximity 2) Study the impact of population density, housing density and population subgroup on park need and identify park disadvantaged areas 3) Study street-level features that impact walkability in the micro analysis of accessibility to identified parks. This study significantly contributes to accessibility literature, reviews park planning idiosyncrasies in the middle east and provides guidelines for park planning practice. Chapter 5 summarizes the key research findings to address the above mentioned three key objectives of this study, discusses the findings in relation to earlier literature, provides suggestions for future research and finally, describes the key contributions of this research to scientific knowledge.

5.1. Key Findings

This study has enhanced our understanding of urban park distribution from generic aspects of park accessibility such as distribution pattern and park need to specific aspects such as walkability and ease of pedestrian access. Key research objectives were (followed up with sections)

1. Analyze green park distribution pattern with respect to population served within walkable access.

2. Determine the park disadvantaged areas in Greater Doha and Al-Daayen from spatial and social standpoints such as population density, housing type and population subgroup.

3. Examine the level of micro-accessibility of pedestrians around parks through walkability audits.

5.1.1. Park Distribution Pattern and Demographic Accessibility within Walkable Distance.

This research was able to determine the current spatial distribution of parks and the degree of spatial accessibility to communities within walkable distance of parks. The area of influence of walkable access was incorporated using the accepted Euclidean service distance of 800 m. This objective measures the percentage of population who cannot benefit from the park by the virtue of spatial distance greater than 800 m or by the lack of proximity which forms the first step in understanding distributional fairness. While this objective does not cover other factors such as social need, community consensus and walkability shadows in park placement, initial review of zones underserved by parks identifies issues in planning processes and confirms the presence of distributional bias, if any.

From the analysis, about 22% of the zones in the study area have less than 10% population served by the parks. While a distributional bias based on socioeconomic status cannot be deduced from the results, migrant workers are at the receiving end of such spatial inequalities. This is not surprising since Qatar's population setup comprises 80% of expatriates. Even though the term migrants include expatriates belonging to different economic classes, background study of the underserved zones show that the highest distributional inequity is felt by the poorer communities. These findings are

crucial because it suggests a need to integrate the needs of different communities in urban planning proposals. Within the structured social setup in Qatar, these preliminary findings propose a need for a 'compensatory' planning methodology that can be updated every few years. Since the population setup of the country can differ in the upcoming years along Qatar National Vision 2030 — a strategy to increase nationals and limit inflow of migrants and replace blue-collar workers with white collar workers — the methodology proposed in the research holds promise and can be used for planning and evaluation at regular intervals in the future.

5.1.2. Areas with Park Need.

The study identified park disadvantaged zones in Greater Doha and Al Daayen using a need index designed based on three critical variables that influence park need : population density, presence of labour gatherings and the number of apartment units. Need index data showed the highest potential need for parks (need index >9) in Zone 25 , Fereej Bin Durham and Al Mansoura area in Greater Doha. Other ten zones (need index > 6) also showed higher potential need with majority of them falling in Greater Doha area.

Actual park need zones differ from the potential park need zones; the former considers the green parks open for public use. The study found that actual park need was equally applicable both in Doha and Al-Rayyan municipality showing a lack of park distributional sensitivity in zones inhabited both by the migrants and the nationals. The actual park need zones include migrant and Arab concentration; Najma, Industrial area, Mansoura and Old airport in Doha municipality as well as zone 55 and 56 in Al-Rayyan municipality. Since the zones in Doha municipality cover lesser area compared

to Al-Rayyan, need based analyses are detailed to a finer scale where strategic and focused interventions can be carried out. This methodology can be utilized on smaller aerial units like blocks for a statistically significant need analysis in Al Rayyan municipality to identify the exact intervention areas.

5.1.3. *Walkability in Neighbourhoods with Parks.*

In the final objective, analysis was confined to understand the ease of walkability around parks. Pedestrian Environmental Scanning (PEDS) audit tool was used to carry out the audit. Observation insights were gained through the audit from both the study areas. Although both Madinat Khalifa south and New Al Rayyan neighbourhoods promote walkability around the parks, differences in street network, plot size, residential typology and street-level urban design features determine its effectiveness. Madinat Khalifa South has a better spatial layout to encourage walkability due to its shorter block size, grid street network and lesser road width. Whereas Al Rayyan has typical suburban development with larger lots, homogenous villa typology and huge compound walls that discourage walking. Even though the spatial layout is favorable for walking in Madinat Khalifa South, the constant presence of obstructions such as cars, posts and garbage bins render these sidewalks unusable. Whereas in Al-Rayyan, sidewalks are comparatively less obstructed especially in the newer development areas. Hence, walkability audits show higher scores in the newer walkable neighbourhoods of the Al Rayyan as opposed to Madinat Khalifa South. Both the neighbourhoods had issues impacting walkability such as dominance of cars both in the roads as well as sidewalks, lack of diverse uses, lack of shading devices and seating as well fewer landscape planting that aid walking. Even though the road

networks in Al-Rayyan is fairly recent, street design does not promote walkability from a place-making perspective. Rather, it seems to follow the standard guidelines of the manual of highway design than a user centric design manual.

The presence and dominance of private vehicles, especially on the sidewalks, is a persistent issue in both the neighbourhoods. Due to the lack of clear planning policies on sidewalk design in residential neighbourhoods; landowners encroach street frontage and claim their ownership, beautifying them with narrow green strips. It also suggests a lack of landscaping and street planting in residential neighbourhoods as part of the public realm development. Other sidewalk obstructions include garbage bins, centrally placed signages, loosened pavers, car porches and construction waste.

5.2. Discussion

This thesis investigated the spatial equality and equity of public park distribution in Greater Doha and Al Daayen Municipalities in Qatar. It also analyzed the level of need-based park placement and identified potential need areas for future park planning. Street level urban design surrounding the parks were also studied to suggest further improvements in pedestrian accessibility to parks. The findings are important not only because they uncover the existence of biases, either intentional or unintentional, but also because they call for additional research in park accessibility. This section will cover a discussion of the important findings of the research, their contribution to the existing literature and their significance for planning discourse in general.

Spatial distribution pattern of parks is a point of departure in ascertaining equality of park access. Area of park per zone in relation to the population density is a

good indicator of equality in park access from a distributional perspective. Park acreage (park area per zone) and park provision ratio (per capita park area) were computed to understand the influence of population density in park planning decisions. Results show that zones with the highest per capita park area have lower population density. Conversely, zones with higher population density, mostly occupied by low-wage migrants, were found to have lower per capita green area due to inadequate number of parks. This is consistent with earlier studies that have discussed the presence of fewer park acreage to poor and densely populated people of color in Baltimore and Los Angeles (Boone et al., 2009; Wolch et al., 2005). Studies have also discussed the presence of higher per capita green areas in affluent suburbs of high-income White people (Matthew McConnachie & Shackleton, 2010). While a consistent correlation could not be obtained due to the lack of socio-economic data (such as median income level or median housing value), an analysis of population structure of lower park acreage zones shows the disadvantages are tolerated by low-wage migrants to a large extent. Considering the urban development history of Qatar, it is easy to speculate the reasons for the neglect of park provisions in denser inner areas of Doha. Higher land acquisition costs, lack of investment in inner areas inhabited by migrants, profitable land reclamation for developer led constructions and strategic locations along the waterfront could have consolidated this trend of proposing parks away from inner areas. Earlier studies have also pointed towards the lack of adequate funding opportunities in economically distressed areas to the presence of insufficient recreational areas (Chen et al., 2019; Wolch et al., 2005).

In terms of the people privileged by proximity that provides walkable access to nearby parks, a similar inequity can be observed and quantified in Doha municipality. Considering the zones that serve fewer people (less than 10% of zone population)

within walkable access of parks in the study area, 7 out of the 10 zones are inhabited majorly by the low-wage migrants. The findings support the hypothesis that a large majority of low-income migrants have disproportionately fewer parks within walkable access, specifically in Doha municipality. These findings are crucial in Doha municipality since it has higher population and urban density and fewer opportunities for land acquisition. Even though similar findings can be observed in Al-Rayyan municipality; where less than 10% of the zone population are within walkable access to parks, results are not conclusive enough to point a bias towards the low-wage migrants since native Arabs form a huge part of Al Rayyan municipality and hence are equally disadvantaged. Additionally, the extent of inequity cannot be ascertained accurately in Rayyan municipality due to the higher zonal land area and the green yard area within the residential units of Arab villas. Hence further research is needed to provide a clear picture of the distributional inequity among Arabs. These exploratory findings should be expanded in further studies.

The results of need-based analysis showed a greater potential and actual need for green parks both in Al-Rayyan and Doha municipality. These findings are important in park planning since they can guide locations for future park planning. They can also be used to design user-centric and demographically sensitive park amenities. Another revealing aspect of the need based park distribution analysis is that even in zones with lower actual park need, parks need not ensure fair access to all sections of the society. Neighbourhood parks exclusive to families, for instance, is a common scene in the residential neighbourhoods and provide lower social access to disadvantaged communities in Qatar. In the study of Madinat Khalifa South neighbourhood which is well served by five neighbourhood parks do not meet the equity aspect since all the five parks cater only to families. Such policy measures exclude communities of single men

from opportunities for recreation, relaxation and physical fitness.

The Supervisory Committee of Beautification of Roads and Public Places has recently announced the implementation of several parks in residential neighbourhoods, named as '*furjan'* parks (Ashghal, 2021). While it is a much needed initiative in the right direction, zones with higher population and building density often do not fall under the ministry priority since land acquisition is difficult and cumbersome. Therefore, developers are encouraged to provide green areas in combination with public amenities such as schools, which result in exacerbating the fragmentation of the green area distribution. Planners must take a normative stance to reconcile the rational needs of equality in park provision with financial and bureaucratic differences. Similarly related research on park accessibility such as the accessibility investigation of the parks using space syntax can be used in further studies, considering the limitations of GIS in establishing spatial relations as effectively as space syntax (Major & Dalton, 2018). Such studies will broaden the scope of the current study from accessibility based on pedestrian movement to accessibility based on the vehicular movement in Qatar. A recent study by Tannous, Major and Furlan (2021a) has found higher integration values in targeted parks such as Al Rayyan park, hinting at its potential to be conceived as a bigger park in the future. Similarly, in another related research, out of the 33 parks identified, only 30% of the sample had a metro station within 400 m pedestrian shed (Tannous, Major, Furlan, 2021b).

Walkability audit of the two neighbourhoods highlighted weak urban design policies at street-level. While streets were increasingly cordoned off for infrastructure maintenance in older neighbourhoods, newer suburban neighbourhoods were more peaceful and had fewer sidewalk obstructions. Denser areas with diverse land uses, however, were found to attract more people in and around the park despite poor

sidewalk design and increased sidewalk obstructions. A persistent issue in both the neighbourhoods was the dominance of private vehicles, car parking in sidewalks, lack of open streets and lack of basic amenities that attract people. Inconsistency in design policies for public realm in the residential zones was also observed in both the neighbourhoods. Some of these contraventions include green strips on through areas, outdoor *majilis* and mobile toilets which are installed along the boundary of the landowner's property in the public realm. The lack of strong policies and penalizations reinforce and perpetuate public landgrab making the streets difficult to traverse, often pushing the pedestrians to step into the streets. One of the means to solve this issue is by using stronger regulations and a user centric street design.

One of the recommendations in micro-accessibility is adopting more qualitative and human approaches in urban design using updated urban design manuals that put pedestrians at the forefront of public realm (Peca Amaral Gomes et al., 2021). Recent report on the form based coding in downtown Doha and the urban design compendium is a development in the right direction (Ministry of Municipality and Environment, 2020).

5.3. Conclusion of Findings

This thesis examined the spatial distribution and access of parks in Greater Doha from a spatial and social standpoint. The research proposed a methodology to understand the current distributional pattern of parks in Qatar to advance equity, and to limit exacerbate the existing inequities. The results from the study highlighted the presence of a higher number of zones with low walkable accessibility to parks. It also found a lack of distributional fairness in park provisions, inadvertently targeting the

low wage migrant population of expatriates who are visibly and socio economically vulnerable in the current social stratification of the Qatari society.

Further, this study provided a rationale to adopt a ‘compensatory’ distributional approach in public park distribution. Compensatory distributional pattern must prioritize both nationals and expatriates under greater park need for park design, planning and implementation. Also, street-level walkability audit has a consistent low score in both the identified park catchment areas, irrespective of neighbourhood age, land use, block size and population density, largely due to poor and unsupervised policy regulations at the street-level. The following implications are drawn from the outcomes of this research.

First, findings from this thesis suggested that the current park distributional pattern based on conventional planning does not ensure equitable park access from a sociospatial standpoint. Nearly 50% of the zones have less than half of the people served by park catchment area and many of these zones are home to economically backward communities. Thus, the thesis highlights injustice in green park distribution where migrants are the receiving end of disadvantages in greenspace proximity, especially in Doha municipality.

Secondly, the current park planning system in Qatar overlooks the actual need of the communities over fulfilling per capita green area requirements. Conventional park planning that relies exclusively on quantitative standards tends to overlook the complexity of need based communities on sociocultural variables. From the findings, this thesis has successfully addressed knowledge gaps in the current distribution system and a proposed an alternate system based on a ‘compensatory’ model by identifying zones which are in immediate persistent need for parks. Therefore, the findings of this thesis provide practical tools to enable planners to identify more efficient ways to

encourage public park distribution systems and analyze distributional fairness. The methodology employed in the study can be finetuned by including more variables for a nuanced need based analysis. Findings also suggest that parks planned for strategic importance or national relevance, or along scenic coastlines does not necessarily meet the immediate needs of a neighbourhood park analyzed through need based assessment. While the positive effects of street planting and corridor patches that accounts for urban 'beautification' cannot be discounted from an ecological perspective, a strategic coordination between ecology, urban wildlife and urban planning is required.

Third, micro-accessibility levels of parks within the walkable service area of neighbourhood parks are confounded by the presence of multiple obstructions including cars. Despite the development of sidewalks and road signages as part of the road development package, the actual utility of these sidewalks is not clearly designed nor implemented. Presence of sign and light posts at the center of sidewalks and public land grab by private homeowners are examples of poorly implemented street design policies. This thesis calls for stronger policy measures in diversifying neighbourhood land use, improving sidewalks with clear regulations on obstructions and public-private land ownership.

Fourth, this thesis explores land use dynamics and their relation to public park accessibility. Current planning regulations of monofunctional zoning has led to segregated conclaves of exclusive population type — natives in detached villas, expats in apartment units/ partitioned villas and low skilled migrant workers, especially men in labour camps. However, land use dynamic is not reflected in park provisioning nor in park entry resulting in lack of access to 'bachelor' migrant population.

5.4. Recommendations

The following key points are recommended based on the findings of this study as possible urban planning policy interventions to increase access to parks:

1) Prioritize provision of green parks in need based areas. The key to an effective distributional system is an understanding of the current distributional layout and its impact on the people. Proposing areas for green park development in need based zones will increase the use of parks and reduce the structural bias prevalent in appropriating the urban realm among the low-wage sections of the society. In neighbourhoods where family parks are prioritized, adequate spaces for relaxation should be nominated for poorly represented sections of the society. Figure 54 shows an example of such a space, a lawn which is used by migrant men for relaxation in Madinat Khalifa South neighbourhood. Where economic constraints hinder land acquisition, culturally sensitive tactical urbanism designs can be implemented for the same. This can be achieved by using the interstitial sites — that arise out of odd road layouts — as public plazas with proper enclosures. These temporal design initiatives are flexible to the changing population structure of the society and can be dismantled and assembled when needed.

Figure 54. Men relaxing in small groups on the lawn.

2) Rank order zones based on need-based priority before investing on urban beautification. Even though a considerable leap was seen in the expenditure for the protection and improvement of public parks and open areas, these improvements do not seem to be based on any locational or need-based priority. A clear priority is observed in street beautification and tree plantation to create choice destinations. For instance, street tree plantation along a 23 km stretch in Al Shamal road under the supervisory committee of beautification of roads can benefit only a smaller section of bikers and joggers rather than people with daily need. Such projects appear to be for the facelifting of the nation as Qatar is gearing up for FIFA 2022. Similarly, ambitious greening of cloverleaf expressway interchanges and the related sunken pits end up unused by people.
3) Provide walkable access to neighbourhood parks by suggesting critical changes to sidewalk vitality. Although multiple variables contribute to walkability, stronger and effective urban planning and design variables can nudge pedestrian behavior in the right direction. Raised pedestrian crossings, speed limits, critical installations of streetlights, tree buffers and benches offer opportunities for safe and comfortable walk. Speed limiting pavers and signalized pedestrian crossing must be installed close to parks along with shaded resting places to aid people from the hot climatic conditions.
4) Draft stricter policies to limit monofunctional zoning, easement land annexation and sidewalk obstructions. Single use over large parcels of land encourages vehicular traffic. Introducing diverse uses increases the street vitality and attractiveness. Policy interventions should include a stronger stance on replacing single land use zoning with smaller lanes and shorter blocks (less than 200 m). Clear demarcation of ‘through’ areas in sidewalk design, where

pedestrians are given unhindered access must be clearly stated and defaulters must be penalized. Car parking and other hindrances on sidewalks must also be dealt with clear policy recommendations.

5) Adopt human centric approach to street design. Rather than relying only on the strict guidelines of highway design manuals, designing user centric streets can soften the street edges and make them more ‘sticky’ and ‘convivial’. Following the regulations from the new urban design compendium (Ministry of Municipality and Environment, 2019) and reinforcing stricter measures on defaulters can improve the public realm walkability. The current practice of zoning and sub plotting that allows large residential units without any form variation must be reworked to include form based codes to ensure aesthetic interest in street façade. Huge residential boundary walls, which create passive street frontage, must be replaced with less imposing privacy and visually desirable privacy buffers such as trees or *mashrabiyas.* Design of doorways and *majilis* must also create interest in the street façade. In areas where there is considerable diversity to sustain walkability, shaded parklets and food trucks can be introduced to attract users.
6) Constitute a body for complaint redressal of both nationals and migrants where opinions and desires of people are reflected. Such a body must allow people from all nationalities to voice their requests and complaints.
7) Guidelines must include a careful consideration of sun path and solar radiation in the orientation of buildings to maximize effective shade on the streets. An interesting opportunity in providing access is found in creating and reinstating unused *sikka* in residential neighbourhoods and rebranding them as pathways to nearby parks.

5.5. Contribution to Knowledge

This research contributes to accessibility studies in multiple ways. Urban planners and private developers can optimize and allocate parks in need based areas by identifying the mismatch between supply and demand. Such a distribution method constitutes ‘compensatory method’ where resources are supplied based on actual need to resource disadvantaged communities. This research, thus, advances a ‘compensatory need’ based distribution by identifying park-need zones and proposing targeted park planning to improve and mitigate the undesired effects of a biased distribution system.

Second, using open source data, the research incorporates both novel and established methodology to study distributional justice of parks. Transparency of such data provide easy and cost effective access to planners for carrying out further studies with more need-based variables. The methodology can be used by planning institutions on a periodical basis to assess the change in demographic characteristics and to make necessary changes in green area provision pattern.

Third, the research introduces a rationale to divert the current budget on ‘cosmetic urban beautification’ projects to more need-based areas. Landscaping as well as other construction strategies in Doha show exhibitionistic tendency, extending from hiring international designers to the simplistic metaphorical abstraction of Islamic designs, failing to acknowledge the importance of landscape design in bringing people together (Andraos, 2016). Ambitious beautification plans such as roadside and median planting as well greening on the leftover pits and swatches of highway and flyovers find equal or more prominence to that of public parks (Ibrahim, 2021). Cloverleaf expressway interchanges and the related sunken pits take up acres of land which end up

beautified for no-use by humans ("Energy Street Intersection, Qatar," 2020). Similarly, unplanned vacant lands are screened off from vehicular view with plant fencing discounting the actual needs versus utility of street plantations.

5.6. Limitations and Future Research

This research has the following limitations: Firstly, population data used for equity mapping analysis are at 3 arc-second spatial resolution, coarser than the block level population density data. Hence, forecasting exceeds the present population data. Therefore, the results must be interpreted in the light of this limitation. Since the calculation involves percentage population and not the absolute population, the results presented are within acceptable limits of practical application.

Secondly, need based variables included in the study exclude other critical variables such as percentage of children below 15, elderly people above 60 years of age, average income level of communities and the presence or absence of ethnic minorities. Similarly, proposed parks are also not considered in the current study.

Thirdly, this research relies on the metric, distance within walkable access as an important indicator of park provision, which constitutes only one aspect of accessibility research. Walkability barriers such as cross walks, overpass and underpasses were not considered in buffer analysis. Other variables determining accessibility of urban parks such as actual and perceived quality of park, willingness of resident's travel preferences and current travel modes are not considered in the current study. The importance of thermal comfort in a predominantly hot region in park access is also not considered in the study.

Fourth, this research relies extensively on Census data obtained from

Government sources. Therefore, the validity of the results relies on the accuracy of the Census data.

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APPENDIX A: PEDESTRIAN ENVIRONMENT DATA SCAN (PEDS)

The following paragraphs detail out the assumptions and steps adopted in carrying out the PEDS audit from the original protocol manual, modified by the author to suit this research.

GENERAL DIRECTIONS:

Surveyor(s) will list the segments and carry the map to the survey site. They will return each day to upload completed results.

SUPPLIES:

- Manual map of area with segments detailed
- Master list of segments
- Google forms link including the survey questions in a mobile device

STEPS TO BE FOLLOWED AT EACH SEGMENT:

1. Decide the area to be surveyed. Identify the segment using master list. Enter the date, time and segment number for every new entry.
2. Survey the segment by initially observing or walking the segment once without inputting anything in survey link.
3. Walk again and fill the survey details (NOTE: While the original audit calls for walking, the author has also videotaped and photographed the streets after an initial inspection of the segment, in some cases.)
4. Once the survey details are filled, ensure that they are complete.
5. Add any additional notes in the ‘others’ question mentioned in the audit questionnaire.

QUESTION BREAKDOWN:

1. Segment Type
   a. *Low volume road – audit both sides*
   b. *High volume road – audit this side only*
2. Segment No _____
3. Day _____
4. Sidewalk continuity
   a. *No sidewalk along both sides (skip to Question 17)*
   b. *No sidewalk along one side*
   c. *Sidewalk missing in some sections*
   d. *Sidewalk missing in few sections*
   e. *Continuous*
5. Sidewalk condition
   a. *Very good*
   b. *Good*
   c. *Average*
   d. *Fair*
   e. *Poor*
6. Sidewalk elevation
   a. *Less than 15 cm*
   b. *15 cm*
   c. *More than 15 cm*
7. Sidewalk width
   a. *Less than or equal to 150 cm*
   b. *More than 150 cm*
8. Obstructions present
   a. *Vehicles parked on one side*
   b. *Vehicles parked on both sides*
   c. *Utility poles*
   d. *Tree trunks*
   e. *Garbage bins*
   f. *Hoardings*
   g. *Shop encroachment*
   h. *Step/ramp*
   i. *Obstructive curbs*
   j. *Fencing*
   k. *Unused objects*
   l. *car porch*
   m. *None*
   n. *Other*_____
9. On street parking
   a. *None*
   b. *On one side*
   c. *On both sides/ median*
   d. *Other*_____
10. Buffers present
    a. *Trees*

b. *Car porches*
c. *Shading device*
d. *None*
e. *Other*_____

11. Shade trees
    a. *None or Very Few: the path is not shaded by any trees (or only one tree) along the segment*
    b. *Some: the path is covered between 25 and 75% of the way.*
    c. *Many/Dense: more than 75% of the path is shaded by trees.*
12. Number of traffic lanes
    a. *1*
    b. *2*
    c. *4*
    d. *6*
    e. *8*
    f. *Other*_____
13. Traffic volume
    a. *Very low*
    b. *Low*
    c. *Moderate*
    d. *High*
    e. *Very high*
    f. *Other*_____
14. Land use
    a. *Majority recreational (Parks, open spaces)*
    b. *Majority residential*
    c. *Majority mixed-use (Grocery stores, cafes, restaurants, salons, tailor shops, other daily need shops)*
    d. *Majority institutional (Mosques, Government buildings, schools, nurseries, hospitals)*
    e. *Other*_____
15. Active frontage
    a. *Yes*
    b. *No*
16. Street lighting
    a. *Pedestrian oriented lighting on both sides*
    b. *Pedestrian oriented lighting on one side*
    c. *Road oriented lighting on both sides*
    d. *Road oriented lighting on one side*
    e. *No lighting*
17. Pedestrians observed during survey
    a. *Less than 5*
    b. *More than 5*
18. Crossing aids
    a. *Road markings*
    b. *Pedestrian signal*
    c. *Median/traffic island*
    d. *Curb cuts*
    e. *Speed bumps*
    f. *Other traffic calming measures*

19. Attractive for walking
    a. *Strongly Agree*
    b. *Agree*
    c. *Neutral*
    d. *Disagree*
    e. *Strongly Disagree*
20. Safe for walking
    a. *Strongly Agree*
    b. *Agree*
    c. *Neutral*
    d. *Disagree*
    e. *Strongly Disagree*

APPENDIX B: PUBLICATIONS

The following papers by the author related to Master's thesis were accepted, published and under review:

Journal Papers (published):

Marthya, K., Furlan, R., Ellath, L., Esmat, M., & Al-Matwi, R. (2021). Place-Making of Transit Towns in Qatar: The Case of Qatar National Museum-Souq Waqif Corridor. *Designs*, *5*(1), 18. MDPI AG. Retrieved from http://dx.doi.org/10.3390/designs5010018

Ferwati, M. S., Al-Hammadi, M., Marthya, K. L., El-Menshawy, S., & Althbah, H. A. (2021). Multi-Layered Documentation of Heritage Villages: The Case of Tinbak, Qatar. *Designs*, *5*(3), 38. MDPI AG. Retrieved from http://dx.doi.org/10.3390/designs5030038

Conference papers (presented by the author) :

Marthya, K.L., Major, M.D., Ellath, L.A., Al-Thani, S. (2020). "Single-Family Housing Market Trends in the Cradle of New Urbanism: Seaside, Florida USA," New Urban Research Session, Congress for New Urbanism 28 (CNU28.A Virtual Gathering), 10-13 June 2020

Accepted for publication:

Marthya, K.L., Major, M.D. (2022). "Real Estate Market Trends in the First New Urbanist Town: Seaside, Florida," *Journal of Urbanism: International Research on Placemaking and Urban Sustainability.* (Expected to be published in Feb 2022)

Marthya, K.L., Furlan, R., Ali, L., Esmat, M., Al-Matwi, R., (2021), 'An Urban Regeneration Placemaking Strategy for Qatar National Museum and Souq Waqif's

Transit Oriented Development in Doha', *Journal of Urban Regeneration and Renewal*. (Expected to be published in March 2022)

Journal papers under review:

Marthya, K.L., Indraganti, M. Spatial Logic of Parks in Qatar (Under review in Frontiers of Architectural Research)

Marthya, K.L., Garba, S.B. Urban Parks, Place Meaning and Identity: A Study of the Aspire Park in Doha (Under review in Urban Design and Planning (Proceedings of the ICE))