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URBAN FORM AND MOBILITY ANALYSIS IN SUSTAINABLE CITIES: THE CASE OF MARINA DISTRICT, LUSAIL CITY

BY

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ABSTRACT

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Title: Urban Form and Mobility Analysis in Sustainable Cities: The Case of Marina District, Lusail City

Supervisor of Thesis: Djamel Ouahrani.

Global urbanization has undergone massive developments in finding the right city standards through various concepts. Middle Eastern cities are no farther away in the era of urbanization as the region is experiencing a tremendous pace of development both in terms of planned urban growth and unplanned urban sprawl. The research explores the literature in transportation systems of cities, sustainable urban mobility and its interrelation with the sprawl and planned developments. The course of urbanization in Qatar is enormous and as a part of the national vision, the ambition is to develop a sustainable city. In consequence, a planned sustainable city of Lusail was built from inception on undeveloped lands to the north of Doha. The research study analyzes the built urban form of Marina District in Lusail City. In the context of the case study area in Marina District, the key categories and parameters adopted in developing the urban form to achieve sustainability standards were analyzed in accordance with the masterplan design and guidelines. However, the vital measure of mobility of Marina District and its impact on the urban environment of Doha is unjustified with the transportation system of the district's masterplan. The study observes that Marina District has sustainable building standards in terms of urban built form whereas the analyzed mobility pattern of the city with respect to Doha weakens the extent of overall sustainability of the district. The research, thus, tries to explore enhancing the transportation system to provide sustainable urban mobility towards

Greater Doha. The data collection is based on the city's planning and design guidelines that includes the masterplan from city developers (LREDC) followed by a mobility survey and site observation. The study, in turn, primarily enfolded the importance of urban form and transportation system, and its significant correlation in accordance to achieve better sustainable urban mobility.

Key words: Urbanization, Planned city, Marina district, Transportation system, Sustainable urban mobility

DEDICATION

This thesis is dedicated to my beloved parents for their endless support and encouragement.

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First and foremost, praises and thanks to God, the Almighty, for His showers of blessings throughout my research work to complete my thesis successfully.

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CHAPTER 1: INTRODUCTION

In the past decade, the urbanization of Middle Eastern cities has taken a tremendous pace over other regions around the world. The State of Qatar, a developing country in the Arabian Peninsula has also witnessed a major urban expansion in its capital city of Doha. In the end of the 20th century the country began its modern urbanization from the discovery of oil and its rapid production. The city has then undergone massive growth leading to large-scale urban sprawl. The pace of sprawl was supplemented by oilfield centered cities particularly in Dukhan in the west. The basic infrastructure development was followed by the formation of the airport, seaport, key urban centers and residential quarters built on the east coast of the capital towards the Arabian Gulf (Figure 1). During the first period, the vast immigration of expatriates, import and accumulation of goods especially cars played a major role in shaping the urban form of Doha. The city sprawled in all directions resulting in uneven land distribution accompanied by widened roads and remote housing developments (Wiedmann & Salama, 2013).

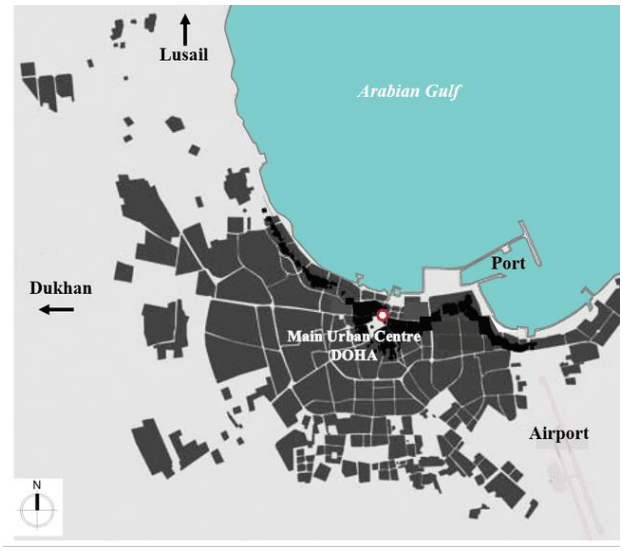

Figure 1. Doha's settlement pattern (Source: Wiedmann 2013, edited by Author)

The modern urbanization in Doha further expanded to large extent around the main urban center with Al-Corniche Road, the Market Area on the coastal part and having the business district development – West Bay, mixed-use development – The Pearl Qatar on the northern side. The new downtown – Msheireb, new airport - Hamad International Airport and new seaport - Hamad Port are the significant developments towards the south aided by predominant residential sprawl in the surrounding neighborhoods. This subsequent massive growth paved the way to develop new development strategies to diversify the economy of the country envisioned as the Qatar National Vision (QNV) 2030 launched in 2008. The City of Lusail was proposed as a flagship project to build a sustainable city to the northeast coast of Qatar (Figure 2).

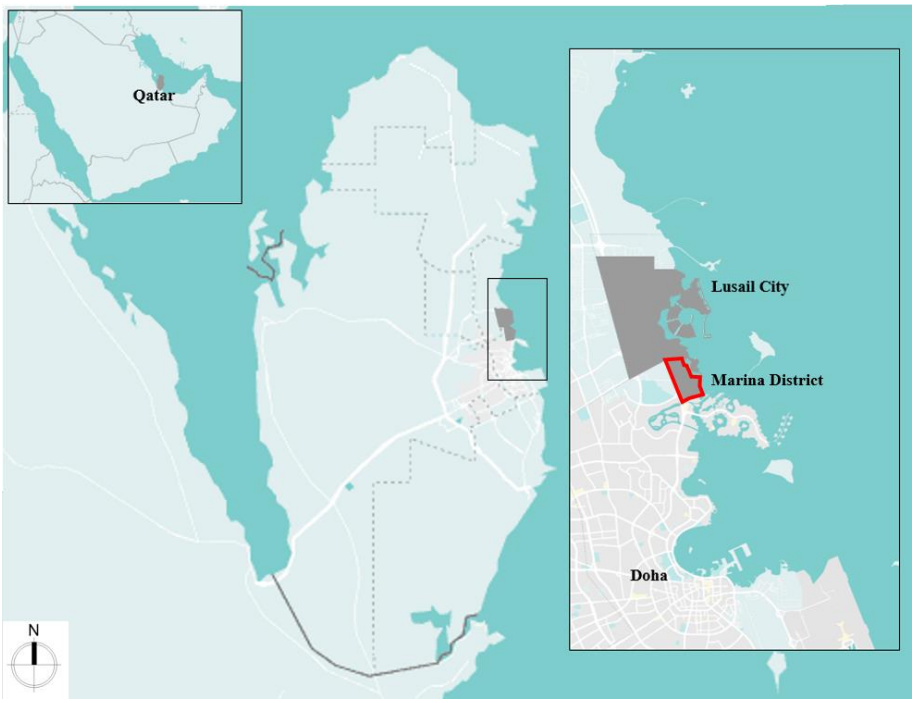

Figure 2. Location Map of Marina District in Lusail City from Doha (Source: Openstreetmap, edited by Author)

The city instigates development towards the north of Doha supported by major roadways built concurrently. The planned development of Lusail City is another coastal

expansions in Doha mainly by the process of land reclamation. The periphery of the city is marked by the coastal road to the west and the Arabian Gulf to the east coast. Lusail is also considered Qatar's major smart and sustainable city project in line with the country's long term vision for sustainable development (QNV 2030). The vision aims to provide a framework in which national strategies and implementation plans can be developed. Based on the vision, the ministry also endorsed the Qatar National Development Framework (QNDF) 2032 launched in 2014 to follow and achieve the new strategic planning objectives.

The geographical location of the development however does not coincides with the urban form where most of the parts in Doha are surrounded by wide urban areas. The sprawl across Doha has also caused to form isolated vacant areas to form uncoordinated development (Al-Thani et al., 2019). The majority of the expansion has taken place outwards to the west and the population predominantly lives in Doha. The lack of accessible infrastructure for public transportation is one of the major causes to lead most of the population to rely on private cars. In the case of Doha, the working population comprising mostly of ex-pats and the rest being the local population are often required to have long commutation on daily basis due to the aftereffect of sprawl development. The research carries out its study in the Marina District of Lusail City, being the majorly occupied district at present has attracted a vast accumulation of private vehicles in the recent times since it has become operational. The uneven distribution of land use and the irregularity in the settlement pattern from unplanned urban sprawl to planned developments have resulted in high dependency on private transportation.

The chapter is categorized to further six sections. The first section introduces the background of the research study focusing on the evolution of Doha's urban

development, formulation of the country's visions and the creation of Lusail City and particularly the Marina District, being the context of the study. The study cannot be analyzed for Lusail City in general since majority of its districts are under construction. The section also emphasizes the problem definition of the research. The aim and objectives of the thesis are developed in the second section followed by the research questions in the third section. The fourth section involves the significance of research in terms of the importance of the topic. Limitations of the research are also taken into consideration briefly described in the fifth section. The chapter concludes with the disciplinary context on the main topics of the research study.

Background

The urban developments of Doha caused extensive transformations to form various urban centers on the inner city scale. During the period, the gradual increase of population contributed to the emergence of these urban centers. On the other hand, the old residential settlements before the modernization period were the ones substituted by these large urban centers such as West Bay, the Downtown capital center and Old Airport capital center in particular (Figure 3). With the discovery of hydrocarbon and its exploitation, a rapid increase in the population was observed and consequent acceleration of growth resulted in an urban sprawl (Al-Thani et al., 2019). Many of the pre-modernized separate settlements were subsequently merged to widen the city borders. These centers with substantial urban developments are reflected under Greater Doha (MMUP, 2014).

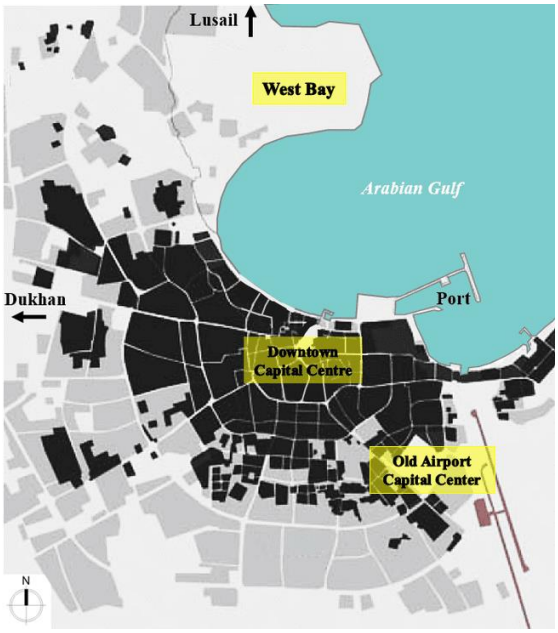

Figure 3. Urban centers of Greater Doha (Source: Wiedmann 2013, edited by Author)

Figure 4. Downtown Capital Center, the 1950s (Source: Msheireb Properties)

The first extensive Greater Doha masterplan addressed the low densified urban pattern of the country and huge dependence on private vehicles. The masterplan also noted that by reduced fuel prices, the transportation component in the plan can be executed yielding immediate solution to the demand (Wiedmann & Salama, 2013). Unplanned sprawl through the years resulted with majority of the population spending

significant time commuting between Doha and the rest of the town centers on a daily basis. As a result, increased traffic jams were observed regularly along with the related increase in air pollution. Furthermore, the urban structure complicates to determine the peripheries of the traditional settlements around Doha in which the residual identity were hard to be distinguishable (MMUP, 2014).

In Doha, the development process were uncoordinated in the first period of its modern urbanization. The increase in purchasing power of the country's population on lands started the transformation from traditional to modern urban area along with investments on modernizing the infrastructure. After the establishment of town planning section in the municipality in 1974, the masterplan was drafted with western stakeholders to form a ring-road system in addition to suburban sprawl in the outskirts of Doha. The land policies introduced newly in the city center facilitated to establish commercial developments, utilities and residential flats. As a result, the traditional neighborhoods were replaced with modern development and most of the residents were moved to the suburbs of Doha (Wiedmann & Salama, 2013). During the period of urbanization, increasing land speculation were observed in the city center and its surroundings. The responsibilities for different ministries in the government overlapped with the development plans causing coordination issues. The development was also unfavorable by the socio-economic aspect of private landlords. The acquisition of land by the municipality in the city center is more complicated as they require a series of undertakings with the local owners. The sensible nature of the indigenous population was a stumbling block for the government in land acquisition. The complexity in these issues lead the municipality to initiate an expansion swift involving land reclamation on the shores of Doha. The initial masterplan of the city proposed with land reclamation in the north mainly including the Corniche development. The urbanization pattern

witnessed the removal of traditional settlements in the shore with modern buildings and roads (Wiedmann & Salama, 2013).

In the transitional period, the replacement of old traditional settlements into the modern developments were rather a swift process with minimal coordination. The extension of the city propelled by land reclamation which was favored by the first masterplan, as mentioned earlier. The development process were managed by the established public administration where the country witnessed significant rise in population in the metropolitan area. Concurrently, Doha's urban area increased due to the imposed land policies and real-estate speculation. The sprawl development led to a scattered urban landscape with low densities which was caused by modern building typologies in the suburbs and a vast portion of vacant land in the city center due to speculation. As a result, the foreign workers were inhabited in the city center and the most of the local population and high-income expats moved their residence to the suburbs. During this time, the city center deteriorated due to the foreign inhabitants and lack of investments in renovation. Subsequently, the suburbs around Doha were developed with modern dwellings which imposed accumulation of vehicles to be the main means of transport. Gradually, the city transformed to a car-based city with high-density urban centers and large spaces for roads and parking sites usually acting as the ends of development (Wiedmann & Salama, 2013).

The major impact of local population on urban development in the city center was due to the involvement of investments in real estate. In turn, this led to create a major increase in vacant lands within the urban center. Since the introduction of planning section in the municipality, the lack of public participation in the decision making and planning process is a factor that circumcised in acquiring lands in the city center. Due to the sensibility factor of the indigenous population, the resistance was

tackled by the government by providing immense improvement in the living standards and public welfare mechanisms. The sprawl of the suburbia took pace in the Doha's surroundings where the consumption rise heavily in line with the huge growth causing a disorganized pattern of development (Al-Khulaifi, 2003; Wiedmann & Salama, 2013).

The expansion swift of Doha's capital centers compelled the municipality to initiate development strategies to serve the expected growth. The strategy framework was formulated based on the Qatar National Vision 2030 (QNV 2030). The framework was driven by the Qatar National Master Plan (QNMP) approved by the Ministry of Municipality and Environment (MME) in 2014. The vision acts as the primary roadmap for future development, and it defines the long-term outcomes and goals of the country. The vision aspires to modernize the country undergoing planned urban developments and deliver a better living standards for the present and future population. In QNV 2030, the significance of creating a sustainable and environmentally responsible country is evident and the development process is envisioned by the defined pillars: Human Development, Social Development, Economic Development, and Environmental Development. The important pillar in the vision is dealt with the environment as the country deals with environmental issues such as the impact of significantly reducing water and hydrocarbon resources, as well as the effects of pollution and environmental degradation. The country also addresses the global environmental issues such as the potential effect of global warming. The vision focus to understand the level of uncertainty and dealing with projected changes as they develop would necessitate mobilizing resources and integrating initiatives to solve issues. The vision has developed numerous initiatives and projects to reduce air pollution, CO_2 emissions, and focus to rely particularly on

renewable energy strategies. The vision also promotes environmental stewardship in order to develop a more sustainable future (QNMP, 2014).

Figure 5. Pillars of Qatar National Vision (Source: QSR 2021)

The country's urban planning strategies and policies context are organized broadly by the Qatar National Development Framework (QNDF) that has been envisioned for 2032. The framework consist of a set of guiding principles and objectives based on the defined pillars of QNV 2030. The QNDF also created structure plans to be developed for each municipality depending on the urban characteristics of the place (QNMP, 2014).

The QNDF vision as it states is to:

"Create a role model for Sustainable Urban Living and Livable Towns and Cities in the 21st Century"

The following guiding principles were devised by the QNDF:

- Quality of Life for All – To improve the living standards, work environment, playing space and learning atmosphere for all people offered with the help of choice, affordability and access.

- Economic Growth and Diversification – To promote competitiveness, encourage to diversify business investments and focus on sustainable innovations.
- Connectivity of People and Places – To provide mobility, accessibility and connectivity in order to improve social, cultural and economic interaction of people, institutions and businesses.
- Ownership in Planning and Implementation – To promote coordination and commitment among stakeholders in the QNDF's planning and implementation.
- Environmental Values – To support the preservation and rehabilitation of the natural and built environments.
- Identity – To acknowledge and respect the national identities.

The above mentioned guiding principles stimulated the urban development resulting in the direction of the vision for the country's future urban developments. Consequently, the QNDF has developed Municipality Spatial Development Plans (MSDPs) as mentioned earlier based on the guiding principles (QNMP, 2014).

Figure 6. Timeline Diagram of Development Plans and Implementation (Source: QNMP, 2014)

MSDP seek to achieve the organized planning of land and infrastructural developments across the Doha municipality (Figure 7). The MSDP sets out a coordinated development approach for the municipality over the next 20 years (QNMP, 2014). The Plan is based on the follows depicted in the table:

Table 1. Coordinated Development Approach Plan (Source: QNMP 2014)

Development Approach	Spatial Plans
Strategy Context	The Vision and Development Strategy for the Municipality.
Zone and Land Use Regulations	Land uses and development standards applying in each zone
Zone Maps	Showing the future land uses across the Municipality

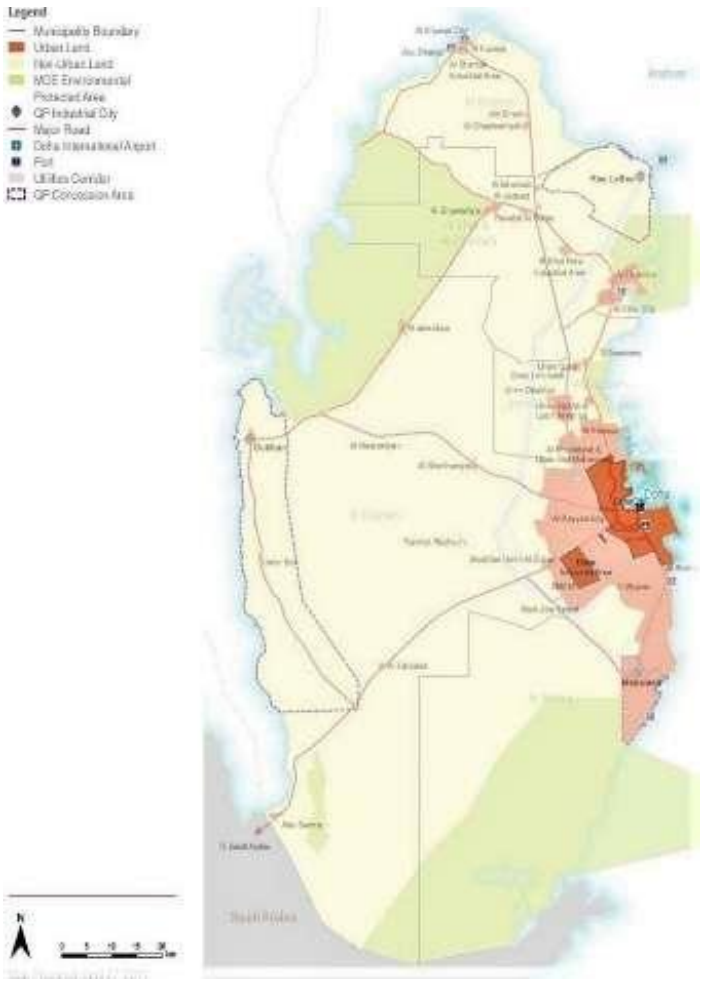

Figure 7. Doha Municipality Context (Source: QNMP)

In addition to provide more detailed planning on specific areas, the MSDP focused on preparing dedicated area plans which improved the overall planning on the respective municipalities (QNMP, 2014).

Figure 8. Doha Municipality Development Strategy (Source: QNMP 2014)

The Doha Municipality Structure Plan produced from the QNDF details the strategy of development for the municipality (Figure 7). The structure plan of Doha Municipality focus on the main commercial, cultural, and administrative hub of the country. The Doha capital and its three major town centres at West Bay, Downtown Doha and Airport City will be the hub for international and national businesses. These centers incorporate improvements to urban architecture and the public realm. The

development of these centers also focus on innovative energy-efficient buildings, public transport systems, use of the underground for metro services and parking facilities for managing the traffic demands. The developments that are incorporated in the plan ensures to improve the living and working standards in the capital. The town center developments and residential areas in the suburbs of Doha is addressed by the subsequent municipal structure plans developed by the QNDF (QNMP, 2014).

The QNDF reiterates the purpose of the national development strategy to achieve the goals emboldened in QNV 2030. Against this background; however, in accordance with the QNV 2030, Lusail City - a futuristic sustainable city project was developed to accommodate part of the projected growth of Qatar's population and economy (QSR, 2021). The driving force behind the city development is the Qatari Diar, a Real Estate Investment Company established in 2005 by the Qatar Investment Authority, the sovereign wealth fund of the State of Qatar. Lusail City is managed and procured via the Master Developer's property development and management company - Lusail Real Estate Development Company (LREDC). It was entrusted with a landmark remit to coordinate the country's real estate developments, in line with national interests and economic priorities. The Planning and Design Guidelines developed by LREDC in 2016 are primarily used where the masterplan strategy maps of the case study district are further explained particularly in the findings and analysis chapter in detail.

The vision for Lusail is for a complete 21st Century Capital City Quarter with well-planned neighborhoods to the north side of Doha's city center. A holistic master plan has been created featuring low to medium density development comprising different communities designed and planned to complement Doha's existing facilities and features. The Lusail Development covers 19 separate Districts with over 4,000

development parcels. A part of the project has been operating under the management of LREDC.

Figure 9. Lusail City (Source: LREDC 2016)

It confirms the status of the development within the national and municipal planning frameworks and shows how the guidance fits into the planning and construction process. The overall masterplan for the Lusail development, including the Vision for the area's development, the character of its parts, including retail and employment, centers, residential suburbs, the transport and green space networks that link its different districts and overall guidelines applicable to all development within Lusail Masterplan. Key design strategies provide two layers of design guidance (Table 2).

Table 2. Key Design Strategies of Lusail City (Source: LREDC 2016)

Key Design Strategy	Design Guidance
District-Wide	These guidelines set out a series of District-wide urban design frameworks explaining the design context for individual or multiple plot development
Parcel & Plot	These guidelines explain the design parameters and approach to be used by sub-developers at parcel and plot level

The District-wide guidelines explain the key development and planning principles for each neighborhood within a district, together with any district distinguishing features and treatments to be applied. The Parcel and Plot guidelines explain the typical and mandatory plot controls along with the guidance on the design intent such as the expected form, building heights arrangement and street relation for a development (LREDC, 2016).

The guiding principles relate to the communities the master plan will ultimately serve, as well as the networks underlying the master plan for site-wide access and utility provision. These are scaled to fit with the density of urban form of Lusail. The principles are reviewed in summary below as per LREDC (2016):

- Identifiable, self-contained clusters - ensuring each neighborhood and cluster has its sense of place and special character, by virtue of its landscape and architectural form. Planned to operate in isolation, while contributing to the wider master plan.
- Complete communities - providing the necessary facilities for each neighborhood including public transport facilities, local shops, estate management, schools, clinics, parks and recreation facilities and places of worship.
- Fixed densities - the capacity of the masterplan's infrastructure is finite and has been scaled to accommodate the profile of uses and densities proposed. For this reason, the density limits of the Plot Building Regulation sheets must be strictly observed so that the completed development can operate within its means.
- Green communities - extensive use of soft landscape is made possible through the creative reuse of available recycled water. This relies upon the participation

of developers and occupiers to plant and maintain low demand (xeriscape) species and adopt a conservative approach to water use.

- Hierarchical infrastructure - roads and access infrastructure have been designed as an efficient and legible series of connected routes designed to service the needs of residents, businesses and visitors.
- Landmark waterfront - world-class attractions and vibrant outdoor spaces connecting the marinas, promenades, beaches and waterfront residential areas as a cohesive edge to the development.
- Gateway identity - key vehicular entrances to Lusail and its districts are marked with high quality built form and landscape to promote the project.
- Cohesive urban design - a simple system of codes are applied to the built form and landscape of the development to ensure each parcel meets the master plan's intent.
- Climatically responsive - planned and designed to achieve sustainable construction, ensuring resource and energy consumption is minimized while maximizing quality of life. The design follows Global Sustainability Assessment System (GSAS) codes responsible for rating the sustainability of buildings (LREDC, 2016).

With an overriding sustainability-driven development strategy, Lusail is a key part of delivering Qatar's forward-thinking, Global vision for a sustainable approach. However, the city faces challenges to accommodate its rate of travel behavior. The Marina District – the main downtown of the city has numerous office and residential buildings functional where most of the travel activities are generated at present. Apart from the daily commutation, numerous travel activities occur around the leisure facilities in the district. In recent times, the accumulation of private transport has been

increased in the district from Doha where most of the trips are generated. Concurrently, congestions have been regular during weekends. The weak public transportation has jeopardized and forced to opt for private transport, in turn, dominating the district which is further discussed in the next sections of the thesis. Thus, the need for transport planning and its incorporation is perceptible to the overall sustainability measures developed for the city and to the national development strategy of Doha.

Aim and Perspective of the Research

The concept of a sustainable city is the present focus in the urban planning literature. The concept is utilized to be implemented in the case study of Marina District. The district is planned and engineered to achieve environmental stability. Urban mobility is explained by the choice of mode of transport to use in day to day life depending upon the transportation system of the district. Urban mobility is a primary focus on improving travel activity to achieve the least impact on the environment. In this regard, the research tries to focus on two inter-related areas of the topic. Therefore, the study focus on the correlation of urban form and urban mobility of Marina District. Since the development attracts the urban mobility of the population, the thesis seeks to understand the travel behaviors and the associated impacts on and from the district. The research also explores the strategies and policy measures available for achieving greater sustainable urban mobility in the wider literature and the process for delivering sustainable urban mobility.

The aim of the research in the context analyzes the Marina District of Lusail City built from inception on undeveloped lands to the north of Doha and the measure of urban mobility of the district and its impact on the urban environment of Doha.

Research Question

The purpose of Lusail and the factors that resulted in developing a planned city

under high sustainable standards instigated the study to analyze the dynamics on the inhabited Marina District in the city. The core of the research tries to focus the study based on three research questions. In the case of Marina District, the main research questions lie on:

1. What was the reason for development of the Marina District in the outskirts of Doha?
2. How sustainable is the district on the urban environment of Doha?
3. How transportation planning for the district is interdependent with Doha's urban mobility in terms of sustainability?
4. How effectively can the sustainability concept be applied in transport context of the district?

The driving factor of the research questions is the result of preliminary groundwork from the analysis of the background study to find gaps in urban development and transport planning. The objective of the thesis based on the aim and research questions is:

1. To assess the need to develop a sustainable district in the characteristics of the urban form of Doha.
2. To analyze the sustainability of the district as per the vision of Lusail and its guiding principles.
3. To determine the sustainability of the district based on the components of urban mobility strategy.
4. To explore the scope of feasible transportation for effectively developing sustainable urban mobility.

Significance of the Research

Transport and mobility are proven to be significant factors for sustainable urban

development (NIUA, 2015). The rate of urbanization followed by the dominance of motorization in the Gulf region has drastically transformed the travel pattern of people in cities, in turn deteriorating the sustainability of the city. The use of the private car and the support in favor for traveling individually have changed the dynamic of mobility choice in cities. Over the recent decades, the dominance of private transport has ignored the very significant adverse impacts on society.

The sustainable city and its planning have addressed the issues of assuring the development to be sustainable for the country in terms of urban mobility and not rather being sustainable based on the targets of the vision. This study signifies the importance of developing sustainable urban mobility. The study also emphasizes the need for improvement in transport planning to prioritize the elements of sustainable urban mobility. The study also encourages analyzing the feasibility of sustainable cities to the greater extent of the country.

Limitations of the Research

The thesis focus on a particular district in the case study city of Lusail. The district is the only operational one and uses as a sample to analyze the nature of the whole city in the context of Doha. The thesis had the challenge for data collection process due to the corona virus pandemic in the country and strict health protocols to shelter in place. The research also limits on the extent of data received during allowed period of public interaction in the city. Further limitations are discussed in Chapter 5.

CHAPTER 2: LITERATURE REVIEW

Human communities have gone under colossal changes in their day to day life. As a result, cities have also developed and transformed as the principal settlements in keeping with the growth of various areas of human life. The growth has occurred either due to an increase in the urban population that led to the urban expansion or because of the requirements of the people of the 20th century, such as the urge to live in nature or to prevent multitudes of metropolitan centers. Since population growth or the interest of the populace in living in nature is not in itself negative, urban development and growth cannot be considered unwanted. What can be a negative factor in the city expansion, however, is related to the growth process. Urban growth is an inevitable phenomenon caused by reasons such as fast population growth, development of knowledge, technology and information systems moment by moment, changes in urban economical structures, etc. Urban expansion is negative if unplanned, unmanaged and inconsistent in the creation of spreading, single-use regions that surpass cities' capacity and demands. The term "sprawl' refers to the bad side of horizontal urban growth by urban planners.

Since the 1950s, the American pattern of residential growth has been spread with the creation of interstate transportation systems. Despite concerns such as the energy crisis and recession, this pattern of development has increased in the past fifty years. Sprawl increases development costs and diminishes environmental variables necessary for sustainable economic growth in the suburbs. It also leads to increased agricultural land, energy and natural resources use. One of the worries in this circumstance is that it has repercussions for the long-term interests of cities and human settlements (Chen, 2008). Although urban zones account for only 14% of the earth's surface, the loss of urban size cannot be understated, as the spread of cities has higher

environmental effects than other kinds of land use, such as floods, landslides, soil fertility alteration, etc (Batisani & Yarnal, 2009).

In the contemporary period, the main pattern of urban growth has been dispersed and rather separated from the historic hubs. This has resulted in cities expanding horizontally with enormous environmental and economic ramifications for urban and human communities. The consequences include scattered urban development, destruction of land and garden areas, evacuation and destruction of central historical contexts, obstacles to the provision of services due to the spread of urban development, environmental problems and pollution caused by the excessive use of vehicles, as well as increased urban boundaries and the destruction of old centers, etc. (Shakibamanesh et al., 2019). However, the literature focuses on the pattern of urban development over the years and influence of transportation in the scale of growth. The literature chapter examines urban development topics, particularly in the first portion, which focus on unplanned urban sprawl and planned urban growth. In the second segment, the transportation system in cities is explored to understand the growth of urban motorization and the notion of transport planning in cities. The third portion examines urban development literature in the Middle East region and the last section provides details on the context of the city of Lusail.

Urban Developments in Global Scale

During human civilization, the growth of the cities was defined by having certain limits to its boundaries. However, as centuries past, cities in many regions of the world faced problems of excessive growth, leading to one of its notable one, namely the urban expansion. In general, the urban expansion of the center of the city is known by many as unplanted and unmanaged to its periphery, which has caused pressure on development near the borders of the city. We have the largest urban expansion in

history, with enormous projected urban increase and a resulting and unprecedented demand for higher mobility levels. The world population is projected to reach 8.5 billion by 2030, 9.7 billion by 2050 and 11.2 billion by 2100 (Figure 10) (UNDSEA, 2015). In the next few decades more urban areas will be built than all the previous ones; most emerging cities in Asia, South America and Africa, for example, are in the global South (Hickman et al., 2017).

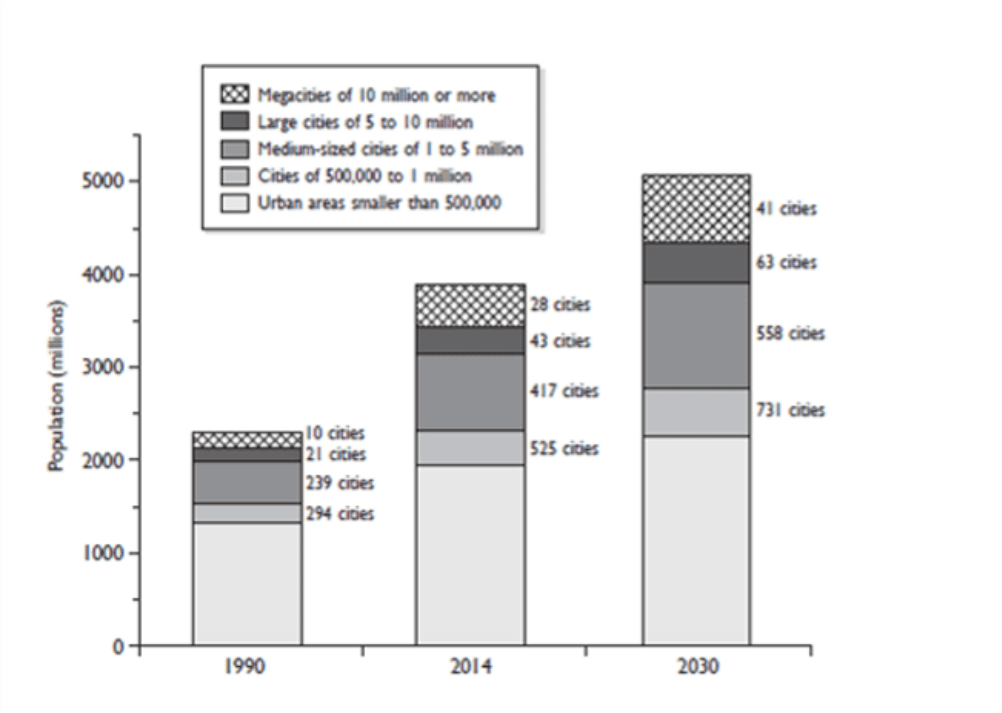

Figure 10. Projected Urban Growth (Source: UNDSEA 2015)

This section studies the various concepts involved in the process of urbanization like patterns of urbanization, components and consequences of urbanization. Urban development has been the subject of discussion among the academicians and researchers ever since the evolution of cities.

Unplanned Urban Sprawl

The rise in the uncontrolled development of cities has led to an exploitation of

natural resources and a significant increase in the adverse effects of urbanization. Urban Sprawl is the cause of increased urbanization and population in the city. Generally, urban sprawl is known by many as unplanned and uncontrolled growth of the inner city towards its periphery causing pressure on the development near the boundary. William H. Whyte (1958) first used the term urban sprawl in a paper entitled "The Exploding Metropole" in the Fortune magazine. White's explicit sense is that urban physical growth is caused by factors such as building towns, the development of transport networks and, ultimately, urban management (Whyte, 1993). Ever since, the planners have referred to this term as a type of urban development which has adverse social, environmental and economic consequences. The spatial expansion of the urban areas to undeveloped areas, often leading to issues like suburban development, is similar with horizontal urban growth (Shakibamanesh et al., 2019). However, the urban sprawl has an inherently negative significance that it is a relative new model in human settlements accompanied by a random collection of residential units (low density) and business developments in strip shaped form. This is the result of the widespread use of automobiles in urban life (Ewing et al., 2016).

Figure 11. Urban Sprawl in Texas, United States (Source: Harry 2018)

Today, urban sprawl is examined and evaluated in various countries with the proliferation of the horizontal expansion of towns. Since countries have their own different characteristics and contexts, urban sprawl will yield different results (Galster et al., 2001; Gillham, 2001). In the United States, urban sprawl has become an important subject of urban planning interest in recent decades (Anacker, 2015; Ewing et al., 2016). The rate of accession of land to urban areas in the United States was higher than the rate of growth of the urban population; the growth in land use was not the sole result of population growth (Ewing et al., 2016). Moving forward to other parts of the world, the urban sprawl literature is utilized to research in-depth study on the topic. Over several decades, theories have emerged around urban sprawl brought by geographers, planners, economists, and transportation engineers. As Baum (2004) states, "suburban pulls" and "urban pushes" are the end-products of sprawl. The pull factor is supported by the dream of living in a less dense countryside rather than in an unhealthy environment that of urban centers (Baum, 2004). A variety of other elements such as market dynamics, demographic factors, housing supply and demand, are likely to influence pull and push factors. The preference of a person, however, is completely subjective and rooted in personal advantages, say in the short term or in long term. Bengston et al. (2004) believe that urban expansion benefits individually new inhabitants, investors and stakeholders. The spread, however, is seen as an important and increasing concern that imposes a broad range of social and environmental costs – in particular in the context of rising energy prices. Awareness on the costs of sprawl has, according to Robinson et al. (2005), pushed policymakers around the world to produce different rules and incentives to reduce this phenomenon.

According to Wang (2004), he acknowledge that there are significant factors contributing to urban sprawl. These considerations are discussed in detail to determine

the cause and they are:

- Population Growth: In response to the increased need for development that occurs when the urban population exceeds a certain threshold, an exterior expansion will unavoidably occur. In the last half-century, the metropolitan population has increased from 85 million to 213 million, representing a 150 percent rise in the population and a 70 percent increase in the suburbs (Stephens & Wikstrom, 2000).
- Land Abundance: The abundance and availability of land in the United States is the primary cause for the rapid development of residential and non-residential regions at frequent intervals throughout the country. Changes in urban areas are unavoidable nowadays as a result of changing needs, resulting in direct excess expenses for the purchase of buildings, as well as for destruction, preparation, and reconstruction of existing structures. Construction restrictions in existing urban contexts can impose significant barriers to construction, both for the general public and for commercial enterprises. As a result, if there is sufficient unoccupied land in the suburbs surrounding cities, it will be promptly seized in order to be developed in order to meet these new requirements (USDA, 2001).
- Employment: Certainly, the costs of land acquisition and development outside urban areas are less expensive than those incurred within them in the vast majority of circumstances. Modern high-speed networks, on the other hand, help to lower transportation costs, which is driving more manufacturers and industries to the suburbs, where they have easier access to highways and other transportation infrastructure. There is also a well-trained and skilled workforce that lives in the suburbs for a variety of reasons, including the benefit of a desired environment with privacy and pleasantness. Because of these

circumstances, the dispersal of employment opportunities is the cause rather than the result of residential suburbanization. People are more likely to migrate to suburban areas if work prospects are expanding (Carruthers & Ulfarsson, 2002).

- Housing: The "American Dream" is characterized by separate and safe homes, suburban areas with grasslands in the background, one or two automobiles for commuting, decent and close public schools, and other characteristics of urban living. The accumulation of wealth among urban dwellers allows them to purchase larger homes in urban locations at reduced prices as their wealth grows over time; the American Dream no longer implies a life of isolation in the countryside, thanks to technological improvements (RERC, 1974).

Figure 12. Continuous growth of suburbs in Poland (Source: Zalewski 2015)

- City Centers: People used to enjoy living in city centers when they were young. However, as the population and economy have grown, city centers have begun

to deteriorate as a result of issues such as traffic congestion, environmental degradation, stagnant housing, poor quality public schools, increased crime, a lack of access to open spaces, and the destruction of infrastructure in these areas. Middle and upper-class people are increasingly leaving urban areas in quest of a better life. Increased emigration from urban areas occurs as the number of jobs in suburban areas increases. Due to financial constraints, when middle-class individuals flee urban cores, the quality of life in such cores deteriorates, and the appearance of these urban districts becomes unsightly. Apart from that, due to the increase in population living outside of cities, taxes collected in cities and towns are being used to improve the services and infrastructure in the suburbs. As a result of a lack of financial revenues, the business districts of cities deteriorate and eventually close (Shakibamanesh et al., 2019).

Figure 13. Linear development in urban sprawl in Milton, Ontario (Source: Simon 2009)

- Transportation: A major cause of sprawl is the lack of available mobility. While growth occurs on a regular basis in most cities, there is a greater emphasis on making them technologically compatible, improving road quality, and providing better public transportation. Because of its inherent limitations in terms of speed and distance travelled, walking and chariots were the primary modes of transportation more than 2000 years ago, resulting in the construction of densely inhabited towns. When the limits around them were in place, the Roman roads had a maximum length of five kilometers and might reach eight kilometers. Later, as trams and railroads were introduced into towns, the population grew and travel times increased. Therefore, private automobiles exacerbated sprawl while also speeding up the development of road infrastructure. Human living style was modified as a result of a move from walking to using urban trams, then private and public transportation. Additionally, personal automobiles made travel easier, more pleasant, and more cost- effective. Furthermore, following the contemporary period, zoning restrictions discriminated between different forms of land use, such as workplace, shopping center, and lodging, and people were compelled to rely on their own automobiles to commute to these various locations (Black, 1991).
- Public Policies: When it comes to spatial deployment preferences, urban sprawl pattern is not simply a personal or corporate concern. People's decisions in this regard are heavily influenced by a variety of government policies, including tax policies, depreciation money, zoning laws and implicit donations, grants for suburban growth, and disincentives to repairing efforts in inner-city and suburban neighborhoods (OTA, 1995).

Figure 14. Sprawl development in San Francisco suburbs (Source: Holden 2011)

Certainly, these factors contribute excessively to sprawl development in one way or the other. As it turns out to be, the main issue of sprawl is the major uplift in the transportation infrastructure. We can say that many of the negative consequences of sprawling urban development are related to the issue of transportation, because it is associated with an increase in the distance travelled, as well as the time and number of journeys. The amount of privatization in the mobility has proven the worst cause to catalyze the rapidity of the sprawl development. Various environmental, social, transportation, economic, and public health issues are associated with urban sprawl. These issues include an increase in the amount of undeveloped land, an increase in the proportion of open space, a decrease in population density, the disruption of urban segments, and social isolation. Hence, these pattern of development in cities has taken definite consequences.

Urban sprawl has the potential to have negative consequences for both the cities and their suburbs (Shakibamanesh et al., 2019). The urban sprawl paradigm has an impact on the city's residents as well. Poor people are denied the opportunity to live in

the suburbs because, in some cases, rental rates for residential units in the suburbs are higher than those in the city, and car ownership is becoming increasingly important for survival in the suburbs (and can only stay in the city centers). It follows that median household income (and, consequently, tax revenues) are reduced in the municipality. Schools and municipal services suffer losses, and buildings in the city are left vacant and in disrepair as a result of the crisis. The relocation of jobs to the suburbs also removes opportunity from city centers, and low-income people cannot afford to travel to these new locations because they do not have access to a vehicle. Suburbs suffer a variety of negative consequences as a result of rapid urban development and horizontal growth. Examples of these effects include the growth of residential units, the development of linear shopping centers, the disappearance of office parks, and the construction of skyscrapers and apartment buildings. After being subjected to urban development, green suburban areas are transformed into grey ones. In contrast to residents of city centers, residents of these areas do not have easy access to public facilities (such as schools, shops, and other services), and instead must rely on private automobiles. In such a scenario, traffic congestion in the suburbs will be worse than in the city. Furthermore, the time required to travel to and from work, transport children to and from school, and perform a variety of other tasks will deprive suburban residents of leisure time. In the end, this sprawl and reliance on automobiles prevents daily interactions between neighbors and the sense of community that existed previously between residents of adjacent neighborhoods (Lewyn, 2000; Shakibamanesh et al., 2019).

In this section, one of the most important part was regarding the nature of urban sprawl, and the discussion began with a brief history of how the word "urban sprawl" came to be used in the field of urban planning literature. It has already been mentioned

that the physical (horizontal) expansion of a metropolis into underdeveloped suburbs is known as urban sprawl in the early phases of its construction. The concept of urban sprawl is a byproduct of the technical and industrial revolutions, and it was formerly impossible due to transportation constraints (pedestrians and chariots). Further research, however, revealed that the development of technology and the invention of motor vehicles alone could not cause urban sprawl, but that the increase in population, congestion in urban centers, and personal preferences all contributed to a decrease in the attractiveness of urban centers and an increase in the desirability of living in suburbs and open fields. After that, the researchers discussed the causes of sprawl in order to establish which variables contributed to the issue the lead to the formation of urban sprawl in the first place. According to the findings of the investigations, the growth of the metropolitan population, the abundance of land, the decentralization of employment in urban centers, the ideal housing image, the development of transportation, and public policies are among the primary causes of the prevalence of urban sprawl.

Some, on the other hand, feel that urban sprawl can provide some benefits to individuals that should not be dismissed out of hand (Bhatta, 2010). Consumers' need for more socially and economically separated areas with lower housing densities and, perhaps, lower housing costs are met by sprawl, which has personal benefits such as reduced housing costs and lower housing densities (Wassmer & Bass, 2004). According to Glaeser and Kahn (2004), a positive element of sprawl is that it allows for the construction of more affordable and larger homes. Burchell (2000) asserts that land located further from the center of a metropolitan area is less expensive, and as a result, less expensive housing can be found. However, these advantages of sprawl developments are a short term gain and heavily depend upon the economy, population growth and demography (Burchell, 2000). In spite of this, planners and engineers have

developed various concepts to regulate the urban growth and downgrade the amount of sprawl which is discussed in the next section of this chapter.

Planned Urban Development

A planned urban development is most often the result of a collaboration between a local or municipal government, developers and other stakeholders. In past few years, urban planners have been more interested in reinstating the mixed-use configuration in communities. Housing, trade and domestic industries were all integrated into these old communities. Water supply and defensible space was commonly employed as the main focus for activities in a community. In the last decade, industrialization and modernization resulted in a transition away from multi-purpose zoning in urban cities to more towards single-purpose zoning in suburbs. As a response to this trend, planned urban development was developed, which emphasizes the communities on the efficiency and addresses on the needs rather than an organic suburban sprawl. Planned development also contributes urban planners and developers to explore possibilities and diversify the use of limited urban space for commercial and residential purposes taking into consideration of the user needs (Chen, 2008).

An urban development trend that originated in North America was the concept of New Urbanism to counter the increasing car culture society (Varma, 2017). When New Urbanism was initially developed as an urban conceptual design, the primary basis of the design was derived from the principles of town development and mixed-use development. The concept prioritizes modern architecture, density driven and high quality of life embraced with accessible neighborhoods, improved walkability standards and enhanced mixed-use facilities (McFarlane, 2015). The concept promotes planning cities driven by people-oriented rather than car-dependent. Houses built in close proximity and commercial retail outlets incorporated into streets within walking

distances are the main features of the concept to restore back to people-oriented cities (Varma, 2017). The development patterns in the ancient times evolved through people who use to walk. It is a gradual process where the amount of time allows the scope for improvement in the architectural standards and quality. The process predominantly allows people to understand with their surroundings. Also, the process allows people to acknowledge with the sense and character of the place, in turn, contributing in the creation of a healthy urban space (Varma, 2017). In this sense, New Urbanism can be defined as an alternative to the traditional approach to urban development. However, urban developments oriented on vehicles, i.e., car culture, indeed affected the urban environment and the complexity emphasized to follow the pattern of development for its efficiency (Varma, 2017).

In the European context, similar development arose in the form of 'Compact City', a concept often attributed in the urban planning literature which focus on efficient land use and urban intensification (Jacobs, 1992). The compact city allows people to inhabit in dense areas in order to improve their proximity with the people around the city. The culture and practices of urban mobility are changing in most of the developed countries. This shift is being taken into consideration by planners and decision makers, who are developing new planning reforms that focus mainly on compact city concepts such as urban densification and mixed use (Rode et al., 2015). In compact city concept, the relationship is well built between the building footprint of the city and the effectiveness of its public transportation systems. Urban areas with high density are thought to increase the use of public transportation and walkability while reducing the use of vehicles. The urban areas of this pattern can serve as the foundation in sustainable transportation for future generations (Christian et al., 2016).

The principles of 'New Urbanism' take advantage of this relationship in order

to provide a more sustainable option for urban living. As a result, a compact city creates an eco-system in which the volume of movement increases rather than the distance travelled (Dennis & Urry, 2009). Distances are walkable due to the close physical proximity of buildings in the compact city, which naturally results in a walk-friendly environment. The characteristics of new urbanism result in a well-designed street environment that sends a message to automobile drivers that driving too fast or too aggressively is anti-social and inappropriate for their surroundings. As a result, drivers would slow down to a more reasonable speed, resulting in a more equitable environment for both motorists and non-motorists (Chellman, 2000). It is advantageous to practice New Urbanism for a variety of reasons. Walking introduces heterogeneity, clutter, and complexity to the urban environment, increasing the opportunities for walkers to interact with the environment and making the place more interesting and interactive through a variety of activities (Urry, 2007). Better quality of life, lower traffic density, car ownership and driving, increased potential income from mixed-use projects, and lower per capita expenditure on urban infrastructure are just a few of the many benefits of living in the city (Rahnama et al., 2012).

The recent literature introduce the concept of Sustainable City or Eco City. The concept emerged during the same time period such as healthy communities, community ecologic development, green development and sustainable development, all had an impact on the development of eco-city concepts (Roseland, 1997). The eco-city serves as a framework for bringing these ideas together. The following are the most important principles to consider when developing sustainable or eco-cities as per Roseland (1997):

- Land use priorities should be re-evaluated in order to create compact and diverse mixed-use communities that are also safe, pleasant, and vital, and that are located near transit nodes and other transportation facilities.
- Revise transportation priorities to walking, bicycling, carting, and public transportation over automobiles, with an emphasis on "access by proximity."
- Restore damaged urban environments, particularly creeks, shorelines, ridgelines, and wetlands, to their original condition.
- Develop decent, affordable, safe, convenient, and radically and economically mixed housing.
- Promote social justice by enhancing opportunities for women, people of colour, and the disabled in the natural environment.
- Support local agriculture, urban greening projects, and community gardening initiatives.
- Promoting of recycling, appropriate technology, and resource conservation while simultaneously reducing pollution and hazardous wastes are key objectives.
- Work with businesses to promote environmentally sound economic activity while discouraging pollution and waste as well as use and production of hazardous materials.
- In order to encourage voluntary simplicity and discourage overconsumption of material goods.
- Enhance public understanding of the local environment and bioregion through activist and educational projects that raise awareness of ecological sustainability issues among the general public (Lundqvist, 2007; Roseland, 1997).

The concept takes a broader approach to sustainability, placing a greater

emphasis on fundamental changes, such as changes in lifestyle. However, the concepts are still in their early stages, making it difficult for cities to put them into action.

Smart cities, another concept in sustainable city literature, are extensively being promoted as the major means in achieving urban sustainability by both governments and the private sector, according to the recent research. It is widely assumed that the smart city would be a place where digital technology will be applied to address urban sustainability issues. The idea of smart-sustainability is based on the notion that digital innovation may lead to gains in operational efficiency and integration of urban infrastructure systems that will benefit economic development, environmental protection, and social equality all at the same time. The above mentioned group of characteristics is at the forefront in emergence of the idea of smart-sustainable city, but the capability to achieve these advantages in practice is backed by strikingly with very few findings. While the smart city concept has been critiqued for representing high technology and corporate strategies in urban development, there is indeed a lack of awareness on how sustainability is addressed and achieved on ground in smart cities (Tomitsch, 2018). As the research particularly focus on the sustainability aspect, the literature on Smart City was limited in order to keep the emphasis on sustainable city and explain the smart city concept as a component.

The concepts of urban developments are reviewed in the context of the research area. Most of the city concepts baselines similar fundamental guidelines. These concepts are further assessed with the help of three brief case studies explained in the next chapter.

Case Studies

The use of smart growth concepts to restrict sprawl and vehicle dependency while also incorporating social, economic, and environmental goals into decision-

making rather than focusing primarily on reducing the congestion is a vital part in the visionary process (Kenworthy, 2006). The case studies follow a similar approach.

- Portland, Oregon is a city in Oregon. Portland, Oregon's capital city, is possibly one of most effective example of a city that has rebuilt itself under the leadership of a strong vision dating back to the 1970s in the United States. To keep sprawl under control, the city established an urban growth boundary in 1985 and built the metro service opening its first line in 1986. The city also abandoned plans for a highway that would have destroyed numerous houses in its construction (Newman & Kenworthy, 1999). Light Rail Transit (LRT) stations are the focal point of all new development in the Portland region particularly focused on variety of mixed-use centers built up along the LRT system and also, tram systems being built in the city's core. Parks and green areas have been built as a result of fast population expansion and business relocation choices, and property prices have risen. Portland is now engaged in a visioning process known as Region 2040. It is a broad-based community participation approach in which a lot of stakeholders collaborate to produce a national strategic vision goals for the region. Strong community engagement and empowerment have been at the heart of Portland's growing success over many years, which have served for a sustainability-based vision for their region, aiming to reduce vehicle dependency and working to improve transit options (Kenworthy, 2006).
- Perth is the capital of Western Australia. The city of Perth in 2003 went through to build a vision described as "Dialogue With The City". The approach was part of a bigger strategy involving government ministries as well as private sector and community. The strategy's residential area component prioritises energy

efficiency and innovation, and also lower waste generation, enhanced livability, and a better place identity (Curtis & Punter, 2004).

The state government sought to involve local on a massive scale in order to produce a 2030 vision for Perth faced with a rise in sprawl and dependency on vehicles. A community survey was conducted with the locals in the community and an awareness program. Locals have been pushed to confront urban planning issues, regarding trade between personal lifestyle decisions and system impacts such as traffic congestion and other implications. The following stage of the exercise will include an action plan entitled "The Network City," which would ask for around 60% of new housing construction to build within existing urban regions in order to minimize dependency on vehicles and sprawl development. The process involves locals to analyze the social, economic, and environmental factors prevalent in the planning, i.e. to address issues, make decisions based on city's sustainability improvement (Curtis & Punter, 2004).

- Vancouver, British Columbia is a city in Canada. The city’s Planning for Long-term Urban Sustainability (PLUS) team developed a 100-year sustainability vision for the greater Vancouver region through collaborative planning and engagement over a relatively short period of time. A collaborative effort that included the participation of the federal and state, as well as business and utility representatives from the civil sector. The resulting vision was recognized with first place in the International Competition of Sustainable Urban Systems Design. Vancouver's achievements in the field of sustainable cities have involved extensive community consultation as well as integrated thinking and professional practice (Itoh, 2003).

Cities all over the world are experiencing a rapid expansion of their populations.

Cities are growing in size, thereby expanding their geographical reach. The Department of Urban and Regional Planning at Florida State University conducted a study of urban revitalization methods in Portland, Oregon, and discovered that the city, which has modelled itself on the patterns of smart growth and new urbanism paradigms, has an urban growth boundary that delineates the city's boundaries. This made it possible to develop a promising public transportation system, a compact development, and urban policies that supported transit-oriented development. In order to achieve success in creating neighborhoods that are well connected and accessible, the city of Portland has employed mixed land use and has created a good social environment indicative of strong ties and collective efficacy in the majority of its neighborhoods (Kenworthy, 2006).

Middle East Context

The studies on urban sprawl should also draw the attention in the Middle East region since it is directly in contact with the context of this research. After reviewing relevant literature from two large countries in the region, including Egypt and Iran, the author concludes that four phenomena are common to both countries that are responsible for sprawling: (1) wholesale land sales to the lower economic classes, (2) deficiencies in planning systems in controlling development plans, (3) rapid and uncontrolled growth of urban population, and (4) migration from rural to urban areas. Trends in demographics and planning-related trends are two categories of drivers that can be found in a given situation. Furthermore, there are a number of anomalous trends that have national origins but are uncommon in Iran and Egypt (Houshmand et al., 2018). The authors of this paper believe that the demographic drivers or sprawl addressed by Middle Eastern scholars are not actual causes but rather consequences, or that there is a correlation between the demographic factors and sprawl, which they

describe as follows: More in-depth historical and socioeconomic studies are required in order to determine the relationships between sprawl and previously unstudied phenomena such as changes in technology, culture, and lifestyle.

The mode of urbanization identified is one that is characterized by an extreme case of primacy, with rates varying among the countries of the region, rather than one that is uniform. This pattern can be traced back to the historical evolution of human settlements as influenced by local environmental characteristics, as well as to the recent large-scale development of urban infrastructures that favored the already existing capital cities in a cyclical fashion. The relative city growth rates in the United States are among the highest in the world, but they are on the decline, which reflects spending patterns and the nature of the regional economies in the United States. The high growth rates are primarily due to a large influx of foreigners into the region, as well as an abnormally high natural increase rate, which occurs when an urban process approaches saturation point. The importance of these primate centers in the development of the region cannot be overstated, and all indications are that this pattern of urban development will continue in the future, albeit at a lower cost in terms of economic and political costs. But a few studies have helped to clarify why Middle Eastern cities began to sprawl in the mid-twentieth century and why this pattern has continued to deteriorate. Is it more likely that social factors, new lifestyles, and/or geographic conditions were at the root of sprawl, or that more controllable factors played a role? The current body of literature does not provide decision-makers with a clear picture of the current situation. As a result, it is difficult to draw lessons from the past half-century in order to ensure that future generations enjoy a higher standard of living in urban settlements throughout the region. It would be impossible to improve future cities unless we first acknowledge and learn from our past shortcomings and mistakes in planning and

administration. The majority of the existing knowledge about sprawl, particularly those focusing on sprawl causes, comes from highly industrialized or westernized countries, whereas the works of Middle Eastern scholars have been limited to monitoring sprawl and assessing its consequences. As a result of coming from diverse cultures, geographies, mentalities, economics, and other backgrounds, the planners and decision makers in the region are unable to rely on knowledge gained from other contexts without taking adaptation considerations into consideration. For the purpose of selecting the most appropriate planning procedures for the future, it is necessary to investigate and define the inefficiencies or problems that exist in various sectors such as planning, demographic management, urban sociology, economics, and so on. Urban sprawl is an existing and expanding trend in the Middle East, but its characteristics differ from those of western sprawl in a number of ways. Nonetheless, the dispersal of settlements observed in the region can still be classified as sprawl. Nonetheless, as demonstrated in this paper, the causes of sprawl may differ from one country to the next depending on the circumstances. The most effective drivers of change in the Middle East, according to academics, are poor planning and a rapidly changing demographic (Houshmand et al., 2018).

The cosmopolitanism of the Gulf cities, where foreigners account for between 60 and 90 per cent of the population, is a distinctive feature of the region (Rizzo, 2014). With the influx of Asian migrants, the Arab component is rapidly being phased out. While the majority of the population continues to come from South and South-East Asia, the catchment area for migrants has grown significantly to include Russia and neighboring countries which is followed by China. In Dubai, a city with a population that is 90 per cent foreign, has emerged as a symbol of this multiculturalism. People there come from all over the world, but Indians constitute nearly half the population;

when the other South Asian nationalities (Pakistanis, Bangladeshis, Nepalese and Sri Lankans) are taken into consideration, this figure rises to nearly three-quarters of the total population. A large diversity of languages, religions, cuisines and traditional dress styles can be found in the cities of the Gulf region, which makes them truly multicultural (Dumortier, 2016). It is important to note that multiculturalism is particularly prevalent in societies where there is a clear distinction between nationals and foreigners. The only truly ethnic neighborhoods, which are also distinguished by the wealth of their residents, are those that are populated primarily by nationals, which is a paradox. In imposing houses whose composite singularity eventually gives rise to a local style of architecture, a blend of architectural traditions from around the world that takes traditional practices into consideration, they live a life that is rich in tradition (Dumortier, 2016; Rizzo, 2014).

The major cities of the Gulf region grew up around small fishing ports or fishing villages in the early twentieth century. A seafront, known as the Corniche, was developed with a seawall-promenade, a wide parallel avenue, and green spaces that were dominated by a row of buildings, depending on the site (Wiedmann & Salama, 2013). The first planners created geometric, semi-radio-concentric (Kuwait and Doha) or orthogonal (Al Khobar and Abu Dhabi) street plans, depending on the site. Cities developed from these initial hubs and expanded into neighboring communities, where industrial areas and low-income housing developments were established, resulting in the formation of urban agglomerations. It includes, in addition to Doha itself (population 587,055 in 2015), Al Rayyan (population 589,531), and Doha's Industrial Area (population 589,531). (pop. 364,710) (Rizzo, 2014). In Kuwait City, the city center accounts for only 16 percent of the agglomeration formed by the city and its satellite towns, according to official figures. The linear expansion of neighboring

agglomerations has resulted in their merging into a single entity. In Saudi Arabia, the Dammam metropolitan area unites under a single administrative authority a conurbation with a population of nearly 1.5 million people that has included Dammam, Dharan, and Al Khobar since the 1980s. Similarly, since the 1990s, Dubai, along with Sharjah and Ajman, has formed a conurbation that consists of a polycentric urban strip that is approximately 70 kilometers long and is home to 3.5 million people (Dumortier, 2016). Additionally, in addition to competition and imitation effects in attracting skills and capital, unequal investment capacities, which have an impact on the quality of infrastructure and urban amenities, have created hierarchies in the attractiveness of cities and established complementarities between them in terms of their respective roles. Efforts are currently being made to strengthen the interrelationships between Gulf cities through the construction of high-speed rail projects and bridges that will bring them closer together, while the Gulf Cooperation Council is increasingly attempting to reduce duplications and interconnect the oil and gas distribution networks, among other things (Dumortier, 2016; Rizzo, 2014).

In the past, the cities of the Gulf have taken a proactive approach. The first master plans were created by foreign consulting firms in the early 1900s. They are now created by municipalities or ad hoc government agencies, such as the Urban Planning Council, which was responsible for the expansion of Abu Dhabi's mainland and the development of previously uninhabited natural islands. Following the depletion of oil reserves, the post-oil era has emerged as a major issue; current urban development plans are only one part of a large number of documents outlining economic strategies, which are generally focused on the year 2030 and are reminiscent of the Singaporean model. Due to a desire to develop resources in the country, the creation of the industrial city of Jubail, the development of small mono-functional cities near oil (Ruwais, Ras Tanura)

or gas (Ras Laffan) terminals, and the establishment of large areas of heavy industry on the outskirts of major cities have all resulted from the desire to develop resources at home. Free zones are given prominence in order to encourage the transition from a rentier economy to a productive one. This is especially true in Qatar and the United Arab Emirates, with a disproportionately large number of free zones in Dubai. The Jebel Ali free zone, established in 1985, is a global enterprise with more than 7,000 companies, many of which are major Western and Japanese corporations as well as transnational corporations (Dumortier, 2016). A similar ambition to become financial hubs can be seen in the development of the Dubai International Financial Centre, as well as in the development of Manama, which has "offshore banking units" that are comparable in size to Singapore's Asian Currency Units (Dumortier, 2016; Rizzo, 2014; Wiedmann & Salama, 2013).

Real estate has risen to become a significant component of revenue recycling. The traditional, customary system of land ownership and management was managed by sheiks, who offered their countrymen land on which they could build houses or buildings, which they could then rent, but which they could never sell, bequeath, or mortgage. Land was under collective ownership, and sheiks managed it for the duration of their lives. Reforms enacted around 2005 removed this stumbling block by legalizing private ownership and granting foreigners access to specific locations for a limited period of time, respectively. In turn, this encouraged speculation: the confluence of the subprime mortgage meltdown with the burst of a speculative real estate bubble explains Dubai's bankruptcy, from which it was forced to seek assistance from its neighbor Abu Dhabi. Developers and promoters have risen to become important players in the dynamics of urban development. The proliferation of high-end real estate projects has resulted in an excess supply of housing that is out of sync with the high demand for

affordable housing in the market. International tourism is regarded as a worthwhile endeavor that should be encouraged. Because international hotels managed by major global and regional chains account for the vast majority of the industry's capacity, it is characterized by a significant oversupply. Tourist attractions and shopping centers for the local population are being added to the ever-growing number of shopping malls in the area. Several major sports and cultural facilities, as well as museums designed by well-known architects and media events, are all part of a regional marketing strategy that goes beyond simple tourism promotion. When it comes to identity and tourism, cultural heritage, which is largely immaterial, plays a dual role: while traditional life is celebrated through folkloric re-enactments, the historic districts of market towns are being re-established (Wiedmann & Salama, 2013).

Using Masdar City as a case study, this article demonstrates how the Emirati eco-city initiative, which is the product of local agendas seeking economic growth through urbanization while also preserving the political institutions of Abu Dhabi, came to be. Following the economic imperatives established by the ruling class, the Masdar City project interprets sustainability as ecological modernization and practices urban environmentalism almost exclusively in terms of economics and economic development. The article demonstrates how the developers of Masdar City are capitalizing on sustainability by creating an urban platform for the development and commercialization of clean-tech products and services. According to the paper, the alleged eco-city in the Emirati desert is an example of urban eco-modernization: a high-tech urban development that is informed by market analysis rather than ecological assessments (Cugurullo, 2016).

In the country, urban agglomeration was regarded as a natural process of evolution that occurred primarily as a result of a bottom-up approach to meet the needs

of the general public. They congregate in groups that are concentrated around an urban center. Their designation did not fall under the purview of the country's planning provisions, and in fact, the regulations were formulated a long time after these developments occurred. The same pattern of growth was visible at the regional level, where it was discovered that it was the beginning of the process of development of Arab cities on a national scale. The land between these spatially concentrated areas frequently resulted in fringe areas, which were then gradually developed over time as the population grew. They were developed primarily with a focus on domestic resource production, which resulted in the establishment of the Industrial City and mono-functional cities near oil (Ruwais) or gas (Ras Laffan) terminals, which were established on the outskirts of Doha's city center. The areas on the outskirts of the city that were later developed to a greater extent were where much of the city's growth was based. The Industrial Area, which connected the old district, paved the way for the commercial sector, which helped to stabilize the economy. Infrastructure, housing, commercial centers, utilities, and other urban amenities were all built in these areas, as was transportation infrastructure.

Transportation System in Cities

Transportation systems are very different across cities and facilitate very varied experiences of life. The development of streets in various cities has changed dramatically over the last few decades, with some cities seeing significant improvements while others seeing significant declines. Walking was the primary mode of transportation in most cities prior to 1900, with only a small amount of public transportation being used. Cycling, like other modes of transportation, was popular in many settings, reaching 60 percent of trips in some cities as recently as the 1940s. However, over the period from the 1950s to the 1980s, the private automobile has risen

to become the dominant mode of transportation in most cities. A complex set of processes, institutions, and actors has worked together to make one mode of transportation the dominant mode on the street: the private car. This has been justified in terms of supporting individualized travel, but the very significant negative consequences for society have been overlooked (UITP, 2015).

People possess different travel habits, travel experiences, and activities usually engaged during a journey. Access to transportation, as well as the consequences of transportation, are extremely unevenly distributed and vary greatly depending on the context. The movements and activities are influenced by the availability and affordability of public transportation systems, the availability and accessibility of walking and cycling networks, the attractiveness of the public realm, and the reliance on the use of private automobiles. According to the transportation systems constructed, there will be significant environmental, social, and economic consequences. Transportation planning should be about more than just increasing mobility; what is built and how travel is formed affects people in different ways, and has significant ramifications at the societal level (UITP, 2015).

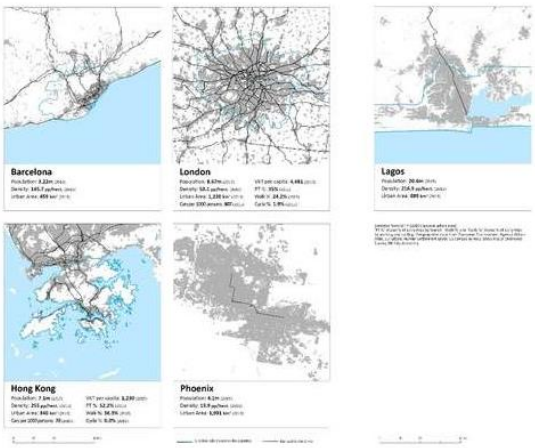

Figure 15. Urban footprints (Source: UITP 2015)

There are large differences in urban footprint by city, i.e. land usage. Figure 15 gives the urban footprints and public transport networks for Barcelona, Hong Kong, Lagos, London and Phoenix (Arizona). The city populations differ significantly and also the population densities, average GDP per inhabitant, average vehicle kilometers by passenger car, and mode shares by public transport, walk and private car (UITP, 2015).

Social equity is another particular issue to consider because some modes of transportation are used more frequently by some individuals than others, and there are varying spatial impacts from infrastructure and the movement of others, i.e. severance, noise, and air pollution fall disproportionately on particular groups and neighborhoods (Hickman & Banister, 2019). Perhaps unintentionally, transportation investment is frequently targeted at and utilized by individuals from higher socioeconomic backgrounds. Consider the investments in highways, rail, tramways, and airports – all of these are disproportionately used by higher-income groups, while others are left with poorer transportation conditions as a result (Vasconcellos, 2001).

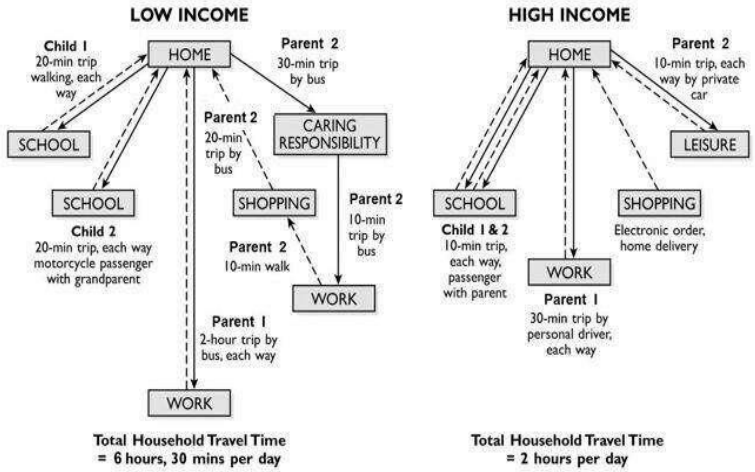

Figure 16. Travel behaviors in typical low income and high income households (Source: Vasconcellos 2001)

As a result, travel behaviors and impacts differ significantly depending on income and other demographic groups. Examples of travel behavior in low- and high-income households are are illustrated above in Figure 15. In order to get to work, school, and other activities, the low-income family of two parents and two children travels a combined total of 6 hours 30 minutes each day to and from work. They live on the outskirts of the city and have to travel a long distance to most activities; they do so using low-quality public transportation, which is frequently overcrowded, or by motorcycle. For recreational activities, there is little time available. The high-income household, which consists of two parents and two children, is located much closer to the city's central business district. It is necessary for them to travel shorter distances, which they do in one of their two private cars or with the assistance of a personal driver. Shopping is done through home delivery. Due to the fact that the average household travel time is only 2 hours per day, there is plenty of time for leisure activities and school work. Although these are only hypothetical examples, and many more could be provided, they reflect a reality for many households: access to transportation systems has a significant impact on the overall quality of people's lives (Vasconcellos, 2001). Despite the fact that many people enjoy travelling by car and many people aspire to own a car, if a large number of people choose to do so, there are significant problems. A city with an excessive number of automobiles, motorcycles, or polluting vehicles can be extremely difficult to live in. Building cities around the private automobile has failed – and many cities are now attempting to improve their public transportation, walking, cycling, and the public realm, as well as managing the space allocated to the automobile, in order to succeed. The right to have access to every building in the city by private motorcar in an age when everyone has such a vehicle, as Mumford (1963) put it more than four decades ago:

"The right to be able to access every building in the city by private motorcar in an age when everyone has such a vehicle, is actually the right to destroy the city."

The section of this literature now categorizes and focus on the scale of motorization and approach of transport planning in cities.

Motorization on Urban Scale

The use of private automobiles dates back to the late nineteenth century, when the gasoline engine was first developed for use in automobiles. It was in 1885 that Gottlieb Daimler and Karl Benz, working in separate locations in Stuttgart and Mannheim, developed the world's first gasoline engine, which would be used in private automobiles for the next century. Electric cars were being developed and manufactured at the same time, but it was the gasoline car that gained popularity. When Henry Ford designed the Model T in 1908, it was intended to be a utility vehicle for mass consumption at a low cost, and the automobile industry grew as a result. Beginning in the 1950s in the United States, and later as it spread to other countries, the private car became the aspired mode of transportation for many people – and the modernist dream of dispersed urban development and motorization was sold and implemented in a number of countries during this period (UITP, 2015).

Fast forward 70 years, and the level of global motorization has reached previously unimaginable heights – there are 1.24 billion motor vehicles worldwide in 2014, including 907 million passenger cars and 329 million commercial vehicles – a record high (UITP, 2015). This is a hugely profitable endeavor, one that has the support of automobile manufacturers, oil suppliers, the urban development industry, and numerous other cooperating organizations (Freund & Martin, 1993). International Organization of Motor Vehicle Manufacturers OICA (2015) reports that the number of

motor vehicles has increased by 4 percent in the three years from 2013 to 2014 and by 38 percent in the five years from 2005 to 2014. The continued increase in motorization is unsustainable due to the numerous negative impacts on sustainability, including environmental, social, and economic dimensions, as well as broader issues such as the quality of the city and the quality of life for individuals (OICA, 2015).

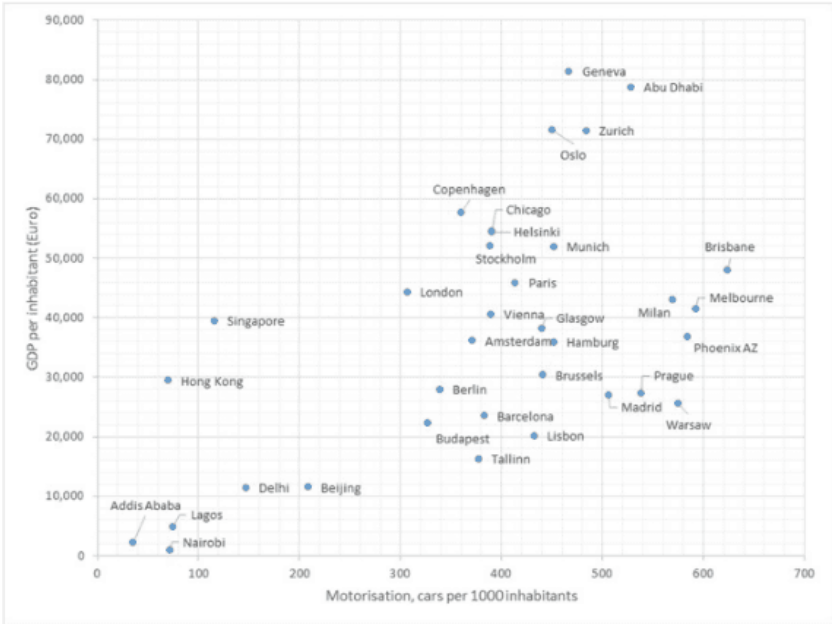

Figure 17. Motorization in cities (passenger cars/1000 population) and GDP (Source: UITP 2015)

Motorization in cities has its own effects in terms of private transportation and is dependent on the extent of public transportation infrastructure. The number of cars per 1000 people and the gross domestic product (GDP) per capita in each city in 2012 is depicted above (Figure 17) (UITP, 2015). A high proportion of people in North American and Australasian cities drive automobiles, such as in Brisbane (624), Melbourne (593) and Phoenix (584). Other cities, such as Copenhagen (360), or London (360), have GDP levels that are comparable or higher, but have significantly better public transportation and/or cycling networks, and thus have lower rates of motorization (307). Singapore (116) and Hong Kong (70) have relatively high levels of

income, but have very low rates of motorization (UITP, 2015).

Furthermore, the shifts in levels of motorization over time are instructive. The evolution of car ownership per 1000 people and gross domestic product (GDP) per inhabitant by city over the last three decades, from 1995 to 2012 is shown below (Figure 18) (UITP, 2015).

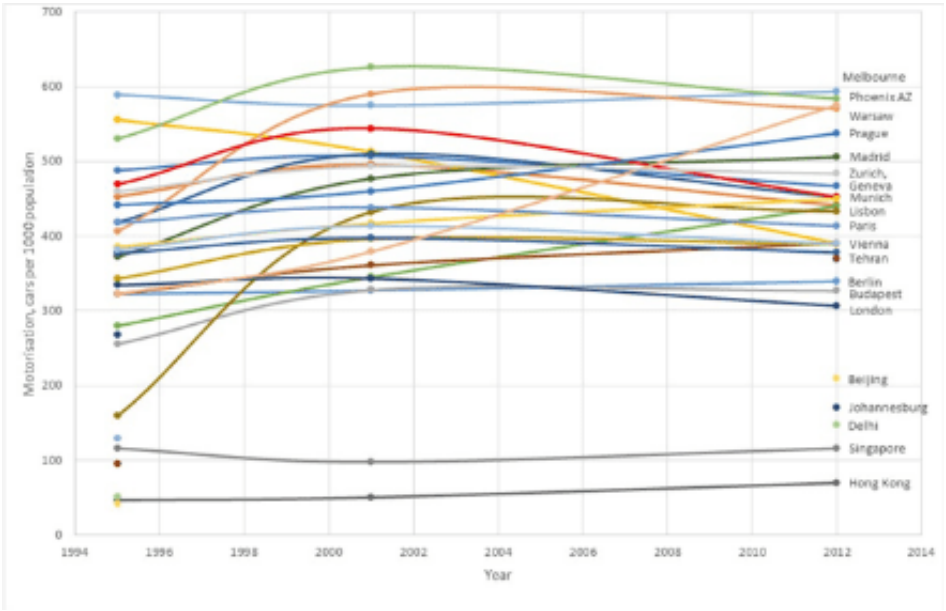

Figure 18. Changing motorization in cities (passenger cars/1000 population) (Source: UITP 2015)

The cities of North America and Australia have high levels of motorization, with approximately 600 cars per 1000 people in 1995 and 2001, but the number of cars per 1000 people has been steadily decreasing over time. In these industrialized cities, there is some evidence of a marginal peaking in car usage, which is consistent with this hypothesis (Millard-Ball & Schipper, 2010). Some European cities, such as Munich and London, have seen a greater decline in car ownership than others. Cities in Eastern Europe, such as Prague and Warsaw, have experienced rapid growth rates in recent years. In a similar vein, rapid growth is occurring in Asian cities such as Beijing and Delhi, but at a lower level – it is from these cities that the global growth is derived,

offsetting any potential peaking of motorization in the more mature automobile markets. Hong Kong and Singapore have maintained extremely low levels of car ownership, with approximately 100 cars per 1000 people, and as a result, they offer very interesting alternative development pathways (UITP, 2015).

The motorization levels is evident to differ depending upon the city and its transport infrastructure. Hence, the need of transport planning is important to research the overview of the planning in the recent years and its use which is discussed in the next section.

Transport Planning

As a discipline, transportation planning was established to assist in the construction of highways and the expansion of motorization – and this has long since shaped the way in which transportation planning is conducted in the modern world. Since its inception in the 1950s, first in the United States and then in Canada, Europe, Australasia, and other parts of the world, the analytical approach has largely been based on forecasting future demand and then providing infrastructure to meet that demand – a process that has come to be known as ‘predict and provide'. A refined decision-making process for transportation planning has been developed, with the majority of quantitative approaches used to project and cater for demand.

This process was instrumental in the development of highway networks in the countries that experienced early motorization growth, but it has since been applied in a variety of contexts, across a wide range of spatial scales, and across a wide range of modes of transportation. The process of transportation planning has aided in the expansion of private automobile ownership and use, as well as the provision of more parking space for automobiles. It is presented as an objective, technical exercise, with the expert analyst serving as the leader. However, there are numerous normative

positions within this framework, each involving perspectives and values on what data to analyze and which projects to pursue. In most cases, only a limited number of people from other organizations and the general public participate in the process.

There are a plethora of intriguing dimensions. As a fluid dynamics-based system, the transportation network was conceived as a system where the volume of traffic was perceived to remain constant regardless of the container in which it was contained (Newman & Kenworthy, 2015). It was anticipated that increased highway capacity would result in smoother traffic flow and improved traffic conditions. This framework and process was applied internationally as a template that could be transferred regardless of the context, and it resulted in a significant amount of highway construction. The results can be seen as we travel around cities in various contexts: an increase in highway capacity, as well as an overriding belief that this is the "modern" way to develop a city; that increased road capacity will allow for more convenient movement around the city (Broaddus et al., 2009; GIZ, 2019).

Numerous complex approaches have been developed to model traffic growth, including the original four-stage model, in which traffic demand was forecast in four stages: trip generation, which determines the number of origins and destinations (based on demographic factors), trip distribution, mode choice, and route assignment, among others. To estimate flows, a gravity model was and is still frequently used. It is based on the attractiveness of a zone and the distance between its origin and its destination. In today's world, more sophisticated modelling approaches, such as activity-based modelling, are sometimes employed, in which the scheduling of activities is examined rather than the scheduling of trips. However, the premise is still based on forecasting demand and meeting that demand as well (Broaddus et al., 2009).

It was extremely successful in forecasting traffic growth and developing

highway projects to meet the demand for increased capacity as a result of this transportation modelling process. However, since the 1970s, it has been widely criticized for a variety of reasons, including the problem of induced travel, which occurs when traffic demand increases in order to meet increased highway capacity, and the vicious circle of motorization, which occurs when more space for the car is required as a result of the increased demand (Figure 19) (GIZ, 2019).

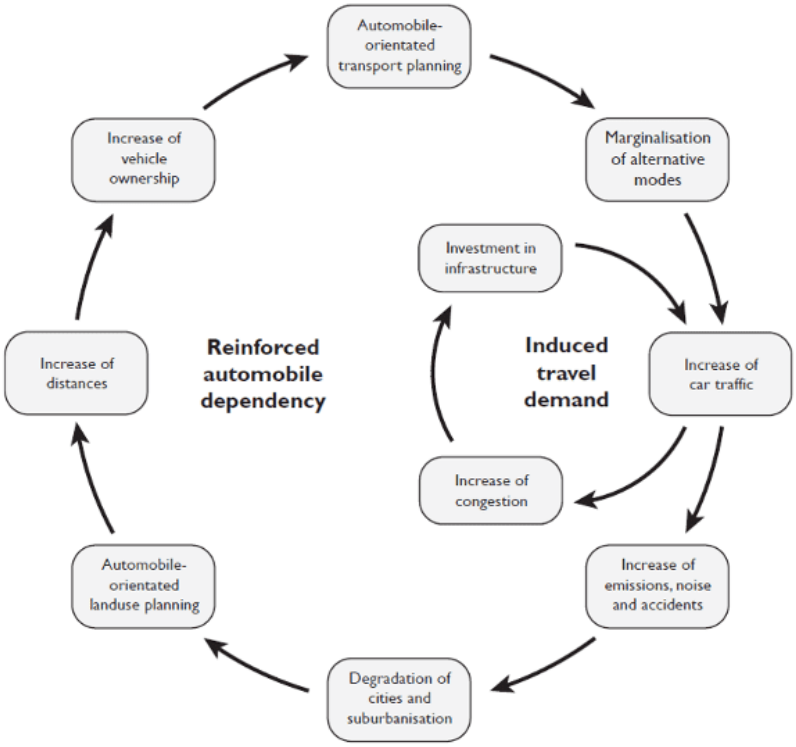

Figure 19. The circle of Motorization (Source: GIZ 2019)

In reality, traffic behaves more like a gas than a fluid, and the new space created by the car is quickly filled as more and longer trips are taken by more and more people. This process can be observed in many cities where there is a high demand for travel and where traffic congestion occurs even after significant increases in highway capacity. Of course, the inverse can also occur: when traffic capacity is reduced, traffic

then "disappears" as people switch to other modes of transportation or alter their travel patterns (Cairns et al., 2002).

Other issues with the analytical approach include: inaccurate forecasting and poor representation of the complexity of travel behavior, individual and societal constraints on travel, the political nature of project investments, the inability to achieve environmental and social objectives, as well as the negative impact on cities and urban planning, among other things (GIZ, 2019).

Travel is generated by the strength of attraction of origins and destinations, and individual behaviors are maximized in accordance with perfect knowledge and self-interest, according to the rational transport planning process. Many of these assumptions are overly simplistic in their depiction of individual behavior. Despite the fact that these issues have been discussed and understood for decades, there is still an excessive amount of emphasis placed on increasing highway capacity in many cities – in order to accommodate increased motorization (GIZ, 2019).

There have been a number of institutional actors who have encouraged the increase in motorization. In addition to the automotive industry (which includes oil suppliers and the development industry), other factors such as national and local policies (which include infrastructure provision and taxes), universities and consultants (which include education, research themes and studies), and the mass media (which generates notions of status, freedom, and so on) are also important (Paterson, 2007). All of these characteristics are extremely powerful, and they contribute to the dominance of the motorization ideal in many organizations and among the general public (Newman & Kenworthy, 2015).

For example, the engineering discipline has contributed to the shaping of our streets and cities in order to accommodate the predominant use of the automobile,

through street widening, street space allocation, spatial segregation, and suburbanization, among other things, and this has had a negative impact on our cities and urban areas. This has only begun to see the beginnings of a counter-movement toward sustainable urban mobility in which public transportation, walking, the public realm, and cycling are given much greater priority (Figure 20) (Colville-Anderson, 2018; GIZ, 2019).

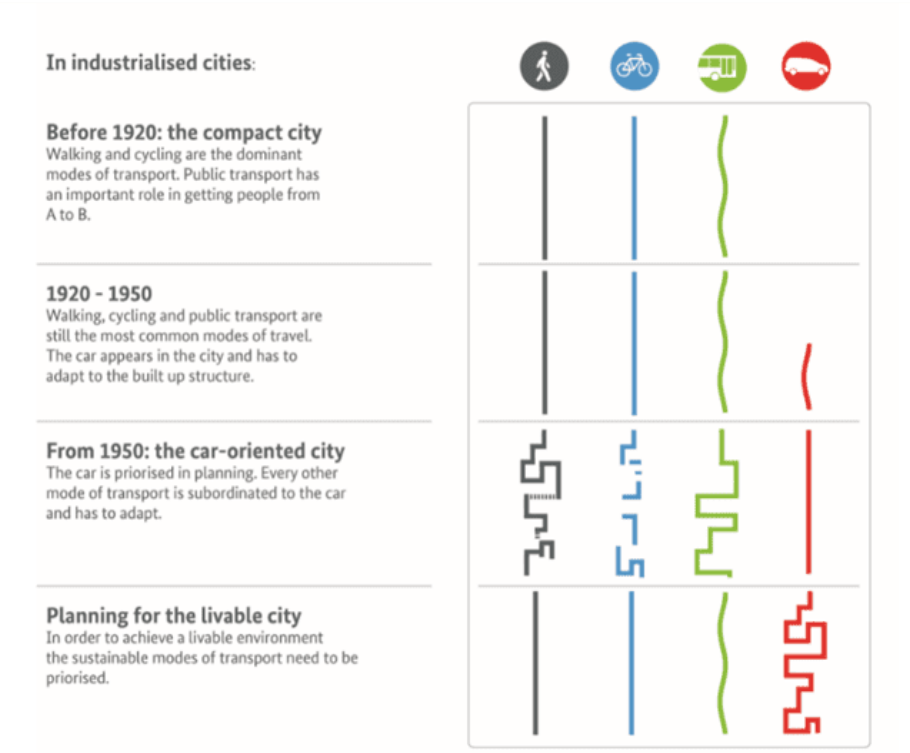

Figure 20. History of traffic engineering (Source: GIZ 2019, Colville-Anderson 2018)

When current trends are unsustainable and significantly different trajectories are required, the conventional process of transportation planning – the old paradigm – is particularly ineffective and counterproductive. Implementation of a revised approach to transportation planning is needed that makes different use of quantitative and qualitative analysis, both within and outside of transportation planning and project appraisal. In general, this is a progressive agenda, but it is particularly necessary in

cities in the Global South, where a lack of data availability prevents extensive quantitative analysis from being used to prioritize and develop transportation projects (Hickman & Banister, 2019).

The privatization of cars as assessed has adverse impacts on cities through traffic congestion. It results from an excessive number of vehicles on the road – and this means that even the experience of driving in a car is unpleasant, on top of the negative consequences for pedestrians and other road users (Hickman et al., 2017). As a result, there are extremely significant negative consequences associated with motorization that are rarely discussed. These serve as justification for a new approach to transportation planning, as well as for significantly increased investment in public transportation, walking, and cycling. The following are some of the negative consequences: Energy depletion, Carbon dioxide (CO2) emissions, Traffic fatalities, Local air quality, Obesity and the wider health consequences of inactivity and Loss of street space to the vehicles. The magnitude and significance of these issues varies depending on the context, but they are all expected to grow in importance as car-based mobility becomes more prevalent. Therefore, interpreting sustainability in transport is vital to incorporate in planning stage (Hickman et al., 2017).

Sustainability has been discussed at least since the 1970s in the countries of the Global North, initially by environmental groups advocating for more environmentally friendly behavior on the part of citizens. Following the publication of the Brundtland Report WCED (1987), the debate over sustainability gained momentum, and it eventually became a mainstream goal in public policy. Many different groups and individuals have embraced the concept of sustainability since then, largely applying the well-known Brundtland definition: (WCED, 1987)

"Sustainable development is development that meets the needs of the

present without jeopardizing the ability of future generations to meet their own needs."

Despite the fact that most transportation strategies and projects are labelled as "sustainable," the term is often interpreted in a variety of ways, and it is rare that they give sufficient consideration to environmental and social goals. When it comes to transportation planning and other domains, the conventional understanding and application of sustainability entails the assumption that the three pillars – economic, environmental, and social objectives – can all be met if a suitable project can be developed, despite the fact that many other important structural factors must be considered (Castro, 2004). There is frequently no such thing as a "balanced" project to be found, and progress toward environmental and social objectives is difficult to achieve in the current political and cultural environment (Hickman & Banister, 2019). Instead, economic objectives are typically given precedence over environmental and social objectives, including during project appraisal, which is primarily concerned with determining the economic efficiency of a project in relation to its cost (Figure 21) (Hickman & Dean, 2017). Consequently, environmental and social goals are underachieved – and, in particular, the social equity impacts of transportation are frequently overlooked. In the case of transportation projects, we rarely consider whether the perceived economic benefits are worth the negative environmental and social consequences, who is likely to use the transportation project being developed, or what activities might be reached by whom. The New Urban Agenda from United Nations (UN) places a strong emphasis on the importance of having a transportation system that is socially equitable (UN, 2016).

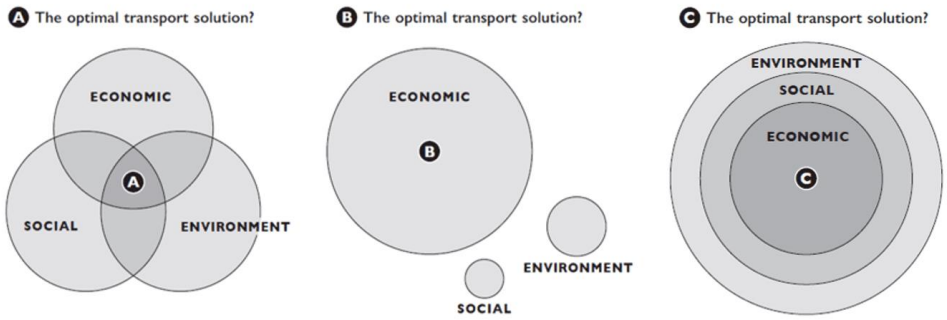

Figure 21. Application of Sustainability in transport (Source: Hickman 2019)

When it comes to applying the sustainability concept in transportation, a more effective approach would seek to ensure achievement of all goals, perhaps drawing on the nested model of sustainability or the related doughnut economic concept (Giddings et al., 2002; Raworth, 2017). Unless and until all objectives are met to an agreed level, projects will not be considered, prioritized, or implemented in their entirety (Figure 21).

Although transportation plays an important role in sustainable development, there is no universally accepted definition of what constitutes sustainable transportation (GIZ, 2019). It is possible that the UNHLAGT (2016), which provides the following recommendations:

> *"Sustainable transport is the provision of services and infrastructure for the mobility of people and goods – advancing economic and social development to benefit today's and future generations – in a manner that is safe, affordable, accessible, efficient and resilient, while minimizing carbon and other emissions and environmental impacts."*

This provides more clarity in planning designated sustainable urban mobility in cities. The planning regulations on measuring the elements of a city is critical to be both environmentally and user friendly. The regulations once planned and approved is also required to be carefully assessed during the execution stage. The research reviews the

literature about developed frameworks in defining and achieving sustainable urban mobility.

The development of a sustainable transportation and city planning strategy is necessary. There are a number of policy initiatives that can be used to do this, such as the Avoid-Shift-Improve (ASI) framework. It was developed in Germany in the early 1990s to bring together the various sustainable transportation policies that were being developed at the time. It challenged the conventional predict and provide approaches that were often associated with highway construction. International Non-Governmental Organizations (NGOs) have embraced the ASI framework, which has been hailed as a comprehensive approach to moving towards sustainable transportation (Dalkmann & Brannigan, 2007). When it comes to developing transportation strategies, the ASI framework has emerged as a valuable tool for cities (GIZ, 2019). There are numerous measures involved, including urban planning, public transportation, walking and cycling, as well as vehicle efficiency improvements (Figure 22).

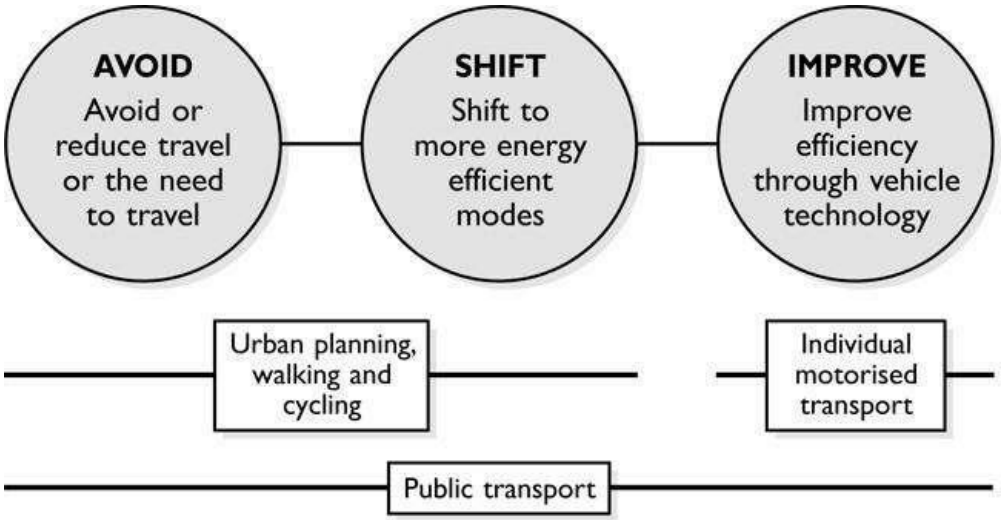

Figure 22. The ASI Framework (Source: GIZ 2019)

Taking advantage of the important principle of limits across a wide range of

policy objectives – sustainable transportation should contribute to the achievement of environmental, social, and economic objectives – Projects should only be prioritized if they have a good chance of achieving success in all of their objectives. Transport should be more than just a means for a few to consume more mobility for their own benefit. Therefore, transportation systems and travel behaviors must support a variety of public policy objectives, which will vary depending on the context. The establishment of a shared future vision can serve as the foundation of our transportation plan. A vision for the future (say, in 20 or 30 years) might be derived from an awareness of the issues and opportunities specific to the context (Hickman & Banister, 2019).

The vision should embody people's hopes and dreams for the future of the city's transportation system, which is why it must be produced in a collaborative manner. For instance, the vision for transport in London is to: (TfL, 2018)

> *"Create a future city that is not only home to more people, but is a better place for all of those people to live in. This relies upon reducing dependency on cars in favour of increased walking, cycling and public transport use."*

Key targets and indicators can be used to support the vision. 80 percent of all trips in London should be made by foot, bicycle, or public transportation by the year 2041. As a result, the vision should be big and the targets and indicators should point in the right direction to help develop the strategy. Instead of delaying action, goals should be used to help shape solutions. Develop a strategy and set of measures together with a plan for their implementation. Using back casting, the program can be created by working forward from the vision (Figure 23) (Hickman & Banister, 2014).

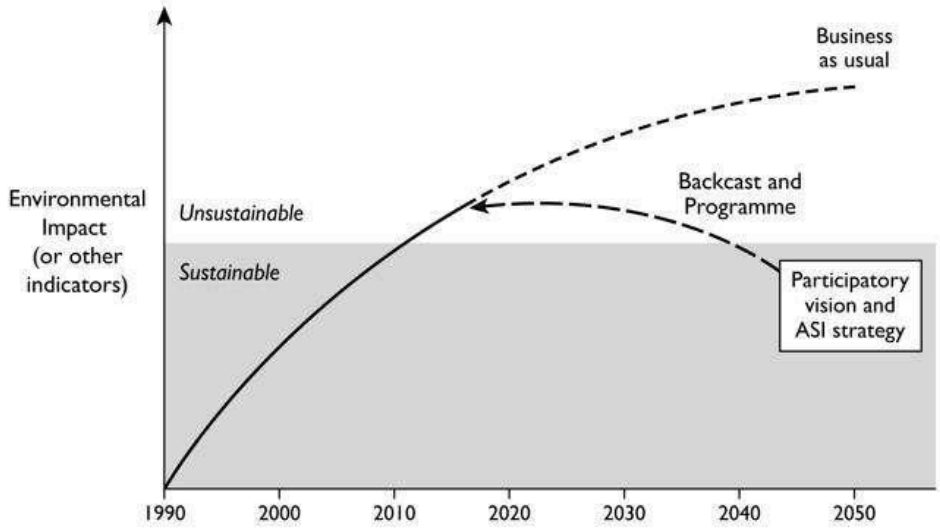

Figure 23. Visioning and back casting (Source: Hickman & Banister 2014)

As a result, we abandon the traditional approach to transportation planning, which focuses on forecasting and providing. So far, transportation policies and programs have fallen short of meeting environmental, social, and even economic objectives. According to Robinson (1990), the back casting strategy is based on:

> *"A concern, not with what futures are likely to happen, but with how desirable futures can be attained. It is thus explicitly normative, involving working backwards from a particular desirable end-point to the present in order to determine the physical suitability of that future and what policy measures would be required to reach that point."*

This normative and progressive approach to transportation planning allows for the development of a strategy that incorporates policy measures that facilitates in the realization of the goal. Retrospective planning helps to make sure policies are large enough to reach the goal, and it also enables for progress to be tracked so the strategy may be adjusted as needed. To move us towards sustainable urban mobility, the strategy and transportation projects need a clear focus and direction. This means our strategy needs to be shaped to meet our vision and goals (Hickman & Banister, 2019). The ASI

framework aids in prioritizing sustainable modes of transportation and creating cities that encourage their usage. It can be put to use in a variety of ways to assist in the development of transportation and city planning initiatives (Hickman & Banister, 2019).

There are various stages in the decision-making process (Figure 24) where ASI policy measures can be defined, such as a vision for transportation and city planning, an ASI strategy, an implementation program, and an evaluation of the implementation program (Hickman & Banister, 2014). ASI's strategy will be guided by this orientation, ensuring that each action is aimed at attaining the shared objective (Hickman & Banister, 2019).

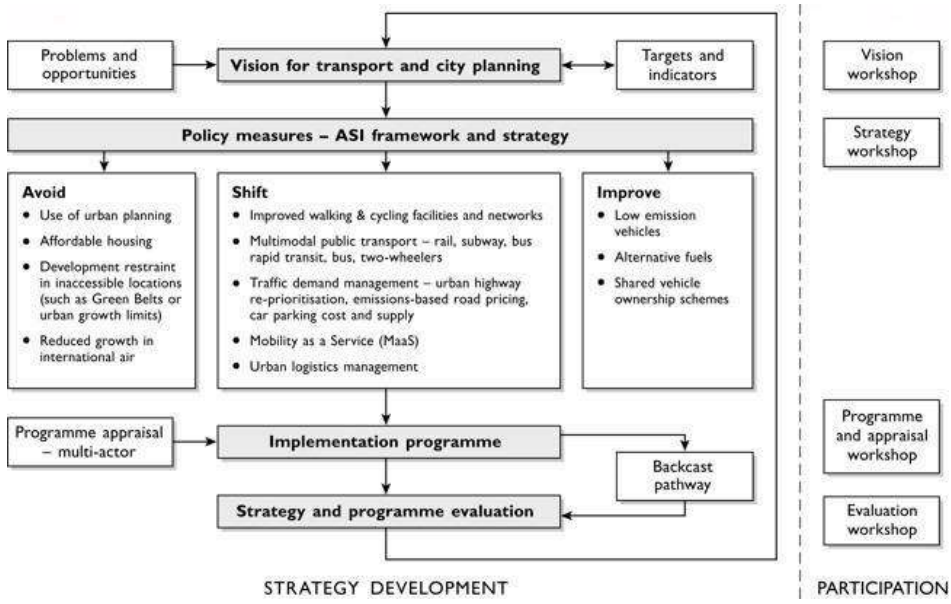

Figure 24. A process for progressive transport and city planning (Source: Hickman & Banister 2014)

There is still a need for quantitative modelling, but it will be utilized to build the most effective strategy and program to achieve the vision, including the set of measures and the most effective execution program. It's also possible to utilize

qualitative analysis to establish a vision and to comprehend some of the more complicated behavioral responses to interventions. Because of this, transportation planning now combines quantitative and qualitative techniques considerably more effectively. A participatory approach should be used, with stakeholders and members of the public offering their thoughts on various phases of the process, including problems and opportunities, the vision, policy measures, implementation program, and evaluation. The debate can also be deliberative in nature, increasing key actors and the public's understanding of transportation planning and leading to a better debate (Hickman & Banister, 2019).

The stages outlined is similar to the steps suggested for the development of Sustainable Urban Mobility Plans (SUMPs) (GIZ, 2017). The steps in SUMPs involve:

> *"Determine planning framework, Analyze mobility situation, Build scenarios, Develop vision, Set targets and indicators, Select measures and packages, Manage implementation, Monitor and review."*

However, further strengthening in back casting and participatory elements - the policy actions can be emphasized to fulfil the vision with stakeholders and the public. These have a policy path or trajectory pre-programmed from the desired outcome. This is how the evaluation and any quantitative modelling is focused — progress is measured against the achievement of the goal, target, and indication. As a result, we can rest easy knowing that the method we've chosen will get us closer to achieving our policy goals. The strategy can be amended to help ensure sufficient progress is made once progress against key targets has been evaluated over time. Achieving goals might be a springboard for reevaluating the plan (Hickman & Banister, 2019).

The strategy in implementing an ideal transport solution is widely discussed with the emphasis on its practicality on cities depending on the context which is

ultimately the case study used in the thesis. The context and its applications on cities are operated on different approaches due to the size, urban form and other elements in each particular city. Over the years, planners and architects have designed transit-oriented neighborhoods in order to limit the usage of vehicles. Therefore, the need to study concepts of different applications designed spatially for a city is important to analyze in terms of development of the thesis and the context of the case study.

Spatial Transport Applications

The spatial applications has been evolved over the years in order to provide mobility in cities. These applications often improve the type of thinking about urban structure, form, and travel. Numerous spatial applications are developed prior to the conduct of some empirical research.

Figure 25. Garden City (Source: Howard 1898)

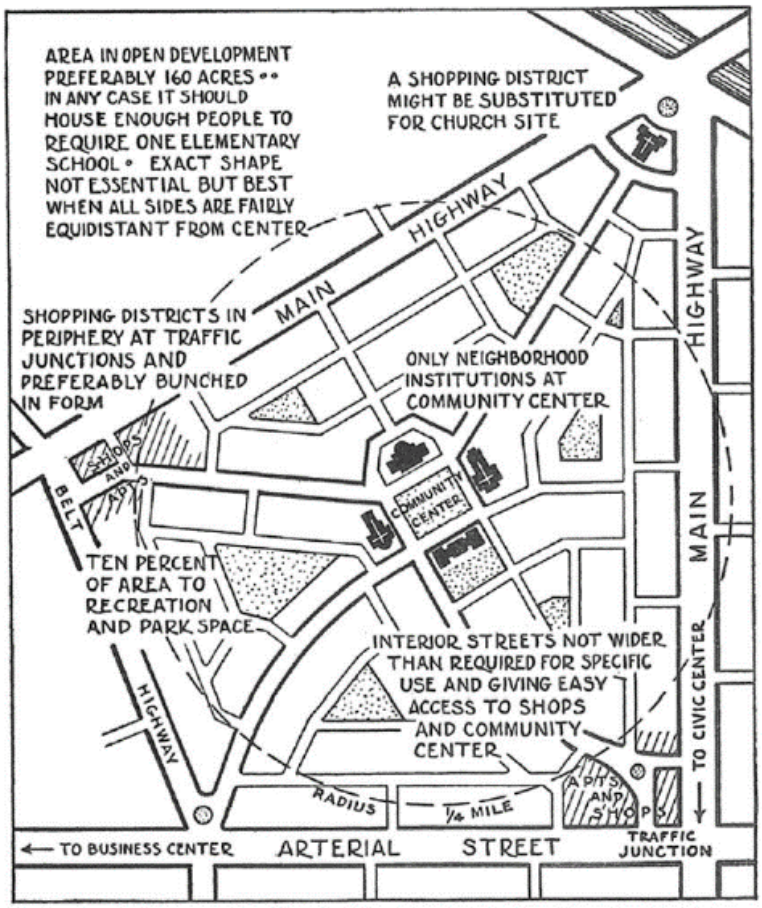

Figure 26. The Neighborhood Unit (Source: Perry 1929)

There are spatial applications to this type of thinking about urban structure, form, and travel. Numerous spatial applications are developed prior to the conduct of some empirical research. So we can retrieve back to Ebenezer Howard and his garden cities, which were intended to develop small settlements with a maximum population of 20,000 people around public transportation networks, such as trams or other modes of public transportation (Figure 25) (Howard, 1898). Clarence Perry in the United States proposed the concept of the neighborhood unit, which was fundamentally a similar concept that focused on creating a walkable environment within the neighborhood and attempting to eliminate the need for cars, at least within the neighborhood's perimeter (Figure 26) (Perry, 1929). The spatial ideas that emerged from this process fed into and drew on the empirical analysis that followed (GIZ, 2019).

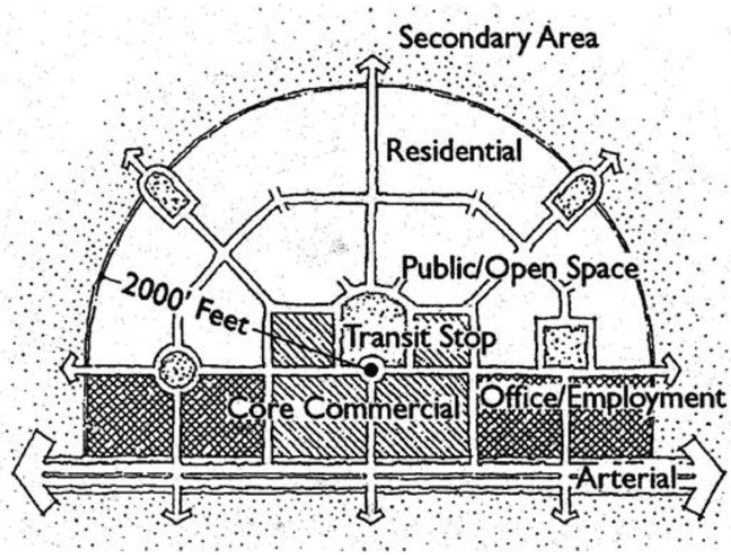

Figure 27. The Pedestrian Pocket/ Transit Oriented Development (Source: Calthrope 1993)

The pedestrian pocket, which was developed by people such as Pete Calthorpe with the goal of improving the legibility and walkability of the walking environments surrounding, for example, a public transportation stop (Figure 27) (Calthorpe, 1993). Also, there has been comparison of the traditional grid to the cul-de-sac style developments that came from the New Urbanist movement in the United States (Figure 28) (DPZ, 2003).

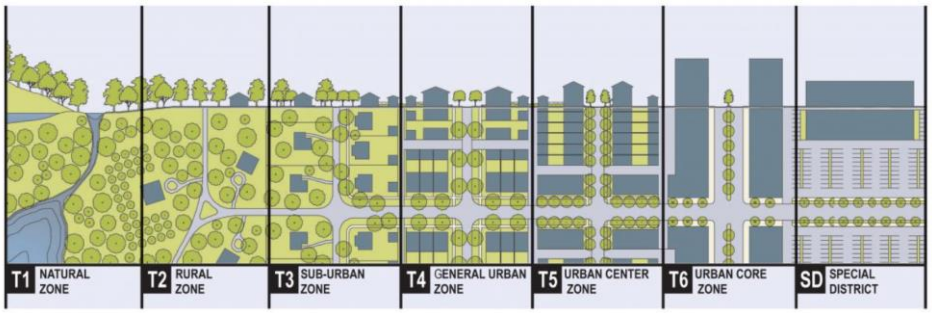

Figure 28. The Transect (Source: DPZ 2003)

In practice, much of the research has been embedded as Transit-Oriented Development or TOD, with the goal of increasing densities, mixed uses, and walkability in the areas surrounding public transportation, and particularly in the areas surrounding public transportation stops, or the catchment areas for stations. In the late 1980s and onward, authors such as Robert Cervero popularized TOD as a concept, advocating high densities and mixed uses around stations, which was essentially the practice that we had evolved in Europe during the preceding decades. TOD also emphasize on increasing walkability in areas near public transportation (Cervero, 1998). Designing development within station catchments (within a 500m or 1000m walking distance) as well as at the corridor or regional scales can be aided by TOD principles. For example, here is an example of a typical corridor with high densities along a light rail or bus rapid transit corridor (Figure 29) (GIZ, 2019).

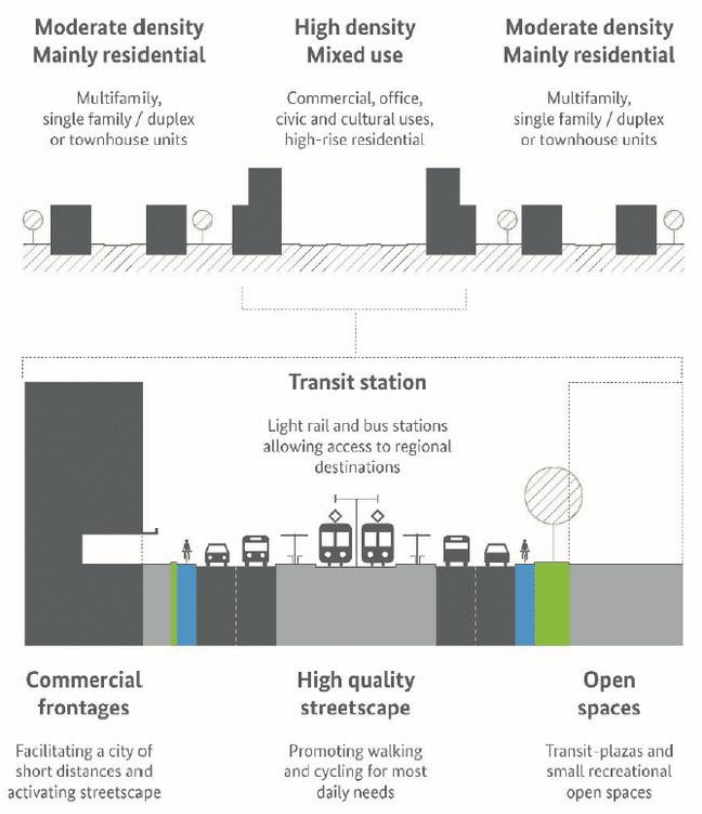

Figure 29. Transit Oriented Development (Source: GIZ 2019)

The ideas of TOD can be applied at various scales. The corridor shown in the above figure depicts the public transportation system running through the middle of the corridor, followed by higher mixed-use densities in the main corridor, and then possibly a flattening down of density when moved further away from the public transportation corridor . This system is achieved on the regional scale by having a planning of development incorporated along with the public transportation network.

Case Studies

The case studies on integration of urban planning and transport is discussed in this section. In the Netherlands, the planning and development of Houten was a new urban town development. Spatial planning at the regional size has been practiced in the Netherlands for many years according to the department of housing, planning and environment.

Figure 30. Houten New Town (Source: Schwanen 2004)

When it came to urban growth in the 1970s and 1980s, a policy of concentrated decentralization aimed in designated metropolitan centers while restricting in smaller rural villages. For more than two decades in the 1980s and 1990s, compact urban expansion was encouraged, with the renewal of urban housing stock, the prohibition of out-of-town shopping centers, and new jobs directed to places well served by public transportation (Schwanen et al., 2004). The key component of this approach was the VINEX strategy (supplement to the Fourth National Policy Document on Spatial Planning), published in 1993, in which housing development was planned over a 10-year period across multiple cities in a polycentric and compact manner. Providing new development sites and coordinating housing, industrial, and commercial development with transportation investment. Under VINEX growth location, the Houten new town plan was developed (Figure 30). The plan's goals were to keep suburbanization under control, protect open spaces from development, and improve accessibility to public transportation. Although the connection of VINEX locations to public transportation has not always been successful, new development has generally been concentrated in existing urban centers or in its extensions (Galle & Modderman, 1997).

The next case study feature Freiburg's suburban neighborhoods of Vauban and Rieselfeld in Germany. Both are well-known examples of new suburban developments that are connected to the city center by tram extensions and high-quality cycle networks. Freiburg's urban development has been praised as a remarkable example of how technology is making urban planning possible. The city has a plan where everyone is concentrated at a distance of 230-250m from the nearest tram station. As a result, the number of private automobiles on the road is drastically reduced. By reducing the use of private automobiles and increasing the efficiency of the city's short-distance transportation system, all the daily needs are accomplished on foot and within walking

distance. Freiburg is well-known for being one of the cities that has successfully translated this concept into a very high standard of living (Coates, 2013).

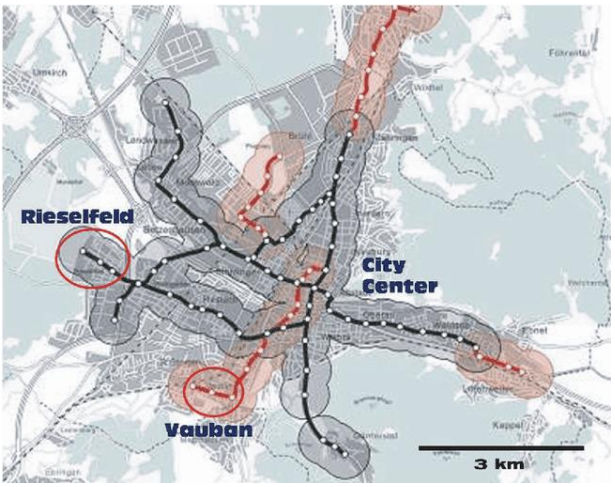

Figure 31. Vauban and Rieselfeld, Freiburg (Source: Broaddus 2010)

Vauban, one of the neighborhood development, has been hailed as a model of sustainable urban development and has received much attention (Figure 31) (Broaddus, 2010). The development contains more than 2,000 housing units and has a population of approximately 5,000 people. It was designed by the city authority with input from the residential community through the Forum Vauban, and it was constructed primarily between 1993 and 2006. Central Avenue, which is surrounded by four- to five-story residential and mixed-use developments, serves as the tram route's starting point and terminus. The neighborhood contains a hotel, schools, shops, small-scale employment opportunities, and other community facilities, and walking or cycling to many destinations on a daily basis is a viable option (Coates, 2013).

It appears that more than 60% of the journeys are made on bicycles, on pedestrian bridges or on tram lines. As a result, it creates an area that demonstrates that it is possible to construct areas that are a mixture of density and infrastructure, all of which are combined into a system in which people simply do not use their cars in the

way that the general public does (Broaddus, 2010). The layout of Vauban, as well as the abundance of communal play space, make it a popular choice for young families. This is a fantastic feature that demonstrates that if car ownership and usage can be reduced, there is a lot of available space that can be used for other purposes other than parking cars. The tram is an excellent mode of transportation into the city center with a journey time of only 15 minutes and a tram frequency of every 10 minutes (Coates, 2013).

Rieselfeld is the second new residential development in the area. It was constructed between 1994 and 2000 and is a higher density development that is primarily residential, but also includes retail, educational, employment, and other community facilities. It has approximately 4,000 housing units and a population of approximately 10,000 people. In comparison to Vauban, there is more car parking available beneath and at the rear of residential units. However, once again, the number of available spaces is limited, with approximately one and a half spaces per unit. And as a result, local ownership and usage have been preserved. A significant amount of community space has been utilized, including extensive landscaping and open space. Freiburg's comprehensive urban planning has contributed to the city's low use of private automobiles. Retailing on the outskirts of town, for example, is prohibited due to the negative impact on city center retailing, and the reliance on automobiles for visiting these types of retail developments has been reduced (Broaddus, 2010).

Freiburg is a unique city with a unique culture. It has a particular population that is supportive of environmentally friendly travel behaviors. This is a university and public sector-dominated city with high levels of education and income, as well as widespread pro-environmental beliefs. It is a difficult task to deliver these types of urban developments, transportation networks, and travel behaviors in a different

political context, with a populace that holds divergent viewpoints on the subject.

Spoorzone Delft (Railway Zone Delft) is a major redevelopment project in Delft that will cover 40 hectares and will be built around the city's new central railway station (Figure 32). Another classic transit-oriented redevelopment, this one situated on the outskirts of historic downtown and adjacent to residential neighborhoods to the west and south, is under construction. The project's impetus was the removal of the old railway viaduct, which allowed the railway to be moved into a tunnel, and then the use of the new space to construct a new railway station and municipal office, as well as approximately 1200 dwellings and offices, a city park, water features and landscaping, bicycle parking, and new road access (UITP, 2015).

Figure 32. Delft station redevelopment area (Source: UITP 2015)

The case studies demonstrates how urban planning and transport can be

effectively integrated at various scales and in a variety of contexts. The literature of urban developments and transportation system has evidently reflected the importance of its quality integration for a sustainable urban mobility. The next section explains the overview of the research study in accordance with the reviewed literature.

Overview of the Research Study

The extent of urban development over the years has exploited the natural surroundings to an uncontrollable scale. The planning and the design approaches in cities and across the country has been dominated by car-oriented lifestyles to a magnitude that the needs of pedestrians in towns were met by a subsidiary problem that often goes unrecognized. An automotive approach in urban areas in today's cities has so far changed the urban trips even small distance often done on foot, have totally changed; in most cases taken away from the urban lifestyle. This has also led to deteriorating the health of the urban environment. Urban people's physical activity has decreased significantly and the irrational use of cars has increased environmental pollution. Therefore, planners around the world are trying to mitigate the adverse effects of the growing population and the spread of cities. To that end, the need of efficient solutions are imminent for improving the humanistic transport to reduce and remove the concerns of urban sprawl and horizontal urban expansion.

The importance of the subjects reviewed in the literature has assisted the research study extensively to shape the case study in the thesis context. The study therefore analyze the planning and design approaches of Lusail City briefly according to the masterplan followed by detailed analysis of case study of Marina District. The transportation system is also taken into analysis to evaluate the effect on the urban environment of Doha. The next section presents comprehensive details of the case study of Lusail City.

The context of the Case Study: Lusail City

A new waterfront setting for living, working, and recreation, Lusail is one of the most significant developments planned for Qatar, serving as a hub for new growth. The city is expected to have a population of 200,000 people, with a transit workforce of approximately 170,000 people and a visitor population of 80,000 people. It encompasses land that is bordered on the east by the sea and on the west by the Al Khor expressway, and it extends approximately 7 kilometers north of the Ritz Carlton Hotel / Pearl Development Area. The city encompasses 38 square kilometers of land area divided into 19 districts focusing on multi-purpose residential, mixed-use, entertainment, and commercial purpose (Figure 33)(Alraouf, 2018).

Figure 33. Lusail City Districts (Source: Alraouf 2018)

Even though it is a self-sufficient urban center, Lusail is considered an extension of Qatar's capital, Doha. The two cities are 15 kilometers apart and will be linked by subways and high-speed train lines (Figure 34) (Buret, 2019). The city also contains a large number of residential units, office buildings of various sizes, and hotels. The estimated population of Lusail is expected to be 450,000 people (LREDC, 2016). The infrastructure of the city is nearing on completion stage along with additional four islands connected with the main land. Parts of the city's districts has been opened and witnessed a populace presence (QNA, 2020).

Figure 34. Satellite Map of Lusail City from Doha and inset map of Qatar (Source: LREDC 2016, arranged by author)

The city possess integrated design and comprehensive planning that has taken into consideration all of the potential disruptions that could occur during the construction and maintenance of the city while not interfering with daily activities. The city is planned to have facilities for work, leisure, and recreational activities, as well as public transportation. A few of the city's most important districts are the Marina District, the Energy City Qatar, Entertainment City, and the Fox Hills

residential neighborhood. Energy City Qatar is the region's first fully operational oil and gas hub, having opened its doors in 2010. Marina District, located in the heart of the city, is one of the 19 integrated districts planned for Lusail City (Figure 35). This integrated district is the case study area to use which includes waterfront residential and mixed-use, commercial and hotel facilities in approximately 1.8 million m² (19.3 million ft²). Currently, the Marina District is partly inhabited by residents and visitors. The district will eventually reach to a target of 103,900 after the final phase of completion (LREDC, 2016).

Figure 35. Location of Marina District (Source: LREDC 2016)

Masterplan Overview

The planned development will consist of a new, vibrant, and world-class master-planned city district and urban environment upon completion with a coherent

and self-sustaining mix of uses such as residential and mixed-use buildings as well as commercial and retail spaces, recreation and sports facilities, educational facilities, leisure facilities, and hotels. The city is home to numerous resorts and entertainment venues that will appeal to both international visitors and expatriate residents, as well as Qatari citizens and residents (LREDC, 2016).

Figure 36. The extent of Lusail City development (Source: LREDC 2016)

By implementing a planned development strategy, the existing coastal area will be transformed, and a variety of waterfront, island, and inland environments and characters will be created to complement one another. Lusail City aims to present as a place where businesses can thrive and appeal to discerning investors who are looking for freehold real estate opportunities. By utilizing the services of the LREDC, the city focus to be professionally managed and procured to the highest possible standards (LREDC, 2016).

The main aspects of the masterplan from LREDC (2016) is briefly described

as follows:

- Design: : The smart city use updated technologies in urban development to create a peaceful and secure environment. The whole city's systems and operations will be controlled by an operational control center. To keep the peace, a centralized command and control center will offer round-the-clock monitoring throughout the city. The parking will be constructed so that both locals and visitors may use it. Underground pedestrian tunnels will link the parking lots across the city. Water taxis will also be employed to transport passengers along the waterfront. The city features underground network for tram lines, gas storage and other purposes. The city also utilizes underground facility for electricity supplies through a network of purpose-built stations and underground substations.

- Transport Facilities: The city have a variety of transportation options. It features a light rail system (LRT), a water taxi system, as well as a cycling and pedestrian network. The tram network consists of 36 stations and four main tram lines situated both above and below ground, spanning a distance of 30.5 kilometres. Water taxi system connects the main locations with the islands in the city. Pedestrian network is driven by latest improvements in street landscape and amble space for walking and cycling with a safe buffer from the roads. Bicycle and pedestrians routes are planned throughout the city, which connect to the light rail system, car parks and metro stations.

- Sustainability Features: The creation of Lusail City is in accordance with Qatar Sustainability Assessment System (QSAS) guidelines. The city will use underground tunnels to carry cooling water pipelines, which will be used to

supply cooling to buildings in an ecologically benign and energy efficient way. The city will be sanitary since all garbage will be transported to the recycling center via a vacuum network. Sewerage will be delivered by subterranean pipes to a treatment facility, where it will be processed. The treated wastewater will be utilized to irrigate the city's green open spaces.

The vision for Lusail is for a 21st Century Capital City Quarter, offering a broad array of quality leisure facilities, with a range of well-planned neighborhoods designed to appeal to visitors, residents with different needs and aspirations. Lusail has been developed as a holistic masterplan, featuring low to medium density development comprising a number of different communities designed and planned to compliment Doha's existing facilities and features (LREDC, 2016).

The guiding principles relate to the communities the masterplan will ultimately serve, as well as the networks underlying the masterplan for site-wide access and utility provision. These are scaled to fit the density of the urban form of Lusail. The principles reviewed from LREDC (2016) is explained in summary below:

- Identifiable, self-contained clusters – ensuring each neighborhood and cluster has its own sense of place and special character.
- Complete communities – providing the necessary facilities for each neighborhood including public transport facilities, local shops and other public and recreational services.
- Fixed densities – the capacity of the masterplan's infrastructure is finite and been scaled to accommodate the fixed target proposed.
- Green communities – extensive use of soft landscape is made possible through the creative reuse of available recycled water.

- Hierarchical infrastructure – roads and access infrastructure have been designed as efficient and legible series of connected routes designed to serve the needs of residents, businesses and visitors.
- Landmark waterfront – world-class attractions and vibrant outdoor spaces connecting the marinas, promenades, beaches and waterfront residential areas as a cohesive edge to the development
- Gateway Identity – key vehicular entrances to Lusail and its districts are marked with high quality built form and landscape to promote the project.
- Cohesive urban design – a simple system of codes are applied to the built form and landscape of the development to ensure each parcel meets the masterplan's intent.
- Climatically responsive – planned and designed according to the national GSAS code for sustainable construction, ensuring resource and energy consumption is minimized while maximizing quality of life.

As these main principles are set based on the vision, the city masterplan has formulated certain sub-strategies that focus on the above principles. They are classified in the below table:

Table 3. City Masterplan Strategies (Source: LREDC 2016)

Category	Masterplan
Integrated Transport Strategy	Integrated with future highway network department
Transport Infrastructure Underground	Light Rail Transit(LRT) below grade
Sustainable Utilities	District Cooling, Pneumatic Waste Collection Gas Network
Lusail City Fiber Optic Network	Infrastructure including Lusail Command and Control Center (LCCC), Smart City services and Telecom services
Smart Home	Automation with renewable and reusable strategies

These guidelines broadly defines the overall expected target to be achieved after total completion of the City. Most of the guidelines are standard principles taken into consideration during the planning stage of the city from scratch. However, these principles are determined after the completion of the city.

This research focus mainly on city's transport infrastructure and its sustainability outcome with respect to the surrounding environment of Doha. The sustainability outcome refers to the urban mobility generated in the city. As mentioned in the city's vision, the sustainable utilities focus mainly on the climatic and environmental factors. In the literature as reviewed in other case studies, the importance on travel movements has a significant impact on measuring city's sustainability. The masterplan confines to particular areas of sustainability resulting to initiate finding gaps in planning to research more on the sustainable travel strategies for the city.

Marina District

The Marina District is a modern business district located strategically in close proximity to the city's waterfront. Marina District, located on the southern edge has been designated as the future Downtown of Lusail City due to its strategic location and panoramic views of the Arabian Gulf. It consists of 105 plots of land covering an area of 183 ha intended for the construction of high-rise towers for office, residential, mixed-use, retail, and hotel uses, with a total built-up area of approximately 3.2 million sqm. It is connected to a waterfront boardwalk and served by an underground Light Rail Transit network, which connects the entire area (LREDC, 2016).

LREDC expects the Marina to be a busy district where all proposals and developments contribute to the creation of a vibrant waterfront downtown with a high-quality built environment. All developments in the Marina District are intended to contribute to the achievement of the urban design goals described in Table 4 (LREDC,

2016).

Table 4. Urban Design Goals intented to achieve in Marina District, Lusail (Source: LREDC 2016)

Design Goals	Development Plan
Character of Place	Create a place with a clear district character areas and identity
High Quality Street Character	Create a place with high quality streets where buildings and public and private spaces all integrate to deliver an attractive street environment
Perceptible Massing & Form	Create a place that has a clear image and is easy to understand
Quality of the Public Realm	Promote public spaces and routes that are attractive, safe, uncluttered and work effectively for all

The District is intended to be a bustling and vibrant waterfront downtown district with high-quality buildings, streets, waterfront, parks, squares, and public realm, all of which will be accessible by public transportation. It will be distinguished by high-quality designed towers ranging in height from 12 to 50 stories, with the height of the towers increasing westward to take advantage of the spectacular views over the Gulf. The district is selected as the case study as it is operational and the research analysis is organized as of the present conditions.

Figure 37. Marina District Masterplan (Source: LREDC 2016, arranged by author)

The district is the first phase of city development and serves as the city's vibrant heart. The district consists of light rail transit connects the buildings, which are designed in an international contemporary style. The transit network connects the Marina District to the rest of Lusail City and underground stations, all of which connected directly to underground car parking facilities (LREDC, 2016). The District is highly accessible from Doha favored by the vast road infrastructure connected to the city. The Lusail Expressway road runs along the west periphery of the district providing easy access to the area (Figure 36). The district attracts mobility due to the towers engaged in business activities taking place in the area. The district also caters the leisure activities along the waterfront with long promenades. The site also is concentrated with social and public engagement attracting more mobility on weekends and holidays. Apart from that, the remaining district construction works also contribute more travel activities.

CHAPTER 3: RESEARCH DESIGN

According to the available evidence, only a few of the projected benefits of sustainable cities and features of these new ‘sustainable' urban forms have been assessed, and the results are uncertain. However, while it is possible to identify specific gaps in knowledge, there is also a more fundamental issue that needs to be addressed. There is a significant lack of evidence-based observation, prediction, and theory about the extent to which urban form as a whole contributes to sustainability, even in cases where successes have been identified and positive claims made. Many of the issues in this broad area are intertwined and at odds with one another. There may be many compromises necessary to achieve progress in sustainability while also meeting the needs of users and local residents. For the study to effectively address the issues and close some of the gaps in knowledge, it was necessary to employ reliable methodology (Jenks & Jones, 2010).

The outline involved in the research aims to achieve a pragmatic approach to analyze the form of urban development and the travel behavior in the case study area. The research design is developed based on the reviewed literature to identify and assess the impact of sustainable cities. However, in accordance with the research questions, the study’s focus lies on the urban mobility of the case study and its footprints on the urban form of Doha. Jenks and Jones (2010) explained in their book about the method to examine the dimensions of sustainable city. Based on the described procedures, the methodology for the thesis is developed to assess the case study. The layout of data methods is further explained in the next section followed by the structure of the data assessment in the research.

Methodology

The methodology introduced aims to integrate the aspects of urban form that

have been identified as having an impact on sustainability. Urban forms are measured and analyzed using methods such as measures of accessibility, building typologies, digital map footprints and configurations using online CGIS (Center for Geographic Information Systems) Qatar Geoportal maps. The transportation impact is measured and assessed mainly by travel activity diaries and field surveys. The research was based on the selection of the case study area of Marina District in Lusail City as the focal point of the investigation. The investigation was conducted based on the urban form of the district and its transportation. To understand the terms of methodology, the case study refers to the data of Marina District. Another term is city-wide which provides data involving about Doha City. Therefore, the investigation was focused from the district and carried out using the methods illustrated in the Figure (38).

Table 5. Methodology of study used in the Thesis (Source: Jenks & Jones, Author)

Variable	Data sets
Urban Form	Land use, Building typology, Building heights (massing)
Tranportation	Transit network, Modes of transport, Road hierarchy and Streetscape cross-sections
Environmental	Open space masterplan, Public realm strategy, Design framework
Social	District-based travel activity diary
Economic	Location-based travel mode choice data maps

It is necessary to analyze these large and complex sets of data in order to identify urban forms that are beneficial, those that are problematic, and those in which conflicts between and within the sustainability impacts arise. The data sets are categorized to the respective variables accordingly. When dealing with significant data sets, the ideal variable should be able to reduce it to its most basic form while still retaining the

essential meaning retrieved from the data. To provide a foundation for the research that was carried out in each aspect of the variables, site observation and mobility survey were utilized in the study (Figure 39).

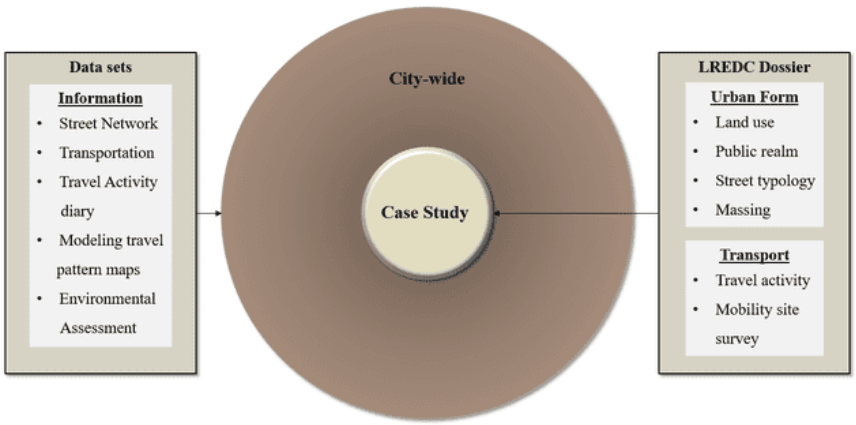

Figure 38. Methodology Illustrative Chart (Source: Author)

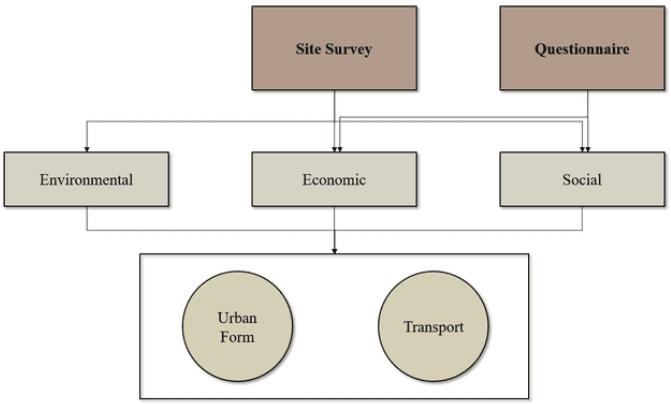

Figure 39. Flow Chart of Common Methods (Source: Author)

The literature in population sampling was utilized and reviewed to determine the sample size for the questionnaire survey. Since the case study site is structured both by resident and working population, the present demographic data is unknown. In these circumstances, the determination of the sample size can be obtained by most common

formula described in the statistical research literature. It is possible to calculate the sample size required for accuracy in estimating proportions when the population is unknown by taking into account the standard normal deviation values are set at minimum percent of confidence level, the percentage of people who make a choice or respond and the confidence interval or margin of error (Sullivan, 2020). The formula for sample size *"n"* is used as below: (Sullivan, 2020)

$$n = \frac{Z^2(p)(1-p)}{E^2}$$

- "Z = standard deviation value determined by the corresponding percent of confidence level usually set at 95%. The standard deviation value according to the Z scores for 95% is 1.96.
- p = population proportion of making a response is described as percentage of value (0 to 100%). The value is 50% if the response is not sure.
- E = margin of error or confidence interval is explained as the percentage of expected sampling error in the survey due to random sampling normally at 5%. The acceptable range varies 4% to 8% at Z = 95% confidence level."

In the case study site, the population proportion (p) is taken as 50% as the survey questionnaire expects response from population from both resident and non-resident population. The margin of error is set at 8% range since the questionnaire data is about travel activity diary where percent of error in terms of distance travelled, commuting time, traffic and period of the day which also depends on weekdays and weekends. As a result, the sample size with the input values will be, $n = \frac{1.96^2(0.5)(1-0.5)}{0.08^2} = 150.06$. Therefore, as per the calculation, the survey questionnaire covered 150 participants in the case study site. The questionnaire data is detailed in the findings and analysis chapter. The structure of the theory involved in questionnaire form and travel activity

diary is explained further in the next section.

Structure of Research

The key to achieve desirable analysis was by carrying out the questionnaires and surveys in the site as mentioned earlier. The constraints in site were analyzed to conduct the procedures described in the methodology. A trial site study was initiated to assess the site in order to pre-determine the feasibility of the research. Since the thesis focus on analyzing the sustainability in accordance with the transportation, majority of the questionnaire and survey were developed based on transport and urban form respectively followed by the social, environment and economic aspects.

The focus of the research attempts to find the extent of developing a sustainable urban mobility. Based on the case studies reviewed in literature, the guideline principles to achieve is the driving force at the background from collecting data through questionnaires and site survey. Since all the data retrieved through these procedures are inter-related and serve to each other, the relationships between the urban form and transport in the context is determined much efficiently. The research structure is also stimulated by the optimal solutions reviewed in the literature to develop and organize into an outline of sustainable urban mobility model (Figure 40) (Jenks & Jones, 2010).

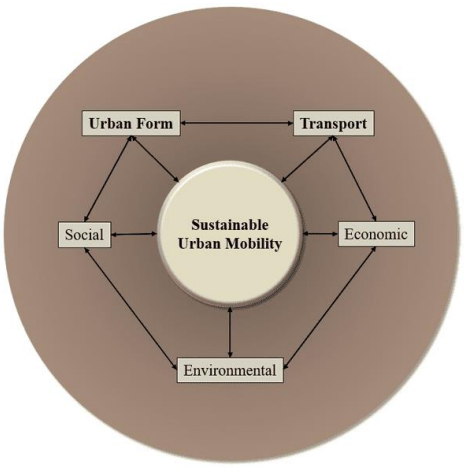

Figure 40. Research Structure (Source: Author)

CHAPTER 4: DATA FINDINGS AND ANALYSIS

The chapter introduce to the core part of the study where data is assessed to the context and organized based on the methodology. The case study has its boundaries predefined as discussed earlier, since the whole city of Lusail cannot be taken into consideration due to the ongoing development. Therefore, Marina district is the center of the case study where data collection is carried out. The data collection is based on the city's planning and design guidelines by LREDC masterplans followed by site survey including travel activity diary and questionnaire. The chapter involves collection of data and analysis discussed in the succeeding sections.

The fundamental part of the research is occupied by data collection. The quantitative analysis were primarily categorized into visual data maps, survey questionnaires, site observations and retrieving authorized statistical data. These categories strengthens the research study in order to produce results and conclusion. The collection procedure was articulated based on research need - the questions formulated for the research. To address the urban mobility of Lusail, how it interacts with the urban structure of Doha is carried out through collecting data based on the developed methodology as explained earlier in the previous section. The city-wide data is collected at first followed by a detailed data sets from the case study. The survey questionnaires utilized in the findings are addressed after the masterplan data collection and a section for summary of findings is added to briefly discuss the mobility analysis carried out for the district. After the summary, the recommendations for incorporating sustainable measures in urban mobility is put forward encapsulated as the last section of the chapter.

City-wide: Doha

The urban form of Doha and the transportation is overviewed in the section. The

data contributing to the variables is collected from authorized sources. The data utilizes the mobility pattern generated from the urban street network of Doha. The map of Doha retrieved from the GIS portal of Qatar depicts the city-wide street network. Doha is extensively served by a range of highways and roads taking the ring shape encapsulating from the old area developing a parallel pattern as it goes further away from the coast towards the west (Figure 41) (CGIS, 2021). The highways and roads are vehicles oriented design with most of them not utilized with pedestrian infrastructure. The huge increasing number and accumulation of cars has forced the urban form to provide more space allocation for cars. As a result, the roads are wider causing to decrease the pedestrian connectivity. All major roads serve considerable amount of traffic congestion during work hours, weekends and holidays.

Figure 41. Street Network of Doha (Source: CGIS Qatar)

The urbanization of Doha has facilitated to expand the street network away from the coast. The suburbs formed as a result were served and connected by vast highways with complete focus for vehicles. The private car ownership is a huge driving factor in shaping up the mobility pattern of Doha. The street network easily contribute much higher accessibility to all the major parts of the city. Lusail, the planned city

development is also favored by the installation of highly accessible street network on the outskirts of Doha. The amount of travel activities has also increased towards the Marina District as well as notable concentration is witnessed in the case study site. The lack of proper public transport infrastructure is evidently visible in terms of the street design, planning guidelines and public awareness for increase in ridership.

Public transportation in Doha is majorly set out by metro and bus services. The metro service has been recently commenced its operation in late 2019 with three lines of network mostly laid under the ground level to serve the metropolitan city (Qatar Rail). The layout provides connectivity to the major town centers and important suburbs of the city. The network is based on a central station in Msheireb, the downtown of Doha. The network provides three lines constituting of red, gold and green (Figure 42). The red line covers more stations and serves as the main line of the network that encompass the north and south suburbs of the city respectively. The north is served to Lusail, the case study area and the south connected to Al Wakrah. The remaining lines serves other major town centers of Doha.

Figure 42. Doha Metro Network (Source: Qatar Rail)

Prior to the metro services that were recently operational, the public transportation were mostly handled by the bus network. The network provides a system of bus stops in the city where it serves its major parts with shuttle services. The bus network also follows the metro pattern of central-based station acting as the main hub station located in Al Ghanim (Figure 43) (Mowasalat, 2017).

Figure 43. Doha Bus Network (Source: Mowasalat 2017)

The street network and the public transportation data for the city-wide is obtained to understand the mobility pattern produced and the travel behavior of the people. The metro service has linkage to most of the major town centers and commercial areas where most of the stations has metro link – a feeder bus shuttle

service that operates from and to the station to its nearby neighborhoods and metroexpress – ride sharing feeder van service that operates in selected metro station (Rail). Apart from that, most of the stations has a transit stop to interchange the mode of transport such as public bus and taxi services. In some stations, public bicycle services has also been installed. The public taxi services named as Karwa is operated at large scale around the city. Taxi ridership services in the city is also distributed by private entities such as Uber and Careem Taxi. The public use of modes of transit network is engaged by the metro, bus and taxi services.

Figure 44. Doha Metro Red Line (Source: Al-Thani 2018)

The Lusail station is located on the north end of the red line as shown in the above Figure 44 (Towards the left) (Al-Thani, 2018). The station is placed on above ground level situated at Al Khor coastal road. The station is at a distance of 6km from the Marina District. The station, however; does not provide metro link or metroexpress service access to the case study area or to Lusail at the time of site observation for the thesis study. But the study has observed case study area has been covered by metro link service from the nearby Qatar University metro station and metroexpress service from

Legtaifiya metro station (Rail). Further data about the station is provided at the end of next section particularly organized on the case study district.

Case Study: Marina District, Lusail City

The data collection involved for the case study was mainly obtained from the LREDC and site survey. As mentioned earlier, LREDC is the city master developer having the data which provides documents of masterplan strategy maps of land use, building heights, public realm, transportation and open space of the district. These prepared and finalized maps are the core data used and are supported by the site survey and questionnaire for research analysis. These maps are depicted and analyzed to visually understand the nature of development in the district. The maps helps to review and explore the design and planning guidelines initiated and examined in the creation of the district and its sustainability. The LREDC also provides a clear overview of all the process involved in planning stages. The district based strategy data maps retrieved helps to provide in-depth description about the Marina District and its urban character.

The strategy maps of the district are utilized accordingly to the designated methodologies explained in the previous chapter. Based on the explained methodology, the chapter is divided into sub sections of each element particularly analyzed on the urban form, transportation and environment which are supported by the maps. The survey questionnaire and its analysis is explained after the above mentioned sections which provides data on all the elements especially on the remaining social and economic elements. This way of approach was used to provide clear understanding and to support the analysis part of the data in a more convenient manner.

Urban Form

The framework of masterplan maps for Lusail city development has been evolved since 2006 (LREDC, 2016). The urban form of city is described in this section

by presenting the masterplan maps. The data sets from the LREDC is keen to help understand the necessity of a sustainable city and its design framework. The data also helps the context of Lusail in regional scale emphasizing the need of the research. The section involves the physical characteristics of the city in terms of land use, design and configuration of settlements, public realm, building typology, building heights etc.

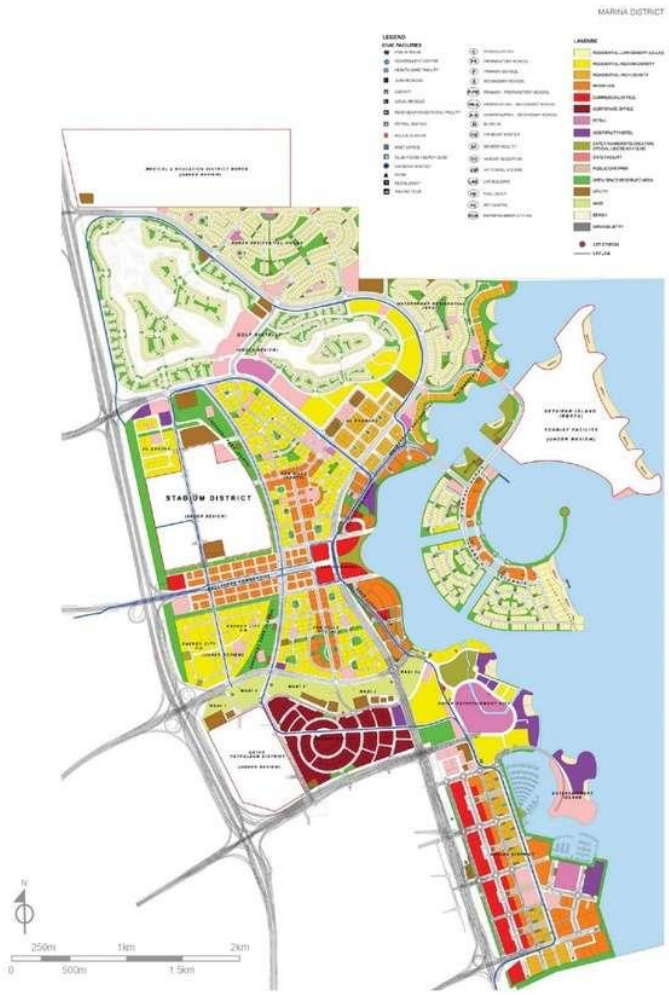

Figure 45. Land use plan (Source: LREDC 2016)

The Lusail Development plan strategy on land is served through a variety of offices, leisure and entertainment venues, retail establishments, and educational facilities. Each district in the city has designated land uses. The latest land use strategy

plan is illustrated in the above Figure 45. The Marina functions as the central business district (CBD) of the city. The Lusail Boulevard perform as a gateway to the city with a variety of commercial and residential involvements. The boulevard also facilitates a tram network on the ground designed as per the masterplan. The Fox hills district serves a major residential district of the city located towards the north. The Stadium District in Lusail City has been designated as the focal site for the 2022 FIFA World Cup Flagship Stadium, being the tournament host. To accommodate World Cup events, the most recent land use framework incorporates new sporting attractions into the plan. Mixed use development is provided in each district with zoning regulations. The above figure also depicts the zoning of the permitted land uses in Lusail City based on their location. The city though possess a large area on the coast, the islands constitute entertainment activities (LREDC, 2016). In a brief, the development incorporates the following elements: (LREDC, 2016)

- Residential: Luxury villas and apartments.
- Community services: Civic offices, schools, clinics, mosques, parks and open spaces.
- Hospitality: Hotels, residents' clubs.
- Entertainment: Arenas, stadia, theme parks and Water-related venue activities.
- Commercial Development: Open retail (boutique shops and restaurants), local/ neighborhood shops, corporate offices, mixed use development.
- Amenities: beaches, golf, marina berths.

In order to ensure that the predicted resident and worker population is served by transit, infrastructure, amenities, and open space networks, the land-use distribution and scale of development for Lusail City have been meticulously planned. The overall masterplan's land-use zoning and development scale are to be maintained and adhered

to as much as possible (LREDC, 2016).

The city of Lusail boasts a large number of waterfront properties. The beach and shoreline protection that has been completed and constructed remains unchanged as per the guidelines. Further proposed modifications is required to comply with all applicable Authority standards and permits, as well as the design aspirations of the Master Developer, before they can be implemented. There are several types of proposals that extend beyond the waterfront boundary line, such as jetties, walkways, pontoons, and other boat landing and mooring facilities. In order to protect the privacy, use, and character of adjacent plots and public areas, no waterfront development is permitted that creates a negative impact on these factors (LREDC, 2016).

Figure 46. Marina district land use distribution (Source: LREDC 2016)

The Marina District consists of three major land uses: office/commercial, residential, and mixed use. The Marina District is divided into three zones: shopping center, a hotel site, and a marina bay as the focal points of the mixed-use development. Public civic facilities, such as schools and a mosque, are located in a central location in

order to provide equal service to the entire district's resident population. At the prescribed master plan density, these uses will be able to support a resident population of 27,000 people, a working population of 45,000 people, and an estimated 6,000 visitors per year ((LREDC, 2016).

Figure 47: Block typology (Source: LREDC 2016)

The guidelines and controls are based on the color-coded plan depicted above in the Figure 47. The plots has been classified according to its land use, built-up area, morphology, or geographic location. This is done in order to create units that are similar and related to one another for comparison, which are referred to as “Block Typologies”. Often incorporating more than one plot, these provide an explanation of the vision for the various components as well as how they work together to achieve the district vision.

Figure 48. Building heights map (Source LREDC 2016)

Figure 49. High-rise towers, Marina District (Source: Buret 2019)

The height and intensity of development increase in the residential and office/commercial neighborhoods, in order to preserve the best possible views of the sea from east to west (Figure 49). Commercial and mixed-use buildings form a development cluster in the District that has the highest building heights and the highest

development intensity or massing as termed in the guidelines. Despite the fact that its prominent sites have the highest buildings, the southernmost area of Marina District is the least densely developed part of the district.

Figure 50. Primary Frontages (Source: LREDC 2016)

It is necessary for the building frontages to be consistent with the overall vision for the district, neighborhood and block when defining the character of a street. The district is distinguished by a number of clustered plots that serve to define specific neighborhoods. They are used to define primary frontages that should be activated either through use or through design of the system (LREDC, 2016). The frontages are observed in the site with safe buffer distance from the road favoured by streetscape and shade from building heights (Figure 50).

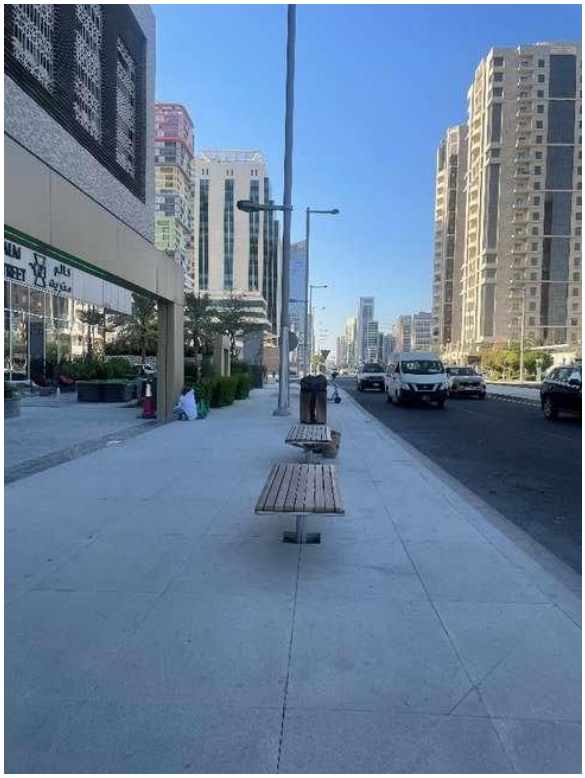

Figure 51. Frontages and streetscape of the District (Source: Author)

A primary frontage is identified on each plot in the plan to the left in order to inform the design of the building on that plot. Developments are ensured that the main entrance has direct access to the primary frontage of the building, the drop-off area is connected to the building lobby and the prominence of the building entrances is increased in order to improve pedestrian visibility (LREDC, 2016).

Transportation

In order to ensure a seamless connection with the rest of Doha and beyond, Lusail has implemented a number of transportation and infrastructure initiatives at the city level. This includes the Light Rail Transit (LRT) tram, bus, and ferry networks, as well as facilities for bicyclists and pedestrians on the streets and sidewalks. The planned public transportation system allows to facilitate seamless movement between residences, places of employment, open space, and recreation areas. The plan shown in

the below Figure 52 depicts the fully developed transportation network that serves Lusail as a whole, as well as each district and parcel within it. As the backbone of the city's utility infrastructure, Lusail's proposed road network incorporates the city's electrical distribution networks and systems, as well as its water supply networks, surface water drainage systems, irrigation networks, sewerage networks, and telecommunication systems (LREDC, 2016).

Figure 52. Transportation Strategy Masterplan (Source: LREDC 2016)

The LRT tram network consist of four lines numbered as 1(turquoise), 2(orange), 3(purple) and 4(pink) respectively with 35 stations as per the masterplan (Figure 52). The purple line of LRT serves as the primary transit link from the center metro station to the city in round shuttle services through the Lusail Boulevard district.

The purple line acts as the spine of the network in which the rest of the tram lines shares its transit stations according to their network configuration in the city. The orange line serves the Stadium District, Energy City District and the Marina District. The turquoise line of LRT covers the north residential and waterfront areas and the Marina District. The pink line primarily provides the connection between the north residential areas particularly Fox Hills to the Marina district. Apart from the trams, the water taxi network consists of two routes operating at different stops around the Waterfront District, Qetaifan Island, Entertainment City, Entertainment Island and Marina District respectively (Figure 52).

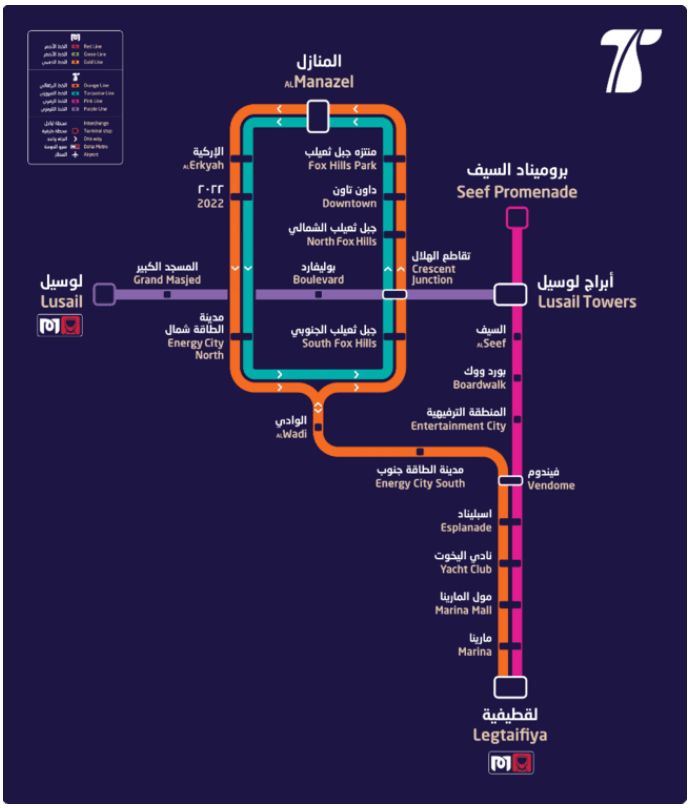

Figure 53. Lusail Tram Network (Source: Qatar Rail)

However, the tram network of masterplan proposal was under review process by Qatar Rail and in turn presented a revised network configuration maintaining the

same number of lines but reducing the number of stations (Rail). The transit connection between metro and tram services for the Lusail City is provided by two interchange metro stations at Lusail and Legtaifiya through the red line of Doha Metro (Figure 53). The network now consists of 25 stations where 15 stations are at grade level and 10 stations at underground level (Rail).

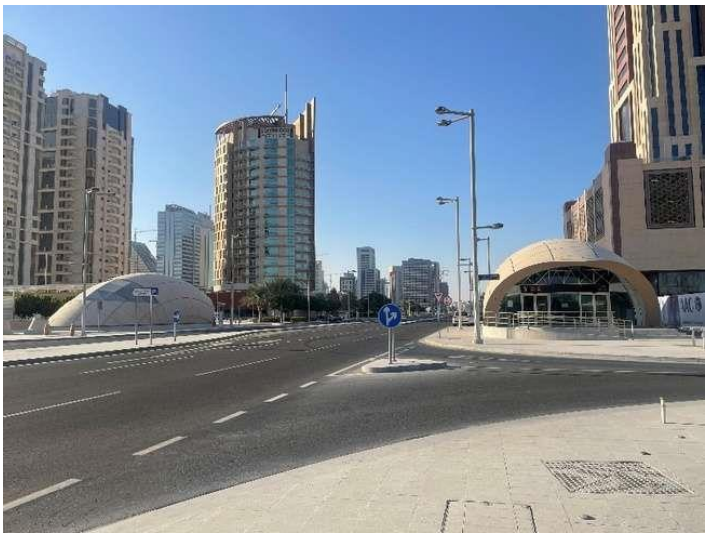

Figure 54. Tram station entry/exit point, Marina District (Source: Author)

The mass transport network in Marina District is designed with underground tram lines (orange and pink) on the promenade area close to the coast. The district consists of four stations at successive interval placed all along on same road connecting the north and south side of the district at a span of 1.5 km (Figure 55). The entry/exit point for each station is located on ground level as seen in the above Figure 54 . They are given on both the sides of the road in order to avoid pedestrian movement crossing over the road. During the site survey, it is observed that the pedestrian shed zone for the station is not continous as per the masterplan. The roads in the neighborhoods aree favoured for smooth passage of cars. The pedestrian crossings are provided only on intersections. Out of the four stations, two stations are placed at midway of the road

with no pedestrian connections on both parcel sides of the road. However, they are connected underground by the station to provide easy and smooth passage. Nonetheless, the weak pedestrian connection on ground level is observed with unclear designated passageway and no proper signages.

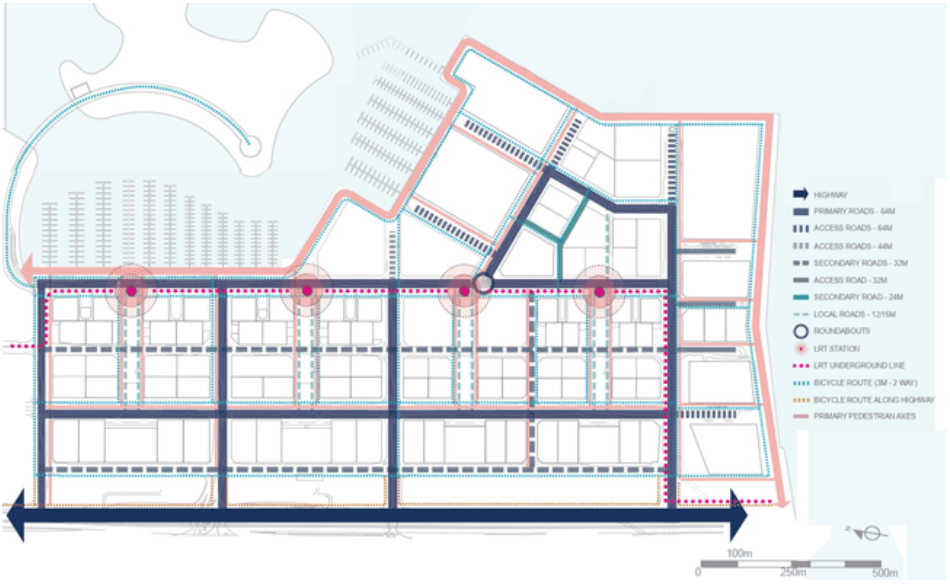

Figure 55. Road hierarchy of Marina District (Source: LREDC 2016)

The road network in the district has primarily divided into primary, secondary and local roads depending upon size and configuration (Figure 51). The primary roads are the main connectors from the highway(Lusail Expressway) road (Figure 56). They are the internal thoroughfares that provide access to the site from other parts of the city. Four gateway points from the highway is designed for the access. The primary road corridor has a width of 64m with desginated streetscape (Figure 57). In other context, these roads act as access roads mainly providing access towards the waterfront. Roadside tree planting, in conjunction with sculptural ground cover, grasses, and shrub planting, serves to frame the road and create a buffer between traffic and the footpath on both sides. On the central median, additional shrub and tree planting is being done

to complement the existing landscape (LREDC, 2016).

Figure 56. Lusail Expressway (Source: Buret 2019)

Figure 57. Primary road cross-section (64m and 44m respectively) (Source: LREDC 2016)

The other primary road of width 44m are the downgraded versions of the main arterial routes (Figure 57). They provide access to the mixed-use plots along the waterfront. Tree planting on both sides of the road with parallel parking are provided to frame the road and create a buffer between the traffic and the footpath on both sides. On the central median, additional shrub and tree planting is being done to complement the existing landscape. Apart from that, Lusail city specifications are followed in the

construction of bicycle route on one side of these roads in specific locations (LREDC, 2016).

The Secondary Road corridors are treated in a similar manner to the Primary Road corridors, but they only have two lanes and no central median to distinguish them (Figure 58). Parallel parking, in conjunction with double street tree planting, frames the road and serves as a buffer between the traffic and the footpath on both sides of the street. Bicycle routes are installed on specific location of these roads depending upon the land use.

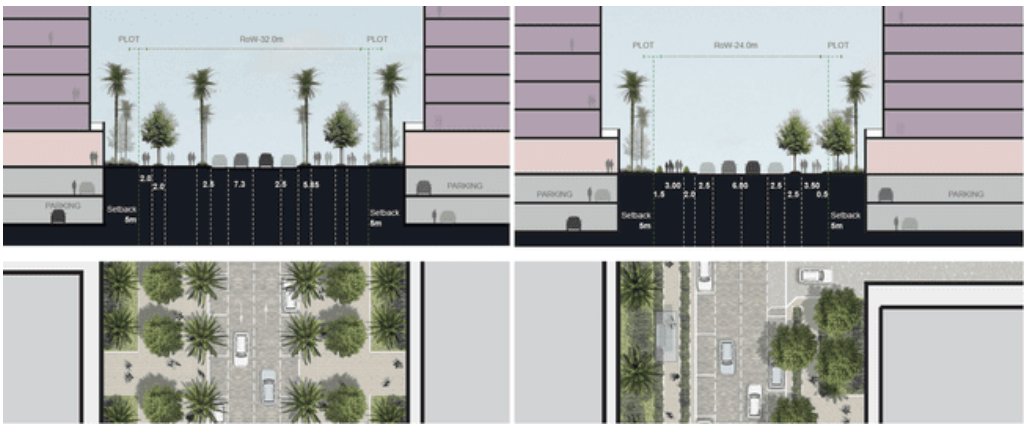

Figure 58. Secondary road cross-section (32m and 28m) (Source: LREDC 2016)

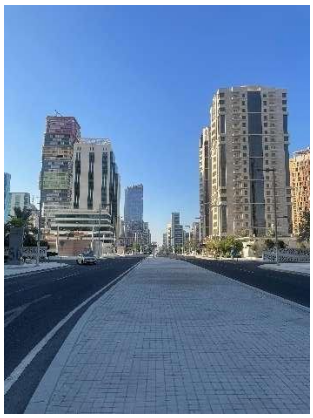

Figure 59. Observed view of Secondary Road (Source: Author)

The Local Urban Access Road corridors are treated in a similar manner to the

distributor road corridors, with the exception that they do not have a central median. On both sides of the road, street trees, groundcover, and planting buffer footpaths are provided. Local Roads are the smallest roads with a width span of 12m to 15m and they are located on the green parks that surround the residential and mixed-use plots of its periphery within the blocks (Figure 60). They are divided into two lanes with parking on one side of the road. On the public space, there is no street planting available. In order to complement the streetscape image, a complementary planting buffer with trees is established within the private plot setback (LREDC, 2016).

Figure 60. Local road cross-section (12m/15m) (Source: LREDC 2016)

Figure 61. Observed view of Local Access Road (Source: Author)

The road cross-sections for all the different types of roads as designed in road hierarchy masterplan is observed on site. As anticipated the primary roads serves with more accumulation of vehicle as the main office towers and cafes are accessed via the primary roads. The access roads in the district is utilized more to the residential towers as observed from site survey. Although strict emphasis is placed as per the masterplan, the survey observes that the pedestrian network and infrastructure needs to be experienced on ground as the flow of passage is often disturbed by improper connections which is analyzed in the next section in detail.

Environmental

The city is planned to commit and follow to the principles of sustainability and the construction of environmentally friendly buildings. Therefore, all projects in Lusail is required to achieve a Global Standard for Architectural Sustainability (GSAS) two-star rating under the Gulf Organization for Research and Development's (GORD) GSAS rating system before they can be approved. All projects in the city is conceptualized as "green" buildings from the beginning of the design process, with sustainability strategies carried forward throughout the project's design development and construction. The procedures is demonstrated at all stages of the development review and approval process, including the pre-development stage. GORD is in charge of administering GSAS and is the organization that determines the star rating of a building. In the course of the development review process, GORD collaborates with LREDC and is consulted early on in order to determine what is required to achieve the star rating the project is attempting to achieve. GORD and LREDC expect all buildings and landscape areas to comply with the GSAS system. This applies to building performance, which should be designed to minimize energy consumption and water consumption, as well as landscape areas, which should be planted with native and

drought-tolerant plant species and irrigation systems that use little water (LREDC, 2016).

A vital component of Lusail's sustainability-driven principles, as well as a critical component of the city's overall movement strategy is its extensive network of open spaces and green spaces. There is a comprehensive network of walking and bicycling paths that connects all neighborhoods to all major parks and waterfront areas. The masterplan aims to achieve for all residents, employees, and visitors a convenient access to city's amenities without the need to rely on automobiles (LREDC, 2016).

Figure 62. Open Space plan of Lusail City (Source: LREDC 2016)

The plan depicted in Figure 62 outlines the various open space components, as well as their relationships to their immediate surroundings and the waters of the Arabian Peninsula. The city has been designed with open space and access to parks, recreation areas and the waterfront at its very core. When it comes to the creation of Districts and Neighborhoods, Lusail tries to understand the importance of quality open space and public realm. The open space network in Lusail not only provide public spaces for general outdoor enjoyment, but also critical in fostering a sense of community and belonging among residents and visitors alike. Parks and open spaces in the District serves as a focal point for the community and a source of local identity, as well as a venue for localized neighborhood activities (LREDC, 2016).

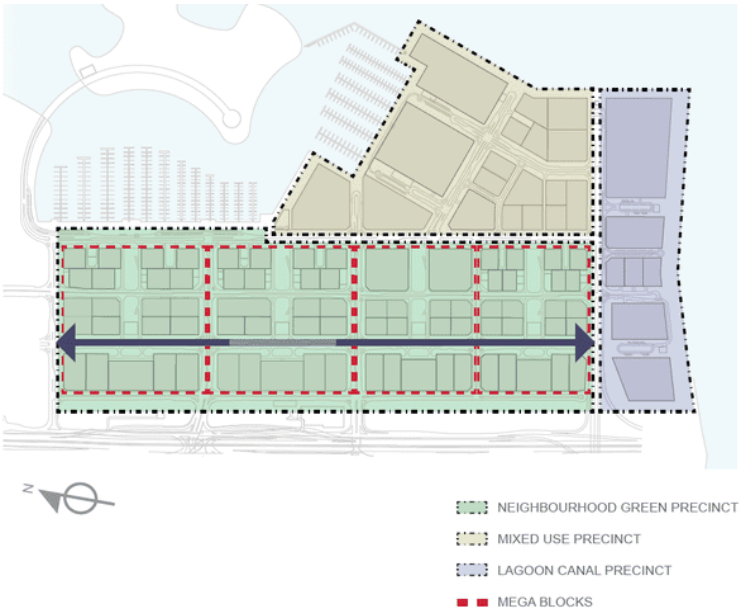

Figure 63. Character of place in Marina District (Source: LREDC 2016)

The district is further divided into precincts, a term used in the masterplan meaning certain area of blocks with defined boundaries in the district (Figure 63). The precincts are formed based on the character of the area. There are three major precincts area in the district which are Neighborhood Green, Mixed Use and Lagoon Canal

precincts. Each Marina District precinct is subdivided into smaller permeable blocks, which allow for a variety of different travel patterns to be utilized. The blocks have a rectilinear shape and possess urban grid pattern (Figure 64). This block structure provides a strong sense of orientation and tries to provide convenient movement. Key landmark buildings are identified as those that are located at critical intersections of the primary and secondary axes that are created by the rectilinear grid. The gateway structures are those that mark the beginning of each of these axes. When the vista terminators close, the green finger corridors that begin at the waterfront come to an end (LREDC, 2016).

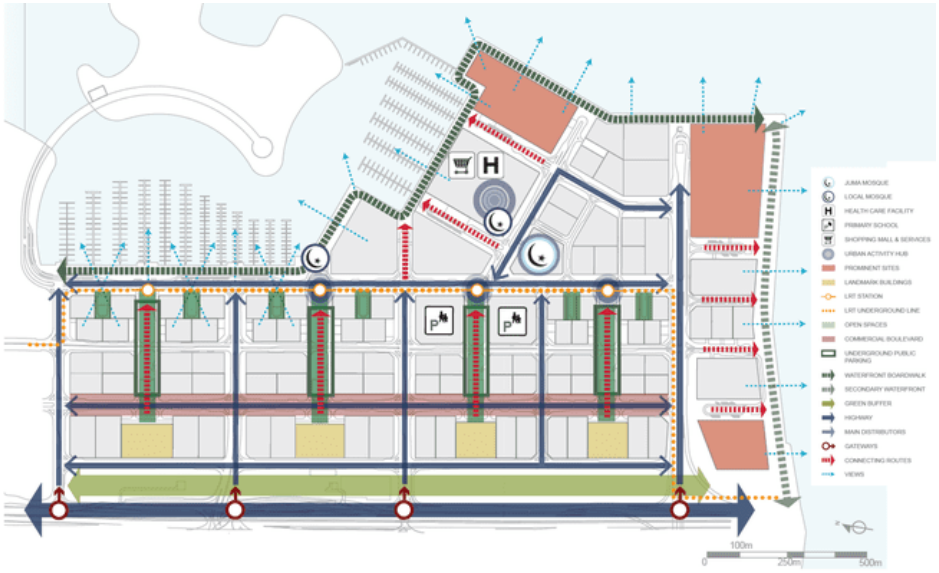

Figure 64. Urban Structure (Source: LREDC 2016)

The design framework focused on the district is to provide a healthy correlation with the open spaces and public realm. The urban structure is designed to facilitate the precincts with high accessibility. Additionally, the landscape design is treated with the inclusion for private plot to public area interfaces which include with sidewalks, points of access, streets and open spaces (LREDC, 2016).

Figure 65. Pedestrian Axes, Marina District (Source: Author)

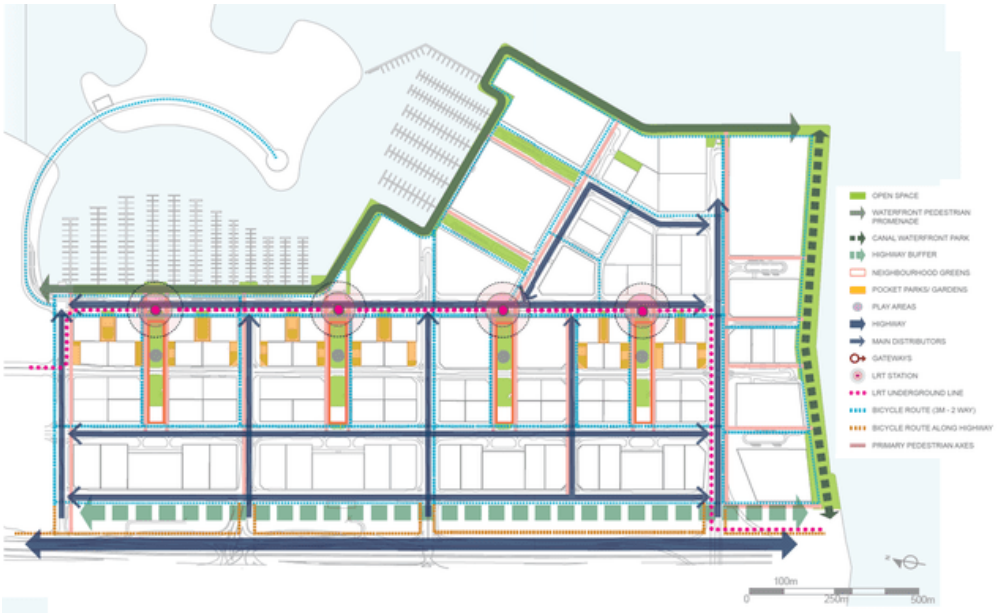

Figure 66. Public Realm Strategy of Marina District (Source: LREDC 2016)

The open spaces in the Marina District are being planned to provide a variety of outdoor experiences and spacious urban environment (Figure 66). These open spaces, in conjunction with street trees and landscaping on private plots contributes to the development of a vibrant public realm that aims to provide both passive and active recreational opportunities. In its waterfront location, the pedestrian promenade supports

leisure activities along the northern segment and more intense urban activities in the southern mixed-use area. In the masterplan, the strategy map depicts Neighborhood Green precinct to sustain dense concentrations of activity that are associated and generated by users of the LRT, underground parking garages and residents in the surrounding area (LREDC, 2016).

The District's zones are organized into separate precincts depending on the character of the place as described earlier. They are Neighborhood Green Precinct, Mixed Use Precinct and Lagoon Canal Precinct. The data about the urban character of each precinct is collected in detail from the masterplan. The open space and public realm for each precincts is planned depending on the design guidelines (LREDC, 2016).

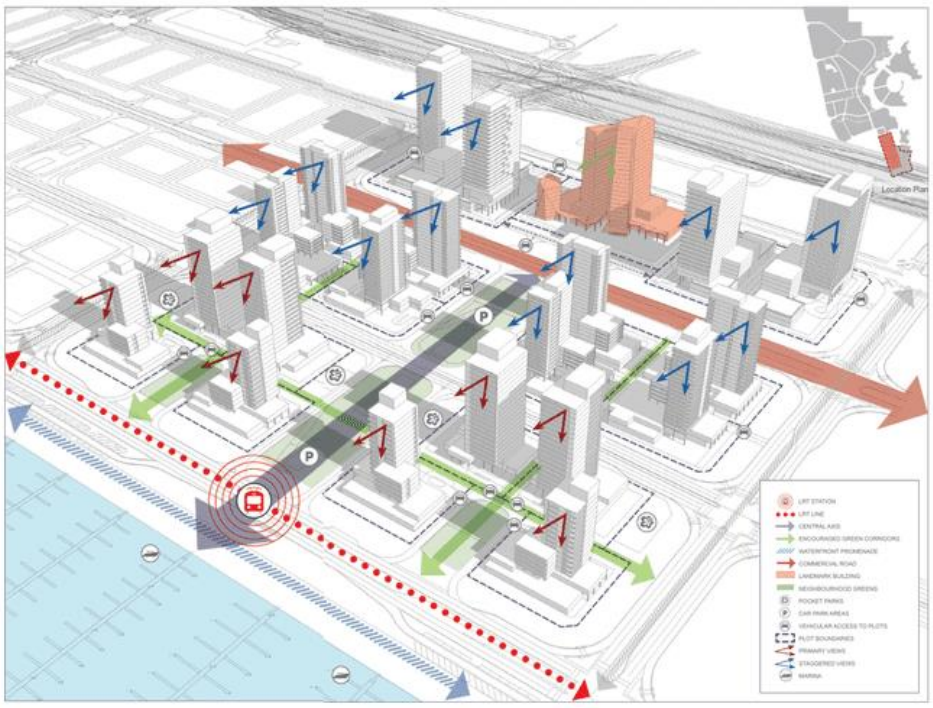

Figure 67. Neighborhood Green Precinct (Source: LREDC 2016)

The Neighborhood Green precinct possess office/commercial and residential neighborhoods that are anchored by open spaces in the heart of the city. The Precinct

is comprised of four main superblocks, each defined by a central green space, with office and commercial uses located on the west side and residential uses located on the east side, with the exception of one block, where civic uses are located on the eastern side of the building (Figure 67). Within these superblocks, the height and intensity of development decreases from west to east, and the development is strategically staggered to preserve the greatest possible views of the water. They are connected by Commercial Road, which serves as a major north-south movement spine through the Marina District's Office/Commercial strip (LREDC, 2016).

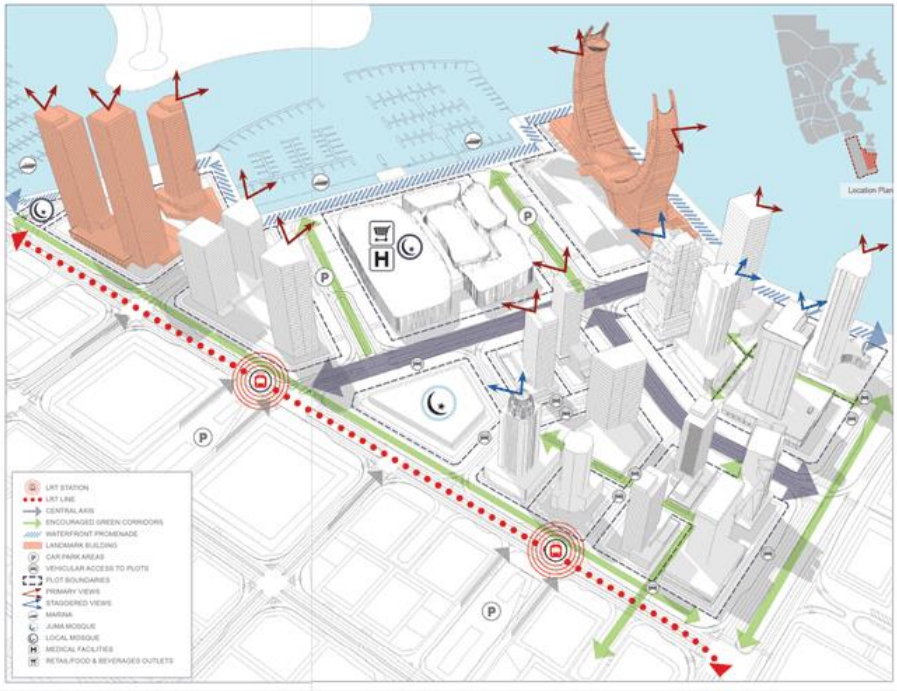

Figure 68. Mixed Use Precinct (Source: LREDC 2016)

Mixed Use Precinct is intended to bring vibrancy and animation to the waterfront promenade by creating a mixed-use neighborhood with a focus on shopping, leisure, and maritime activities. As a distinct break from the district's regular street grid pattern, the Mixed Use Precinct is located in its easternmost section of the Marina District and has streets that are aligned differently from the other streets in the district

(Figure 68). A shopping center, a hotel, and a marina with 300 berths serve as the focal points of this neighborhood. These uses are surrounded by mixed-use buildings, which combine to form a development cluster with the highest building heights and the highest density of development in the Marina District. This neighborhood is bordered by a waterfront promenade, which provides excellent access to the water's edge for residents (LREDC, 2016).

Figure 69. Lagoon Canal Precinct (Source: LREDC 2016)

The residential neighborhood with an emphasis on ample landscaping and large open spaces, all of which are centered on a broad waterfront promenade, is being developed. The Lagoon Canal Precinct, which is located at the southernmost edge of the Marina District, provides waterfront living and working opportunities (Figure 69). This is the precinct in the Marina District that has the least amount of development. Because of its strategic location as a gateway, the westernmost plot is developed into an office or commercial building of significant significance. Its broad waterfront promenade, which provides outdoor recreation and leisure opportunities for residents,

workers, as well as visitors distinguishes this precinct (LREDC, 2016).

The collected data and the analysis describes the extent of urban form and its elements, the transportation system, the public realm and the open pace approach in the design framework. The data collection for this process was retrieved mainly on district scale but also certain aspects from city scale as well. The next section analyzes the site survey and survey questionnaires data collected to understand the travel activity diary and public opinions of the travel choice in the case study site.

Social: Travel Activity Diary

The research is favored by utilizing the most efficient and common method in the urban literature to survey the case study site and undergo a social interaction. The interaction involved a survey questionnaire with the public which covers district-based travel activity diary. A trial site survey was initiated to understand the functioning of the place. The questionnaire included prepared questions focusing only on the travel behavior of the users. This included daily commuting activities of people in the area, recording the initial and final location of travel, modes of transport and purpose of travel. The users around the waterfront of district is the area where survey was conducted mainly involving in leisure activities. Later, the trial survey was conducted around the offices complex and hotel apartments. The responses and feedbacks recorded were analyzed to find the errors in the survey questionnaire. The lack of sorting residents, employees and visitors in the survey weakened the results for analysis. Also from the feedbacks, the survey recorded more private transport users as a result of which it encouraged to add questions for using public transportation in future.

The final survey questionnaire was drafted after thorough revisions to produce improved results. Revised questionnaire form was prepared and all the data from the participants were collected through in-person conversations and via google forms. The

questionnaire form is attached in the appendix section at the end of the thesis. The questionnaire were divided into three sections according to the response from the participants. The sections included visitors, employees and residents. As per the defined sample in methodology chapter, 150 participants were addressed by the questions that relates to the type of their travel activity based on the district. The survey was conducted in weekdays and weekends in order to have a comprehensive analysis on the travel behavior in the district. The responses from participants who produce work-based travels were taken mainly from street frontages of the office buildings. The cafes and parks of the public realm especially in the waterfront were engaged by participants who indulge in leisure activities and the local residents. Majority of the users were non-residents of the district comprising of 73% and rest of 27% district residents (Figure 70).

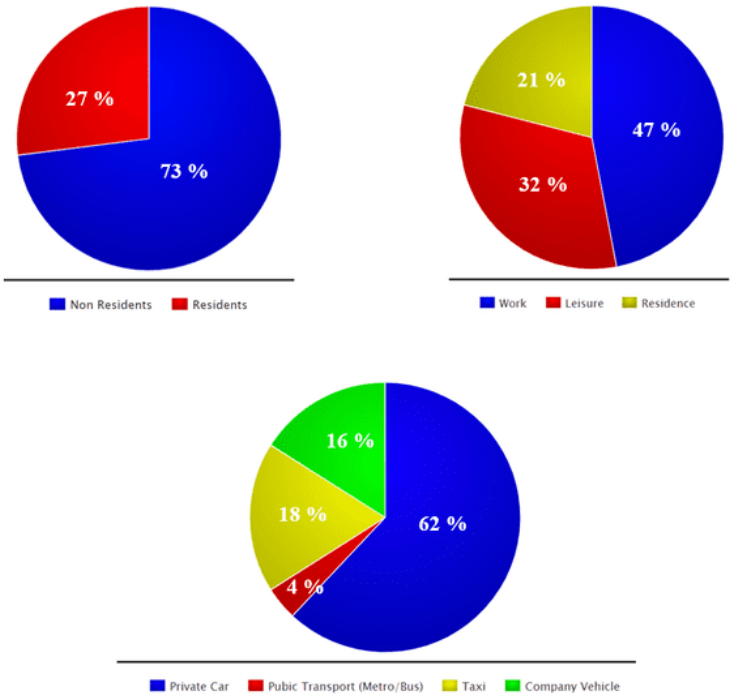

Figure 70. Pie chart representation of site travel behavior of users (Source: Author)

The questionnaire managed to collect the travel activity diary from residents and visitors in the district. The purpose of travel for most of the participants were mainly engaged for work (47%) followed by leisure activities in the cafes located at the waterfront and primary frontages (25%) Most participants in the survey traveling to and from the district opts private vehicles to commute for their daily trips. As shown in the figure, private cars were used by 62% of the participants as travel mode followed by company vehicles and taxi services (Karwa, Uber and Careem) which take up to 16% and 18% respectively. The notion of using private transportation has been evident explicitly from the responses due to high quality road connections and vast underground parking facility to the district (LREDC, 2016).

Figure 71. Metroexpress van service from Legtaifiya metro station observed in Marina District (Source: Author)

The district is served by the Doha metro feeder bus/van services from the Qatar University Station and Legtaifiya Station as mentioned earlier in the transportation section (Figure 71). As a result, site observation was carried out to analyze the metro

users in the district. 4% of the participants in the survey use metro as their commuting mode of choice. In addition, the survey involved the metro users to provide their opinion on the transport strategy based on the district. The covered responses comprised majority of visiting workers in the site as they are comfortable with service, however; prefers private vehicle over metro since the time of commuting is comparatively more. Also, some of the other participants especially the residents expressed their interests in using metro services to Lusail when the LRT services gets functional. On the other hand, the responses from participants from the waterfront who spends time for leisure comes from different parts of Doha.

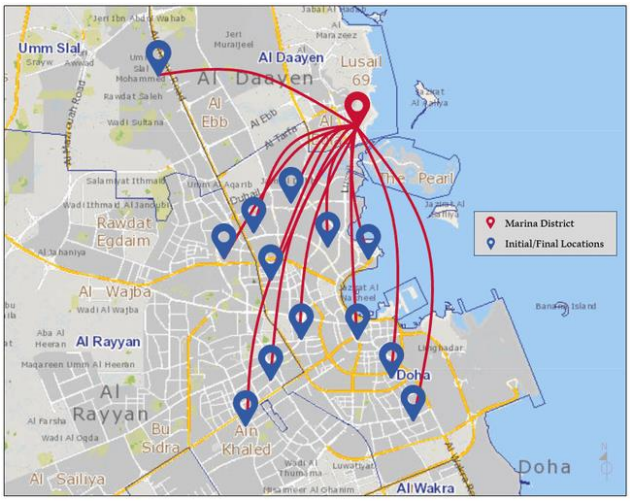

Figure 72. Travel pattern based from Marina District (Source: Author, CGIS Qatar)

These participants traveling to the site reside in Doha from a range of locations. These locations are termed as initial or final locations in the questionnaire survey. The locations vary from West Bay, Msheireb, Al Hilal, Old Airport, Al Aziziyah, Onaiza, Umm Salal, Al Gharrafa etc (Figure 72) (CGIS, 2021). Overcrowding of private cars on weekends were observed in the waterfront area, thus creating traffic congestion around the coastal roads. Limitations of parking around the café zones and other

crowded spots around the waterfront in the Mixed Use Precinct is often over-saturated by private vehicles. The marina promenade, a four kilometer stretch is widely engaged by users for recreational activities. The waterfront offers pedestrian lanes, dedicated cycle lanes along with street furniture and other beautifications. The buildings in other blocks adjacent to the promenade area includes offices and resident apartments. These areas are often concentrated by vehicles and drop-off and also some of the apartments is covered by the standard pedestrian shed of the tram station.

The lack of connectivity in pedestrian movement is widely addressed by the user participants. Concurrently, the survey also observes the pedestrian connections on road are not demanding to the offices and other buildings from the promenade and between other parcels and neighborhood. Also, due to the wide space between the blocks and lack of pedestrian infrastructures like shading devices, the pedestrian connectivity is weakened. This in turn discourage in walking between the precincts.

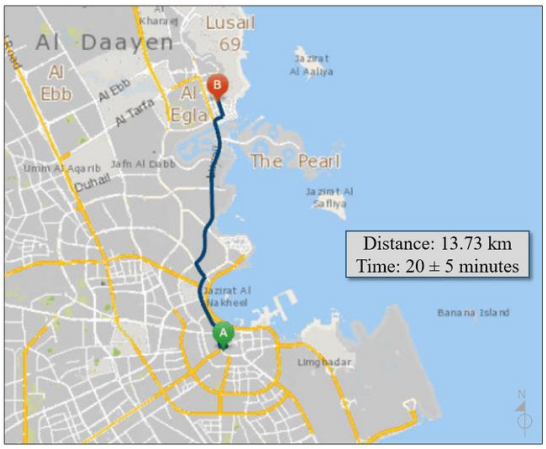

Figure 73. Average travel time between Marina District and Doha in private transport (Source: CGIS Qatar, Author)

The survey analyses the travel time and distance between private transport and

metro service. As per the data collected, Msheireb is selected as the initial location since it serves as the downtown of Doha and the main metro hub station. The travel time is concerned as one of the primary indicator of the participants between private and metro users. When analyzing travel in private transport, the trip usually depends during the office hours and normal traffic hours. On an average, the time taken to reach Marina district is 20 minutes from Msheireb (Figure 73) (CGIS, 2021). However, participants mentioned the time taken is about more than 20 minutes during peak office traffic hours. Nevertheless, the accessibility is supported by the participants to use private transport. On other hand, the time taken in metro to reach Legtaifiya station is 17 minutes approximately from Msheireb station (Figure 74). The data is retrieved from Google maps service since the geoportal service from CGIS does not provide travel time data for metro. Also, the time taken from Msheireb station to reach Qatar University station is 22 minutes approximately (Figure 74) (Maps). An additional time of 10-15 minutes is required to reach the district from Legtaifiya and Qatar University stations with the help of feeder van or bus services respectively.

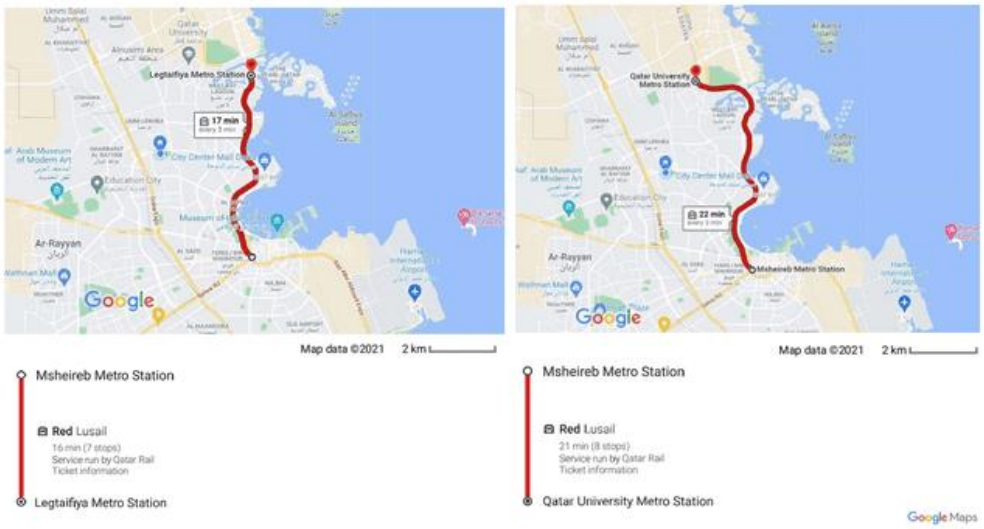

Figure 74. Average travel time from Legtaifiya and Qatar University to Msheireb Metro Stations (Source: Google Maps, Author)

The travel time taken as measured and observed for metro and private transport can be drawn to infer that average travel time is equal or close at all scenarios. Sometimes using private transport during low traffic takes much lesser time comparatively than while traveling in metro. The responses also proved the same aspect of time pointed out by the participants who prefers private transport over metro service. The end of the questionnaire was dealt with opinions from participants when the city is fully functional with LRT services, their notion to shift to public transport and change their travel habits. Most of the participants prefer to shift to public transport in the future if the infrastructure is fully installed. Some other participants prefer private transport as they are hesitant to use metro service due to comfort of travel, privacy and harsh weather conditions especially at summer. The weather concerns were observed from many participants to prefer private transport and continue their normal travel habits.

The weather conditions in the region is a factor to limit walkability. However, the city and the district has masterplan regulations to provide shading infrastructure in terms of streetscape, building frontage with shading and underground LRT service with passageways. The design of tram along with the station pedestrian shed is a critical analysis with the urban form of the district as much as the study is concerned. The detailed understanding about the urban form, transportation, environmental, user behavior and travel pattern is discussed in this section. This analysis helped to acknowledge the site and its masterplan which aims to regard as a sustainable district.

Analysis Summary

The study in the thesis has a primary focus on the urban form and transportation

system in accordance with maintaining sustainable mobility standards. From the analysis, it is evident that the transport strategy based on the vision for the district are not practically sustainable at present in terms of interacting with the urban form and the travel behavior. This statement is supported by the site observation and questionnaire survey carried out in the district. As mentioned earlier, the district attracts a huge inflow of cars for during office hours as well as during nights for leisure at waterfront areas (Figure 76). The congestion varies from weekdays to weekends. The waterfront area attracts a huge amount of cars due to vast parking lots. Most of the cafes in the area is designed and configured without seating space and promote drive-in vehicle services (Figure 75). Apart from that, the district also hosts a number of cultural and entertainment activities resulting in more public engagement.

Figure 75. Traffic Congestion during office hours in Marina District (Source: Author)

Figure 76. Vehicular movement observed during night at Marina District (Source: Author)

The urban form as analyzed typically follows a well-connected grid pattern with wide roads focused for vehicle flow and sufficient pedestrian space as observed in most parts of the district. The primary roads are often four lanes and six lanes at intersections. The district has 21 traffic signal intersections. All the intersections are created by primary and access roads. All the local roads are connected on primary and access roads along with some secondary roads in the waterfront area in Mixed Use and Lagoon Precincts. Hence, the vehicular movements are highly favorable for accessing all the buildings with in-built drop-off area and underground parking garages. As a result, the amount of vehicular movement is proved by the analysis of masterplan and site observation.

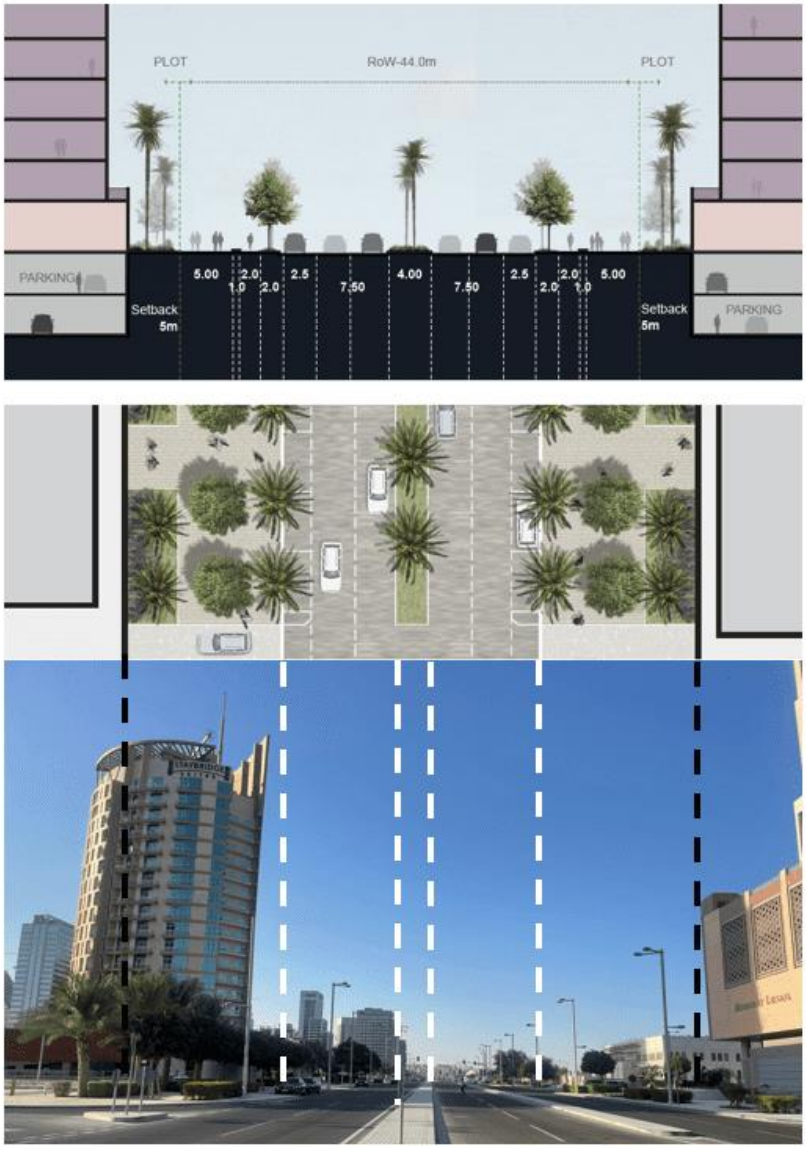

Figure 77. Primary road cross-section analysis in Marina District (Source: Author)

The primary roads is analyzed further with the masterplan developed for the site. As observed, the completed road doesn't follow the masterplan completely with reduction in landscapes. The primary roads has a combined pathways for pedestrian and bicycle routes (Figure 77). However, the observation has proved that there is significant poor connection between pedestrian and vehicle movement. One of the widely noted reason is the discontinuity of pedestrian crossways between neighborhoods and defined precincts in masterplan. The pedestrian crossings over

primary roads are only provided at intersections where some of them are located at larger distance. It is also observed that pedestrian pathways on primary roads are often without streetscapes even over completion of the work.

Figure 78. Pedestrian and Bicycle route on primary roads (Source: Author)

At the same time, the continuity for bicycle network from primary to local access roads is broken and unclear since there are no defined pathways as provided for primary roads. The discontinuity is observed at the intersection point of primary and local roads. The synthetic pathways used for bicycle route is observed to end at these intersections as shown in the above Figure 78. The survey also witnessed users walking on footpath close to the road as there are no defined pathways on secondary and access roads. The streetscape benches on these roads are observed on irregular intervals. Other types of benches is also seen while observation on access roads. At the same point, absence of landscape and pathways is observed (Figure 79). Moreover, all the LRT stations are located on the primary road. These stations and their location plays a major role in providing efficient public transportation in the district.

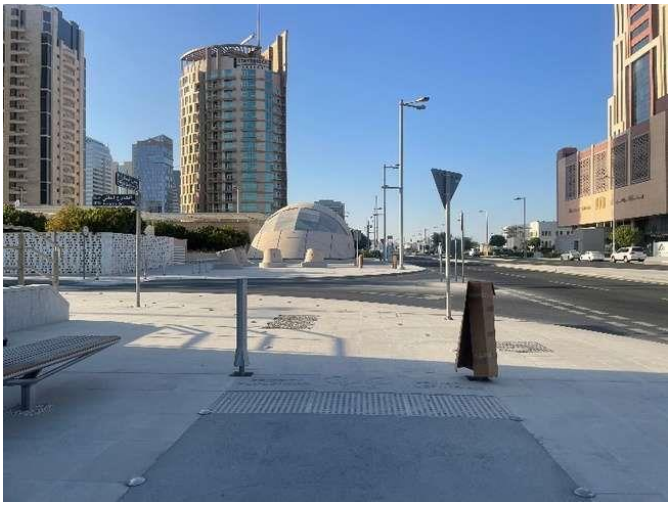

Figure 79. Unclear pathways on primary road (Source: Author)

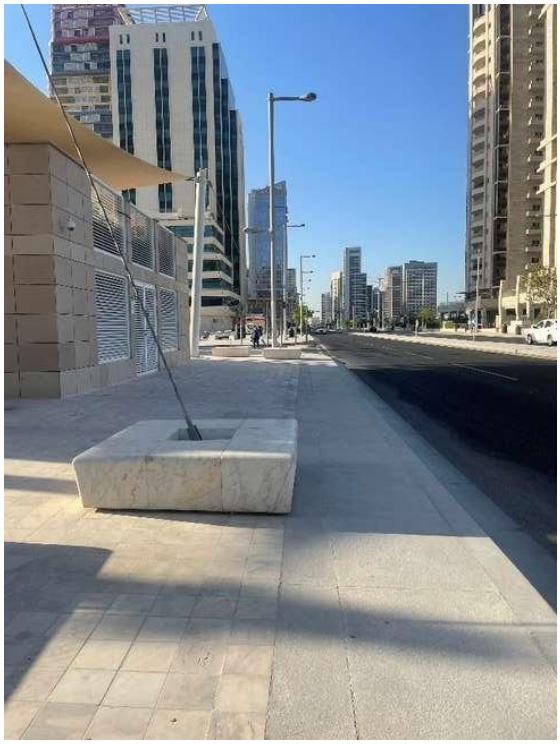

Figure 80. Streetscape on access road (Source: Author)

The tram stations as mentioned are provided on linearly on the same axis of the road. As explained in the masterplan, all the stations have a neighborhood green buffer zone with ample landscape and underground parking facilities. These green corridors are provided with the intention to facilitate smooth pedestrian movement towards the

landmark buildings comprising of mixed use services such as offices and commercial centers. The station surrounding is served with local roads that takes the users to these buildings. One of the station in the line is analyzed with respect to the nominal pedestrian shed (400m) of 5 minute walk of the immediate surrounding.

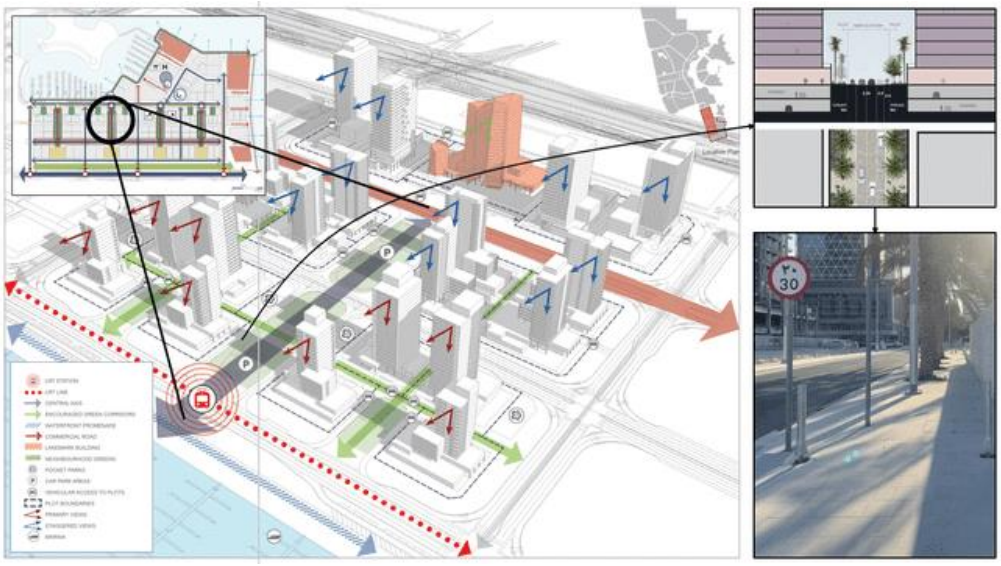

Figure 81. Tram station Analysis (Source: LREDC 2016, analyzed by author)

The shed access to the station from the waterfront is easily provided with entry/exit point since they are located on the same parcel of the waterfront. The Neighborhood Green precinct is the significant area the survey aims to analyze under the pedestrian shed. The green corridors served by the local roads as observed has insufficient space for pedestrian movement. The efficient inclusion of landscape and footpath is observed on the site analysis. As mentioned earlier, the discontinuity of pedestrian network from the local road to access road is also observed forcing the users to walk an extra distance in order to reach the intersection for crossing. The nominal shed for 400m is covered by the movement pattern as observed by the author on the site. Since the main office buildings are located more than 400m from the tram stations,

the amount of users can be significantly low while it commence for operation. Whereas, the waterfront area in the Mixed Use Precinct is highly accessible to/from the station which can ultimately increase ridership from different parts of the city for engaging in leisure activities around the waterfront. This accessibility also attracts the residents from Doha to prefer metro-tram transit service provided at Legtaifiya Station to reach the Marina District as depicted earlier in Figure 53.

The metro service of red line as per the masterplan has a transit access to tram line. There are two tram lines (orange and pink) operated from Legtaifiya metro station. As discussed, the average time taken from Doha is around 17 minutes (Figure 74) and an additional waiting time for tram and travel time is needed to reach the district. This serves a variety of public users who prefer daily commute on taxis comparing to public transport providing much low fares economically. Also, the residents in the district have access to the metro service via the tram lines as the district is located at one end from the city and more time required to reach the central metro station of Lusail. However, the stations in the district as described does not cover the nominal area for pedestrian movement. During uncomfortable weather conditions, there would be significant reduction in walking along the area for a much higher time in order to reach the office buildings from the station. The questionnaire as described targeted the private car users who works in the site about their notion to shift to public transport once it is operational. The response were varied according to the gender, nationality and type of working job. Some of them responded to shift to tram once it is commenced and would decide if they are comfortable for travel in terms of time and economically. Some others preferred tram if the pedestrian environment is favorable to reach to their offices. The remaining majority preferred to remain using their private transport for work due to all favorable infrastructure facilities as described in the earlier sections. But also some of these users

also preferred to use tram and metro service over private for leisure during evening time from their homes. The questionnaire also focused to provide information and collect opinions from the participants about the importance of their private mobility choice as a primary issue and shift to public transport in order to improve the and encourage sustainable urban mobility.

The study observes the buildings constructed in the district has to achieve sustainability standards to reduce and maintain the footprints on the environment. The study analyzes the district as per the masterplan has a comprehensive overview in the approval and construction process in maintaining the GSAS rating over time. The primary focus indeed for the study was to analyze the transport behavior with the urban form of the district. As per the planning regulations, the strategic perspective is to ensure that the city achieves as a destination of high sustainability standards, which will have positive implications for the city's residents, businesses, and visitors. However, when the district aims to achieve sustainability in all prospects, the transport behavior as per the analysis does not favor in accordance it’s vision. This concern jeopardizes the overall sustainability of the district. Therefore, the district cannot be fully accepted to be claimed as sustainable on its own scale as well as when analyzed in terms of the scale for Doha. The amount of trips generated from Doha to Lusail in private transport ultimately reduces the sustainability in terms of urban mobility. Therefore, to promote the district as per the vision needs to incorporate sustainable urban mobility in connection with public transportation. The misconception of the traditional travel behavior in the region as reviewed in the literature is the major issue in order to implement sustainable urban mobility. These travel behaviors in similar in the district. Hence, this is where the study understands to address the issue and put forward practical recommendations which is discussed in the next section.

Recommendations for Sustainable Urban Mobility

According to Hickman and Banister (2019), the sustainable transport is defined as;

> *"A means to access activities, within environmental limits and equitably."*

As reviewed in the literature, sustainable transportation should contribute to the achievement of environmental, social, and economic elements. Transport should be emphasized more than just a means for a fee proportion of the public to consume more mobility for their own benefit. Overall, transportation systems and travel behaviors must support the public policy objectives which will vary depending on the context. Therefore, the Marina District of Lusail City urges to incorporate a much stronger transport strategy into its masterplan. This is done within the context of a progressive transportation in planning process that includes the development of a transport vision followed by its strategy and policy measures, strategy evaluation, and a backcasting programme for implementation. The vision helps in assisitng the consideration of policy measures that are available and can be implemented for the transportation strategy. As a result, the strategy strenghtens the focus and direction that will drive the process towards a more sustainable urban transportation (Hickman & Banister, 2019).

Transport Vision

Transportation system being developed that supports sustainable cities is more than a technical process; it is also a normative undertaking that involves a range of values and discussions about what these cities and transportation systems should look like in the future. A transport vision based upon which an ideal foundation can be served and guided to develop an appropriate strategy and projects. The vision and strategy for transportation must also be appropriate for the specific context in which it is

implemented, and thus should be reflective of the problems and opportunities unique to that context – there are no templates that can be easily transferred between contexts (Hickman & Banister, 2019).

In the case study context, the results from findings and analysis has proven the weak transportation strategy due to improper planning framework. As reviewed in the literature; in order to provide sustainable urban mobility, the transportation strategy should have a strong framework to be applied on the district and its urban form. Therefore, the study analyzes that with the incorporation of a strong transport vision into the district's sustainability standards reiterates its design guidelines and also improves the travel behavior of Doha.

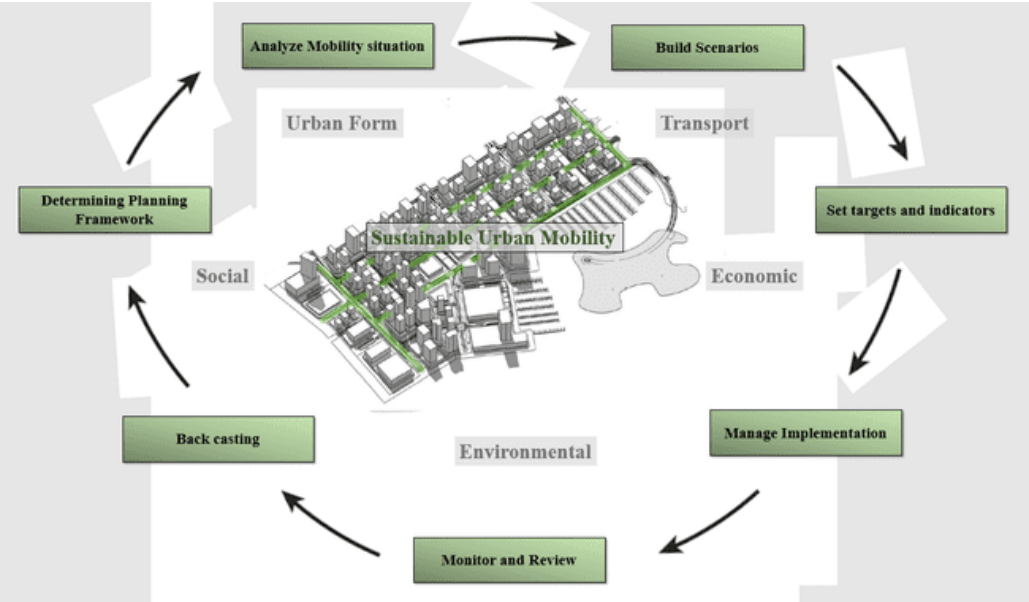

Figure 82. Marina District Transport Vision (Source: Author, LREDC 2016)

The application factors of Sustainable Urban Mobility Plans (SUMPs) and the Avoid-Shift-Improve (ASI) framework has been utilized as the driving forces of developing the transport vision and strategy in the case study context. The stages of SUMPs were employed to carry the transportation strategy for analyzing the sustainable

urban mobility in the Marina District (Figure 82). The structure of the research to analyze mobility were configured based on its key elements as discussed in the particular section of the thesis. This in turn favorably aided the advantage to serve as the foundation to implement SUMP strategy. The vision is facilitated by the process of developing the planning framework for an integrated mobility choice. The current mobility situation is analyzed with the urban form with the help of building scenarios to review the possible outcome and undertake improvement steps for better results. The process of improvement is carried out by setting targets and indicators in terms of planning incorporated to the Districts infrastructure network. These implemented targets are then managed at regular intervals. The environmental impact is monitored and reviewed as per the network system for the District and fully connected to the city. The important step to back cast the implemented vision with the participation from public helps to overview the strategy results and repeat the cycle of improvement.

In the context of district with the help of SUMPs has provided a framework improvement. A strong transport vision is a needed focus to apply elsewhere in the rest of parts of Lusail. As described earlier in the thesis, the city comprises of 19 districts with distinctive neighborhoods. Even though each neighborhood has a dependent mobility pattern, however; the SUMPs provide a great scope to review the planned guidelines and improve the overall sustainability standards of Lusail. The study also analyzed the travel pattern of Marina District with the capital city of Doha. As explained in the analysis, the urban structure and transportation has a major role in determining the sustainable urban mobility of the district. The study utilized the ASI framework to reduce and improve the conventional urban mobility pattern created in Doha with respect to the Marina District.

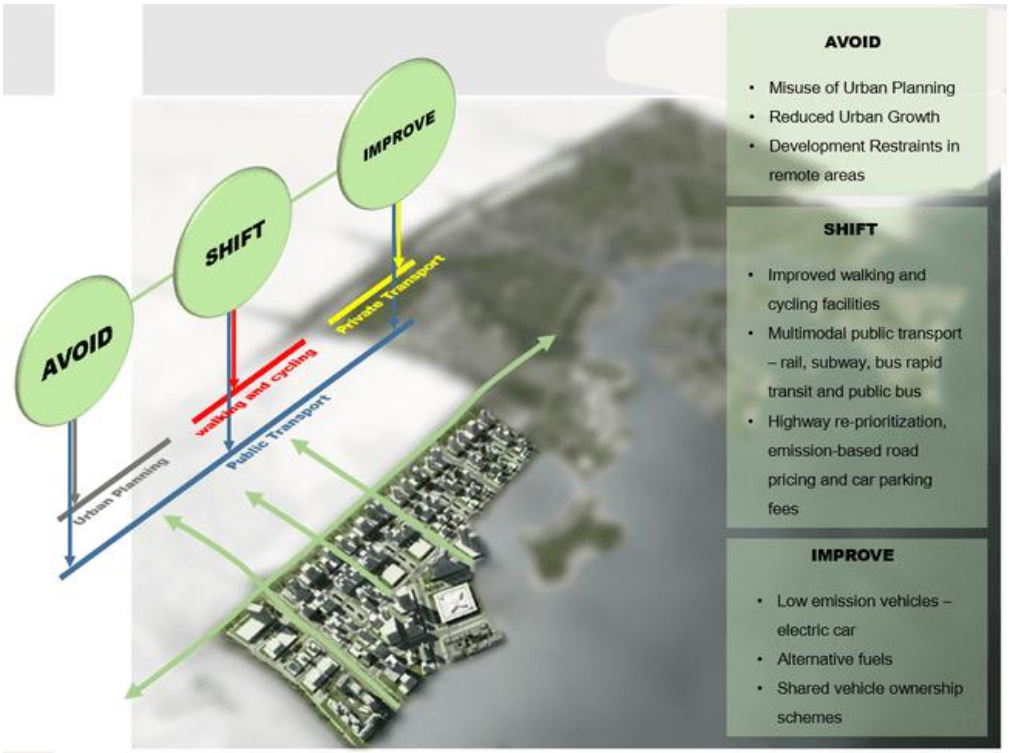

Figure 83. ASI Framework application for the Marina District (Source: Author, LREDC 2016)

The ASI framework provides a much effective approach to change the conventional transport behavior in the context of the district and Doha. The framework map depicted above (Figure 83) illustrates the policies and planning guidelines required for implementation at Doha scale with respect to the district. The extent of ASI proposals at an outer scale of the district (green lines in the figure) from the district emphasize the applications of framework in order to achieve sustainable urban mobility. In the case of Lusail, these frameworks can be incorporated with greater proficiency due to its planned infrastructure networks. Although, the buildings in the district achieve higher sustainability standards, the overall measure as per the analysis with respect to Doha draws contrasting results. However, the district possess high quality infrastructure that supports urban mobility in which the framework is needed to be sustainable.

The ASI measures for the district context comprise of tailored guidelines classified to the known three categories: Avoid, Shift and Improve respectively. The misuse of urban planning without proper detailed ground study, to implement reduced horizontal urban growth and restraints for development in remote areas are the guidelines in the first category. The guidelines helps to reduce travel distance within and between cities through compact development. Certainly with the above mentioned procedures, the amount of travel distance, public movement can be reduced as a whole in respect to Doha and elsewhere.

The shift category is the most challenging one from the user perspective to change their travel behavior to a more environment friendly by improving the walking and cycling infrastructure from private cars. The strengthening of planning guidelines to implement integrated multimodal public transport with the help of services like metro, tram, bus rapid transit and public bus. The services are not just to be provided for achieving the vision but installed with high integration for transit between modes of transport and safe and smooth accessibility for public. Also, another important aspect is to re-prioritize the highway planning about its feasibility in order to achieve sustainable urban mobility. The provision for highways with high number of lanes and width holds an influential factor to limit the privatization of cars. These provisions should be tackled by providing emission-based fines depending upon the vehicle type and implement car parking fees in huge traffic areas. The emission footprints can be improved by introducing low emission vehicles especially electric cars. The vehicles of fuel alternatives can also greatly improve the travel emissions. The improve category also emphasize to shift to share ownership schemes which especially implemented in the office areas. The scheme is not familiar in the Doha's context but nevertheless the guideline is an achievable one to push forward for implementation.

The three ASI categories summarizes a systematic approach to shift and maintain a sustainable travel behavior with particular focus on public transportation, walking and cycling with high quality infrastructure. Therefore, a comprehensive measure of SUMPs and ASI framework integrated as transport vision is attainable with regards to sustainable urban mobility for the Marina District.

CHAPTER 5: CONCLUSIONS AND DISCUSSION

The research study carried out for the thesis understands that urban planning must be tightly integrated with transportation investment in order for public transportation, walking, and cycling to be the most popular modes of transportation. In the case of Marina District, the transportation hub at present demands much more integration since the anticipated travel time required as analyzed from site has no difference to private transport travel time. Hence, the integration is vital to entertain sustainable urban mobility with the help of rapid metro and bus transits. The pedestrian infrastructure is also an important factor to determine the positive outcome of public transit in terms of accessibility. The growing population of the district shapes the mobility pattern. In order to implement, participation from residents as explained earlier paves a pathway to back cast the planned vision and its expected outcome. The challenges for practicing as a sustainable city is a difficult process. The critical aspect is to develop a long term vision incorporating all aspects of sustainability with a particular focus on urban mobility as it entails great practical difficulties.

The District possess a grid pattern in terms of the urban form and street configuration. In terms of the buildings, the efficiency of sustainability is utilized in construction and its related underground systems in the form of sewer, electrical and other public amenity lines. The study solely focuses on the space allocation between the buildings for pedestrians and vehicles. The majority of the space is utilized by the vehicles than the pedestrians. This is because the street space allocation when compared with the pedestrian infrastructure allows a more favorable environment for driving into the district rather than encouraging walkability. The walkability factor is also affected by the poor utilization of outdoor spaces with respect to the inactive building frontages. Lack of commercial activities connected directly with the pedestrian path is a major

factor of poor walkability in the district. The building facades for shade is not consistent throughout the district, considering the weather conditions, people opt to move in vehicles rather than walking in the pedestrian footpath in the district. The pedestrian path from the tram stations also verifies from the analysis that the lack of tree shades and footpath space does not encourage walkability. The study also finds that most of the people who walks in the district is obliged for a purpose of reaching a point for their needs and less encouraged for leisure walks in the district other than reaching the promenade area for safe and comfortable walking in the evening times. The lack of public and commercial activities on the building frontages as mentioned earlier does not motivate and attract walkability. The study with the analyzed details tries to be more critical in the lack of building regulations for pedestrians and observed gaps in urban planning of the district. The study reiterates to improve the walkability of the district to achieve sustainable urban mobility.

The significance of urban mobility in sustainable cities is well aware from the study in terms of defining the city to be sustainable. Urban mobility has become a primary focus in planning literature and various studies have regarded on improving travel activity to achieve the least impact on the environment. The study focused on the correlation of urban form and transportation of the Marina District in Lusail City as being one of the operational district at present. The methodology developed from the literature was based upon urban form and transport being the core elements followed by the environmental, social and economic supporting elements. All the elements were catered by data maps retrieved from LREDC and site observations. The site survey played a significant role in the study to understand site analysis along with survey questionnaires as a key data tool. The observations were analyzed with the masterplan to examine the urban form and transportation in the case study area in particular and in

the scale of Doha in general. The analysis helped to find the necessity of improving the mobility with the help of a long term vision to be correlated with the overall vision of Lusail. The application concepts of ASI and SUMPs were utilized in the thesis context to promote and implement the certain measures and framework defined in these concepts. Therefore, the study's results emphasize to have a modelling of integrated public transport infrastructure. The quantitative and qualitative analysis should be used to achieve the best combination of explained policy measures and strategies.

A radical change for transport planning for sustainable urban mobility is evident in the present circumstances of the city of Doha. The conventional planning has had huge repercussions in the last decade in accordance with the huge accumulation of private vehicles. Thus, the thesis helped to research the scope of sustainability in transport and its application in the local context. The introduction of sustainable city of Lusail in Qatar paved the way for thesis to study the city's attempt on the interdependence with its planned sustainable urban form and Doha's urban mobility.

Acknowledgement to Research Questions

The questions developed to initiate the study has guided the research to the desired results. The answers drawn from the study is briefly described in accordance with the questions:

- What was the reason for the development of Marina District to the north of Doha?

  The development of Marina District and Lusail City was initiated by the Government as a top-down planning approach to present a flagship project based on smart and sustainable standards with the latest trends of high quality infrastructure. The planned development plays a major role to attract the residents and future population envisioned in the city's vision and also aligned

with the country's national vision (QNV 2030) in setting out the economic strategies. The LREDC focused to highlight from a strategic standpoint to ensure that Marina District of Lusail City achieves International Destination status, which will have positive implications for the district's residents, businesses and visitors.

- How sustainable is the district on the urban environment of Doha?

  The analysis of the district assessed on its masterplan significantly helped to determine the sustainability measures taken into consideration. The integration of urban form, transportation and environmental aspects were assessed to understand the sustainability of the district. The urban form was supported by sustainable building designs under the assessment of GSAS ratings. All the buildings in the Marina District were followed by the GSAS standards of sustainable construction. Hence, the district as envisioned through its masterplan with all the policy measures in place insists that city attains a sustainable environment in itself with the procedures of smart technology. However, it depends on the proportions of residents and visitors in the district. Since at present majority of the users as per the survey are visitors over residents, the city is yet to fulfill the sustainable design standards.

- How transportation planning for the district is interdependent with Doha's urban mobility in terms of sustainability?

  The urban mobility of Doha has an adverse effect of huge concentration of vehicles in the district. The weak planning in district's transportation is observed with more access to roads over pedestrians. The effectiveness of LRT trams in the district is questionable as the purpose is not served for the district's wider public use. Being the downtown of the city, the district now hosts a

number of offices and businesses in the towers of the district. Ultimately a large proportion of visitors from Doha works in the district. As per the survey, the user's dependency on metro is biased by the travel time. The example provided in the analysis describes the average time taken is almost similar in metro and private vehicles. Also, private transport is preferred generally over the metro service since the metro has limited access with respect to its network.

- How can the sustainability concept be applied in transport context of the district?

The analysis was catalyzed by the concept of sustainable urban mobility in transport planning. The research study examines the gap in transport planning for the district. The concept of urban mobility in the context was determined to develop a strong transport vision with practical policy and strategies to be applied in the context of installed public infrastructure of Marina District.

Practical Constraints of Research

The study involved in the research to analyze the new Lusail City was limited on Marina District since the district was the most developed and functional one with offices, commercial centers and residential towers up to date. Due to its new location, practical constraints were addressed during data collection, analysis and recommendation results. The survey questionnaire data from the participants were not collected in the same period due to COVID-19 health protocols in the country. As a consequence of these protocols in place, most of the questionnaire was forced to record on Google online forms. Concurrently, the collection of data maps for the city was significantly dependent on the City's Master Developer documents and maps. The site analysis was confined on the available elements on the site at the time of data collection as the site was not completely built and occupied. The other constraint dealt with the

site was the lack of sufficient metro user data due to the feeder bus service timing issues in the district. On the other hand, the district's LRT tram network is analyzed with the transit metro station for comparative prediction analysis on travel time against private vehicles since the tram was not yet operational. Also, the recommended strategies for the case study context although propose a transport vision, the site observation constraints limits the overall practicality of the strategy.

Advancement for Future Research

The study is analyzed with the limited data resources on an ongoing site development. Thus, the analysis provides adequate scope for further research. The transportation planned and the forecasted pattern from the developers can overturn the present travel choice of private vehicles to public transport by the users. The urban mobility results after complete operation of metro and LRT tram service to the district area can invalidate the recommendations proposal of the thesis.

The growing interest for metro travel by local users can act as an important factor to shape the urban mobility in the district provided with the LRT tram stations. Based on an interviewee from a department of Qatar University, out of scope of the case study; quoted:

> *"I use park and ride facility of Doha Metro to reach Qatar University as it is more safe and comfortable over traffic jams during office hours."*

The notion of the public with increasing levels of privatization of cars causing traffic congestions has resulted to shift their mode of transport for daily work commute. Therefore, the study can be taken into consideration for future implications.

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APPENDIX

Appendix A: Survey Questionnaire - Commuting Choice in Marina District

Dear Participants,

My name is Labeeb Ali Ellath, a Graduate student in Urban Planning and Design at Qatar University. This survey questionnaire is conducted as a part of my research thesis. The questionnaire is about the user's commutation choice of Marina District of Lusail City. The survey tries to record the travel movements to/from the district and formulate an outline map for a study on Sustainable Urban Mobility.

The survey is of 10 questions averaging with an overall completion time of 5-8 minutes. The survey is kept strictly confidential and not shown to any third party, or used for any purpose apart from research standpoint. We warrant that all survey responses remain entirely anonymous and only managed for the purpose of this survey. We appreciate your time taken to participate in this survey.

Part I: Personal Data

1. 1. Gender: Male/Female/Family
2. Age: 13-20/21-30/31-40/41-50/50+

Part II: Travel Movement Study Data

3. Are you traveling?
    - □ to Lusail
    - □ from Lusail
4. Purpose of visit?
    - □ Work
    - □ Leisure
    - □ Residence
5. Choice of mode of transport?

- □ Private Car
- □ Public Transport (Metro/Tram/Bus)
- □ Taxi
- □ Company Vehicle
- □ Other, please specify:

6. Location of residence?
7. Location of occupation?
8. If you are using private transportation, would you be interested to switch to public transportation system (Metro/Tram/Bus) when it gets operational?
   - □ Yes
   - □ No
   - □ Other, please specify:
9. If you don't live in Marina District, would you be interested to shift your residence to Lusail?
   - □ Yes
   - □ No
   - □ Other, please specify:
10. Your opinion about the extent of mobility in Marina District?

Thank you for your cooperation.

Appendix B: Publications

The following papers were published by the author related to Master's Thesis:

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