

Original Paper

Refurbishment Model for Qatari Neighborhoods

Soud K. Al-Thani^{1*}

¹ Sustainable Development Program, College of Science and Engineering, Hamad Bin Khalifa University, Education City, Doha, Qatar

* Soud K. Al-Thani, Sustainable Development Program, College of Science and Engineering, Hamad Bin Khalifa University, Education City, Doha, Qatar

Received: September 12, 2019 Accepted: October 1, 2019 Online Published: October 2, 2019

doi:10.22158/se.v4n4p211

URL: <http://dx.doi.org/10.22158/se.v4n4p211>

Abstract

Present a model that remedies root causes of sustainability and livability issues as they are not tackled in Qatar's current urban development plans with relation to the most basic unit of urbanism: the neighborhood. The developed model presents modifications to Al-Markhiya in short-, medium-, and long-term implementation phases that include typical characteristics applicable to any Doha neighborhood so that they could be easily adopted by municipalities as well as local communities. Developed model received favorable feedback when presented to a group of environmental and urban planning experts at the frontlines of developing and updating Qatar National Master Plan and details of urban planning regulations to poll their views on its applicability for greater. This study is expected to influence decision makers in Qatar to pay the required attention to the enhancement of neighborhood sustainability and livability. This model may be the stepping stone to future strategies and plans of refurbishment as the next national goal post the World Cup to be hosted in 2022.

Keywords

sustainable neighborhoods, livability, Doha, QNDF 2032, urban form, sustainable mobility

1. Introduction

Doha is the capital of the State of Qatar and where 80% of the country's around 2.7 million population reside (Al-Thani *et al.*, 2019). Doha is a fragmented and multi-centric metropolis. Qatar's oil and gas industry has propelled a rapid economic growth over the past two decades since 1995 in conjunction with an explosive population growth rendering unrestrained urban sprawl of Doha into the surrounding municipalities of Al-Rayyan and Al-Daayen. Consequently, metropolitan issues have manifested in Doha, such as proliferation of city centers and traffic congestion, compromising overall city sustainability, livability and walkability.

Expectedly, Doha lags in ranking of urban livability indices that assess and rate international cities. In 2017 and 2018, Doha ranked 87 out of 140 world cities on the Global Livability Index, for example (EIU, 2018). The Economist Intelligence Unit's Global Livability Index, scores city livability according to weighed performance in five categories: stability, healthcare, culture environment, education and infrastructure. Each category is assessed according to qualitative and/or quantitative indicators (EIU, 2015). There are several other livability indices and they all essentially attempt to comparatively quantify suitability, comfort and habitability of cities. Nevertheless, Doha face unique livability challenges that are not best explained by a limited number of indicators or a scoring system that is generally western in reference criteria. Fairly comparable to other Middle Eastern cities, dynamism of the expatriate population and the social norms of Qataris, for instance, are key factors that propagated the low density of Doha while simultaneously accelerated the residential development in the city suburbs with insubstantial, practically non-existent, public transportation system and quite limited walkability opportunities (Qatar National Master Plan Team, 2018).

Qatar National Vision (QNV) 2030, decreed in 2008, sets Qatar's sustainable development goals. The commitment to host the 2022 FIFA World Cup, the charged geopolitical atmosphere of the Middle East region and the recent 2017 blockade on Qatar have catalyzed delivery of the goals outlined in QNV 2030, above all, liberalizing the economy and transforming it to be knowledge-based, mainly fueled by technology and light industries. Stemming from these goals, Qatari government and semi-governmental entities continue to exert efforts in promoting urban sustainability and livability. Most importantly, the Ministry of Municipality and Environment (MME) has launched the Qatar National Master Plan (QNMP) program to reclaim authority over urban planning and development in the country (QNMP Team, 2018). QNMP has released a wide range of regulatory documents, most recently and importantly the Qatar National Development Framework 2032 (QNDF). Urban/spatial translation of the QNV 2030 goals are separately developed and put into QNDF 2032. QNDF 2032 is a policy-setting agenda that declares Qatar's urbanism "Guiding Principles, Strategic Planning Objectives, Policies and Policy Actions". However, QNDF 2032 does not address the root causes of impaired sustainability and livability vis-à-vis the neighborhood, the most basic urban unit. QNDF 2032 rather sets broad guidelines and policies, relegating the task of producing neighborhood development plans to Municipalities (Al-Thani *et al.*, 2019). With no specific time frame or scope set for Municipalities, it is still not clear whether these measures will be enough to mitigate currently impaired local sustainability and livability.

As early as the turn of the twentieth century, various theories and models have emerged to improve neighborhood livability, trying to keep up with the rising industrialized/developed societies (Al-Thani *et al.*, 2018) (Al-Thani *et al.*, 2018) (Al-Thani *et al.*, 2018) (Al-Thani *et al.*, 2018) (Al-Thani *et al.*, 2018) (Al-Thani *et al.*, 2018) (Al-Thani *et al.*, 2018) (Al-Thani *et al.*, 2018) (Al-Thani *et al.*, 2018) (Al-Thani *et al.*, 2018). Garden City, Neighborhood Unit Movement and New Urbanism, to name a few, have paid particular attention to neighborhood planning. From

these early theories, contemporary models and practices have emerged, such as Transit Oriented Development (TOD) and Traditional Neighborhood Development (TND), and the work of contemporary urban planners such as Jen Gehl, whose work heavily influenced QNDF 2032 (Al-Thani *et al.*, 2019). Despite the simple discrepancies among the aforementioned theories, for example regarding the provision of commercial services, there is a consensus on walking as the primary factor that shapes neighborhood urban form and determines the extent of sustainability and livability. In addition to the obvious environmental and economic benefits of walking to the built environment, enhanced walkability in a neighborhood strengthens the sense of local or communal identity and promotes social integration. QNDF 2032 particularly delves into such urban planning theories which tackle low to medium density neighborhoods, as it is the case in Doha, confirming MME future direction will remain in support of low-density, nonetheless, QNDF 2032 circumvents planning details of neighborhoods. Additional concepts on the advent of technologies that are reshaping cities are mainly inspired by the smart city concept. There are many views of what and how to develop a smart city (MOTC, 2010). QNDF 2032 espouses the perception that focuses on technology implementation in infrastructures.

As all national development projects were strategized and commissioned by higher authorities in the Qatari governmental body, local/neighborhood sustainability and livability may also be approached in a similar manner. A top-down refurbishment—not a new development—strategy that mitigate sustainability and livability problems in existing neighborhoods is very much needed. Such strategy will be inspired by—rather than replace—current efforts of urban planning, i.e., QNMP (Al-Thani *et al.*, 2019).

The question is no longer whether Doha can be made sustainable and livable by refurbishing its existing neighborhoods, but rather how the refurbishment process should be approached and accomplished. This study aims to supplement the principles promoted by the Spatial Strategy of QNDF 2032—economic prosperity, livability, conservation of the natural environment, sustainability of the built environment, accessibility and efficiency of utility infrastructure—so that they can be applied to the neighborhood level. In other words, this paper attempts to translate QNDF 2032 into granular level to enhance urban sustainability and livability.

In light of the recited in this section on the urbanization history of Qatar, previous attempt to remedy sustainability and livability problems of Doha and prominent neighborhood planning theories, this study proposes a model of three phases. The model considers implementation strategies that shall be enacted by municipalities and/or local government bodies in Qatar, in addition to inducements to communities to adopt proposed modifications.

2. Site Selection

To develop and validate a refurbishment model, an existing neighborhood site was to be selected. Firstly, allowing for a moderate margin of approximately 30% undeveloped land, neighborhoods of northern Doha meet this standard. Primary information and satellite image assessment of the primarily

selected neighborhoods in Doha have led us to select Al-Markhiya as the testbed of this study. Four neighborhoods (a, b, c and d) labeled on aerial view in **Error! Reference source not found.** were considered.

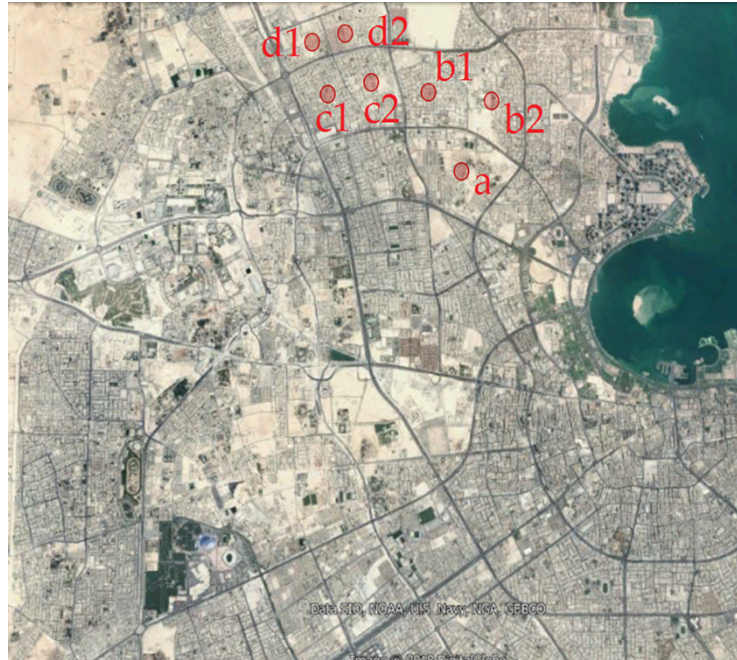


Figure 1. Metropolitan Doha

The four neighborhoods are among the least planned neighborhoods by MME's Zoning Regulations documents (Qatar National Master Plan Team, 2018). With the exception of (a) Al-Markhiya (d1 & d2) Duhail (c1 & c2) North Madinat Khalifa (Umm Lekhba) and (b1 & b2) Hazem Al-Markhiya, Figure 2. **Al-Markhiya to the South and Hazm Al-Markhiya to the North;** are split by main roads running through them, making each part known locally by a name different from the zone name. Although the three neighborhoods are currently assigned three zone numbers, it is expected that they will be divided into six separate zones in following editions of the Doha Master Plan given their urban layout and their large areas which notably exceed average areas of other Qatari neighborhoods (Qatar National Master PlanTeam, 2014).

Al-Markhiya, Zone 33 of Doha Municipality, is a recently developed neighborhood in northern Doha. The neighborhood name is derived from the desert herb known locally as "Markh". The small Markh tree has been historically known to grow naturally in the area and is considered a suitable fodder for camels (Al-Aqidi, 2016).

The neighborhood is situated mid-distance between the first two government housing projects of Madinat Khalifa and Al-Dafna. Prior to the year 2000, Al-Markhiya land was divided into plots that were property of private individuals, with the exception of the land strip contiguous to the freeway bordering the neighborhood to the south (Qatar National Master PlanTeam, 2014). The area of Al-

Markhiya is larger than the average neighborhood area in Doha. Of the total area of 2.113 km², 1.523 km² is developed and 0.590 km² is vacant, unutilized land. A predominately residential neighborhood, the built housing area of Al-Markhiya occupies 1.277 km² (60% of total area) and the road network occupies 0.105 km². Built facilities of other uses occupy 0.246 km² (MME, 2014)



Figure 2. Al-Markhiya to the South and Hazm Al-Markhiya to the North;& Umm Lekhba to the South and Duhail to the North

As of 2015, there are approximately 6,300 people residing in Al-Markhiya of which 58% male and 42% female, indicating a family residential area by comparison to the dominatingly male population of almost all other neighborhoods in Qatar. A quarter of Al-Markhiya residents are Qataris and three quarters are non-Qatari expatriates. Density is irregular throughout Al-Markhiya as there are plenty of undeveloped plots and a concentration of low-paid workers around a local commercial area on the southern edge of the neighborhood (The ministry of development planning and statistics, 2010).

A Variety of building and house typologies are in Al-Markhiya area with overall low and medium-low density, according to the QNMP classification of density (Qatar National Master Plan Team, 2016) Figure 3. Though the neighborhood area in general and specifically the center lack commercial or administrative buildings, all the four borders of Al-Markhiya have commercial and/or administrative facilities; various commercial buildings spanning from a luxury mall to small grocers and administrative and other buildings such as healthcare clinics, law firms, grade schools and kindergartens and a major-league sports club. Surprisingly, at the center the neighborhood a small privately-owned cattle barn/farm is located, **Error! Reference source not found.** to **Error! Reference source not found.**

Land in Al-Markhiya and Hazm Al-Markhiya is not leveled plains, as is most of the country lands, but rather has a few distinct topological surface features. Surface height reaches 7 meters near the northern edge of the neighborhood. Road condition is generally very good in Al-Markhiya and nearby neighborhoods as they are newly constructed, especially the area surrounding Hazm Mall. Un-paved service roads are found sounding the commercial strip to the south.

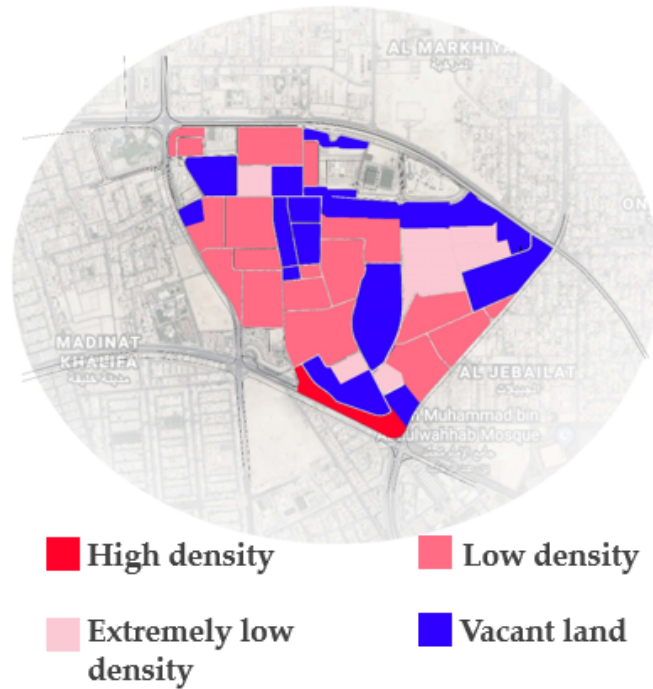


Figure 3. Density Distribution of Al-Markhiya



Figure 4. Southern Commercial Strip onto Khalifa Street

Figure 5. Al-Hazm Mall at the North Eastern Corner of Al-Markhiya

**Figure 6. Cattle Barn****Figure 7. Public Kindergarten**

It is obvious from the development of Phase 1 of the Doha metro that the three lines shown in **Error! Reference source not found.** are constructed along highways, hence, all metro stations are located by the highways bordering districts and neighborhoods. Though a high density residential and commercial area, the Pearl, for instance, does not have a serving metro station other than the Legtaifiya Station. Evidently, much to the inconvenience of neighborhood residents, the Doha metro network was not envisioned to do away with the culture of private vehicle transportation in Qatar.

Public transportation in Qatar is as recent as 2004 when Qatari government established “Mowasalat”. The system of public buses operates in Doha and serves only selected areas and neighborhoods. Thousands of buses operated by Mowasalat (The Ministry of Interior Affairs, 2015), arguably, has not changed transportation culture of Qatar. The buses, nonetheless, have marginally supported the low-income class of workers/laborer in Doha (Salama & Wiedmann, 2013). In 2011, Qatar Railways Development Company was established to develop high-speed (mostly) underground metro to serve Doha as well as above-ground railways to connect urban settlements scattered across the country. The railroads are developed in two stages. Phase 1; **Error! Reference source not found.**, nearing completion and Phase 2 is planned to commence soon. In an early tender proposal for Phase 2 of the Doha Metro, containing names of metro stations, Al-Markhiya is not among the areas that will have Blue Line stations (Qatar Rail, 2019b).



Figure 8. Phase 1 of Doha Metro – 56 km Underground

Source: Qatar Rail Web Page.

Location of Al-Markhiya, denoted by a blue star on **Error! Reference source not found.** (Qatar Rail, 2019a), is attractive to residents as its bordering highways shortly lead to Qatar Foundation’s Education City, West Bay Business District and Al-Gharafa. Such a strategic location has a high probability of having more than one metro station possibly shared with Hazm Al-Markhiya to the north, or possibly there will be two stations on the border with the relatively dense Madinat Khalifa. Potential Blue Line stations of Al-Markhiya shown in **Error! Reference source not found.**

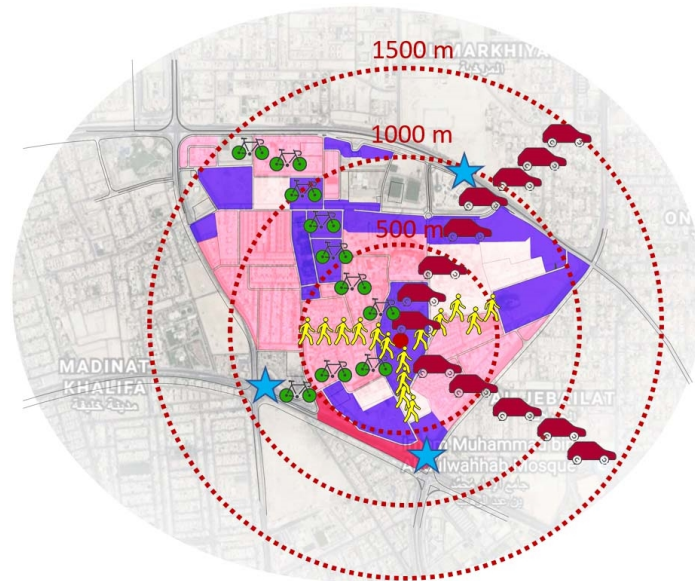


Figure 9. Extent of Walking and Transport Modes in Al-Markhiya

The sustainability and livability issues of Doha, at large, are those of its individual neighborhoods; Al-Markhiya, most critically, has no public parks/spaces. Further magnifying the walkability issue within the neighborhood, the neighborhood is not pedestrian-friendly as it has no infrastructure provisions of walking and/or cycling along the car roads. Metro locations on the fringes of the neighborhood will necessitate more than 1 km traveling distance, **Error! Reference source not found.**, from the neighborhood center which is double the typical walking distance of 500 m which takes approximately 5 minutes for an adult to travel to public transportation hubs (Duany, Speck, & Lydon, 2010) known as Last Mile Transportation (LMT) or Last Mile Connectivity (LMC) (Goodman, 2005). Besides efficiency and accessibility of public transportation, the concept of LMT/C is becoming increasingly important as it helps reduce the need for private vehicles.

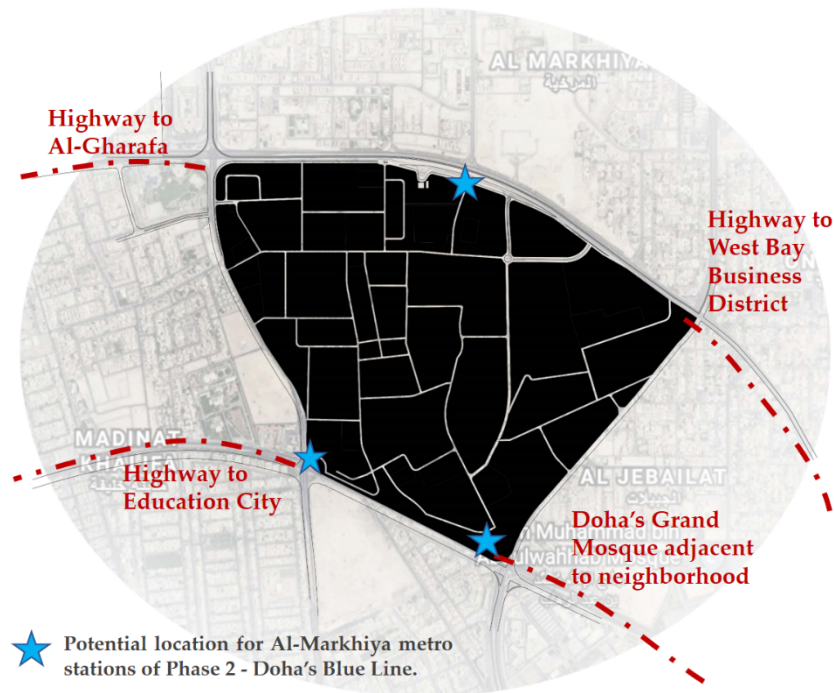


Figure 10. Potential Metro Stations to Serve Al-Markhiya

The “urban nature”, manifesting in green public spaces surrounding places where people live and work, is overlooked in urban planning around the world and especially in Qatar. In addition to physical health effects, it has been proven that green urban spaces introduce many psychological and social wellbeing benefits to communities (Chiesura, 2004). Introduction of green public spaces into neighborhoods is of utmost vitality to sustainability and livability.

In summary, the sustainability and livability issues of Al-Markhiya are notably:

- The local sense of identity and community is tenuous, as the neighborhood is completely car-dependent and has no public spaces where residents, especially families and children, can meet and socialize or group activity can take place. Further attenuating the sense of community, most of new residential developments currently taking place in Al-Markhiya are exclusive gated-communities (compounds).
- Though sufficiently available, majority of educational, healthcare, recreational commercial and retail amenities and services are located on outer edges of the neighborhood. The Site is strictly residential and/or vacant in the middle.
- With no dedicated central public space, the size of Al-Markhiya exceeds the average neighborhood size, such as the size proposed by the Neighborhood Unit Movement (Perry, 1929), which challenges walkability. As it is the case for all other non-residential facilities in the neighborhood, proposed locations for the metro station are on the site edge, further hindering walkability.

3. Model Development

After identification of the design gaps in the selected neighborhood, enhancement objectives are set. Enhancement model, with various design elements, is proposed in Part 3. Elemental sustainability and livability attributes employed in the development of the refurbishment model of this study are drawn from different theories and models of urban planning that particularly pay attention to the neighborhood level (Neighborhood Unit Movement, Traditional Neighborhood Development (TND) and Smart City)

Table 1 (Jenks, Burton, & Williams, 1996; Goodman, 2005; Carlton, 2009; Lawhon, 2009; Duany, Speck, & Lydon, 2010; Lombardi & Giordano, 2015; Leach *et al.*, 2016). These elements are then assessed against their efficacy in improvement livability, adding cultural value, enhancing sustainability of the neighborhood urban form and applicability to Doha neighborhoods. They are then weighed against benefits, payback periods, ease and readiness and for implementation since the model, for an existing, moderately developed neighborhood, is impossible to be implemented at once. The implementation phases group the design and enhancement elements into three progressive stages.

For example, the provision of a public space, like a park, has many benefits to the local community. It encourages people to walk, can increase sidewalk activity helping local businesses thrive, create and boost a unique sense of belonging and a local identity. The design of a park-in of itself-is simple but can sow seeds of benefits to the community that are reaped in a relatively short period of time. However, the implementation of drone delivery-to replace currently used vehicles-will require longer time and sophisticated planning for people to accept it and for current delivery companies, processes and systems to adopt it even though it has the potential to substantially reduce the carbon footprint of delivering goods.

Table 1. Design Elements of a Sustainable Neighborhood

Criteria	Sustainable urban form	Livability	Neighborhood Unit	TND	Smart City	Cultural Value
Housing & building Characteristics						
Housing affordability		x		x		
Housing topology	x	x		x		
Housing density	x	x		x		
Retail and Shop availability	x	x	x	x	x	
Social activity nodes, including recreational facilities		x		x	x	x
Allowing for appropriate workplaces	x	x	x	x	x	x
Neighborhood schools	x	x	x	x		

One-stop-shop civic services office	X	X		X	X	
Public realm		X	X	X		X
Allowing to change and expand in response to changing socio-economic conditions with no major upheavals		X		X	X	X
Housing unit/buildings as well as urban scale adaptability to changes		X		X	X	
Accessibility and transportation						
Safe, shaded, well-lit and pleasant pedestrian routes leading to transport nodes, services and facilities	X	X		X		
Shared amenities and public transportation nodes should be located within maximum walkable distances of 400 m	X	X	X	X		
Ease of access to local services and facilities	X	X	X	X		
Local services and facilities centrally gathered around the transport node	X	X	X	X		
Efficient public transport providing access to district and city centers	X	X		X	X	
Celebrating nature		X	X	X		
Design speed (Calmed street traffic inside neighborhood)	X	X	X	X		
Bicycle network	X	X		X		
Parking	X	X		X		
Transportation choice	X	X		X		
Lively Street and public parks		X		X		X
Interconnected and hierarchical networks of streets.	X	X		X		
Density						
Neighborhood size		X	X	X		
Neighborhood population	X	X	X			
housing density	X	X	X			
Hi-Tech						
Ability of individuals and the		X		X	X	X

community to shape their own environment and take part in the decision making within the local community					
Monitoring and reporting			X	X	X
Efficient/electric vehicles	X				X
Shared vehicles	X	X			X
Production of food	X	X		X	X
Utilizing renewable energy resources and other localized infrastructure services	X	X		X	X
Land layout and use					
Mix use	X	X	X	X	
Location of amenities and services	X	X	X	X	
Size of building blocks	X	X		X	
Accessibility of daily amenities, services and facilities by foot, bicycle, and short public transportation ride.	X	X	X	X	X
Integrated residential, commercial, recreational, and civic uses that are connected by both public and private transportation alternatives.	X	X	X	X	X
Safety and security					
Visual surveillance in the public realm		X	X	X	X
Universal design that considers the needs of children, the disabled and elderly people		X		X	
Local Identity					
Distinguishable features and sets of activities		X		X	X
Distinguished identity of neighborhoods in urban and architectural design			X	X	X

4. Model

There are several overlapping—and even interchangeable—elements among the Phases presented hereafter. Local food production for example is a shared element between vegetation of Phase 1 and self-sufficiency of Phase 2. This is due to the fact that this phasic model converges to the ultimate goal

of a sustainable circular economy of a neighborhood, where all the following design elements are tightly interconnected.

4.1 Phase 1: Vegetation and Public Places

Elements of this Phase are straightforwardly implementable, and their paybacks are obvious on the short run. For this Phase, there are three important attributes of a sustainable and livable neighborhoods: green public spaces, a neighborhood center and particularization of neighborhood traits for a local sense of identity.

➤ Green public spaces

Needless to be clustered in a single or a few parks, green landscapes can be abundantly featured in a neighborhood like Al-Markhiya by provisioning several small parks that are spread across the area and/or by mandating green yards in individual detached villas, as the most common building type in the neighborhood.

QNMP has declared regulations and guidelines for the development of “Open Space, Recreation and Sport Facilities”. The (zoning) guidelines acknowledge direct correlation of these spaces/facilities to sustainability, betterment of quality of life, preservation of Qatari identity, social connectivity and environmental conservation. In addition to recognizing the lack of public spaces and the inadequate distribution of parks and public spaces, the said guidelines recognize the discoordination with local community planning (Qatar National Master Plan Team, 2018). Nevertheless, the document disregards setting mechanisms by which locales can overcome these problems and rather rushes to set classifications and standards of development. A strategy for community image by allowing for neighborhood gathering spaces should precede the declaration of universal development patterns. Three passive-oriented parks for family picnics, children play, relaxation—and other non-structured activities—and one active-oriented park at the western border of the neighborhood with soccer field and serving facilities are proposed as illustrated in Supplementary Materials.

In addition to the obvious improvements to the microclimate and dust control, humidity, heat and air quality, green public spaces may also bring back life to a neighborhood with a range of commercial activities. Outdoor cafés, most vitally, help invigorate a place. Cafés, especially in the hot climate of Qatar, should have external awnings to create shade, protect from rain and add colorful attractiveness to the outdoors. When outdoor cafés are available, it is essential to maintain connecting walking passageways (Gehl, 2010).

Sidewalks are an important feature of streetscape that can be put to use in a myriad of ways. First and foremost, mandating a minimum width for sidewalks is an initial and very important leap forward in the direction of enhancing the outdoor environment for pedestrians. Sidewalk landscaping provides for esthetic and environmental purposes by the addition of trees, and shrubs. Plants of green landscaping are irreplaceable by any amount beautiful paver stones, decorated walls or other artificial, esthetic street features.

In addition to road sidewalks, there are several other walking corridors that can take place in a neighborhood. Intra-neighborhood alleys and narrow streets can be turned into green passages and pathways. Greening of these passageways can present a combination of outdoor comfort tools, such as natural tree shading, better-quality air movement and evaporative cooling. These environmental improvements are passive in nature yet excellent for public spaces. It is also important to have well-connected network in the neighborhood that is secure and inviting. Illustrated in Supplementary materials the provision of landscaping onto existing motor vehicle roads and the suggested new green passageways reaching from the center of the neighborhood through its far corners.

➤ Allocation of a neighborhood center

The Doha Municipality Vision and Development Strategy, as well as QNDF 2032 and several other QNMP documents, highlights the “lack of a clear hierarchy of mixed-use centers” as the leading planning issue in Doha (Qatar National Master PlanTeam, 2014, 2018; Rizzo, 2014). QNMP documents, as a remedy, designates the hierarchy of Capital City, Metropolitan, Town and District Centers, descending respectively. Shown on Doha Zoning Map, the centers are cross-neighborhood and even extend across multiple neighborhoods in the larger center classifications, further disproving the perception of the neighborhood as the most rudimentary urban building unit. The centers are transit-oriented, described to be “highly accessible by a variety of transport modes”, but walking, from and to residential neighborhoods, is not one of the modes intended as noted from the distribution of the hierarchal centers.

With anticipated growth in population of Al-Markhiya (The ministry of development planning and statistics, 2015; Qatar National Master PlanTeam, 2018), a neighborhood destination center is key for neighborhood livability and creation of a unique local identity. Arrangement and orientation of buildings that yet to be developed may be designed to lead to the neighborhood center with buildings between one and two stories on furthest edges of the neighborhood. Progressing towards the neighborhood center, building can reach a height of up to five stories. The variation in building height may not constitute large variations in population density towards the center of the neighborhood as building uses will vary.

The center is to have a main park, a mosque, one neighborhood school, a community center, a public library, a small theatre, a family café and small-to-medium level grocery market. The purpose of the neighborhood center is to provide e-services for neighborhood residents, e.g., e-health, e-learning, etc. It may also be used to hold neighborhood communal events. A transportation hub takes place at a central location where people can access alternative transportation modes, such as electric car and bicycle sharing schemes, which may be LMC mode to the metro station closest to Al-Markhiya. **Error! Reference source not found.** depicts Al-Markhiya neighborhood center. The proposed center is 7% of the total neighborhood area, has clear boundaries and is currently a vacant land lot.

➤ Particularization of neighborhood traits that create a sense of identity

People go about their day visiting retail, healthcare, educational, transportation and recreational facilities. The development of the suggested mix-use center which accommodates these facilities will add unique architectural, spatial and microclimatic traits that in return will develop a communal sense of belonging. The following are additionally proposed design elements for the neighborhood center:

- Building structures that promote diverse Qatari and Arabian architecture serving as important connections between the new and the heritage culture.
- Corners between buildings may provide seating opportunities.
- Passages and pathways are inviting to with curves of shading.
- Lighting in pathways may be wall-mounted, unlike the majority of lighting poles in Qatar. For special occasions, artistic lighting may be placed for local events.

Error! Reference source not found. portrays a section of the neighborhood center, showing variable height buildings, outdoor motorized shading and minimum above-ground parking lots.

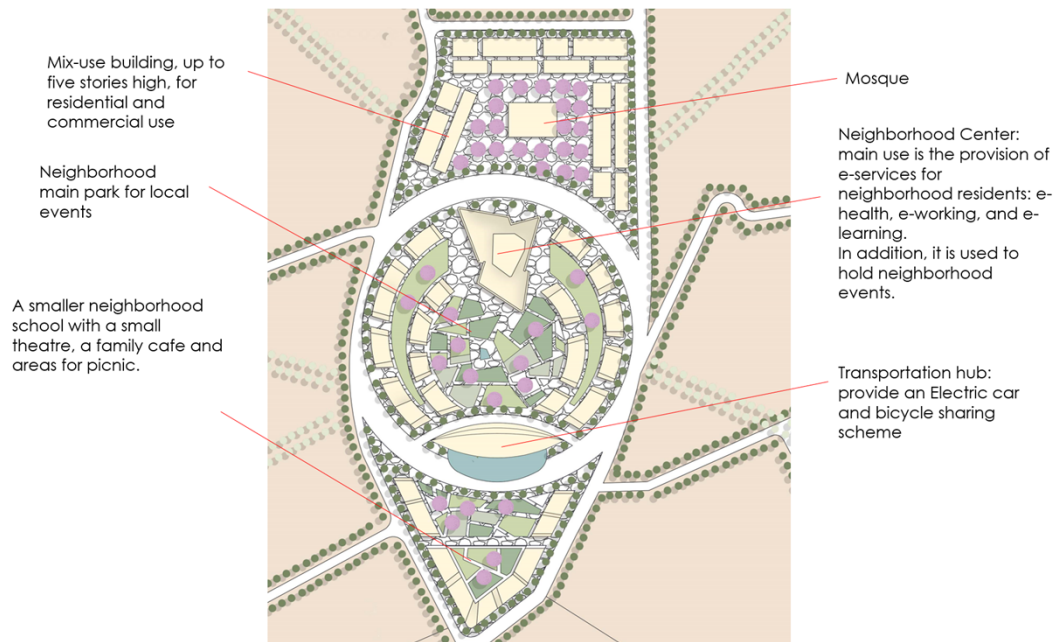


Figure 11. Plan of Al-Markhiya Neighborhood Center

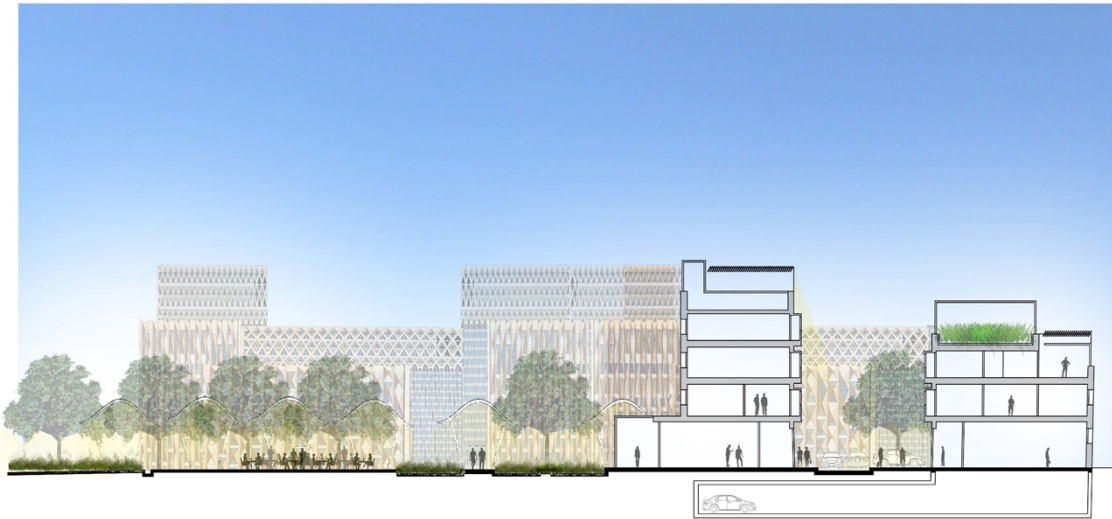


Figure 12. Cross-Sectional Perspective of Al-Markhia Center

4.2 Phase 2: Smart Infrastructure and Self Sufficiency

This Phase, on the medium run, can be the most impactful, is the most complex, and yet will be the least visible in the current Al-Markhiya. This Phase is concerned with increased efficiency in exploiting resources of/in the neighborhood to eventually optimize self-sufficiency, aided by “smartening” infrastructures.

➤ Food-production

Qatar currently produces a minimal amount of food for local vegetable consumption (MME News, 2018), while targeting a minimum of 35% local production for all food consumption. Qatar, as a result, accelerates projects like constructing new ports, increasing food storage capacity (Qatar National Agency, 2017) and creating new marine navigation lines with food exporting countries like India (Magdeburg, 2017). Even so, ramping up local food production capacity is the most resilient resolution will ensure economic resiliency in the unstable political atmosphere in the region (MME News, 2018).

As planned and provisioned in Phase 1 of this model, public parks can grow a sizable portion of local food needs, especially catering to vegetarian dietary requirements of the local population. Permaculture is the system of agriculture concerned with the use of locally available, renewable resources to grow foods. Local food production has been becoming an increasingly popular sustainability element, like green rooftops. In this case, agriculture can be practiced with advanced tools, such as indoor greenhouses, vertical farming and LED farming which may incorporate the use of solar power. Though such agricultural system would require an in-depth study of local dietary need of residents, crop seasonality and the local ecosystem, we herein propose planned areas for that purpose. Prudent planning of local food production in large neighborhood such as Al-Markhiya may advance to include

apiculture and poultry farming. Proposed food production sites in Al-Markhiya are laid out in Supplementary Materials.

➤ Utility infrastructure-energy & water

Desalinated seawater is the main freshwater source that cater to agriculture and all other water uses in Qatar. Increasing water consumption along with the environmental impacts of seawater desalination emphasized that extensive water reuse is critical for Qatar (MDPS, 2008). Enacting policies that modify high water consumption behavior, on the demand side, with water recycling, at least for non-potable uses, on the supply side, is the path toward sustainable water use (MDPS, 2018; MME News, 2018).

Treated Sewage Effluent (TSE)–salvaged water from primary sewage–is abundantly produced by sewage treatment plants in Qatar. Though local/neighborhood sewage treatment is unfeasible at the present, reclaimed wastewater distributed from central wastewater treatment plants can satisfy a wide range of water uses (MDPS, 2018; MME News, 2018). Though the current use of recycled water is predominantly for agriculture and landscaping, which can completely cover neighborhood needs in these areas, TSE can also be used substitute for other water uses:

- Domestic uses that do not require potable-quality water, such as toilet flushing, car washing.
- Non-domestic applications, such as cooling water in district cooling, dust control, construction site activities, concrete mixing and artificial waterbodies/water features.
- Replenish groundwater aquifers as a strategic resource of freshwater.

Buildings have the lion's share of energy consumption. With no notable change to building view, however, buildings can start operating as power stations. All local generation technologies are commercially available at the present and can make immediate saving if employed, however, rolling out these technologies at a cost-effective price remains as the main challenge. Utilizing solar roofs to harvest solar energy, Doha Municipality in cooperation with the Qatar General Water and Electric Corporation (QGWEC/Kahramaa) may provide to a neighborhood like Al-Markhiya modern energy services (Qatar General Electricity & water Corporation (Kahramaa, 2016). At an early stage, these services can be grid-tied or off-grid, serving as either backup power to the central city-wide electricity grid or as sole/primary power source. This already know micro-grid system with distributed generation will require sizable initial investment to be kick-started country-wide but will benefit QGWEC/Kahramaa and consumers in a few years of operations.

Digitization of the utility infrastructure is accomplished by deploying smart meters and building what is known as the Advanced Metering Infrastructure (AMI). Smart meters can record and transmit large number of service metrics as well as information on the condition of the network's physical parts. The currently common digitization technologies, such as Supervisory Control and Data Acquisition (SCADA), collect measurements, approximately every 15 minutes. However, new technologies are pushing the needle. New equipment can collect measurements up to 30 times per second streaming real-time data on utilities. Kahramaa has completed an experimental AMI project in 2015 for electricity

distribution. The project covered 17,000 residential and commercial customers in 3 different zones in Doha. Al-Markhiya could be a suitable zone to pilot services of AMI (Qatar General Electricity & water Corporation (Kahramaa), 2016).

➤ Transportation infrastructure

Current urban planning practices design cities around cars. This prevalent design practice increases congestion, discourages the use of public transportation and leaves no choice other than sprawl for urban development/expansion. Thus, transforming the transportation sector to be more sustainable promises great benefits, particularly, in urban livability and environmental sustainability. Designing a neighborhood like Al-Markhiya for people, not cars, can will transform livability in ways people did not think could be possible. Similar to bicycle sharing, every neighborhood center may have fleet of car parked for short-term car renting service. Multiple locations maybe available for large size neighborhoods such as Al-Markhiya. Alternatively, when technologically possible, central locations may be substituted with the ability to locate a car where a previous user has left it. This car sharing scheme will eliminate the need for parking lots for most building and places within the neighborhood, giving rise to walking and biking. The scheme will also vitalize sidewalks neighborhood passageways as passengers will walk to cars for longer distances than house or building garages.

While many countries are currently considering the banning of private cars altogether in city centers (Sage, 2018) or phasing out internal combustion vehicles, Qatar is investing in the construction of a local electric car factory (The Peninsula Team, 2018). Electric mobility is becoming increasing essential to the modern sustainable transportation paradigm. Especially for an expansive metropolis like Doha, electric vehicles promise decreased air pollution, eased traffic congestion and conserved energy. Urban planners and policy makers, however, will need to initiate this leapfrog into this promising side of transportation by provisioning charging infrastructure (Kumar, 2019). Charging infrastructure, as a result, will not only power cars that does not emit GHGs, but will facilitate expansion of smart electric grids which will encourage the shift to generate power using renewable energy sources. For the strong private-car culture of Qatar, this may be the best introductory solution since Qataris might not easily convert from private cars to other means shared transportation (Al-Thani *et al.*, 2019). Perspective of the transportation hub at Al-Markhiya center showing shared/electric cars and conceptual intra-neighborhood tram is shown in Supplementary Materials.

Roads, primarily in the neighborhood center, may be turned into “pedestrian plazas” if the abolishment of car use is envisioned by a community in the future. This concept of the pedestrian plaza in place of motor vehicle roads has been experimented with recently in the Pearl during weekends. There has been a notable rise in site visiting and pedestrianism in the designated ‘closed-for-cars’ areas. City- and district-wide “Urban Plazas” are provisioned by the Open Space, Recreation and Sport Facilities Development Guidelines, but are not considered for the neighborhood level (Qatar National Master PlanTeam, 2014).

Prior to phasing out motorized vehicles or resorting to alternative modes of transportation, there are several aspects that can be improved presently for enhanced neighborhood transportation. The following are suggested mandates of a transportation initiative in Al-Markhiya:

- Reduce vehicle speed limits on internal neighborhood roads.
- Enhance safety and connectivity with adjacent neighborhoods.
- Improve comfort and accessibility for non-motorized transport modes.
- Information and Communication Technology (ICT)

Living in the 'Information Age' is a rather confusing experience. On one hand, a growing share of our everyday life relies on electronic streams and invisible bits. On the other hand, the 'real' world exists, and it demands physical and visible inputs; face-to-face meetings are still irreplaceable and there is still a growing demand for physical movements of people and goods. Using ICT to promote economic and social goals is therefore based on visions on the one hand, and critical judgment of the ICT potential (MOTC, 2010) on the other hand. This paper has demonstrated that decision makers have different views on the potential and limitation of ICT effects on the urban environment. Such differences are also reflected in their views on the relevance of ICT in promoting urban goals. Therefore, anticipating ICT initiatives in European cities should be done not only by examining ICT initiatives, but also by studying beliefs and perceptions of local decision-makers and their perspectives. Local initiatives are likely to take place in cities that are led by frontliners who strongly believe in the abilities of ICT to affect their city in a positive and visible manner.

4.3 Phase 3: Circular Economy

Simply defined, circular economy is an economic system that targets minimization of all waste by making the most of available resources (Lew &owski, 2016). In this study, Phase 3 aims at considering elements of circular economy that are pertinent to urban sustainability in the long run.

- Sustainable Construction system (for retrofitting or new developments)

Shifting from linear economy to circular economy is most needed in the construction industry simply because the built urban environment currently houses the majority of world population, generating the most waste. Though it is a long, difficult way to reorient the construction sector toward circular economy, incremental change is surely an acceptable start. The following are suggested initiatives that impeded circular economy into construction projects, helping to minimize resource wasting:

- Engineering and reengineering products and structures to be lighter as means for dis/reassembly.
- Rapid manufacturing techniques of building materials, e.g., 3D printing.
- Separate, recycle and reusing construction and demolition waste.
- Promote eco-design elements of buildings.
- Integrate methods of life cycle assessment in valuation of materials

- Automation

Driverless, autonomous cars and AI-operated municipal services might be two examples of the future direction to full city automation. Services are certainly becoming increasingly automated. While the

debate on the job market and the human role and involvement in the future is tumultuous, the impact on urbanism is not discoursed as extensively. Smart City concept has fertilized imagination with an image of a world where all services are voice activated. There are areas, however, where the advent of sophisticated technologies can significantly help (Think Tank Demos, 2014).

LMT, for example, is impeding logistical needs as well as individuals (Goodman, 2005). Amazon, the world's largest online retailer, struggles with LMT in optimizing their delivery operations, hence costs. The company's resolution, the drone delivery program, has been undergoing extensive research and development, attracting unprecedented attention to drone delivery (Butler, 2015; Amazon, 2016). Obviously, drone delivery will substantially reduce carbon footprint of delivery operations presently carried out with motorized vehicles. It will also revolutionize all aspects of merchandise trade, giving rise to new concepts such as virtual store. Drone delivery also has the potential to transform manufacturing industries as more time and effort will be invested in new material development; materials that are lighter, hence convenient for the logistical tools, yet more durable.

Though it still appears to most as science-fiction, it may be several years or possibly decades before regulatory, infrastructural and commercial systems are in place, drone delivery is attracting more attention and gaining momentum as a sustainable delivery method. In Qatar, such revolutionary methods are being introduced and espoused by the Supreme Committee for Delivery and Legacy as they deliver several stadiums for the FIFA World Cup 2022 in Qatar with novel features such as disassemble structures and 3D printed materials/parts (Supreme Committee for Delivery & Legacy, 2018).

5. External Evaluation

Urban Planning is multidisciplinary science that is in many ways subjective to heterogeneous theories that, in many cases, may forthrightly come down to individual views and judgments. Thus, this study has been presented to a group of experts at The Ministry of Municipality and Environment- MME to especially evaluate the proposed conceptual design for Al-Markhiya neighborhood. The group of experts were architects and environmental specialists. MME experts are perhaps the most exposed group of people to the future direction of the National Master Plan and are certainly the most knowledgeable of the challenges to urbanism in Qatar.

The feedback re-emphasized that the categories and sub-categories of the phasic model are realistic and new. Some concepts are worth investigating, such as the smart communication and smart transportation impact on a low-density in Doha. Such concepts are integrative part of the Smart City concept which the Excepts indicated as becoming increasingly interesting to the Qatari government, in general, and particularly to the Ministry of Transportation and Communication (MoTC) and the Ministry of Municipality and Environment (MME).

Although MME representatives have explained that they clearly understood the proposed model is conceptual in nature and that Al-Markhiya is a sample test-bed of neighborhoods in Doha, they have shown strong interest in further investigation of:

1) Community self-sufficiency: the administration of energy generation, water distribution and reuse, waste treatment and food-production will require a rigorous level of monitoring and control that is typically managed by larger local government bodies, such as the Municipalities in Qatar. With higher degree of autonomy, energy and water management could be controlled and monitored by centralized municipal facilities. The case for food production, however, is different. Should it be individual gardens or public/community gardens, there are many parties involved in making the decision on food production in neighborhood.

2) Local social norms: most of Qatar neighborhoods have a mixture of Qatari and non-Qatari-expat residents. Alternatives to current transportation and housing choices might be more acceptable to the expatriate community than they are to Qataris. A mechanism for engaging Qataris as equally as non-Qataris to a more sustainable and livable life choices will need to be socially and economically investigated.

3) Car-dependency: Though the proposal suggests that automated and electric cars might be an acceptable option to local communities and could possibly have a great impact on their lifestyle. The design of the center is still car dominated. The form of the roads should be altered to make walking the most suitable option followed by alternative transport modes.

4) Materials recycling and reuse: MME stressed that they had a definite agenda to realize, jointly envisioned with Qatar National Research Fund (QNRF) in areas of research and development for specific projects. This, specifically, is an area of development that surpasses the scope and the realm of responsibility of any single ministry.

The representative kindly expressed their willingness to take part in further stages of this study in an effort to incorporate sustainability and livability qualities to future updates to the National Master Plan.

6. Conclusion

Sustainability, livability and walk ability of existing neighborhoods in Doha are not well strategized by QNMP and will require in-depth investigation. Neighborhood is the essential building block of urban centers, certainly of Doha, for it is where people reside, work, shop and go about their daily lives.

Mobility contribute to many of the neighborhood sustainability and livability issues. Further exacerbating mobility problems, Doha is low-density city making public transportation options like underground metro unfeasible and ineffective. Other issue of the city are the social norms and weather Smart technology in transportation and communication might solve the sustainability and livability problems in a low-density neighborhood. First, it will support the reforming of existing form. Second, it has many choices that can reduce carbon foot print of the city, improve its operation and social cohesion and quality of life.

Al-Markhiya neighborhood of Doha has been chosen as test bed for theory and evaluated against compliance with the concept of sustainability and livability. A gap analysis highlighted the categories and subcategories that were converted to design element and evaluated against benefits, payback and easiness of implementation. The outcome is represented in different phases of a design model that is broadly applicable to the residential neighborhood of Doha.

The importance of this proposal stems from the perceived future of Qatar post construction of the mega event to be held in 2022. The focus of urban development, then, should shift to upgrading city sustainability and livability through the renovation of existing neighborhoods.

The short-term implementation phase tended to be high embodied energy in construction and development and low in operation, mostly passive strategies. However, it has a great impact as it aims to changing the people behavior and social norms, to be more sustainable. The long-term strategies aim to improve the environmental performance of the neighborhood and ease the impact of the harsh climate.

Experts from MME confirmed that the proposal is original, and there is a great interest in the proposed categories and subcategories, in addition, not many of the proposed work by MME established a strong link between community and smart technology though there is a strong interest. In addition, most of the work accomplished and proposed by MME target a highly level and not much work is done regarding a micro level. There is a great interest from MME in investigating future changes, such as social norms, of community in operating and walking attributes.

Recommended research to better develop a comprehensive model for variable neighborhood forms (not only Qatari neighborhoods) requires thorough studies on each and every element of the Phases introduced herein, especially in relation to social norms, livability, walkability.

References

- Al - Aqidi, M. (2016). Alasod: The history of “Western Al-Markhiya”. *ALSharq Newspaper*. Retrieved from <https://www.al-sharq.com/article/08/06/2016/الأسود-ديروي-الشرق-تاريخ-المرخية-الغربية>
- Al-Thani, S. *et al.* (2018). Smart Technology Impact on Neighborhood Form for a Sustainable Doha. *Sustainability*, 10(12), 4764. <https://doi.org/10.3390/su10124764>
- Al-Thani, S. *et al.* (2019). Urban Sustainability and Livability: An Analysis of Doha’s Urban-form and Possible Mitigation Strategies. *Sustainability*. <https://doi.org/10.3390/su11030786>
- Al-Thani, S., Amato, A., & Al-Ghamdi, S. (2019). QNDF 2032: Do Doha’s Current Plans for Sustainability and Livability Address Neighborhoods?. *Sustainability*.
- Amazon. (2016). *Amazon Prime Air, Amazon web page*. Retrieved from <https://www.amazon.com/Amazon-Prime-Air/b?ie=UTF8&node=8037720011>
- Butler, S. (2015). Drone home: Amazon to triple R&D staff at Cambridge base. *The Guardian*. Retrieved from <https://www.theguardian.com/technology/2017/may/04/amazon-to-boost-rd-staff-in-cambridge>

- Carlton, I. (2009). *Histories of Transit-Oriented Development: Perspectives on the Development of the TOD Concept*. Berkeley, CA: University of California, Institute of Urban and Regional Development (IURD). Retrieve from <http://hdl.handle.net/10419/59412>
- Chiesura, A. (2004). The role of urban parks for the sustainable city. *Landscape and Urban Planning*, 68(1), 129-138. <https://doi.org/10.1016/j.landurbplan.2003.08.003>
- Duany, A., Speck, J., & Lydon, M. (2010). *The Smart Growth Manual*. New York, USA: McGraw-Hill.
- EIU. (2015). *Liveability ranking and overview: Full ranking with rating and category breakdown 2016*, *The Economist Intelligence Unit*. London, UK: The Economist Intelligence Unit. Retrieved from <http://media.heraldsun.com.au/files/liveability.pdf>
- EIU. (2018). *The Global Liveability Index, Economist Intelligence Unit*. Retrieved from <http://www.eiu.com/topic/liveability>
- Gehl, J. (2010). *Cities for People*. New York, Covelo & London: Island Press.
- Goodman, R. W. (2005). *Whatever You Call It, Just Don't Think of Last-Mile Logistics, Last* (pp. 84-86). Schindellegi, Feusisberg, Switzerland: kuehne nagel & Global Logistics & Supply Chain Strategies.
- Jenks, M., Burton, E., & Williams, K. (1996). *The Compact City: A Sustainable Urban Form?* London, UK: E & FN Spon.
- Kumar, S. (2019). 400 electric car charging stations by 2022 in Qatar. *The peninsula newspaper*. Retrieved from <https://www.thepeninsulaqatar.com/article/17/01/2019/400-electric-car-charging-stations-by-2022-in-Qatar>
- Lawhon, L. L. (2009). The neighborhood unit: Physical design or physical determinism?. *Journal of Planning History*, 8(2), 111-132. <https://doi.org/10.1177/1538513208327072>
- Leach, J. M. *et al.* (2016). Measuring urban sustainability and liveability performance: The City Analysis Methodology. *International Journal of Complexity in Applied Science and Technology*, 1(1), 86. <https://doi.org/10.1504/IJCAST.2016.081296>
- Lewandowski, M. (2016). Designing the Business Models for Circular Economy—Towards the Conceptual Framework. *Sustainability*, 8(1). <https://doi.org/10.3390/su8010043>
- Lombardi, P., & Giordano, S. (2015). Evaluating the Smart and Sustainable Built Environment in Urban Planning. In *In Handbook of Research on Social, Economic, and Environmental Sustainability in the Development of Smart Cities* (pp. 44-59). Hershey, PA, USA: IGI Global. <https://doi.org/10.4018/978-1-4666-8282-5.ch003>
- Magdeburg, H. (2017). New Qatar-India shipping line launched. *Gulf Times*. Retrieved from <https://www.gulf-times.com/story/553366/New-Qatar-India-shipping-line-launched>
- MDPS. (2008). *Qatar National Vision 2030*. Doha, Qatar: General Secretariat For Development Planning: Ministry of development planning and statistics. Retrieved from https://www.mdps.gov.qa/en/qnv/Documents/QNV2030_English_v2.pdf

- MDPS. (2018). *Qatar Second National Development Strategy 2018-2022*. Ministry of Development Planning and Statistics, Doha.
- MME. (2014). *Interim Zoning map- Al-Markhiya (Zone 33)*. Doha Qatar: The Ministry of Municipality and Environment.
- MME News. (2018). *Qatar has achieved significant successes in achieving food security, The Ministry of Municipality and Environment*. Retrieved from <http://www.mme.gov.qa/cui/view.dox?siteID=1&id=1440&contentID=5612&print=1>
- MOTC. (2010). *Qatars National ICT Plan 2015*. Doha, Qatar: ICT Qatar: the Ministry of Transport and Communications. Retrieved from http://www.motc.gov.qa/sites/default/files/qatars_national_ict_plan_english_1.pdf
- Perry, C. (1929). City Planning for Neighborhood Life. *Social Forces*, 8(1), 98-100. <https://doi.org/10.2307/2570059>
- Qatar General Electricity & water Corporation (Kahramaa). (2016). *ADVANCED METERIN INFRASTRUCTURE COD 2016*. Doha Qatar.
- Qatar National Agency. (2017). QR1.6bn deal signed to construct food security facilities and warehouses at Hamad Port. *The peninsula newspaper*. Retrieved from <https://thepeninsulaqatar.com/article/16/07/2017/QR1.6bn-deal-signed-to-construct-food-security-facilities-and-warehouses-at-Hamad-Port>
- Qatar National Master Plan Team. (2018). *Doha Zoning Map*. Doha, Qatar.
- Qatar National Master Plan Team. (2014). *Doha Municipality Vision and Development Strategy*. Doha, Qatar.
- Qatar National Master Plan Team. (2016). *Land Use Map-Al-Markhiya Zone 33*. Doha Qatar: The Ministry of Municipality and Environment.
- Qatar National Master Plan Team. (2018). *QATAR NATIONAL DEVELOPMENT FRAMEWORK*. Retrieved from <http://www.mme.gov.qa/QatarMasterPlan/English/QNDF.aspx?panel=qndf>
- Qatar Rail. (2019a). *Doha Metro, Qatar Rail webpage*. Retrieved from <https://corp.qr.com.qa/English/Projects/Pages/DohaMetro.aspx>
- Qatar Rail. (2019b). *Projects: Doha Metro, Qatar Rail webpage*. Retrieved from <https://corp.qr.com.qa/English/Projects/Pages/DohaMetro.aspx>
- QNMP Team. (2018). *about the Qatar National Development Framework, Ministry of Municipality and Environment*. Retrieved from <http://www.mme.gov.qa/QatarMasterPlan/English/QNDF.aspx?panel=qndf>
- Rizzo, A. (2014). Rapid urban development and national master planning in Arab Gulf countries. Qatar as a case study. *Cities*, 39, 50-57. Elsevier. <https://doi.org/10.1016/j.cities.2014.02.005>
- Sage, A. (2018). Mayor Anne Hidalgo plans to ban cars from centre of Paris. *The times*. Retrieved from <https://www.thetimes.co.uk/article/mayors-car-ban-will-turn-paris-into-amusement-0z2wlgn35>
- Salama, A., & Wiedmann, F. (2013). *Demystifying Doha: On architecture and urbanism in an*

- emerging city. Demystifying Doha: On Architecture and Urbanism in an Emerging City*. New York, USA: Routledge.
- Supreme Committee for Delivery & Legacy. (2018). New construction material named after 2022 FIFA World Cup Qatar™ stadium. *Supreme Committee for Delivery & Legacy web page*. Retrieved from <https://www.sc.qa/en/news/unique-construction-material-named-after-2022-fifa-world-cup-stadium>
- The ministry of development planning and statistics. (2010). *Data of the Al-Markhiya demography (social status, education & jobs)*. Doha, Qatar: The ministry of development planning and statistics.
- The ministry of development planning and statistics. (2015). *Data of The Al-Markhiya Demography (Gender)*. Doha Qatar: The ministry of Development planning and statistics.
- The Ministry of Interior Affairs. (2015). *Mowasalat Services, MOI web page*. Retrieved from <https://portal.moi.gov.qa/UNCCPCJDoha/Arabic/Transportation.html>
- The Peninsula Team. (2018). \$9bn electric car plant in Qatar to reach full capacity after 7 years. *The peninsula newspaper*. Retrieved from [https://thepeninsulaqatar.com/article/20/09/2018/\\$9bn-electric-car-plant-in-Qatar-to-reach-full-capacity-after-7-years](https://thepeninsulaqatar.com/article/20/09/2018/$9bn-electric-car-plant-in-Qatar-to-reach-full-capacity-after-7-years)
- Think Tank Demos. (2014). *Smart Retro Smart: Novel Way to Develop Cities*. Helsinki, Finland. Retrieved from <http://www.demoshelsinki.fi/en/julkaisut/smart-retro/>