

## Transit-Oriented Development Approach to Social Sustainability, Doha city as a Case Study

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### Abstract

Transit-oriented developments (TODs) are widely used to promote sustainable mobility by encouraging residents to use public transportation and to reduce car dependence (Calthorpe, 1993). Doha, the capital of Qatar, has faced numerous challenges including excessive reliance on private vehicles and lack of integrated last-mile connections. This study points to better integrating TOD models with sustainability indicators, to achieve more sustainable urban development. Quantitative and qualitative methodologies were used, including literature review concentrating on TOD and sustainable urban mobility, SWOT assessment, site analysis, data collection from the Qatar Ministry of Municipality and Environment (MME), consultant companies, and Qatar Railways Company. The study demonstrates the adaptation of TOD approach to non-western country through promoting socio-cultural spaces, heat mitigation strategy, integrated transport system, and more community engagements.

**Keywords:** Transit-Oriented Development, Sustainable Development, travel behaviour, Doha, Qatar

### 1. Introduction

An increasing number of communities have adopted the concept of transit-oriented developments (TODs) as a tool to enhance the city's urban fabric and increase the usage of public transport. The aim of TOD is to promote urban development near the transit nodes, integrate the land use and transport system, and improve compact urban development. Consequently, promoting sustainable urban mobility and a livable urban pedestrian area. The assessment of TOD is crucial for reaching the society's needs. It reflects the pedestrian catchment area (PCA) known for the adequate walking distance. TOD concentrates on 10 - 15 minutes walking distance (400 m - 800m) as a strategic area (Al Saeed and Furlan, 2019, Song et al., 2021).

Doha, Qatar capital city, experienced a rapid development and economic growth over the past two eras. It turned out to be an international leading city due to the host of distinctive worldwide events like the forthcoming FIFA 2022 World Cup (Boussaa et al., 2021). Broad infrastructure developments were developed including the operation of the Doha metro network, as part of the Qatar integrated railway scheme. However, the city lacks the integration of land use and transportation system and suffers from heavy cars dependency causing high traffic congestion. The State of Qatar launched the Qatar National Development Framework (QNDF) 2032 as a long and short-term strategy, at the national level for achieving sustainable development. The

QNDF emphasizes the significance of connecting the Doha Metro within the city's urban development by applying the TODs principles (Nafi et al., 2021).

The TOD design strategy is valuable for improving the air quality, creating compact and sustainable urban form, fostering a pedestrian-friendly environment, promoting attractive and livable spaces, and locating the city development form around transit nodes (Renaissance, 2016, Dong, 2021, Ann et al., 2019).

Consequently, this research aims to evaluate the TOD towards sustainable urban mobility in Doha. The paper investigates the land use and transportation system of Al Waab neighbourhood, mainly the area nearby the Sport City metro station. For the study, the analysis area focuses on 5-10 minutes walking distance (400m) a Quarter mile. Al Waab neighbourhood is located between the municipalities of Al Rayyan and Doha in the state of Qatar in zones (54 and 55), approximately 10 km far from the city centre of Doha. The Sports city metro station operates through the Doha Metro Historic line (Gold line) and is located adjacent to Al Waab primary road and Sports City minor road. Al Waab Road is marked by its distinctive curving streetlights and includes a path to Al Shamal Highway, while Sports City Road includes the path to the Aspire Zone (250-hectare sporting complex).

The research also examines the social travel behavioral change toward Doha metro as a sustainable public transport system; and formulate integrated land use and multi-use transportation system strategies for policymakers to attract the usage of sustainable public transport.

Quantitative and qualitative methodologies were used, including interviews and other qualitative data collection from the Qatar Ministry of Municipality and Environment (MME), International consultant corporations in Doha, and Qatar Railways Company. Moreover, and SWOT assessment. The paper proposed a guideline for the policymakers to develop TOD through sustainable urbanism principle and TOD design strategy.

## **2. Methodology**

In this study, a diverse-method was involved including a mixture of quantitative and qualitative analysis as follow (a) a literature review of recent theories about the relevant topic of sustainable urban mobility, transit-oriented development model and assessments; (b) data collection analysis, containing interview and graphic data from the Qatar Ministry of Municipality and Environment (MME), International consultant companies in Doha, and Qatar Railways Company; and (c) Site observation and SWOT analysis. The mentioned research methodology is represented in Figure 1.

### **2.1. Literature Review**

The review was done through examining the findings of the selected literature and evaluating these findings by using a non-statistical procedure. This helped in building interpretations and conceptualizations based on the previous studies. In addition to identifying the key elements for TOD in the research area, such as (a) enhancing pedestrian spaces and mixed-use areas; (b) promoting walkability and connectivity; and (c) integrating land use and public transportation system.

## 2.2. Data collection analysis tools

The study used a qualitative data collection tool, including a visual analysis and SWOT (strengths, weaknesses, opportunities, and threats) assessment to establish a framework to analyze the study area current conditions. Additionally, interviews were obtained with transport planning specialist working in the governmental agencies and international consulting companies. The data were analyzed and managed through Geographical Information System (GIS) software. This tool helped in gathering information on the study area existing situation and collecting the land use data. This contributes to deeply understand the spatial and geographical data of the study area.

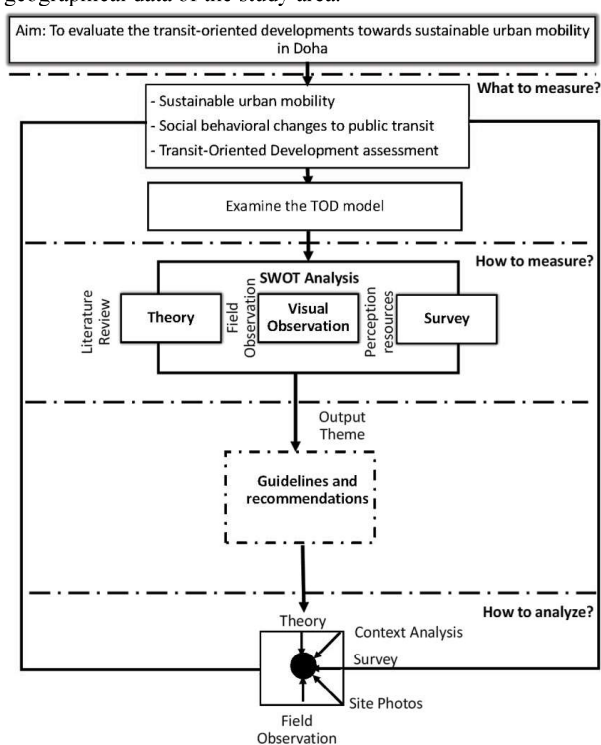


Figure 1: illustration of the research methodology.

## 3. TODs assessment approaches

TOD usually focuses on an area of 10 minutes walking time (400 m-800 m) as a strategic area when planning the pedestrian catchment area (PCA). (Alawadi et al., 2021, Al-Harami and Furlan, 2020, Dong, 2021). The standard thresholds are 400 m (quarter mile), 500 m (third mile), 600 m (2000 feet), and 800 m (half mile) (Tong et al., 2018).

Using the node-place model, Bertolini (1999) analyzes and examines the interface between the transport and land use systems within station zones. Even though the node-place model does not specify potential development, it is useful for better understanding growth dynamics. (Caset

et al., 2020). Essentially, this model consists of two dimensions: "place" (quality and quantity of land use) and "node" (proportional accessibility of traffic). As a result, if a site is a node for a range of traffic forms, it needs to operate as a diverse land-use pattern. Similarly, intensive use cannot occur in areas where access is inaccessible (Figure 2) (Schulman et al., 2015).

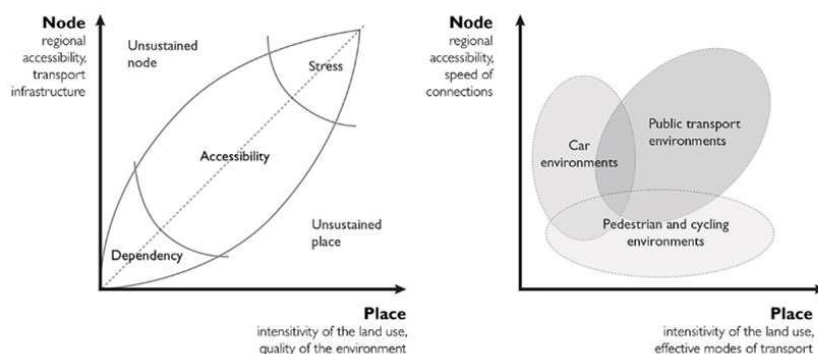


Figure 2: illustration of Bertolini's node-place model (Schulman et al., 2015)

The gap of the TOD features was carried over the outcomes of the political impact of TODs through integrating the essential character like density, compact development, connectivity, integrated land use and public transportation, and amenities (Su et al., 2021, Yildirim and Arefi, 2021). The study process brings several measures to conduct the study and analysis by enforcing various requirements to test the method relating to the TOD (Al Saeed and Furlan, 2019).

#### 4. TODs as a Sustainable urban mobility

Sustainable urban development mainly relates to urban design from the built environment perspective. Urban design can be defined as an "act of designing and forming cities". It is also known as the "art of placemaking" which involves people, space, nature, and activity setting (Alawadi, 2017). Lynch (1981) refer to urban design as "a field handling the built environments form and the link among the physical city and human values.

Various articles have outlined the perception of sustainability, highlighting the social pillar of sustainability. Literature about social sustainability illustrates some assessments and themes. However, due to its complexity, it did not include a specific definition (Bouzguenda et al., 2019). Four main aspects were developed to enhance the social sustainability concerning urban renewal developments including open spaces availability, resources conservation, and enhancing liveability (Figure 3) (Canitez, 2019).

In summary, the sustainable and vibrant cities involve the following: (a) diverse and wealthy urban life and well-designed community spaces; (b) offers a sense of safety and low levels of pollution; (c) generating a positive impact living conditions quality in cities, and (d) facilitating a various social activity (Al-Thawadi and Al-Ghamdi, 2019, Baobeid et al., 2021). Inhabitants feel unsatisfied to live in cities where they are obliged to live in congestion, spend lots of their time at traffic congestion, far to the nature access, and hardly communicates with their neighbours (Al-Thawadi et al., 2020). Interpretation of the literature emphasized that a city to be liveable, it shall offer jobs access that enables a platform for interaction between each other;

and allow self-fulfilment along with providing access to recreation and green open spaces (Al-Thani et al., 2019).

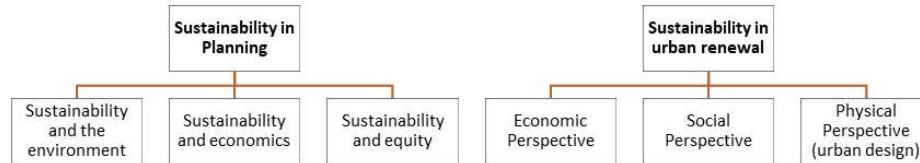


Figure 3: Sustainability in planning and urban renewal.

Generally, TOD for a particular city's requires an integrated transport system encompassing the entire city (Nafi et al., 2021). Consequently, the catchment areas are measured at the urban level instead of the individual level of the transport station, which involves a broad awareness of land use design and the aspects to deliver it. The land-uses shift should be carefully considered as they are mainly affected by the local environmental aspects (Mai et al., 2021, Revoltós Fort et al., 2017).

Nowadays, TOD is known as a well-recognized urban planning model; intended to promote affordability, enhance accommodation quality, promote compact development, and diversify public open spaces (Zhou and Yang, 2021). Once TOD is applied effectively, it could assist in progressing toward the world of vital and sustainable cities (Al Saeed and Furlan, 2019). In addition, TOD improves the creation of wealth for residents, facilitates economic opportunities, and enables societies to react flexibly to possible disruptive incidents like pandemics (Patnala et al., 2020) Figure 4 illustrates the theoretical approach.

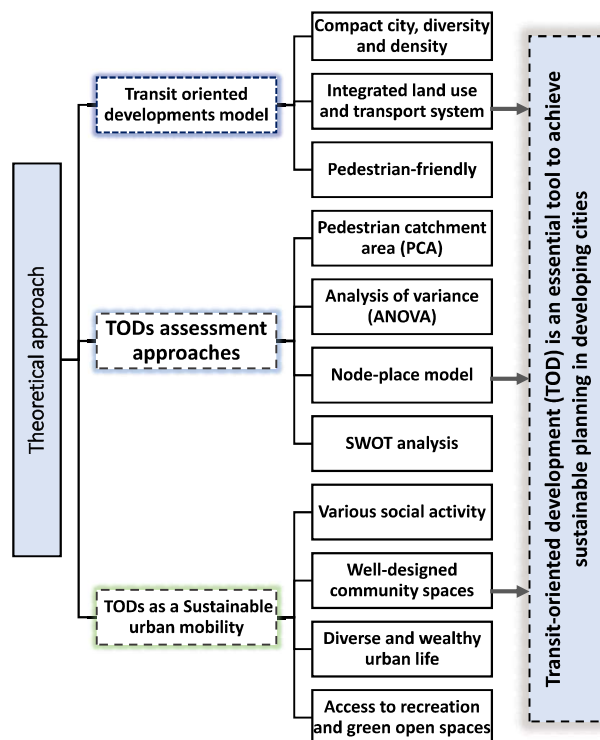


Figure 4: Theoretical approach

Finally, the TOD model is beneficial in promoting sustainable development through (a) lessening the costs and usage of driving; which leads to lowering the air pollution and the usage of energy; (b) raising revenue and economic development; (c) preserving land and green areas; (d) enhancing the neighbourhood diversity and compactness near to transit nodes; and (e) promote accessibility for pedestrian and cyclist which lowering the usage of private car (Furlan et al., 2021, Knowles et al., 2020, Furlan et al., 2019).

### 5. Qatar's Transport System and Vision

A detailed analysis Qatar has rapidly transformed from a fishing and pearling economy to a powerhouse driven by energy resources over the past two decades. Due to extensive oil and natural gas exploitation since the late 1930s, this shift has shaped the economic landscape but also led to remarkable urbanization. Consequently, Qatar has created a modern cityscape with distinctive architecture that reflects its strategic ambitions for economic diversification, sustainable urban development, and global influence (Burt et al., 2017). Doha, the capital of the country, has gained international prominence by hosting distinctive global events, such as the FIFA 2022 World Cup (Wiedmann et al., 2013, Zaidan and Abulibdeh, 2018). Globalization has resulted in extensive infrastructure development, leading to modern buildings replacing traditional residential structures. The Central Business District of Doha has emerged

as a result of this evolution (Nafi, 2015). Qatar National Development Framework (QNDF) has been developed as a national action plan for managing sustainable urban development.

Emphasizing the importance of transit-oriented developments (TODs), the QNDF aims to integrate the Doha Metro system with city growth (Furlan et al., 2020, Mannan et al., 2019). 'Light Rail Trains' (LRTs) and 'Bus Rapid Transit's (BRTs)' serve the main cores of the city through the Doha Metro network. With this comprehensive plan, users will be able to travel efficiently from origin to destination, promoting public transportation and aligning with Qatar National Vision 2030's sustainable development goals (Rizzo, 2014).

Several major stadium sites are accessible via Doha's metro network, including the Doha Port, Hamad International Airport, and Doha's urban core. In total, there are four metro lines in the city: the Red, Green, Gold, and Blue. The metro line network consists of underground, ground-level, and above-ground railways with a total length of 300 kilometers. Al Wakra in the south and Lusail in the north are served by the Red Line, also called the Coastline. The city center and Hamad International Airport are connected by this line. The network consists of 18 active stations, including West Bay, Katara, and Qatar University. Stations on this line include Lusail QNB and Legtaifiya interchange stations for trams and metros (Al-Janahi et al., 2020). In the direction of Al Mansoura, the Green Line runs for 22 kilometers from west to east. Notable stops on the line include Qatar National Library, Msheireb, Hamad Hospital, and Education City (Revoltós Fort et al., 2017). From Al Aziziya to Ras Bu Aboud, the Gold Line stops at 11 stations including Sports City, Souq Waqif, Qatar National Museum, and Al Aziziya. A 7.5 km semicircular route will connect West Bay and Airport City North along the blue line ("City Line") (Figure 5) (Amerio, 2020).

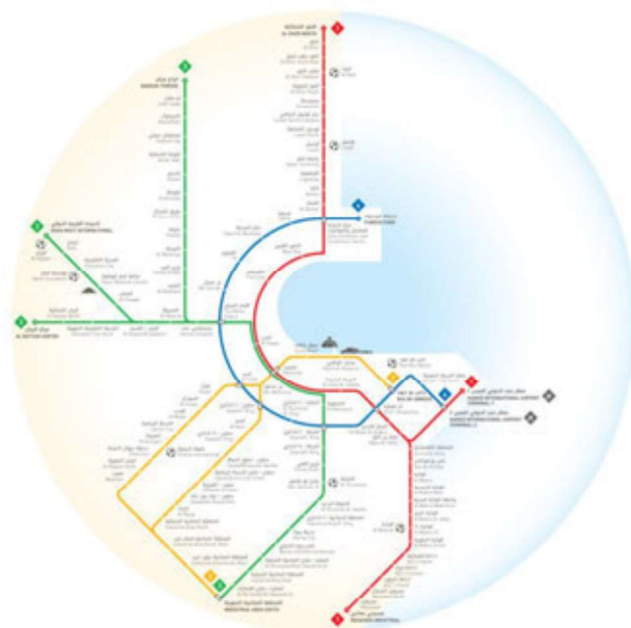


Figure 5: Scheme of Doha Metro Network (Rail, 2022)

According to Qatar's National Development Framework (QNDF), a well-integrated public transit services will make transportation safer, more efficient, and more convenient. This will reduce the number of cars on the road, helping to reduce traffic congestion and air pollution (The Ministry of Municipality, 2016). Figure 6 illustrates Qatar road hierarchy.



Figure 6: Qatar road hierarchy (*The Ministry of Municipality, 2016*)

## 6. Results and discussions

A detailed analysis of the site was made to examine the land use and transportation system of the study area. Survey questioner was also conducted to gain a wide idea about the inhabitants' perceptions of their neighborhood. In addition, the existing situation of the site and challenges were examined through SWOT assessment tool.

### 6.1. Site context

During the site visit, it was observed that the research zone contains diverse land-uses such as residential, commercial, recreation, and educational. The Sports city metro station is located near several popular sites in Qatar, such as the Aspire Zone, Villaggio Mall, Khalifa International Stadium, and Aspire Torch tower (the tallest building in Qatar). Furthermore, the Al Waab neighborhood contains various residential compounds, attached, and detached private villas, and medical developments. The land use data was validated by the Qatar Ministry of Municipality and Environment.

In addition, the study area includes numerous Western schools such as the American School of Doha, Newton International School, and Doha College. Gated communities are common in the Al Waab neighborhood, which generates isolated areas within the city urban fabric, and creates

social segregation which lessens the degree of interaction. Moreover, generating an economic disparity through altering the land values (Figure 7).

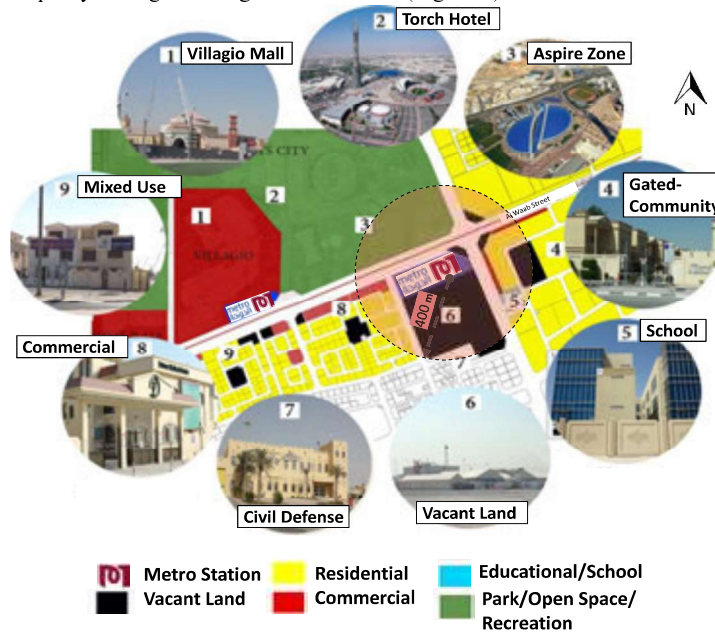


Figure 7: Current land-use map in Al Waab area showing a diverse use.

## 6.2. Transportation system

The study area consists of various modes of transportation, such as private vehicles, buses, taxis, and the Doha metro. Private vehicles are the frequent mode of transportation in the study area along with buses. An intersecting usage of various transportation systems is not present. Nevertheless, the operation of the Doha Metro has introduced the feeder buses flow at several stations to make it easier to commute. The Sports city metro runs across the Doha Metro Gold line from Doha East-West directions connecting the Airport City North with Salwa Road, Al Waab Street, and Al Rayyan South. The Sports city station includes a key destination for sporting and recreational activities such as the Aspire Zone and Villaggio shopping mall (Figure 9).

The Doha Metro seeks to establish a transport zone through the main city centers and guarantee an effective user's experience. It includes an interchange station between the metro and the tram through Legtaifiya and the Lusail QNB stations. The Green Line (Education Line) passes for 22 km connecting the Al Riffa area from the east to the Al Mansoura area from the west. Finally, the gold line (Historic Line) passes for 14 km connecting the Ras Abu Aboud area to the Al Aziziya area (Al-Harami & Furlan, 2020; Al Saeed & Furlan, 2019).



Figure 8: Current transportation system in the Al Waab area (a) Aspire zone (b) Villaggio mall parking (c) Hayatt plaza sculpture (d) Sport city metro station (e) Al Aziziya metro station.

### 6.3. SWOT Assessment

SWOT Assessment represents a framework to assess the strengths, weaknesses, opportunities, and threats of the site. It was obtained to get a rich idea of the existing situation of the site and consider the site strengths and opportunities. The assessment examined the weakness and threats of the study area. The weaknesses contain the physical aspects that create the disadvantages of the study area, which reflect as the following: the shortage of mixed uses within a walking distance; traffic congestion due to high traffic flow; lack of integration between the sports city, malls, and residential area; and high noise level. While the threats are the absence of pedestrian and cyclist safety; rents prices for residential and commercial properties have increased due to the existence of the metro; not addressing the transit connectivity and parking management which will attract personal driving.

Furthermore, the results show that the strengths of the study area are the availability of attraction points such as Aspire zone, Villaggio Mall, and Khalifa international stadium; and the accessibility to the sports city and malls attract people to live in the area. Finally, the opportunities are the presence of the metro, which fosters a multimodal transport system leading to less traffic congestion and sustainable solutions. The SWOT assessments summary is shown in Figure 9.

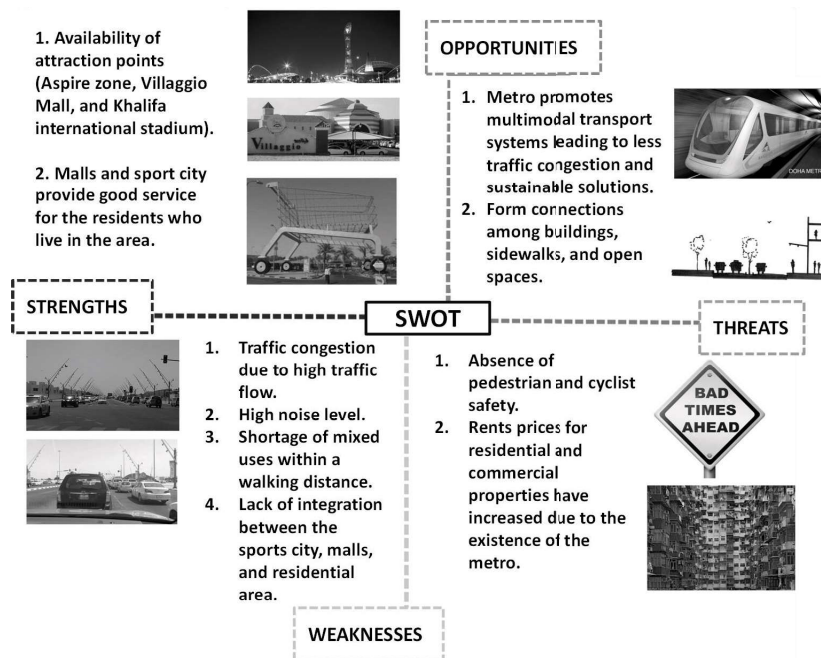


Figure 9: SWOT assessment.

## 7. TOD Design guidelines and recommendations

A series of TOD design guidelines and recommendations were made to support the stakeholders and policymakers in developing a comprehensive approach of TOD. These guidelines were developed based on the study findings and in relation to the survey outcomes. Mainly through sustainable urbanism and TOD design strategy taking into consideration the Qatar cultural heritage.

### 7.1. Integrated land uses and social heritage

Literature pointed out that, the TOD model is beneficial in fostering sustainable development through improving the neighbourhood diversity and compactness near transit nodes; and promoting the accessibility for pedestrian and cyclist which lowering the usage of private car (Canitez, 2019). The study area shall include a diverse use along with a social-cultural heritage places that promote the Qatar unique identity and enhance the social interaction in the study are, the proposed spaces are (a) the Barahat which is an open area around the houses that can held some traditional performance and attract public gathering; (b) the Sikka which is a narrow shaded walkable path that create a pedestrian-friendly environments; and (c) the Majlis which considered as a social engagement place where neighbours sit together, socialize, and debate about local events and issues. The neighbourhood will be more liveable when ensuring a balances and mixed distribution of uses where people live, work, learn and leisure. This reduces the travel distance which leading to lessening the private travel demand supporting the public transport, cycling, and walking.

### 7.2. Public realm and open space scheme

Public realms which contain plazas, souks, parks, squares, and leisure area promotes social cohesion. It also offers a sense of safety and low levels of pollution which generate a positive impact on the living conditions (Al Saeed and Furlan, 2019). As a result, the following has been proposed in the study area to promote TOD and enhance sustainability: (a) create a green corridor in Al Waab Road to connect the Sports City with Aspire Zone; (b) develop a green public realm around the metro station; (c) enhance the street furniture, plaza, and landscaping; and (d) locate the schools near the edge of the commercial zone and the recreational area in a highly visible points around the transit stop. Furthermore, to promote TOD in the study area, public open spaces shall contain areas for inhabitants to contribute to community public activities and celebrate their socio-cultural identities. The research area additionally proposes incorporating a public realm with a secure car-free movement adjacent to the metro station.

### 7.3. Cohesive transport system and pedestrian-friendly design

As reviewed in the literature, the preferred walking distance in the case of TOD is 5 to 10 minutes' walk for 300-800m diameter (Dong, 2021). The neighbourhood within 400m radius shall contain a cohesive transport system with a connected walking and biking networks along with metro and bus stations on the borders. Furthermore, the street system shall be planned in a way that ensure the pedestrian safety, and intersection shall be designed to reduce the distance crossed by the pedestrians. Also, shaded walkways shall be created near the metro station to encourage the individuals to use the public transport.

Through adopting these guidelines, several enhancements will take place in the study area, for example (a) increasing the public transport usage and mobility choices, like the bus, metro, and rail; (b) lessening the traffic congestion which will reduce the pollution and promote sustainable developments; (c) improving access to open spaces, parks, and squares; and (d) promoting the accessibility to retails, recreational area, services, and cultural spaces. Figure 10 illustrates a summary of the reviewed literature.

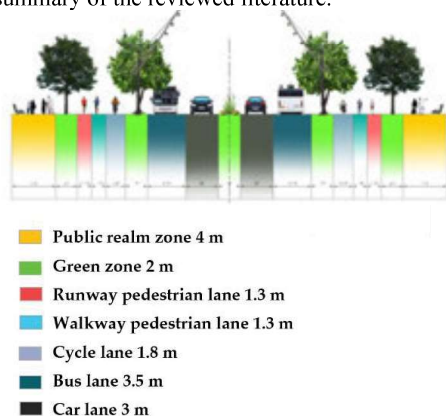


Figure 10: proposed street network for a cohesive transport system and pedestrian-friendly design

## 8. Conclusion

This paper examined the TOD model implementation for the Al Waab neighborhood in Doha, covering a 400 m radius centered around the Sport City metro station. The social travel behavioral change was explored toward Doha metro as a sustainable system. The study attempts to formulate integrated land use and multi-use transportation system strategies for policymakers to attract people to travel by a green public transport. The findings of this research study also demonstrate the significance of applying the TOD model to promote sustainable urban development and socio-cultural spaces leading to more community engagements. This is achieved through establishing the following guidelines: (1) creating a diverse land-use approach including attractive public areas; (2) promoting the identity of the space surrounding the study area; (3) designing a shaded walkway with cool shading techniques; (4) creating a cohesive transport system and pedestrian-friendly design; and (5) developing a green public realm around the metro station.

The Qatar Rail Development Framework, which includes the Doha Metro and Lusail Tram, serves as a prime example of TOD on a national scale. This framework strategically combines transportation networks with urban development to foster sustainable growth and enhance the quality of life for people. To foster lively and inclusive neighborhoods, it is necessary to strategically design many development and revitalization initiatives centered on metro and tram stations.

Implementing TOD in Qatar presents both obstacles and opportunities. For instance, the region's elevated temperatures and predominant focus on automobiles make it difficult to create pedestrian-friendly environments and efficient public transportation. However, the implementation of strategic planning, creative design, and the acceptance of technology have the potential to revolutionize urban transportation and sustainability.

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