

Creating a Smart Transit Option for a Car-Dependent City: The Case of Jeddah City



Nada T. Bakri and Asmaa Ibrahim

Abstract The city of Jeddah faces an increase in motorization and car dependency in transportation systems, resulting in increased traffic congestion and more negative effects such as an increase in pollution and car accidents. Nowadays, the citizens are not in favour of using public transportation services due to the lack of several factors, which include but are not limited to mal-planning in the land use distribution causing long journeys from one destination to another, quality of hygiene, safety, destination and location, affordability, and other factors that this research aspires to determine and highlight. The interpretation of "smart city" should not be limited to using advanced technology in transportation but should also include the smartness in adopting different transit options to satisfy the different social needs of the different community sectors. The execution methodology of this research is based on exploring the current understanding of Transit-Oriented Developments (TOD) that contributed to bettering the transportation issues that occurred in car-dependent cities. Following that, an empirical case study of Jeddah city will be conducted to divide the city into homogeneous zones supported by a qualitative data gathering of different stakeholder's opinion that aims to gain a better understanding of Jeddah's condition with public transportation modes up to this date. The city of Jeddah is experiencing a surge of car dependency, given the increasing traffic congestion, which causes the city to suffer from increased pollution and vehicle accidents.

Keywords Transit-oriented · TOD · Walkability · Car-dependency

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1 Research Introduction

Urban planners and decision-makers face a difficult challenge with cities that grow rapidly. Cities in Saudi Arabia have experienced rapid growth and urban sprawl in the last five decades, with Jeddah city leading this event [1]. Jeddah City has a rich functional dimension that includes a movement system that passes long distances from north to south. However, it faces a problem with limited urban transportation and the lack of public transit amenities and infrastructure that supports walkability.

Jeddah City has become a car-dependent city since the travel pattern has changed dramatically due to the linear urban sprawl in the last four decades. The city expansion resulted in only 7% of the citizens using public vehicles [2]. Jeddah nowadays has only four public transportation systems provided by the government & private companies:

SAPTCO: Saudi Arabian Public Transportation company.

Coaster Buses: Operated by Individuals.

Taxi Service or “Ojrah.”

Uber and Careem services.

When the sprawl started to come into action in the 80s, as Al-Joufie mentioned, the city started expanding dramatically. Even the main city attractions and locations started varying from north to south (Fig. 1). The citizens of Jeddah city do not favour using public transportation services due to the lack of several factors. These factors include but are not limited to mal-planning in the land use distribution causing long journeys from one destination to another, quality of hygiene, safety, destination and location, affordability, and other factors. Therefore, this research investigates this challenge to promote walkability and the dependence on transit options.

Jeddah is experiencing a surge of car dependency, given the increasing traffic congestion, which causes the city to suffer from increased pollution and vehicle accidents. This research aims to understand the reasons that discourage citizens of Jeddah city from using public transportations. It proposes a framework incorporating different stakeholders attempting to motivate private car users to use transit-oriented services and options for walkability if relevant.

Based on the problem statement of this study, the objectives of this research incorporate the following:

- Investigating the main factors that motivate citizens to use public transportation services through a literature review and an empirical case study in Jeddah. These factors will be later compared with the socio-economical characteristics of Jeddah city to ensure its correspondence with the needs and desires of the users.
- Determining the factors that promote the dependence on walkability and transit options by analyzing different international and national case studies that have previously formulated plans for achieving this objective. This objective is essential to understand the practical design approaches and learn from them to be considered

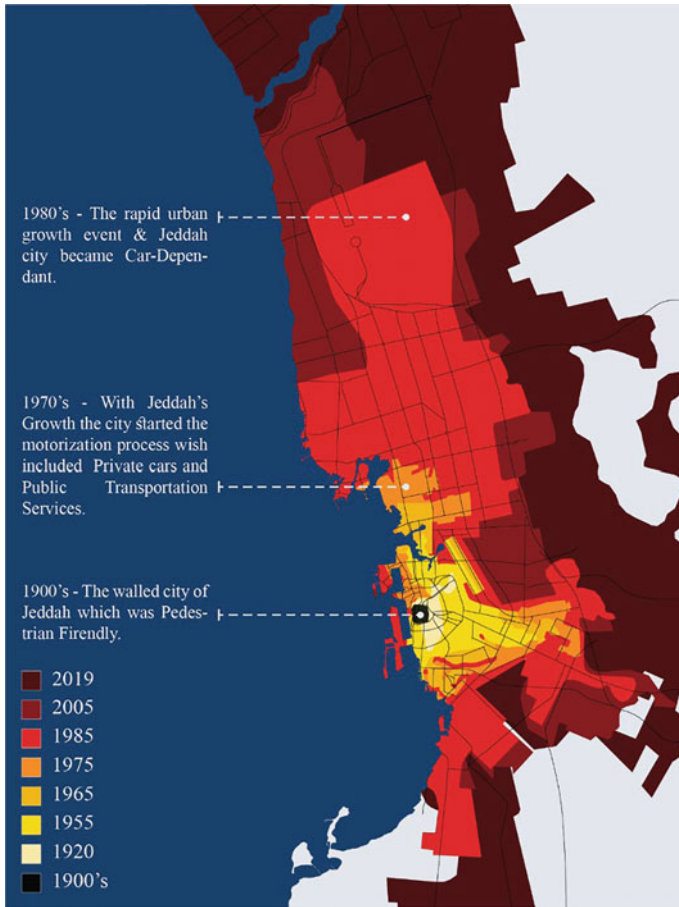


Fig. 1 A map of the urban growth of Jeddah city between the 1900's–2019

in the case of Jeddah city. Moreover, and finally, the study will analyze these factors concerning the preference of the citizens of Jeddah city. The case studies will be selected based on criteria identifying similarities with Jeddah City. The empirical part of this study shall explore the unique aspects of Jeddah City and deduce the specific factors for promoting walkability related to Jeddah City in particular.

- Analyzing how citizens select their mode of mobility inside the different parts of Jeddah.

This research is limited to 3 municipalities in Jeddah: Northern Ubhur, Southern Ubhor, and New Jeddah. This limitation is due to the lack of time within this research process and the lack of accessibility to participants from other municipalities. Also, the limitations of this study include not being able to reach stakeholders representing the local public transportation companies of the public and private sectors.

The methodology of this research is based on exploring the current understanding of Transit-Oriented Developments (TOD) that contribute to bettering the transportation issues that occur in car-dependent cities—also determining the impacts of TOD on such cities. This study will ensure a comprehensive understanding of TODs and what the city of Jeddah could benefit from. Later, this study aspires to investigate the current condition of the transportation modes and citizens of Jeddah city up to this date. Therefore, this research will consider using an evidence-based approach through an action research methodology that includes three levels of investigation. First, this research will explore through a qualitative methodology the concept of TOD by investigating its applications and approaches to implementation. Next, the study will conduct an analytical methodology to explore two transit service projects in the middle east to learn about the implementation of TOD in cities with similar conditions to Jeddah city. Following that, an empirical case study of Jeddah city will be conducted through a mixed-approach methodology to divide the city into homogeneous zones supported by a quantitative analysis of a distributed survey that aims to gain a better understanding of Jeddah's citizen's socioeconomic characters and their satisfaction level of public transportation modes up to this data. Finally, the study will use a deductive methodology to analyze all findings and recommend a framework for the future implementations of TOD in the proposed areas in Jeddah city, if applicable.

The study is divided into six chapters. The first chapter outlines this study's research background, importance, goals, and objectives and the methods utilized to complete it. The following chapter explores the general understanding of TOD using an inductive methodology. This chapter also investigates the principles of TOD and the requirements that users of such projects need while comparing them to the case of Jeddah city. The third chapter will analyze different case studies related to the successful usage of TOD in cities; The fourth chapter explores the historical development of public transportation modes introduced in Jeddah city, highlighting the change in the transportation system that different authors documented. This exploration will aid in initiating a framework of design that will help the citizens of Jeddah with resilient travel modes that reflect their culture and respond to their socioeconomic needs. The fifth chapter presents the empirical case study in Jeddah city. It investigates the city's physical and socioeconomic character. It divides it into categorized homogeneous zones to have a cross-sectional analysis and ensure the representation of all socioeconomic sectors. Later, the study seeks to determine the satisfaction of Jeddah's citizens by surveying to analyze the requirements that would motivate the citizens to use different transportation modes instead of relying on private cars. Finally, the last chapter will conclude the study by compiling the different results of the study chapters, recommending a framework for TOD implementation in different areas of the study, and proposing future research areas (Fig. 2).

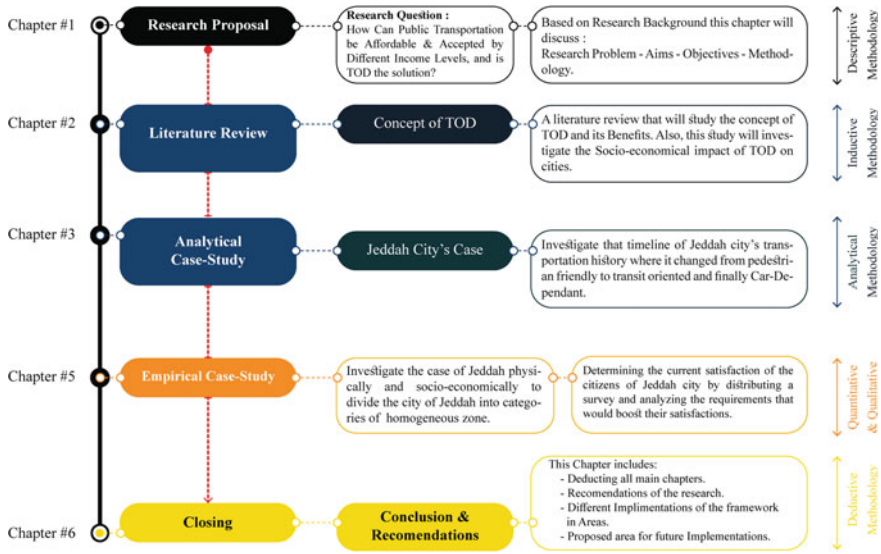


Fig. 2 The structure flow diagram of the study

2 Literature Review: The Concept of Transit-Oriented Developments

In highly urbanized cities such as Jeddah city of Saudi Arabia, a large percentage of the population depends on private cars for daily travel. This study aims to investigate the concept of TOD and discover the factors that helped motivate the citizens toward using different transit-oriented solutions. The study selected the TOD concept for its efficiency and ability to offer diverse mobility and transportation options.

Transit-Oriented Development (TOD) is a concept that has been developed as a cure for car-dependent cities. Chan, Nakamura & Imura (2016) described TOD as a radical concept that focuses on an alternative method of travel that is more efficient than vehicles. Therefore, TOD leads to compact, walkable, mixed-use neighbourhoods based on high-quality transport systems.

C40 cities advise planners to use the eight principles of TOD that were stated by the Institute of Transportation and Development Policy (ITDP) that would lead to efficient use of the TOD concept [3], and these principles were:

1. **Promote walkability** by offering the users of the neighbourhood the required infrastructures and facilities, such as paved sidewalks with different usable zones.
2. Provide the users with the opportunity to **choose non-motorized transportation modes** such as cycling.
3. Develop a street and **path network that is dense** and well-planned to serve the user's daily travel destinations.
4. Plan developments to be **located nearby high-quality transportation services**.

5. Used **mixed-use planning** approaches to provide users with their required services within walking distance.
6. **Maximize transportation** capacity and density.
7. Develop **commuter-friendly** areas.
8. Regulate parking and the use of roads to **improve mobility**.

3 The Case of Jeddah City

Jeddah is the second-largest city in Saudi Arabia, and its size has significantly affected the travel-ling pattern [4]. Since 2007, the usage of private cars has increased up to 93% in Jeddah city. This fact urges this research to understand where Jeddah city has reached in the 2020s to conclude whether TOD could assist the car-dependency situation. Jeddah is an important city with a rich history, and its strategic location has been glorified through the words of many historians. The city of Jeddah has a history dating back over 3000 years when it was utilized as a fishing settlement. During that time, a tribe known as the 'Quda'ah' moved into the region, and legend shows that the city got its name from the Qudah tribe. The numbers account for more than 96 per cent of all daily travel, and many of Jeddah's roadways are congested. The UN-Habitat conducted a study in 2019 to examine the functionality of Jeddah city's road network. Forty-eight percent of the population, or two million individuals, had access to the city centre within a 15-min drive. In addition, three essential city districts were subjected to a pedestrian accessibility investigation. This analysis shows that the culture of walkability is attached to the concept of sports activity and exercising (Fig. 3).

4 The Empirical Case Study of Jeddah City

The study aims to analyze four main homogeneous zones of Jeddah city to understand better the different categories of locations and citizens that this study will face. The empirical case study identifies its primary data from interviews and distributed questionnaires. Later, the study will continue to compare the primary data collected with the secondary data gathered previously to design a framework that resembles a vision that will create an efficient and desirable solution for the problem of car dependency. This research phase will look at four primary homogenous zones in Jeddah to further study the different areas and inhabitants that this research will encounter. The region of Aubhor in northern Jeddah and the area of new Jeddah in the centre zone of Jeddah city will be the only homogenous zones that this study will investigate due to the limitation of time and resources (Fig. 4). This analysis aims to study the zona's road network, street pattern, and socioeconomic character.

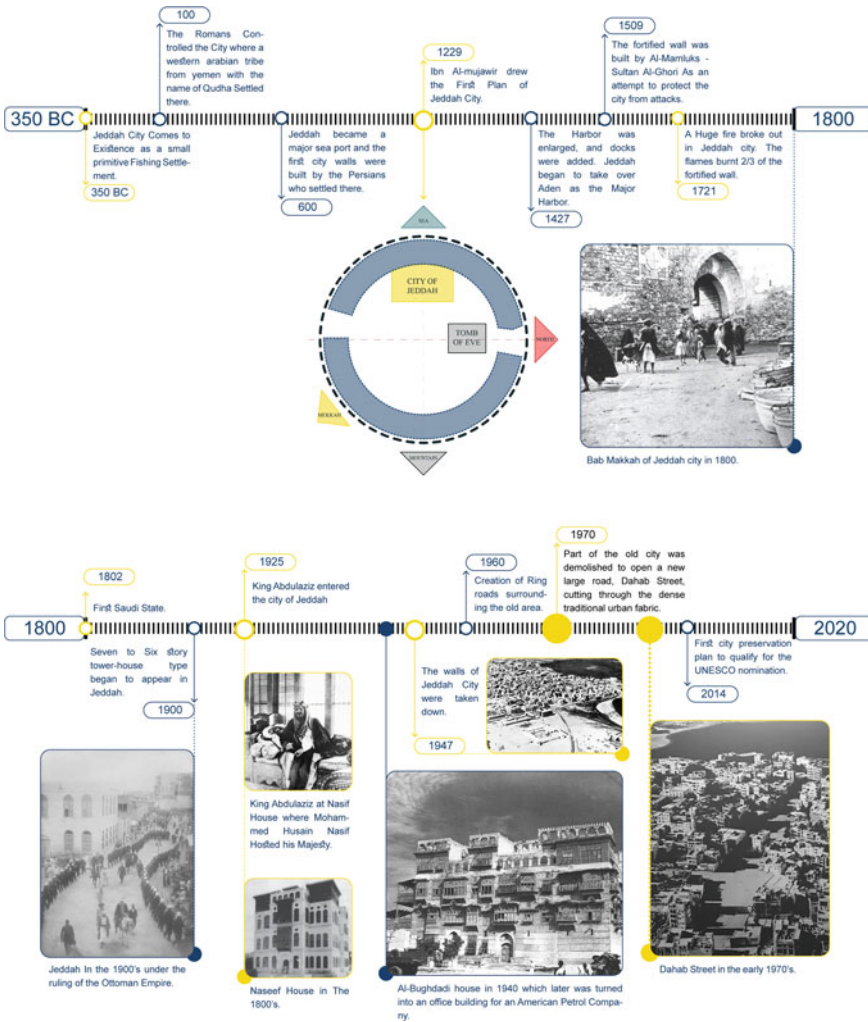


Fig. 3 The Morphological Changes of Jeddah city between 1970–2007

4.1 Category#1: The Zone of Aubhur, Northern Jeddah City

This category comprises 25 districts under two major municipalities of Jeddah - Ubhur and Northern Ubhur Municipality. However, only 6 of those districts are homogeneous regarding social, physical & economic aspects. The six districts are North Ubhur, Al-Safari, Al-Shara'a, Al-Yaqoot, South Ubhur, and Al-Asalah.

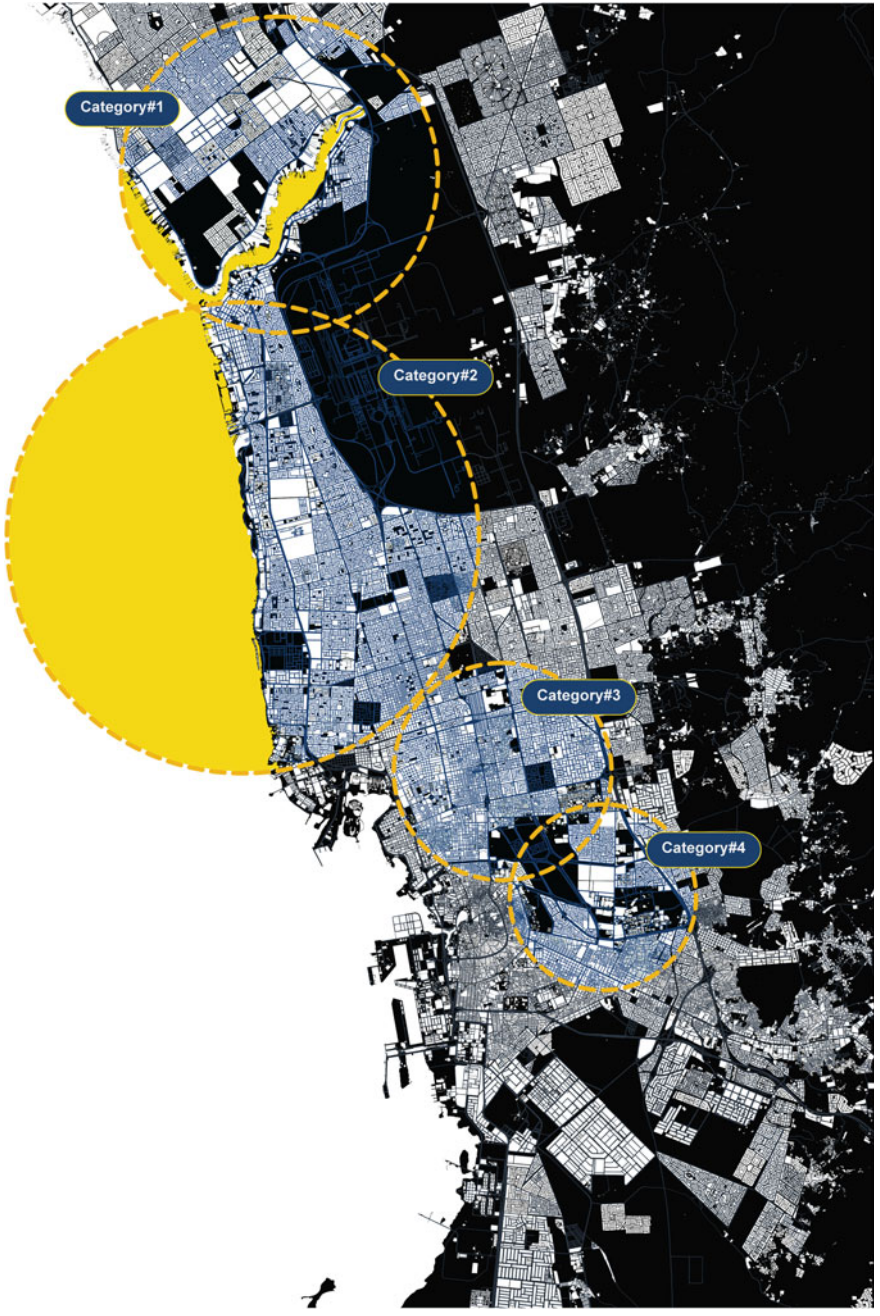


Fig. 4 The Selected Homogeneous Zones of Jeddah City (Category 1,2)

Category.1 is significant for three prominent landmarks as the zone's main attraction and destination. As shown in Fig. 5, The first prominent landmark (1) is Jeddah's economic city which is expected to be completed in 2025. Also, the first landmark includes Jeddah's Tower, which is expected to compete with the international towers of the world in its height. The second landmark on map (2) resembles one of the Al-Haramian train stations. Finally, the third landmark on map (3) is the King Abdulaziz International Airport of Jeddah city. These landmarks resemble the prominent landmarks and attractions of category.1. The network of categories.1 roads, as shown in Fig. 6, is focused on two main highways of Jeddah city. These highways are Al-Madina rd. and King Abdulaziz rd. which are the leading used rd. to reach most zone destinations, as shown in Fig. 13. As shown in Fig. 7, the street pattern in category.1 is mainly fragmented parallel. The streets in this zone have minimal curves following the major arterial roads, which eases the driving experience between districts and neighbourhoods (Figs. 8, 9, 10, 11 and 12).

The population in category.1 varies between 1 and 28 p/ha. Compared with the other categories this study discusses, this category includes the least population density since it expanded in the late 2000s. The zone of category.1 includes excellent housing conditions in high-socioeconomic-status districts (Level 1), with villas designed for one or two families being the norm. These areas often have a low population density and two or three automobile lanes on their roadways. South Aubhor has low socioeconomic level districts with low housing and living conditions (Level 3). These are the only regions where poor non-Saudis can afford to live due to the low cost of housing. Central and southern Jeddah City areas have dense populations, and power and water are frequently unavailable. As a result, many save water in tanks to use when they need it. The drainage system is insufficient, and surface water just needs a tiny quantity of rain to arrive [5].

4.2 Category#2: The Zone of New Jeddah, Central Jeddah City

Category.2 is the largest category in this analysis. It includes two significant municipalities of Jeddah city: Ubhor and New Jeddah. This category includes ten districts that will be discussed: Al-Basateen, Al-Shate'e, Al-Mohammadeya, Al-Murjan, Al-Nae'em, Al-Nahdha, Al-Khaldeyah Al-Rawdhah, Al-Zahrah, and Al-Salamah District. Category.2 was selected due to its location's significance near the King Abdulaziz Airport (1), as shown in Fig. 8. Also, it includes one of Jeddah city's primary touristic locations, the Waterfront of Jeddah city. This category includes one of the largest central commercial areas of Jeddah city, where most commercial and office buildings are located. The network of category.2 roads, as shown in Fig. 9, are also focused on the two main highways of Jeddah city. **Al-Madina rd.** and **King Abdulaziz rd.** are the most often used highways to access most zone locations. Also, Another major street that tourists and entertainment facility users



Fig. 5 Category#1 of the empirical casestudy of Jeddah city_landmarks locations



Fig. 6 Category#1 of the empirical casestudy of Jeddah city_network analysis



Fig. 7 Category#1 of the empirical casestudy of Jeddah city_street pattern

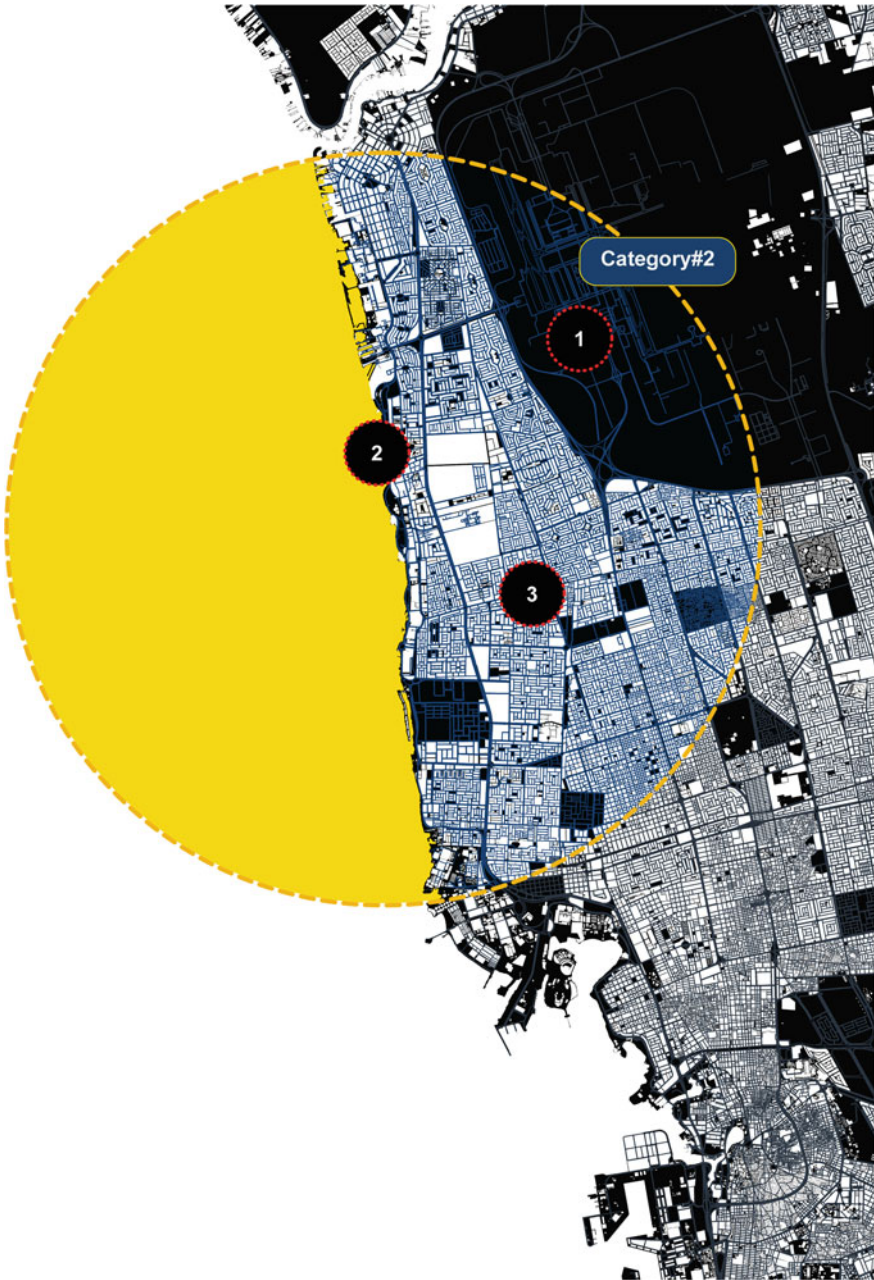


Fig. 8 Category#2 of the empirical casestudy of Jeddah city_landmarks locations

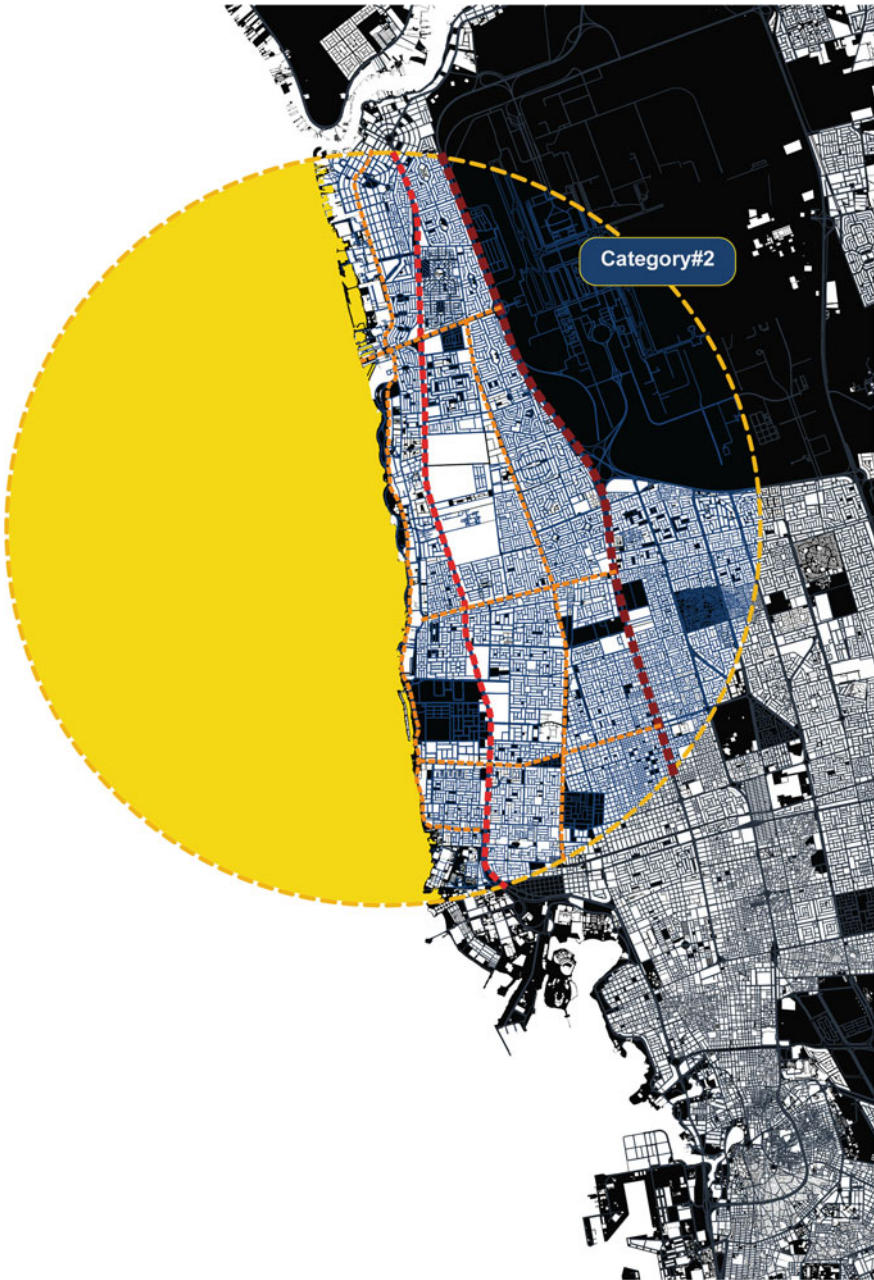


Fig. 9 Category#2 of the empirical casestudy of Jeddah city__network analysis

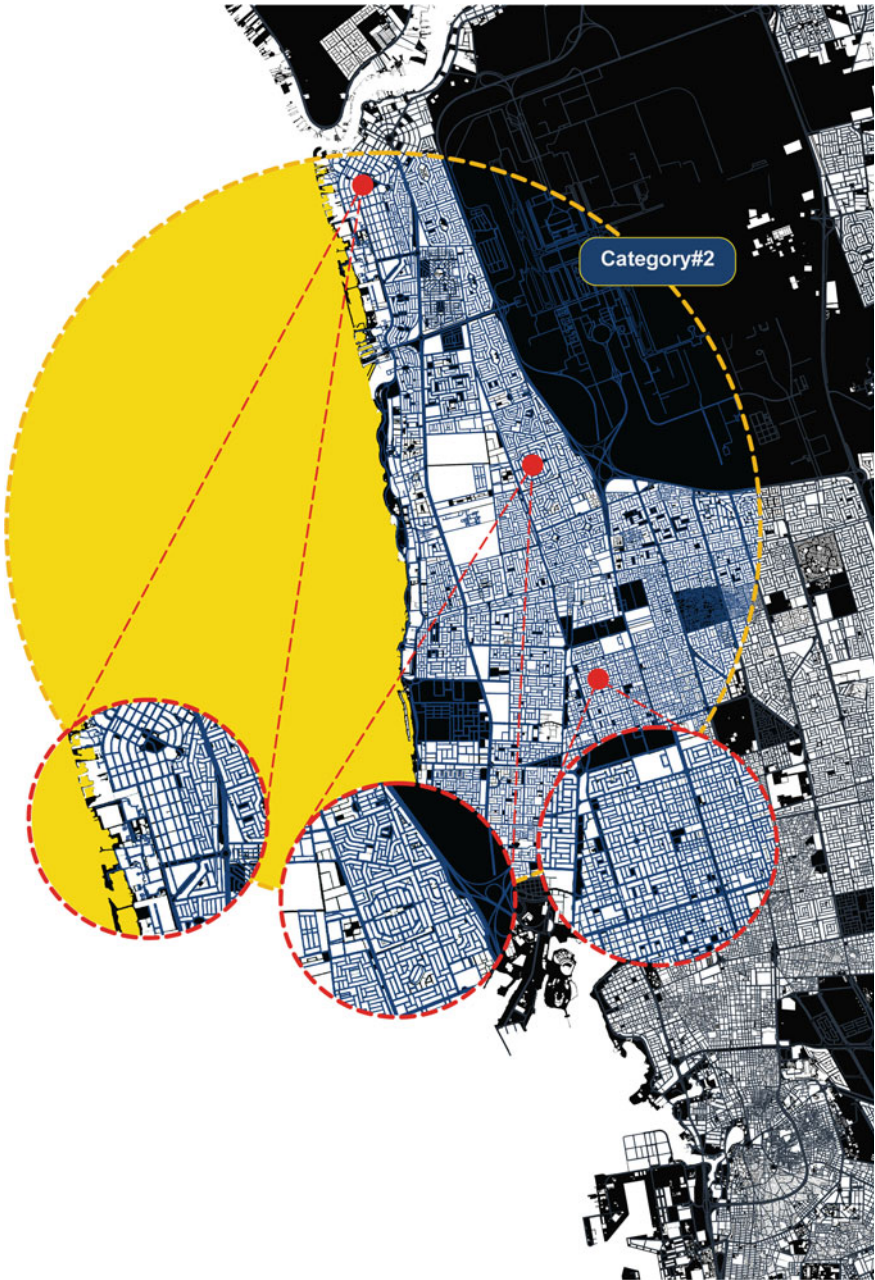


Fig. 10 Category#2 of the empirical casestudy of Jeddah city__street pattern

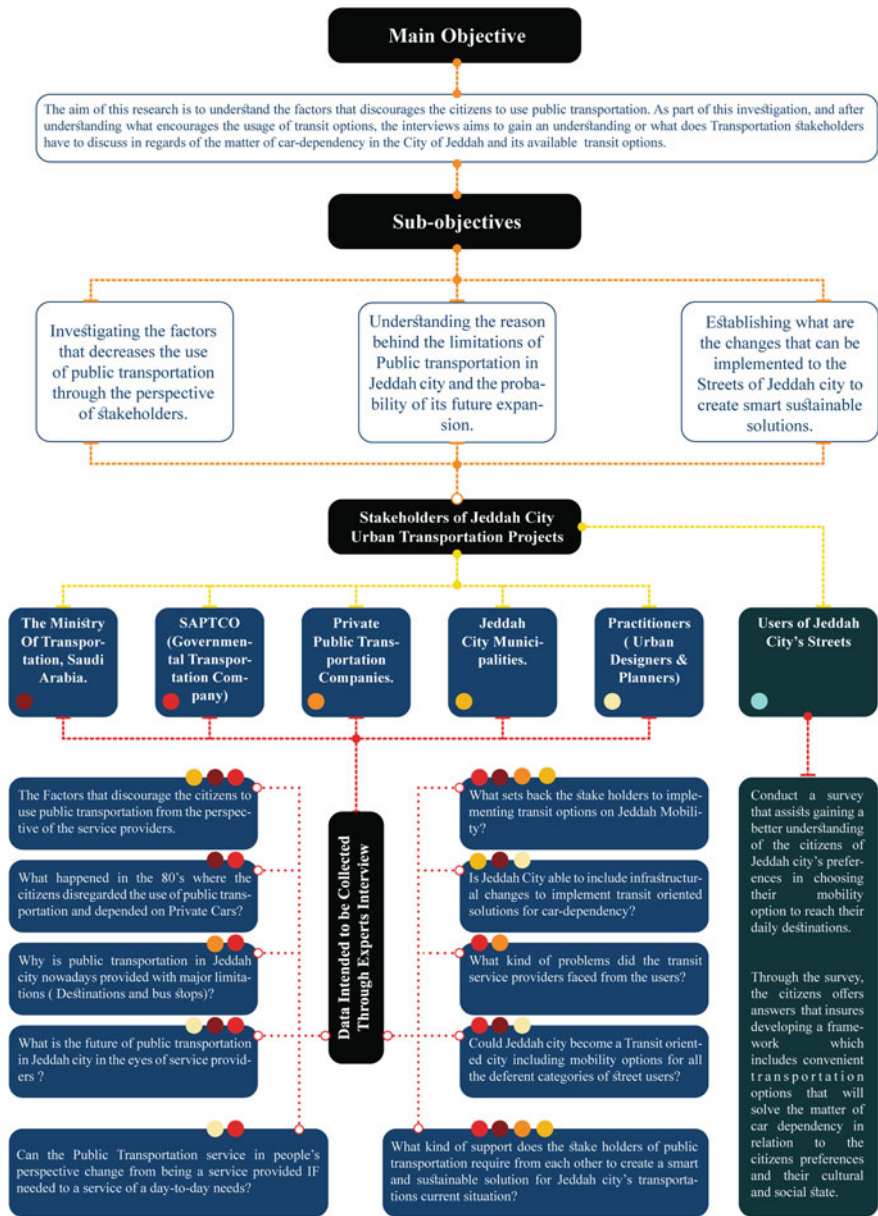


Fig. 11 Category#2 the mindmap of the urban transportation stakeholders in Jeddah City (Red circles identify the interviews and questionnaire conducted)

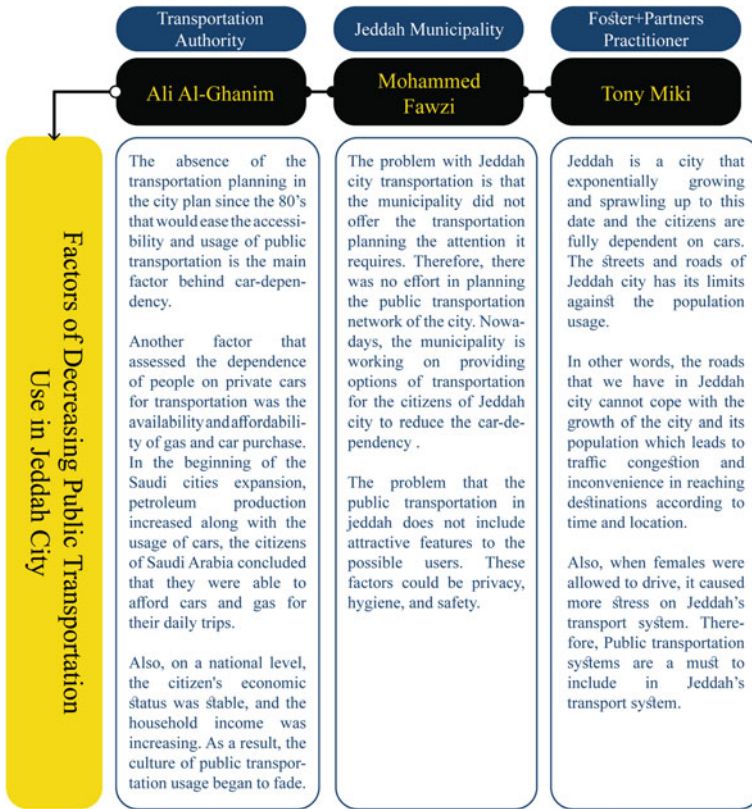


Fig. 12 The perspective of stakeholders on the factors of decreasing public transportation use in Jeddah City

mainly use is Al-Corniche rd. which overlooks the seashore of Jeddah city. Other main streets are included in category.2 are **Hira st., Prince Sultan st., Sari st. and Prince Mohammed bin Abdulaziz st.** The street design in category.2 is mostly fragmented parallel, as illustrated in Fig. 10. The roadways in this zone feature few turns and follow main arterial roads and highways, making travelling between districts and neighbourhoods easier. Housing conditions in high-socioeconomic status neighbourhoods (Level 1) are outstanding [5]. The population density in category.2 fluctuates between 1 and 43 p/ha. Most of these areas are densely populated and primarily Saudi, with more than 6–8 individuals living in a 4–5 bedroom flat.

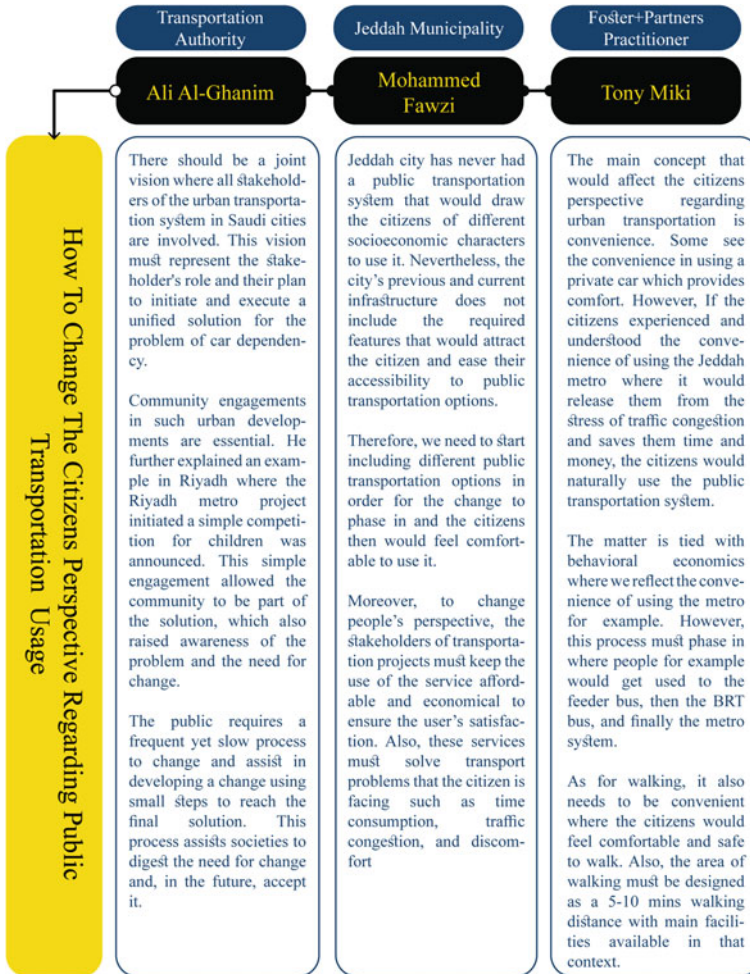


Fig. 13 The stakeholders' perspective on how to change the citizen's perspective regarding public transportation use

4.3 Interviews of Primary Data Collection

The research conducts semi-structured interviews with five main stakeholders of Jeddah's urban transportation model. As shown in Fig. 11, the main aim of this study is to discover what variables deter individuals from using public transportation. Moreover, the figure identifies the five main stakeholders of Jeddah's urban transportation system. The interviews are conducted with four stakeholders, excluding the users of Jeddah streets, where a survey is distributed to reflect their opinion and preferences.

Interviews were conducted with members of the Jeddah Urban Transportation Development Authority (TDA) to understand the current situation of transportation through the eyes of different members involved in the transportation planning process. The questions were based on the themes of the chapter on urban transport and were designed to examine the city's transport sector's social, cultural and economic aspects. The Interview shows that there are many different opinions and perspectives when discussing the phenomena of car dependency in Saudi Arabia. The first factor discussed was the neglect of transportation planning during the expansion of Jeddah city. The second factor that the authority representative mentioned was the rise of the oil and gas industry and the affordability of cars. This factor disregards any transportation planning that includes public transportation services. Jeddah Municipality believes that the streets we have in Jeddah city cannot cope with the city's continuous expansion and development.

On the other hand, A practitioner of Foster + Partners believes that it would be better to start the change slowly and frequently, and the citizens will adapt. The transportation authority saw the solution in creating a joint vision that all stakeholders agree on and engaging the community. Many solutions require major and minor changes in the city to solve the problem of car dependency. The authority of transportation and the municipality of Jeddah saw that making infrastructural changes is a huge challenge that requires significant funding. In Contrast, the practitioner of Foster + partners argues that the solution is that the government should provide incentivization, and stakeholders should develop guidelines and requirements of what the streets need to become transit-oriented.

Many factors caused Jeddah city to become car-dependent. First is the city's rapid growth in a short period compared to other cities and the neglect of public transportation planning. Second, the affordability of gas and car purchases when the urban sprawl started, and third, the fact that the streets were not and cannot cope with growth. The citizens have their perspective oriented to use private cars, but this can be changed if a plan is set to start the change. Therefore, the solution must also attract citizens and investors to fund such a project. The ideal change is to make Jeddah city a network of different TOD projects where each project is connected to the other yet serves the area and is location efficiently (Fig. 14).

4.4 Study Guidelines Towards Creating TOD Networks in Jeddah City

By deducing the primary and secondary data collected, the study has concluded major guidelines resulting from a correlation between the three themes of Jeddah's socioeconomic, cultural, and physical environments study and the variable of walkability, non-motorized, and public transportation. Accordingly, six diagrams of urban transportation guidelines have been created to identify the role of the project's future investors, the project advertisement, and urban project designers. The first thing



Fig. 14 The stakeholders' perspective on what kind of change could Jeddah city encounter regarding urban transportation

stakeholders must remember is that Jeddah city cannot become one holistic transit-oriented development. Nevertheless, the city is not able to become entirely walkable. Therefore, the city must become a network of other transit-oriented developments that include walkable zones between the neighbourhood streets to reach transit stops and stations. These guidelines are described in the following Figs. 15, 16, 17, 18, 19, 20.

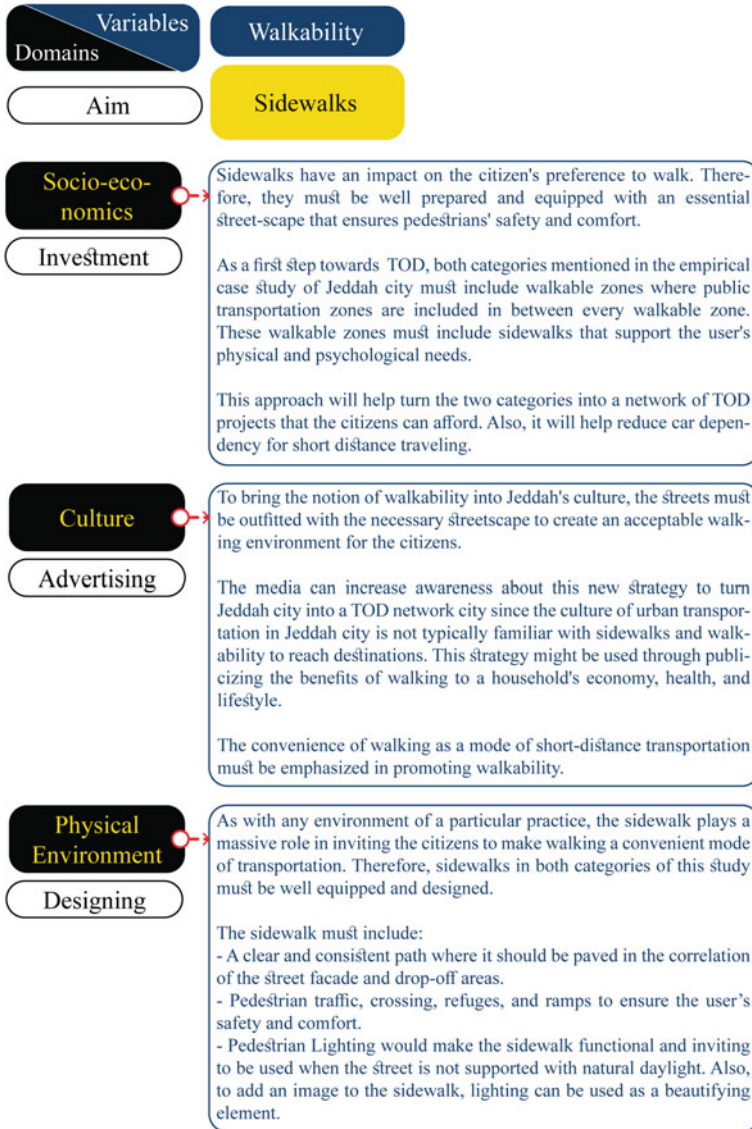


Fig. 15 The study guidelines of Walkability in Jeddah city_Sidewalks

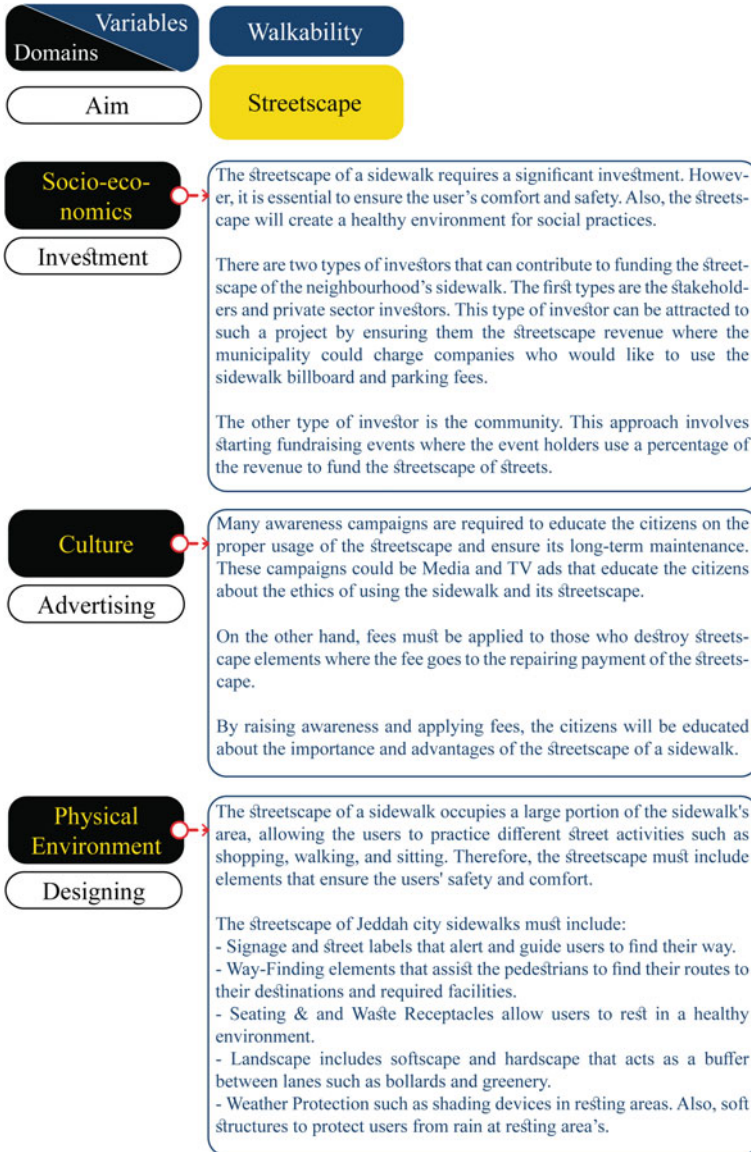


Fig. 16 The study guidelines of Walkability in Jeddah city_Streetscape

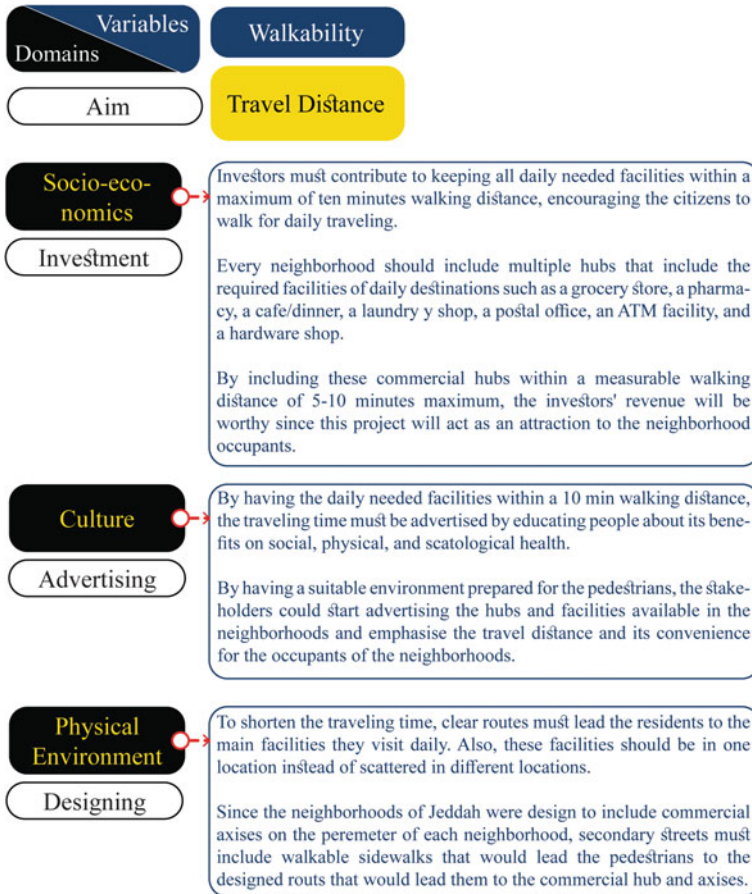


Fig. 17 The study guidelines of Walkability in Jeddah city_Travel Distance

5 Conclusion

Cities that are quickly growing present a significant task for urban planners and decision-makers. Jeddah City has a diverse functional component that comprises a long-distance movement system from north to south. This study tackles the issue of car dependency by studying the principles of TOD and how to create guidelines that represent a holistic vision toward an iconic urban transportations system in Jeddah city. As a result of interviewing three of the major stakeholders of the urban transportation sector in Jeddah city, the city requires a holistic vision that would define the stakeholder’s role to achieve a network of TOD in Jeddha city’s plan. This network of TOD is essential to create walkable zones that pedestrians can use to reach

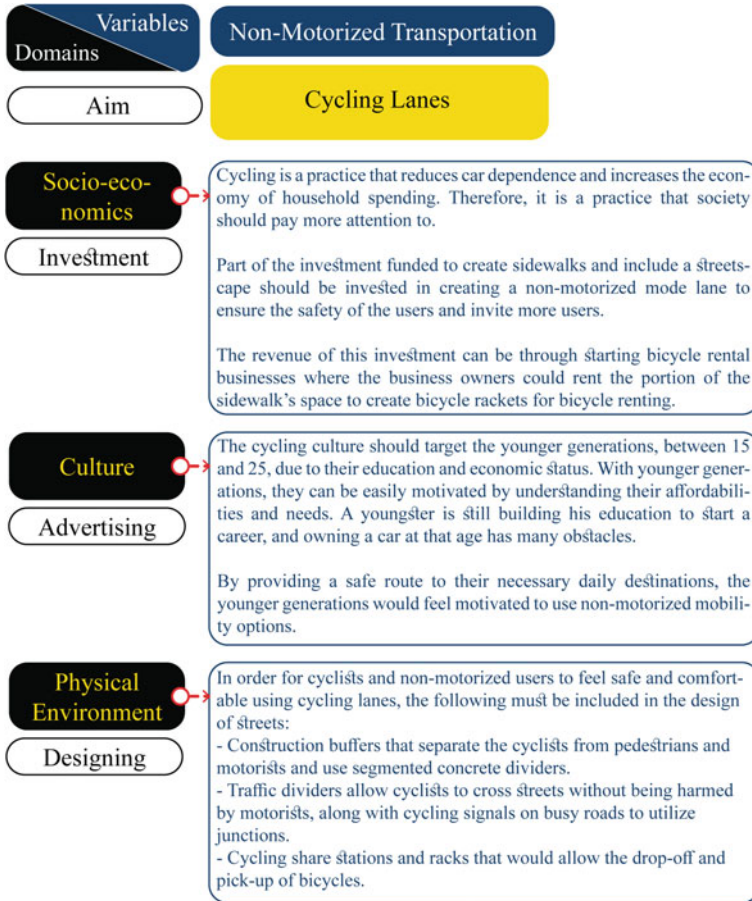


Fig. 18 The study guidelines of Non-motorized Transportation in Jeddah city_Cycling Lanes

public transit stations or stops. The guidelines discussed in this study are the essential requirements that will ensure revenue to the investors funding this project, the introduction of public transportation into the urban transportation culture of Jeddah city, and, most importantly, motivating citizens of Jeddah city to practice walkability and use public transportation. These guidelines must be taken into consideration by the transportation stakeholders to start solving the problem of car dependency and high traffic junctions on the streets of Jeddah city. By that, the city of Jeddah will endorse a resilient and intelligent urban transportation system that will affect many generations and citizens with different socioeconomic levels as the city will become humanized and easily navigated.



Fig. 19 The study guidelines of Public Transportation in Jeddah city_Public Transportation Services

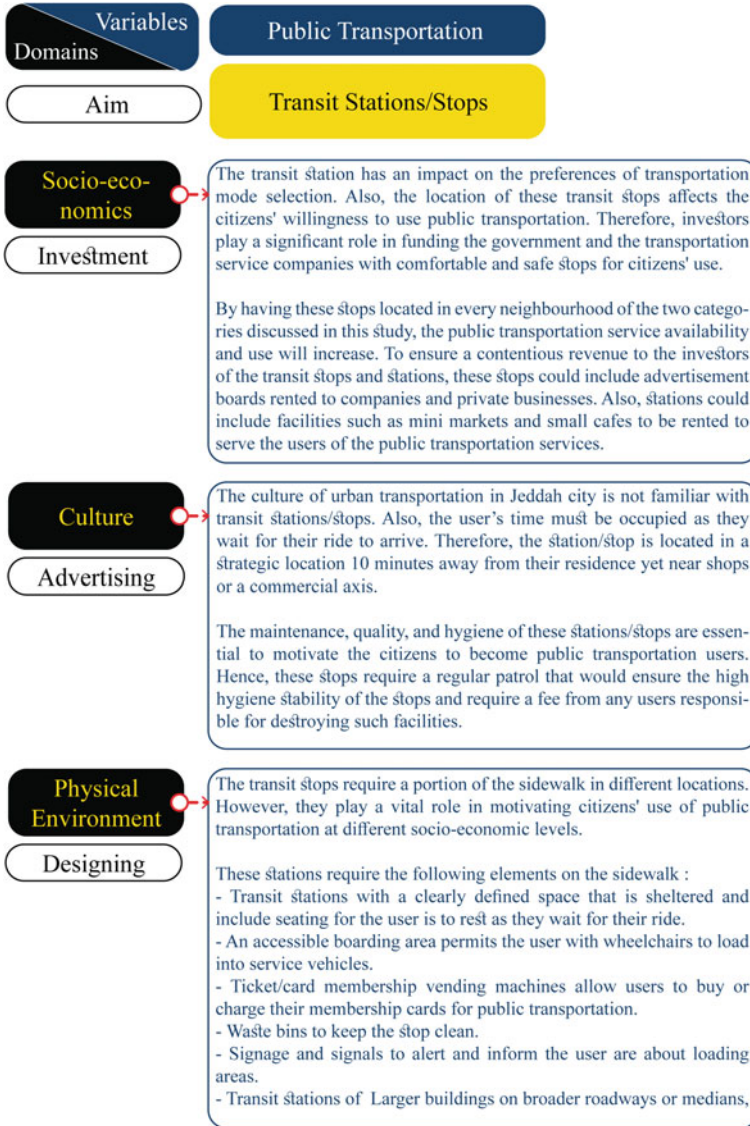


Fig. 20 The study guidelines of Public Transportation in Jeddah city_Tranit Stations/Stops

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