



The Role of High Density in Public Transportation-Oriented Development, (Study on the Application of Public Transportation-Oriented Development in the City of Nasiriyah)

Sarah Abdulkareem Hanoon

College of Engineering, University of Thi-Qar, Thi-Qar, Iraq.

ARTICLE INFO

*Received: 25 Sep 2024,
Revised: 30 Sep 2024,
Accepted: 3 Oct 2024,
Online: 21 Oct 2024*

Keywords:

Transit-oriented Development (TOD), Mix Land Use, High-density, Urban Densification, Sustainability, Accessibility.

ABSTRACT

The research deals with one of the strategies related to transport planning in high-density cities through urban densification, where the concept of transit-oriented development is one of the most recent strategies for sustainable development. In its theoretical framework, the research dealt with the concept of transportation, the concept of urban densification, the relationship of transport with urban densification, the impact of transportation on urban land uses and the complementary relationship between them, and a set of common indicators between them was reached, which were represented by (density, diversity, ease of access, mix of land uses, the design). These main indicators also include several other sub-indicators, as they can provide an appropriate basis for knowing the possibility of a shift towards sustainable transport. As for the practical aspect, it was represented by conducting field surveys for the study area (the city of Nasiriyah) in order to identify its planning characteristics, and after that the indicators that were deduced from the theoretical framework were applied to them. The research found that there is a great approach in three indicators, which were represented by (ease of access and diversity), as it achieved proportions appropriate to the required rate in the specifications of development directed to transit, while the density index and the mix of land uses index were partially achieved as it approached the minimum limits of the specified rates. Thus, it can be concluded that the high density, the method of distributing the uses of the land and the intensification of the area has imposed a great impact on the indicators, as this was reflected by encouraging a mixture of land uses in the region and thus proximity to activities and services, providing high accessibility, and creating diversity and vitality in the region.

1. Introduction

Cities around the world, especially after the increasing number of densities, seek to provide an integrated transportation system that provides its services to the city at an affordable cost and with

high efficiency, as it is expected that this increase in land use densities and mix, which we call "urban densification," will lead to the protection of natural resources, Such as agricultural land and

Corresponding author:

E-mail addresses: sarah.abdulkareem@utq.edu.iq & Sarah.a.kareem2@gmail.com

doi: [10.5281/jgsr.2024.13958265](https://doi.org/10.5281/jgsr.2024.13958265)

2523-9376/© 2024 Global Scientific Journals - MZM Resources. All rights reserved.



This work is licensed under a Creative Commons Attribution Share Alike 4.0 International License.
<https://creativecommons.org/licenses/by-sa/4.0/legalcode>

clean air, and supporting better use of social services. However, it has also been noted that without consistent urban transport policies, costs associated with densification (e.g. congestion and pollution) may prevail rather than benefits.

In order to be able to understand and deal with this complexity in an effective manner, it is argued that transportation and land use planning must be done in an integrated manner. This research will reveal how transportation and land use planning in the city of Nasiriyah deals with the challenge of urban densification.

2. Materials and Methods

The research will follow a mixed methodology, combining quantitative and qualitative methods. This design aims to provide a comprehensive understanding of the role of high density in improving the effectiveness of transit-oriented transport (TOD) systems. This methodology will help explore the complex relationships between density and transport, and provide reliable data to support the findings.

Century, we need to make it efficient, reducing energy requirements, making it sustainable by integrating technology and intelligence into the physical transportation infrastructure [1].

3. The concept of urban densification

The term density often has a negative connotation and is associated with a feeling of suffocation, tightness and crowded places, but now in sustainable densification we reveal interesting positive aspects [2]. The inevitability of sustainable densification leads us to urban densification, which supports economic vitality and gives diverse options for land use, through which air quality can be improved and gives the possibility of supporting public transportation. It is densification that does not lead to suffocation or the elimination of public spaces in the city, but rather depends on using the urban environment in a thoughtful way. And sound [3].

4. Sustainable transport and urban densification

The relationships between urban density and

mobility are subject to much debate and are more complex than they may initially appear. Transportation and land use influence each other directly internally, but they are also affected by external factors such as individual attitudes and socio-economic and demographic variables [4].

4.1. Ease of access

Transportation options available with land distribution create accessibility, defined as ease of access to desired activities from other locations. Changes in land use are affected by accessibility (a more accessible location will be more advantageous for development), along with other factors such as the quality of the local environment, available land, and land use planning policy. Densification around existing public transportation networks is enhanced because this leads to changing activity patterns and shifting modes of transportation [5].

Services are mostly concentrated in urban centres, near important public transport points [6]. To improve the standard of living and accessibility, inner city growth should be located near public transport stations. There are also interventions that deal with transportation planning and densification in an integrated manner. Therefore, "a great commitment to several principles can be found that allow the integration of transport and land uses" [7].

4.2. Multiple transportation options

Dense and more mixed land use will lead to more activities in the same space, thus intensifying the use of the urban area. This also means that the transport network will be used more intensively, and over short distances in particular. To support densification, the available transportation options must be of high capacity [8]. Densification works to increase the share of sustainable modes of transportation (public transportation, cycling, walking), as land use intensification helps to increase sustainable modes of transportation through integrated planning for accessibility [9].

5. Transit-oriented development (TOD)

Transit-oriented development (TOD) is a type of urban development that increases residential, commercial, and recreational space within walking distance of public transportation. It

promotes a symbiotic relationship between dense and compact urban form and the use of public transport, by doing so TOD aims to increase public transport traffic by reducing the use of private cars and promoting sustainable urban growth [10]

Many of the new towns created after World War II in Japan, Sweden, and France have many of the characteristics of TOD communities. In the United States, a half-mile radius has become the de facto standard for rail transit catchment areas for TODs. Half a mile (800 metres) corresponds to the distance a person can walk in 10 minutes at a speed of 3 mph (4.8 km/h) and is a common estimate of the distance people walk to get to a railway station. The half-mile area is just over 500 acres (2.0 km²) in size [11]. It contains specific features designed to encourage the use of public transit and differentiate the development from urban sprawl. Some examples of these features include a mixed-use development that will use transit at all times of the day, and excellent pedestrian amenities such as high-quality pedestrian crossings, narrow streets, and a strip of buildings as you become further away from a public transit node [12].

Another major advantage of transit-oriented development that distinguishes it from “direct transit-oriented development” is the reduction in personal parking. Opponents of compact or transit-oriented development typically argue that people around the world prefer to live at low densities, and that any policies that encourage compact development will lead to significantly reduced utility and therefore significant social welfare costs [13].

5.1 Principles of Transport Oriented Development (TOD)

One of the most innovative densification experiments is the American TOD experiment, the practice of densification in the areas of existing stations and project stations. Transit-oriented development (TOD) is defined as a medium-high-density settlement located within a pedestrian radius of a station or station for rapid public transit, and which is designed to facilitate and facilitate its use [14].

The scenario aimed at by TOD projects, based on the creation of sustainable walkable communities,

which allow residents to have housing and transportation options and to live in an economically affordable way, in a pleasant environment - with playgrounds for children and specially designed for the elderly, has a positive impact in the social sphere. By maximizing the use of space in areas surrounding public transportation stations or stops, transit-oriented development practices follow smart growth principles to achieve the following environmental, economic, and social goals [15]:

- Reducing greenhouse gas emissions by increasing the use of rapid public transportation.
- Improving air quality by providing more transportation alternatives.
- Reducing energy consumption through efficient use of space and connections.
- Maximizing the use of transportation infrastructure; Reducing the amount of travel on the entire transportation network.
- Reducing traffic congestion, accidents, casualties and related costs.
- Recovering unused spaces.
- Increase the choice of mobility through the availability of more opportunities.
- Increase the choice of home, work, and services within the current city.
- Improving the balance between residential function and economic activities.
- Achieving the health benefits of spaces that can be reached on foot.
- Use TOD as a catalyst for economic development.

“Smart growth” policies deployed in the 1990s represent a system of rules designed to limit suburban sprawl and govern growth. These urban policies had among the greatest advantages of encouraging people to live closely together, within walking distance of shops and offices. The stated purpose of these policies was not only to reduce car use, but also to create neighborhoods rich in interesting “urban landscapes” and, above all, to congregate residents in high-density areas to preserve large areas of open space [16]. In the

background lies the difficulty of building infrastructures, especially if by mass transit, by public administrations – which are increasingly difficult to plan and implement on their own. It is the possibility that these areas can begin effective operations to use the increased value of the areas to build, complete or improve the infrastructure itself [17].

5.2 Transit-oriented development goals (TOD).

Transit-oriented development consists of a number of goals as follows [18]:

- Promote the design and construction of attractive pedestrian-oriented streets, as well as public spaces complementary to mass transit.
- Promoting the type of building that focuses on the pedestrian characteristics and nature of the neighborhoods and areas served by public transportation.
- To promote rapid mass transit as a focal point for areas connected to the rest of the city.
- Increase mobility by improving access to public transportation services.
- Designing compact, high-density spaces integrated into rapid transit where people can live, shop, and use services.
- Achieving safe traffic, such as balancing the needs of pedestrians, cyclists, and cars.
- Promote a building type that includes a wide range of functions that complement public transportation, in a space system that increases the opportunities and quality of neighborhoods.

5.3 The seven main factors of transit-oriented development

The application of a transit-oriented development strategy depends on a set of factors that must be present in the city and that must be taken into account when planning the city. These factors are as follows [19]:-

- Transit should be at the heart of development, whether it is heavy rail, light rail or bus. This should be provided by high-quality, high-frequency services, making public transport a viable and desirable alternative to the use of private cars.

- Developments need a high density of residential and commercial properties in order to provide a critical mass for transit use. Density is also essential to ensure that residents can walk or bike to the nearest station or public transit stop. In the United States, commuters typically walk twice as far to reach railway stations as they do to bus stops, about a half-mile and a quarter-mile respectively.

- TOD neighborhoods should support walking and cycling as first options for accessing public transportation and other services. This encourages healthy lifestyles and posture choices that have lower environmental impacts.

- Driving and ownership of private vehicles should be discouraged. Alternatives, such as car clubs, can be included. This can increase the benefits of TOD and support walking and cycling.

- Services should be integrated into the development, such as shops, healthcare and schools, to encourage more local trips.

- The use of brownfield sites (generally recognized as previously developed land) for TOD programs should be the sites of first choice [20].

5.4 The role of density in applying the idea of TOD

Density is one of the fundamental principles of successful TOD schemes. There are no commonly accepted density thresholds for TODs but current good practice provides a useful guide, for example [21]:

- The minimum density proposed for bus service is 25 dwellings per hectare, and for tram service it is 60 dwellings per hectare.

- The average density in London is 42 dwellings per hectare⁹, while the high density of apartments in Kensington is 80-120 dwellings per hectare.

- The average density in Freiburg, Germany, is between 90-100 dwellings per hectare and is well served by trams.

- The average housing density in Stockholm is 145 housing units per hectare, and it is well served by trams, buses and ferries.

These places provide an indication of the density

levels that can support high-frequency public transportation infrastructure and show the level of density achieved by some neighborhoods. However, sparsely populated areas still support public transport services, such as services to cities and rural areas, and these services provide vital links to communities [22].

5.5 Key indicators of transit-oriented development

5.5.1 Scope of influence

An area in the immediate vicinity of a transit station, i.e. within walking distance, and having a compact, high-density development with mixed land use to support all basic needs of residents is called the influence zone of a transit station/corridor. [23]

The area of influence is created either at transit stations or along transit corridors. It reaches a radius of approximately 500-800 meters from the transit station. When the distance between transit stations is less than 1 km and there is an overlap in the influence area, it can be defined as a specific area (about 500 meters) on both sides of the transit corridor within a 10-12 minute walk.

The area of influence, where the TOD is planned to be implemented, must be determined by the master plan and local area plans before implementation. If the TOD is anyway implemented in a phased manner, the area of influence can also be notified of the TOD in phases. The principles for determining the area of influence must be clearly defined so that there is no speculation or confusion regarding the area of influence [24].

5.5.2 High-density inclusion index

TOD promotes densification in the impact zone by providing a higher floor area ratio (FAR)/floor space index (FSI) and higher population and job density compared to the surrounding area and outside the impact zones. To ensure sustainable development, the minimum FAR should be 300-500%, and can be higher, depending on the size of the city. This will promote a higher concentration of people within walking distance of the transit station, thus increasing public transportation ridership and leading to increased fare revenue, and reduced congestion [25].

It is not necessary to maintain consistency of density and FAR standards for impact areas across the city. It can vary depending on available infrastructure, land use division, transportation capacity etc [26].

Cities must follow green building standards, adopt renewable energy sources such as solar energy and waste for energy options, adopt rainwater harvesting and groundwater recharge techniques, which encourages water conservation, use of clean energy and promote sustainable waste management in order to make them self-sufficient. Through the efficient use of resources and infrastructure [27].

5.5.3 Land multiple use index

Mixed use of land for development/redevelopment in the TOD area should be encouraged or worked on as it will reduce the need for travel by providing most of the activities such as shopping, entertainment and public amenities such as schools, parks, playgrounds, hospitals etc. within walking distance of the residents. It will also improve accessibility to transportation facilities and at the same time the link assets and destinations, i.e. residences with workplaces or activity nodes. This will ensure better utilization of the transport fleet by distributing loads in both directions, rather than creating one-way peak hour flows [28].

A mix of land uses helps optimize physical infrastructure and resources, as all components such as roads, parking, water, sewerage, etc., remain functional at all times of the day [29].

The benefits of TOD cannot be achieved with the type of developments that encourage the use of personal vehicles. It is therefore necessary to restrict developments such as low density housing, low rise development, warehouses, petrol pumps/CNG stations, cremation ground, rooftop/multi-level stands etc. in the impact area.

A mix of uses within TOD can be achieved either by horizontal mixing, i.e. separate activities in plots of land/buildings, or vertical mixing, i.e. merging different activities within the same building [30].

5.5.4 Multimodal transport index

The area of influence must have a high-quality integrated multimodal transportation system for optimal use of facilities by residents/users. The system should have seamless physical connectivity, information integration, and price integration across modes so that first- and last-mile connectivity does not become a bottleneck in the use of public transportation systems by citizens [31].

The public transportation system, including its stations, must be designed to provide high-quality services that ensure user satisfaction in terms of safety and comfort. Citizens should have unhindered access to all amenities required in the transit system as well as around transit centers [32].

The hierarchy of facilities in the transportation system should give priority to pedestrians, followed by bicycles, delivery facilities, and parking.

Public transportation stations should have ample bicycle parking spaces with room for future expansion if necessary. To support TOD, parking can be provided, if necessary.

Facilities, with appropriate pricing that prevents the use of private vehicles, can be planned primarily at terminal stations and can fall differently according to intermediate contract requirements. On-street parking in the impact zone should be prohibited and, if necessary, priced higher than off-street parking [33].

5.5.5 Pedestrian road percentage index

Streets should be designed for users of all age groups and for all types of travelers, including pedestrians, cyclists, motorists, and transit riders. It should be safe and accessible to everyone [34].

The impact area should develop in smaller blocks with a finer street network with pedestrians and cyclists. This will create a network of small, traversable blocks that contain sidewalks and facilities such as lighting, information signs, etc., and ensure pedestrian and cyclist access to public transportation stations [35].

Continuous, unobstructed pedestrian walkways of appropriate width must be provided on both sides of the streets. To protect pedestrian walkways from trespassing and parking, buffers, barriers, etc. can be provided [36].

Table 1: Indicators for transit-oriented development (TOD)

Main indicator	Sub-indicator	Measurement method	Standard
Density	Population density	Ratio of population/units to total area	90-160 people per hectare
	Labor intensity	Field study	10 jobs per hectare within activity concentration areas that include 1,000 jobs or more
	Intensity of activities	The number of working people divided by the area of the activity center	300-370
Diversity	Diversity of land uses	Entropy index	The indicator value is from 0.5-1 and the ideal is close to 1
Easy access	Easy pedestrian access to the network	GIS software	(1000 m) for rapid public transport, trams and railways, and (500 m) for traditional public transport, buses.
	Close to alternative transportation	GIS program distribution of public transport stations	The distance between any two stations is 200-600 meters.
	Access to various services	GIS software	The number of stations is 3 stations per kilometre
the design	Density of intersections	The total length of roads divided by the total number of buildings built in the city	90% of the number of dwellings within a radius of 400 meters from the service center as a minimum
	Supportive structure for safe paths	Study of the availability of supporting infrastructure services	Acceptance standard 5.14

6. The Case Study Area

6.1 An overview of the study area (Nasiriyah city)

The growth phase in the city of Nasiriyah began in 1920-1930 AD. The streets in this phase were characterized by (the alley system), in a perpendicular manner, and followed a unified, harmonious system in terms of width and direction. They were characterized by high building density and coverage and their proportional relationship with roads and open spaces, which together created a sense of (visual density) and high cohesion between the components of the urban planning structure of the region. This phase was also characterized by the blending of land uses that would create a vital human environment that attracts people's movement to the various activities present in the region. In the next stage between 1930-1950 AD, the city of Nasiriyah witnessed rapid growth, especially in the second half of the twentieth century, during which the city expanded south and north, crossing the Euphrates River as a determinant of expansion. As a result, many bridges were built that connected the two banks of the city on the Euphrates River [37].

6.2 Applying the indicators to the study area, Nasiriyah city

6.2.1. Density index

- **Population density :**

The average total population density reached 272 people/ha, which is higher than the standard of (90-160) people/ha by 61 people/ha.

It is the number of units divided by the total residential neighborhood area, which includes public services, surrounding streets, and the connection to the residential neighborhood

Total population density = $157355 / (448 + 261.2)$
= 221.

- **Intensity of activities**

In the study area, there is one type of activity and employment center, which is the secondary center of the city of Nasiriyah in the Baghdad Street area, where the area of the activity concentration area is 69 hectares, and the number

of job opportunities reached 1,605 jobs. Therefore, the density of activity concentration reached 23 jobs/ha, which thus achieves the standard. .

Employment can be calculated by identifying buildings with large commercial and industrial businesses, as well as institutions and offices that contain workers and jobs. Some studies have determined that the minimum threshold for the area that can be considered an area of concentration of employment and activities is that it must include at least 1,000 jobs and a density of 10 jobs. By hectare.

Activity intensity = $1605 / 69 = 23$

- **Labor intensity**

The density in the secondary center of the study area was 170 people/ha, which did not meet the standard (300-370) people/ha.

We conclude that the secondary center (Baghdad Street) needs to develop a high density of activities in order to accommodate a larger number of people in the area by 130 people/ha as a minimum to 200 people/ha as a maximum standard.

6.2.2. Diversity index

This indicator refers to measuring the extent of diversity and frequency of uses in the study area, and it indicates a combination of activities within the urban fabric of the city, and it can be measured from the Shannon-Wiener index, as the value of the index is equal to 1, and the closer the ratio is to one indicates an increase in urban complexity.

$$H = - \sum p_i \ln p_i$$

$$H = - \sum (0.10 + 0.06 + 0.01 + 0.02 + 0.56 + 0.007 + 0.07 + 0.008)$$

$$H = 0.9$$

Pi = the proportion of species i in the sample consisting of a number of $P_i = n_i / N$

High values of this index mean that dominance is not concentrated in a few, but is distributed among many species

The value of the index was 0.9, which is close to the value of criterion 1, and from here we conclude that the study area has great urban

diversity, as there is a mixture of diverse and repetitive activities within the urban fabric.

6.2.2.1 Mix of land uses

A. Vertical mix of land uses: This indicator contains two types:

- Percentage of the number of apartments for commercial use compared to the number of apartments for other uses: After conducting a field survey, it became clear that the number of commercial buildings is 31 and the number of apartments is 124 for an area of 9,300 square meters. Thus, it constitutes 20%, as it achieved a

value of 0.54 according to the entropy index, and thus it is within the acceptable limits of the standard, as shown in Table (2) below.

- The percentage that includes both commercial and residential use from the total area of commercial buildings: It was found that the number of vertical buildings that include residential and commercial use reached 13 buildings with an area of 9312 m², representing 27% of the total area of vertical buildings, which amounted to an area of 24570 m², achieving a value of 0.83 according to the entropy index. Thus It is within the acceptable limits of the standard.

Table 2: Number of buildings and apartments for vertical use and their areas

Usage	Number of buildings	Number of apartments	Area m ²
commercial	31	124	9300
residential	84	864	- - -
mixed	13	52	3912
the total	128	1040	311212

These percentages are for vertical buildings consisting of 3 floors or more, as the percentage of vertical buildings is very small compared to horizontal building.

B. The horizontal mix of land uses

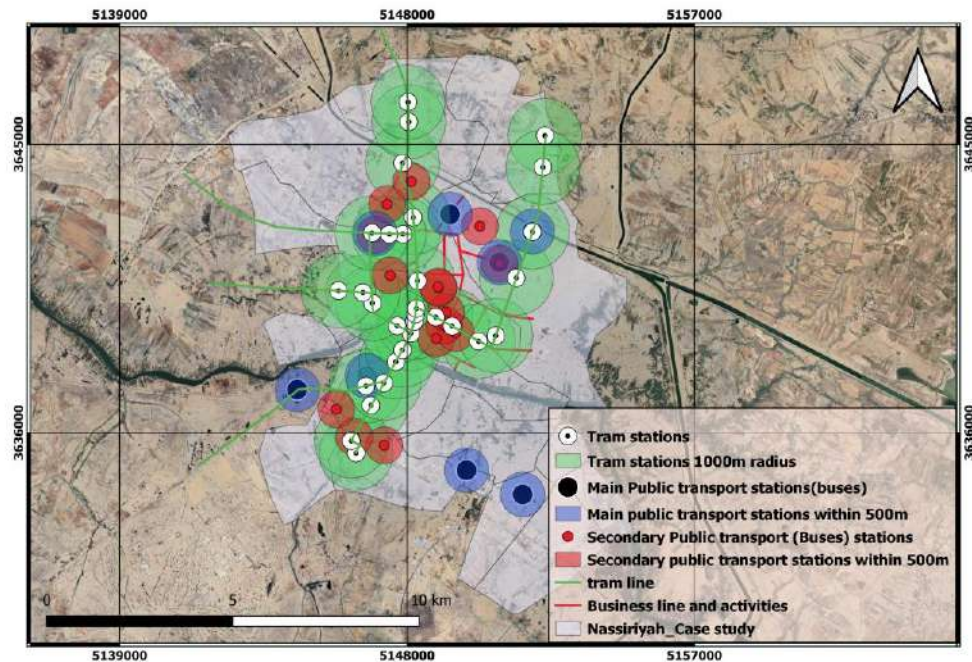
Through the field study, it was found that the value of the horizontal mix of land uses amounted to 0.45 as a general average. It is less than the standard of 0.5-1, as the index value for each neighborhood was calculated according to the number and area of each use per unit, and then the general average was found for the study area.

We conclude from this that this value is less than the standard because residential use dominates the rest of the uses. Therefore, we need to increase commercial use to achieve the acceptable limits of the standard.

6.2.2.2 Ease of access index

According to the transportation system proposed in the basic plan for the city of Nasiriyah, consisting of buses and the tram system, it was considered an implementable proposal, and work will be done on the basis of implementing the TOD system.

When applying the index of ease of access from the furthest building in the region to the public transport station, which is (1000 m) for rapid public transport, trams and railways, and (500 m) for traditional public transport buses, we note that the entire region is well served and the range of ease of access to public transport stations is (10- 12 minutes) on foot serves the farthest building in the area, as shown on the map(1) below.

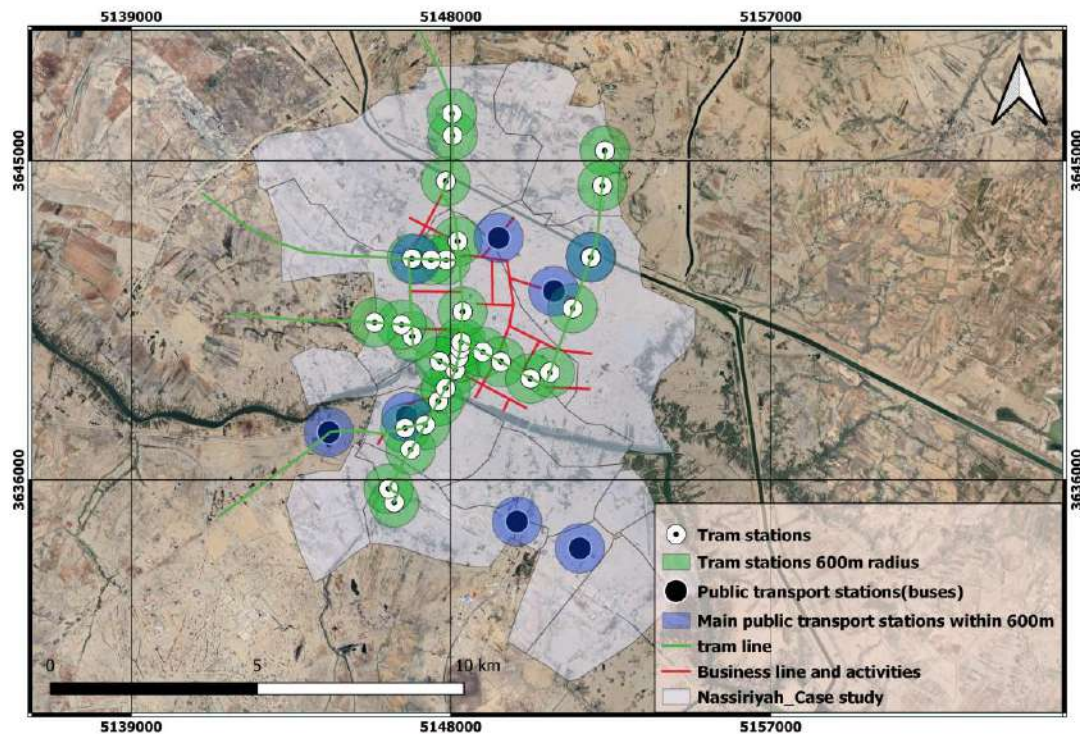


Map (1) Easy access to public transportation stations

Source: Author , based on the GIS 10.3 program

- **Close to alternative transportation**

There are two types of transportation in Nasiriyah city: private transportation and the alternative type, which is public transportation. The proximity of this alternative (public transportation) is measured through the distribution of public transportation stations. There are 8 public transportation stations in the study area (main bus stations), where there is an overlap in 3 stations within a range of 600 m, in addition to tram stations, where the served area of them is 70% within an area of 600 m, meaning that 30% of the area is not served, as shown in Map (2) below.

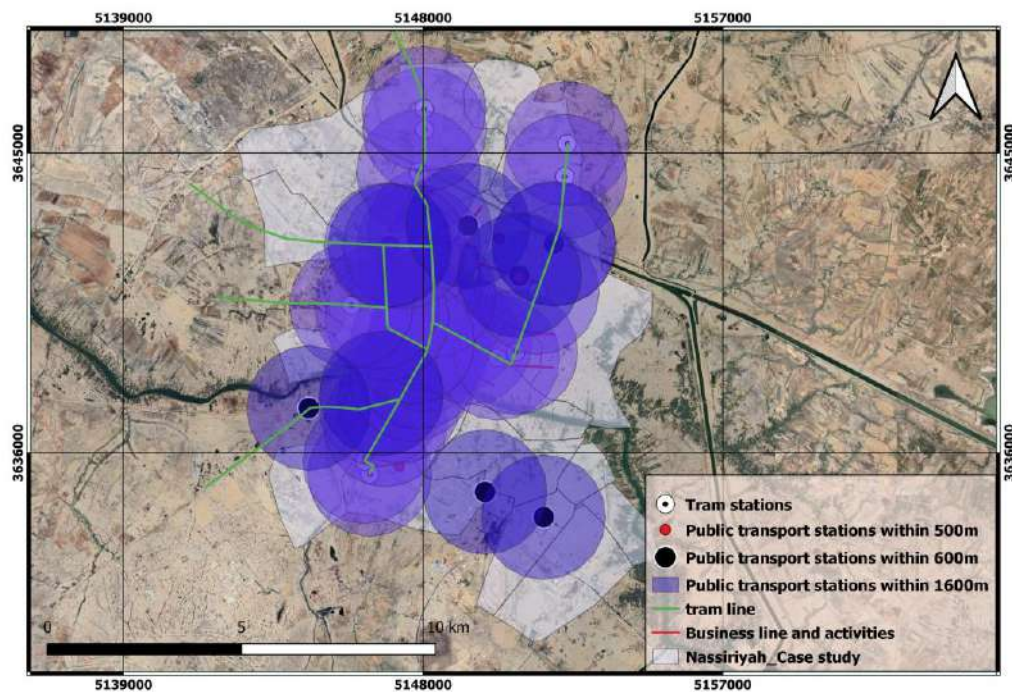


Map (2) Easy access to alternative transportation stations

Source: Author , based on the GIS 10.3 program

- **Ease of access to services index**

Through studying the activities and services available in the study area and for the purpose of studying the scale of access distances to sectoral services: Through a field survey of the study area, four areas were identified in which sectoral services are concentrated for daily shopping purposes according to the standard of 1600 meters from the sectoral service center, which can be traveled by bicycle. It was found that the number of unserved units is 125 out of 12,458 housing units, i.e. 1% of the unserved units, while the serviced residential units are 99%, which is close to the 100% standard, as shown in the map (3) below.



Map (3) Ease of access to services

Source: Author , based on the GIS 10.3 program

6.2.3 Design index

- **Road density**

This indicator is considered very important in determining road densities in the city. The total length of roads is divided by the total number of buildings built in the city. The total length of roads in the study area reached 43,177.87 m. It was found that road density reached 3.4 m/building. It is less than the acceptance standard (5.14).

- **Percentage of pedestrian road**

It is determined by the population density of pedestrian roads. Upon field study, it was found that the study area does not have an area designated for pedestrians, as the streets in the area are mixed between cars and pedestrians, and this is contrary to the standard that requires the presence of pedestrian streets.

7. Conclusion

1. The density index was largely achieved through the total population density, which amounted to 221 people/ha, which is higher than

the minimum limits of the standard. The density of activities reached 23 jobs/ha, which is higher than the minimum limits of the standard. Likewise, the labor density in the study area is less than the minimum standard, and hence the density index was partially achieved in the study area.

2. The study area contains an acceptable mix of vertical land uses, as it achieved 0.54, which is a value close to the minimum standard. As for the mix of horizontal uses, it achieved a ratio of 0.45, which is less than the standard. Therefore, this indicator was partially achieved in the region.

3. The diversity index was achieved to a large extent in the study area, reaching a value of 0.9, which is very close to the standard. Therefore, the diversity index in the study area was achieved to a large extent.

4. The accessibility indicator was achieved significantly, as the service covers the entire study area by public transportation, as well as in terms of proximity to alternative transportation services, in addition to proximity to services, and thus meets the minimum limits of the standard.

5. As for the design index, the density of roads reached 3.4 buildings/ha, which is therefore less than the minimum acceptable standards. In addition to the special percentage of pedestrian roads, they are not available in the study area and thus do not meet the standard. Therefore, the design index is not achieved in the study area.

8. Recommendations

1. Increasing the number of activities in the secondary center to accommodate a larger number of workers within the limits of the standard.
2. Providing a mix of horizontal land uses within the study area.
3. Providing special pedestrian and cycling paths to create a diversity of transportation options.
4. Providing and designing special areas for pedestrians and social interaction.

9. References

- [1]. Nekoonam, Mahdi, R. Hooman, and A. Keyvan. "Evaluation of urban transportation indicators with emphasis on sustainable development (Case study: Andishe New City)." *Journal of Research in Science, Engineering and Technology*, vol 5,, no. 4, pp 50-58, (2017). DOI: <https://doi.org/10.24200/jrset.vol5iss04pp50-58>
- [2]. Ahmad, Sohail, and Jose A. Puppim de Oliveira. "Determinants of urban mobility in India: Lessons for promoting sustainable and inclusive urban transportation in developing countries." *Transport policy*, vol. 50, pp: 106-114, (2016). DIO: <https://doi.org/10.1016/j.tranpol.2016.04.014>
- [3]. Guermond, Yves. "Repenser l'urbanisme par le développement durable?." *Natures Sciences Sociétés*, vol 14, no. 1, PP: 80-83, (2006), DOI: 10.1051/nss:2006010
- [4]. Duffhues, Jan, and Luca Bertolini. "From integrated aims to fragmented outcomes: Urban intensification and transportation planning in the Netherlands." *Journal of Transport and Land Use*, vol. 9, no. 3, pp:15-34, (2016), DOI: <https://doi.org/10.5198/jtlu.2015.571>.
- [5]. Nasri, Arefeh, and Lei Zhang. "The analysis of transit-oriented development (TOD) in Washington, DC and Baltimore metropolitan areas." *Transport policy*, vol. 32, PP: 172-179. March (2014). DIO: <https://doi.org/10.1016/j.tranpol.2013.12.009>
- [6]. Vashisth, Amit, Ravinder Kumar, and Shashank Sharma. "Major principles of sustainable transport system: a literature review." *International Journal for Research in Applied Science & Engineering Technology*, vol. 6, no. 2, pp: 218, (2018), 2321-9653
- [7]. Ahmad, Sohail, and Jose A. Puppim de Oliveira. "Determinants of urban mobility in India: Lessons for promoting sustainable and inclusive urban transportation in developing countries." *Transport policy*, Volume 50, August 2016, pp:106-114, DOI: 10.1016/j.tranpol.2016.04.014
- [8]. Nigro, Antonio, Luca Bertolini, and Francesco Domenico Moccia. "Land use and public transport integration in small cities and towns: Assessment methodology and application." *Journal of Transport Geography*, vol 74 pp: 110-124,(2019) DOI: 10.1016/j.jtrangeo.2018.11.004.
- [9]. Ewing, Reid, Gail Meakins, Grace Bjarnson, and Holly Hilton. "Transportation and land use." *Making healthy places: Designing and building for health, well-being, and sustainability* PP: 149-169, (2011), DIO: doi.org/10.5822/978-1-61091-036-1_10
- [10]. Schlossberg, Marc, and Nathaniel Brown. "Comparing transit-oriented development sites by walkability indicators." *Transportation research record* vol. 1887, no. 1, PP: 34-42, (2004), DIO: <https://doi.org/10.3141/1887-05>.
- [11]. Dittmar H, Ohland G, editors. *The new transit town: Best practices in transit-oriented development*. Island Press; 2012 Jun 22. PP:272.
- [12]. Cervero, Robert, and Danielle Dai. "BRT TOD: Leveraging transit oriented development with bus rapid transit investments." *Transport Policy* 36 Nov 1, PP: 127-138, (2014). DOI: <https://doi.org/10.1016/j.tranpol.2014.08.001>
- [13]. Duncan, Michael. "The impact of transit-oriented development on housing prices in San Diego, CA." *Urban studies*, vol. 48, no. 1, PP: 101-127, (2011).
- [14]. Bertolini, Luca, Carey Curtis, and John L. Renne. "TODs for a Sustainable Future: Key Principles to 'Make TOD Happen'." In *Transit Oriented Development*, pp: 257-267, Routledge, 2016. eBook ISBN9781315550008
- [15]. Sung, Hyungun, and Ju-Taek Oh. "Transit-oriented development in a high-density city: Identifying its association with transit ridership in Seoul, Korea." *Cities*, vol. 28, no. 1, PP: 70-82, (2011). DIO: <https://doi.org/10.1016/j.cities.2010.09.004>.
- [16]. Carlton, Ian. "Histories of transit-oriented development: Perspectives on the development of the TOD concept." (2009). https://escholarship.org/uc/iurdp_wps
- [17]. Kamruzzaman, Md, Douglas Baker, Simon Washington, and Gavin Turrell. "Advance transit oriented development typology: case study in Brisbane, Australia." *Journal of transport geography*, Vol. 34 January, PP: 54-70, (2014). DIO: <https://doi.org/10.1016/j.jtrangeo.2013.11.002>.
- [18]. Thomas, Ren, Dorina Pojani, Sander Lenferink, Luca Bertolini, Dominic Stead, and Erwin Van der Krabben. "Is transit-oriented development (TOD) an internationally transferable policy concept?." *Regional Studies*, vol.52, no. 9 PP: 1201-1213, (2018). DIO: <https://doi.org/10.1080/00343404.2018.1428740>
- [19]. Loo, Becky PY, Cynthia Chen, and Eric TH Chan. "Rail-based transit-oriented development: lessons from New York City and Hong Kong." *Landscape and urban planning*, vol.97, no. 3, PP: 202-212, (2010).

- DIO:
<https://doi.org/10.1016/j.landurbplan.2010.06.002>
- [20]. Zhang, Ming. "Chinese edition of transit-oriented development." *Transportation Research Record* , vol. 2038, no. 1, PP: 120-127, (2007). DIO: <https://doi.org/10.3141/2038-16>.
- [21]. Cho, Im Sik, Zdravko Trivic, and Ivan Nasution. "New high-density intensified housing developments in Asia: qualities, potential and challenges." *Journal of Urban Design*, lov. 22, no. 5, PP: 613-636. (2017). DIO: <https://doi.org/10.1080/13574809.2017.1311770>.
- [22]. Cho, Im Sik, Chye-Kiang Heng, and Zdravko Trivic. *Re-framing urban space: urban design for emerging hybrid and high-density conditions*. Routledge, eBook ISBN9781315725147, PP: 268, 16 December 2015. DIO: <https://doi.org/10.4324/9781315725147>
- [23]. Du Plessis, Danie J. "Land-use mix in South African cities and the influence of spatial planning: Innovation or following the trend?." *South African Geographical Journal= Suid-Afrikaanse Geografiese Tydskrif*, vol. 97, no. 3, PP: 217-242 , (2015). <https://hdl.handle.net/10520/EJC172009>.
- [24]. Shi, Yuan, Kevin Ka-Lun Lau, and Edward Ng. "Developing street-level PM2. 5 and PM10 land use regression models in high-density Hong Kong with urban morphological factors." *Environmental science & technology* ,vol. 50, no. 15, pp: 8178-8187 , (2016). DIO: <https://doi.org/10.1021/acs.est.6b01807>.
- [25]. Chen, Jie, Jianhua Ni, Changbai Xi, Siqian Li, and Jiechen Wang. "Determining intra-urban spatial accessibility disparities in multimodal public transport networks." *Journal of transport geography* , vol . 65 , pp: 123-133, (2017). DIO: <https://doi.org/10.1016/j.jtrangeo.2017.10.015>.
- [26]. Chen, Haiyan, Beisi Jia, and S. S. Y. Lau. "Sustainable urban form for Chinese compact cities: Challenges of a rapid urbanized economy." *Habitat international* , vol. 32, no. 1, PP: 28-40, (2008). DIO:
- [27]. Wey, Wann-Ming. "Constructing urban dynamic transportation planning strategies for improving quality of life and urban sustainability under emerging growth management principles." *Sustainable Cities and Society* , vol. 44, pp: 275-290, (2019). DIO: <https://doi.org/10.1016/j.scs.2018.10.015>.
- [28]. Geurs, Karst, Barry Zondag, Gerard De Jong, and Michiel de Bok. "Accessibility appraisal of land-use/transport policy strategies: More than just adding up travel-time savings." *Transportation Research Part D: Transport and Environment*, vol. 15, no. 7, pp: 382-393, (2010) . DIO: <https://doi.org/10.1016/j.trd.2010.04.006>
- [29]. Karou, Saleem, and Angela Hull. "Accessibility modelling: predicting the impact of planned transport infrastructure on accessibility patterns in Edinburgh, UK." *Journal of Transport Geography* , vol.35, PP: 1-11, (2014). DIO: <https://doi.org/10.1016/j.jtrangeo.2014.01.002>.
- [30]. planner, A.SH. J. J. o. , "Aesthetic Elements of Urban Townscape of al Nasiriyah City." *Journal of planner and development* , vol. 14, no. 2, pp: 144-169, (2009).DIO: <https://doi.org/10.1177/0042098009359958>
- [31]. Kamil, B. A., Hasan, A. F., Al-Jameel, H. A. E. (2024). Evaluation of Public Transportation Requirements for the University of Kufa: the Main Campus. *Journal of Global Scientific Research*. 9(1): 3393-3409. DIO: <https://zenodo.org/records/10462736>.