

# The Public Bus Transport Network in the City of Sfax: From its Origins to its Current Structure

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**Abstract:** *This article discusses the genesis and evolution of the public transport system by bus in Greater Sfax, the second largest city in Tunisia. The first urban public transport line in Sfax was built around 1925. The initiative was taken by two Italians to bring travelers on this journey using horse-drawn carts known among the Sfaxians as "carrou". In 1927, the number of Italian operators was five. The latter crossed the radials of Sfax on varying distances between 3 and 5 km. The Sfaxians did not intervene in this area in the 1940s. From the 1950s onwards, with the use of mechanical traction, the Faxian network of public transport began to take on its present form (Belhareth, 1990). In the mid-1980s, the network of the only state bus transport company: Sfax Governorate Regional Transport Corporation (SORETRAS), developed. Most lines extend to areas further away from the large Merkez and peripheral Sakiets. Currently, the network consists of about thirty radial, circular, tangent and special lines, but with a significant dominance of the radial. The total length of all lines reaches 540 km (round trip). The limited extension of the network since 2000 has been generally by line extensions (Belarem, M, 2011). The current public transport network by bus is not sufficient to the extent that the city of Sfax has a significant spatial extension and an increase in population and economic activities, this requires the intervention of the regional transport company involved in developing the network to meet the growing needs for urban travel.*

**Keywords:** *Public Bus Transport Network, Urban Mobility, Transport Infrastructure, Spatial Analysis, Sfax City Development*

## 1. INTRODUCTION

The city and transport are inseparable. Every city has a need for mobility in residence, work, shopping and leisure. Demographic and spatial changes are reflected in the spacing of the population by the size and extent of the movements. The development of cities is conditioned by public transport, especially those. Urban public transport is both a cause and consequence of the development of the city, its population and its urban activities.

In this paper, we cover the public transit system by bus in the Greater Sfax. In this city, the transport network has structured space by promoting the excessive extension of the city, excessive urban sprawl, the spread of spontaneous habitat, the formation and deformation of urban spaces, the structuring of different networks. It also enabled the localization of activities, the transformation of social practices, etc. and the valorization of space, although it did not develop sufficiently. Over time, the shortcomings of public transport by bus have been well noticed quantitatively and qualitatively.

In the following paragraphs, we discuss the genesis and evolution of the public transport network by bus in Sfax, managed by SORETRAS, and which remains insufficient in the face of pressing and accelerated needs from one year to the next causes the spread of urban space and the increase in population size and density and the development of urban activities

## 2. METHODOLOGY AND TOOLS

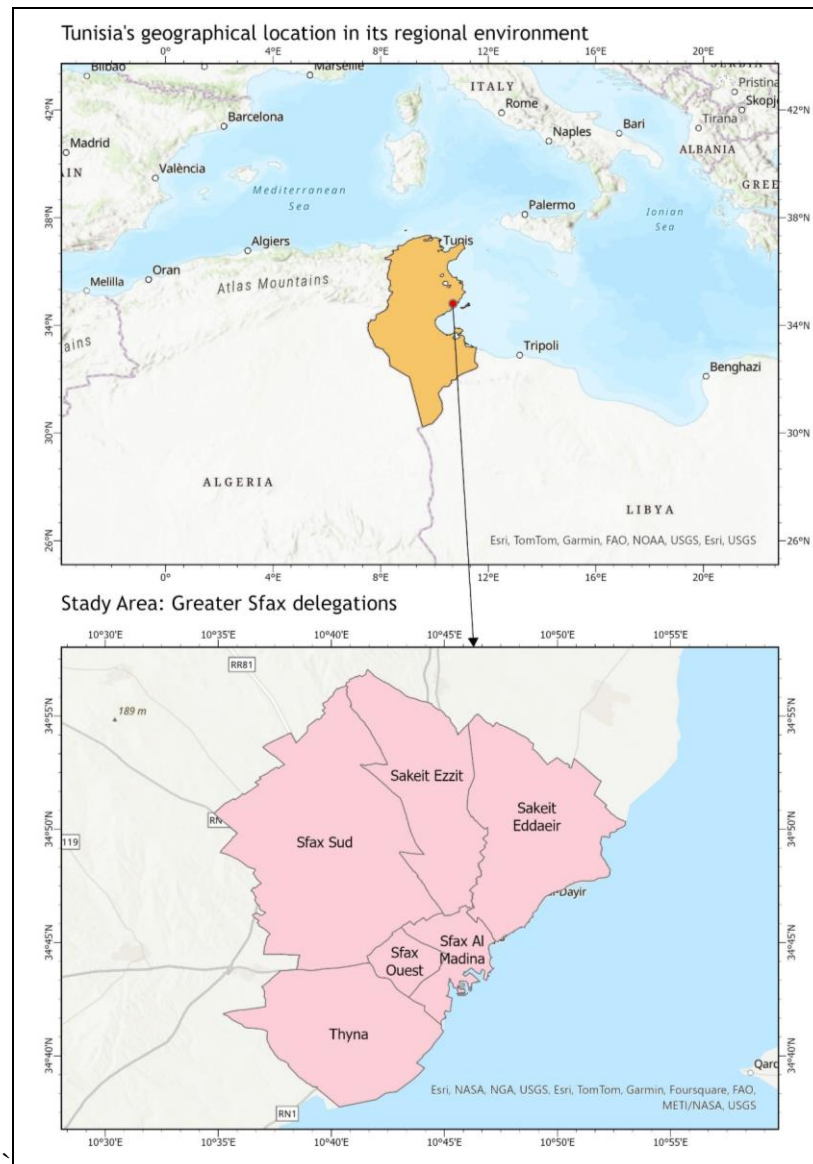
To carry out this study we collected data from several sources, and then build a database. This database was created on ArcGis Pro software, after processing some data in Excel. Some map collections were created with the free Phildigit digitization software (<http://phildigit.free.fr/>). A series of spatial analysis operations were performed with the tools and functionality of ArcGis Pro.

### 3. STUDY AREA

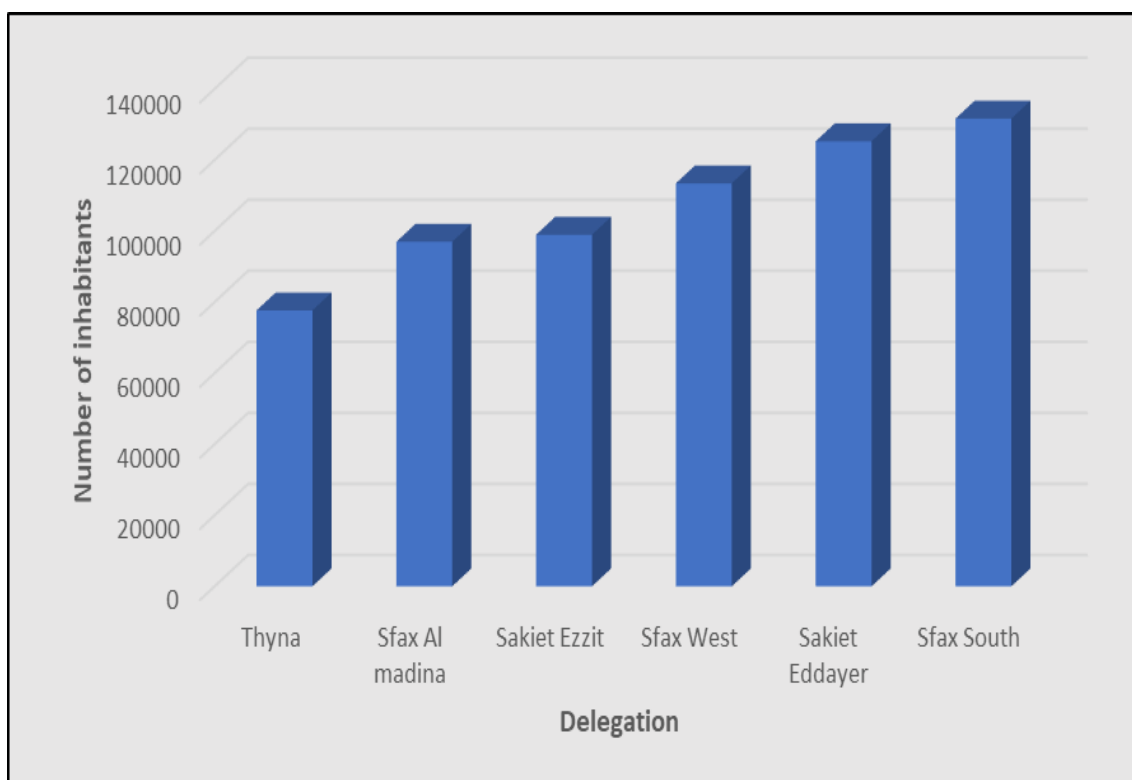
This is the city of Sfax which is 270 km from Tunis. It is bordered to the east by the sea, by the governorate of Mahdia in the north, by the governorates: Kairouan, Sidi Bouzid and Gafsa in the west and by the governorate of Gabes in the south (figure1). This city is known as the capital of the South, since it serves as a link between the northern areas and the south of Tunisia and between the inland areas and the sea. It is the second most important Tunisian city in demographic, economic and cultural terms, with coasts dominating on 235 km of the Mediterranean Sea (<http://www.commune-sfax.gov.tn/>). It was followed by the Roman and Byzantine civilizations, and their remains are still in the ancient cities of Thyna and Bataria. Its glorious Islamic history began in the time of the Aghlabids, in 849 (AD), when the Great Mosque and Suras were founded. It has also been known since antiquity for its intensive economic activity thanks to its economic and commercial role played between the cities of the south and north and the reception of Mediterranean merchants on its open coasts (<http://www.commune-sfax.gov.tn/>).

The governorate of Sfax has an area of 7,545 km<sup>2</sup>. It includes 16 delegations, six of which are in the Greater Sfax (study area): Sfax Al medina, Sfax West, Sfax South, Sakiet Eddayer, Sakiet Ezzit and Thyna. This governorate has in 2023, 1028364 inhabitants which represent about 9% of the Tunisian population. The Grand Sfax has 643852 inhabitants (INS, 2023), that is 62.6% of the population of the governorate (figure2).

**Figure1.** The study area



**Figure2.** Distribution of the Sfaxian population in 2023 by delegation.



Data source: NSI, 2023

#### 4. DOCUMENTATION AND DATA SOURCES

To carry out this study, we used a very varied range of graphic, tabular and textual documents supplemented by surveys and site visits. These documents include:

- The Urban Development Plan of Grand Sfax (PAU): The main source of the graphic data is the large-scale PAU, drawn up in 1998 and published in 2002 by the Ministry of Equipment and Planning. It is composed of the urban development plans of the various municipalities of the agglomeration and consists of 225 sheets. The PAU for the municipality of Sfax is composed of 60 sheets (<http://www.commune-sfax.gov.tn/fr/plan-damenagement-urbain>), that of Thyna 40 sheets, the PAU of Sakiet Ezzit has 30 sheets, the PAU of Sakiet Eddair, Gremda and El Ain are formed of 25 sheets each, finally 20 leaves make up the PAU of Chihia.
- Topographic maps are important sources in this study. The topographic maps used are at scales 1/200,000, 1/50,000 and 1/25,000 published by the Office of Topography and Cartography (OTC), renamed to become currently the Office of Topography and Cadaster (<https://www.otc.nat.tn/>).
- Aerial photographs: panchromatic aerial photographs used are published by the OTC and correspond to mission 1997 TU 751/10, scale 1/10000. We have updated several data by these spatial photos.
- The satellite image: we used a SPOT scene, a color image dated 29 May 2020 with a resolution of 20 meters, to identify aspects of the urban sprawl of the city of Sfax and to determine the nature of land use. We also used a scene IKONOS, more recent (2023), 1 meter resolution in color therefore excellent quality.
- The data for public transport by bus are from the Sfax Regional Transport Corporation (SORETRAS). Other data relating to transport are taken from the Directorate-General for Roads and Bridges (DGPC).
- Population and habitat data are from the National Institute of Statistics (<https://www.ins.tn/>).
- In addition to these documents we have noted, we have integrated several other development documents such as the National Spatial Planning Plan (SNAT), the Master Plan of Sfax (SDA), the Urban Development Plans (PAU), Master Transport Plans and traffic plans . We also used

other thematic documents at different scales, generally excerpts from research work, theses, reports and studies (Belarem M., 2003, 2005, 2006, 2007, 2011, 2018, 2019, 2020, 2021; Baklouti A. 2004, Belhareth T., 1990 and 2004, etc...).

## 5. ANALYSES AND RESULTS

### 5.1. Structure of the Bus Transit Network

The SORATRAZ urban network currently has 29 lines. All lines converge in the city centrum to three bus stations around the Medina: Bab Jebli station with nine lines, Bab El Kasbah station serving nine lines and El Karia station with ten lines. Bab Jebli station represents the convergence of seven lines, and if we take into account the creation of lines by elongation, we can estimate the total number to ten. El Karia station has ten lines, but if we take into account the new line creations by extension, we will get, in reality, twelve lines. El Kasbah station: ten lines converge towards it, but if we take into account the new line creations by extension, we can distinguish thirteen lines (table 1).

**Table1.** Bus line allocation by station

Bab Jebli Station		El Karia Station		El Kasba Station	
Code	Line	Code	Line	Code	Line
7	Tenacious	3	Sidi Mansour	1	El Bostan
7B *	Tenacious	4	Saltnia	2	Hached
7C *	Tenacious	5	Sakiet Eddair	13	M. Chaker
9	Gremda	5B *	Errached	13B *	Boumerra
10	Lafrane	6	Sakiet Ezzit	14	El Matar
12	El Aïn	6A *	El oued	14B *	Esghar
12B *	Aïn Torkia	6B *	Sidi Salah	15	Soukra
17	Port	8	Caïd M'hamed	16	Thyna
23	Bouzayyane	11	El Kassassat	16A	Sidi Abid
24	Faculties	20	Ziadi	16B *	Thyna prison
		22	Bou Ali	17	Port
		30	Mongi Slim	18	Mharza
				18B *	Erriadh City

\* Creation of line on the same line with line extension. Data Source: SORETRAS, 2024.

#### 5.1.1. The current public bus lines

##### Line length evolution

The total length of the SOETRAS network is currently in the range of 740 km. It was in the range of 688.3 km in 2006. This network has not evolved much in a long time (Figures 3, 4, 5, 6, 7 and 8). The total length of return lines has increased from 409.5 km in 1989 to 421.7 in 1990, with an increase of 12.2 km due to the extension of the El Matar line and the creation of three lines: Errached, El Oued and Cité Ennour. Note that the average length of an urban line in 1990 was 21,085 km (round trip). The longest line was in 1990 that of El Aïn: 36.7 km (A+R) going to Aïn Torkia, while the shortest was that of the fishing port with a length of only 8 km. During the first five years of the 1990s, as a result of the extension of some lines, the network was extended by several kilometers. Then between 1994 and 1995, the total length of lines increased from 627.6 km to 565.9 km with a decrease of 61.7 km due to the elimination of four secondary lines (3A Ras Ettabia, 13A Oued Châabouni and 14C International Airport of Thyna) Following a decision by the municipality of Sfax because these lines have low profitability. Thus, there was a change for the heads (city center) of lines Caïd M'hamed and El Kassassat to avenue des Martyrs near the shopping center of "Sfax 2000" instead of the station Bab Jebli. This transfer has resulted in a 700-metre round trip increase for the Caïd M'hamed line.

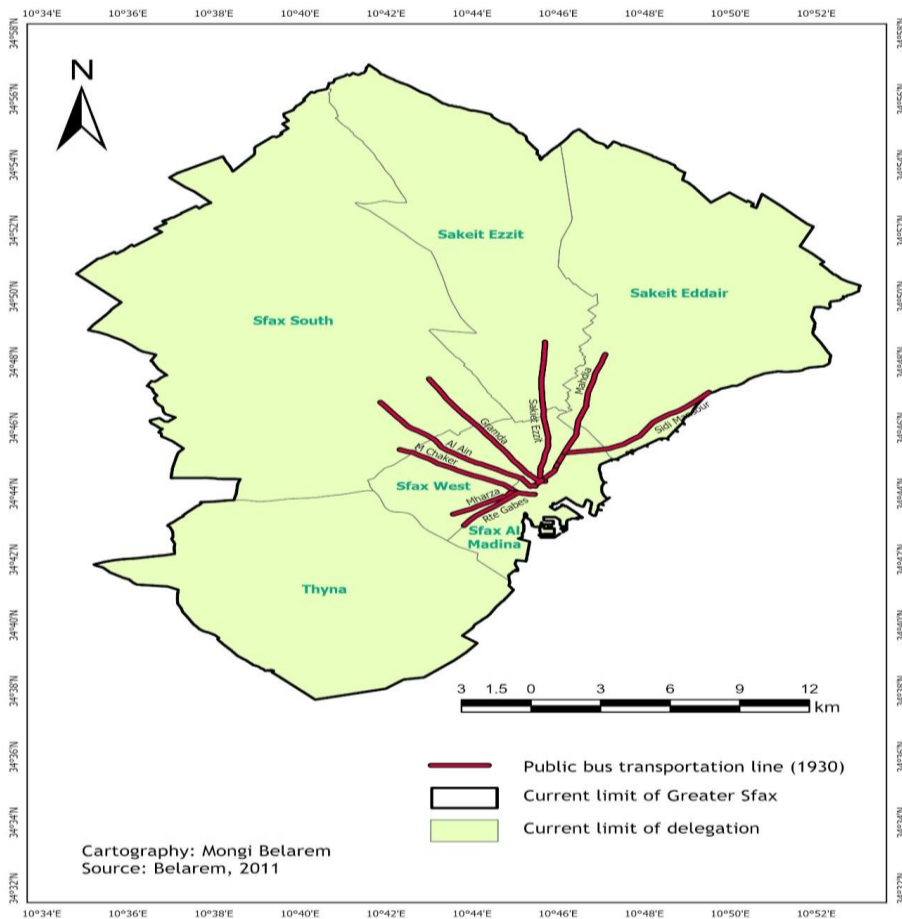


Figure3. Urban bus system in the Greater Sfax region in 1930

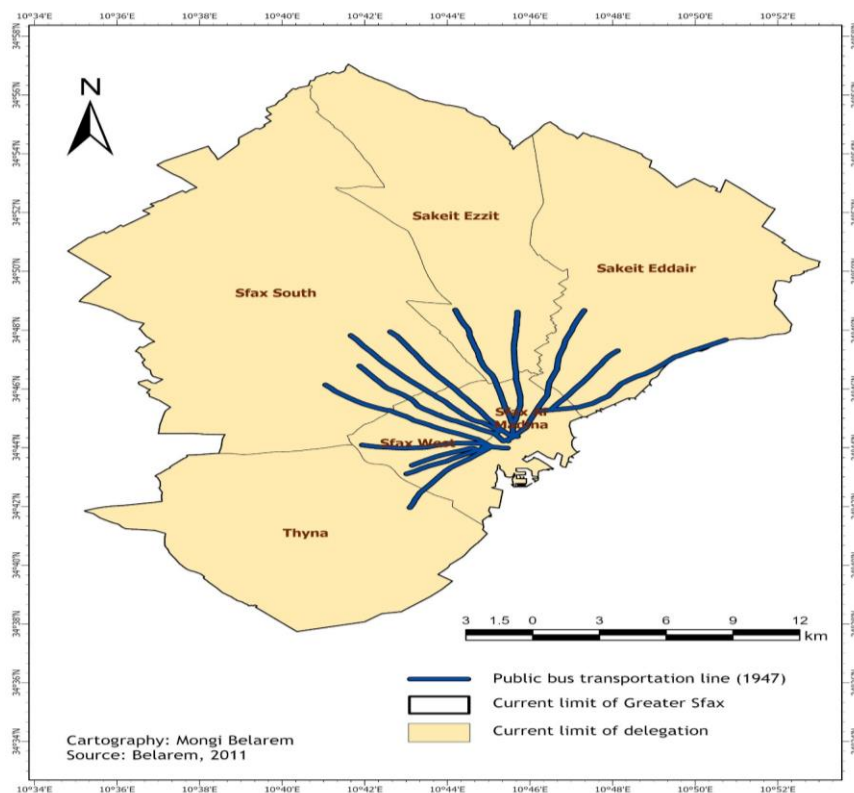


Figure4. Urban bus system in the Greater Sfax region in 1947

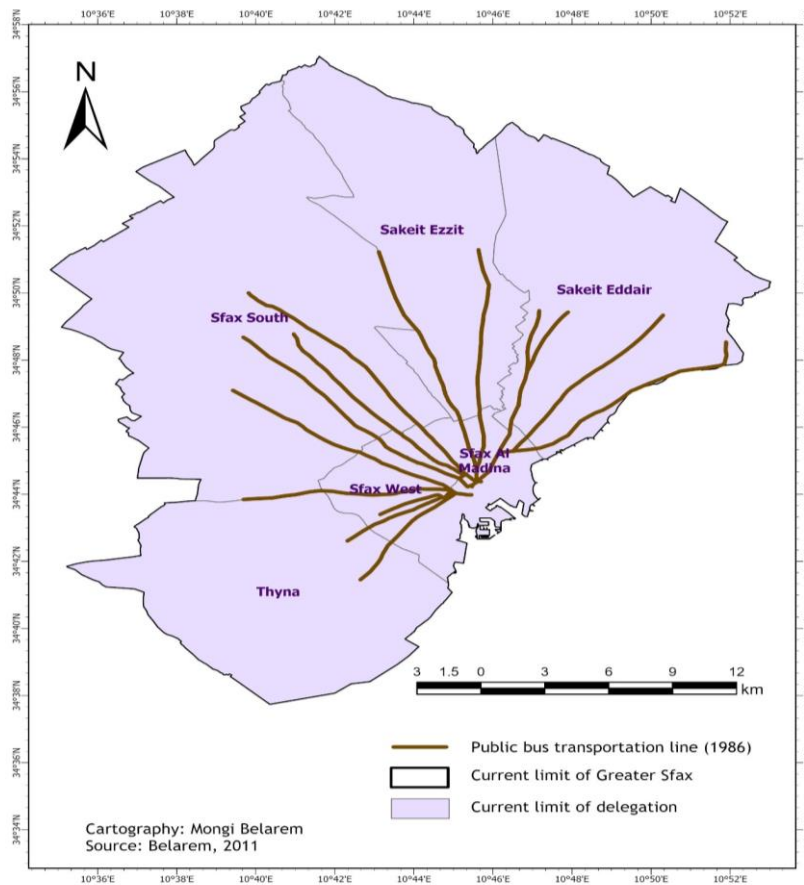


Figure5. Urban bus transport network in the Greater Sfax in 1986

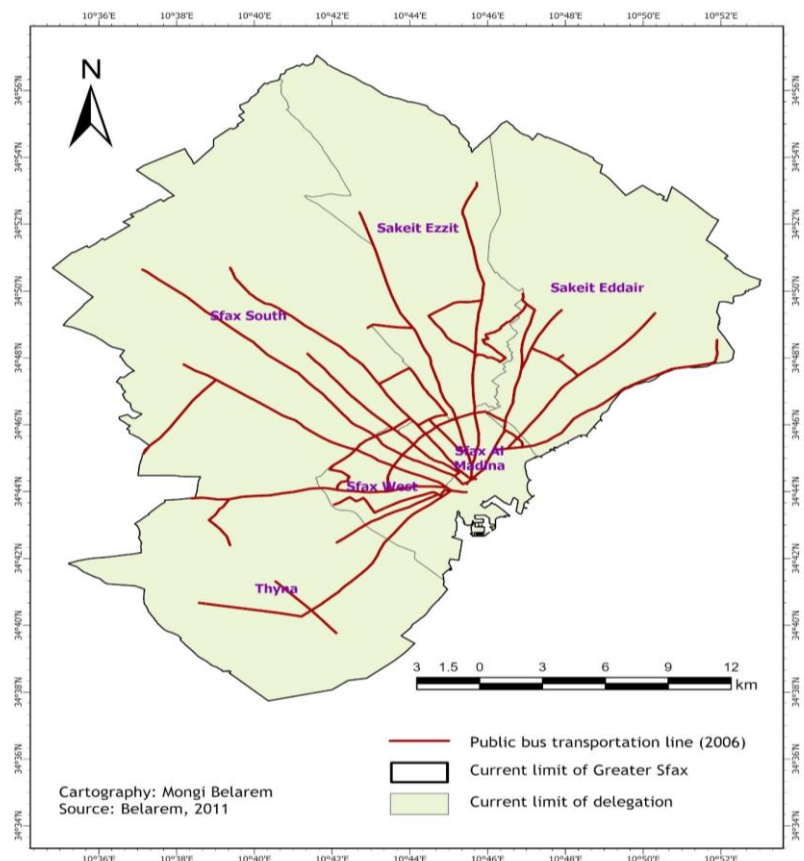


Figure6. Urban transit system in the Greater Sfax region in 2006

In addition to the urban network, SOREA ensures the connection of the agglomeration with cities and even with some small towns in the hinterland and with other cities outside the governorate of Sfax (North, West and South Tunisia). It has a large network of "main lines". The urban network in the agglomeration of Sfax represents only 1/20 of the total length of the network within the governorate which extends over 10530 km. Compared to other lines whose destinations are outside the governorate, the "sfaxian" network The number of lines and length are still quite large, since the SOREAS network to the neighboring governorates is 1500 km long and that linking Sfax with the other governorates is about 3500 km.

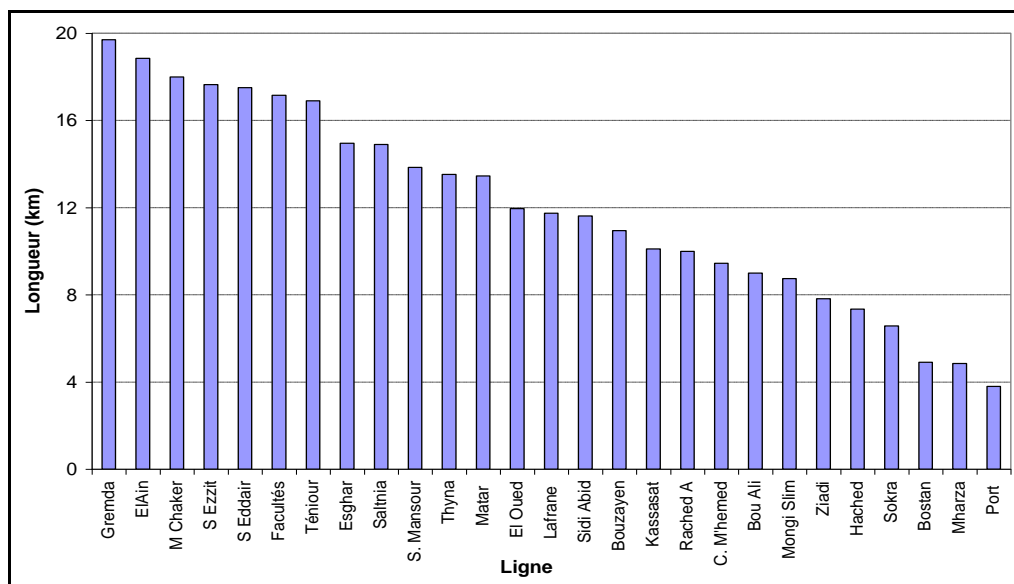


Figure7. Length of the Transportation Network Collected by Line in 2024

5.1.1.1.1. Negligible increase in number of lines

In Sfax, the number of urban lines has changed very little. Indeed, since 1990 and until today (2024), only 4 lines have been created. These are the lines of Bou Ali, Bouzayyan, Faculty’s and Mongi Slim. In view of this "small" increase in the number of lines, the Sfax urban network has seen the deletion of the line of Habib Thameur. The extension of the transport network was therefore done by lengthening lines and not by creating new ones.

5.1.1.1.2. Evolution of the average length of lines

The average length has also not changed much. In 1986, the average length of the lines was estimated at 9.1 km (Belhareth T., 1990). After five years (1991), this average reached 10.61 km. Then it slightly decreased between 1990 and 1995 to reach the average of 10.11 km following the closure of some unprofitable lines (11.87 km). In 2006, following the lengthening of a few lines, the average length was 11.87 km. Between 1986 and 2006, the difference in average length was only +1.16 km, after which the network remained almost stable. We note that even the average length of lines has remained relatively stable although there is a slight increase in the number of lines.

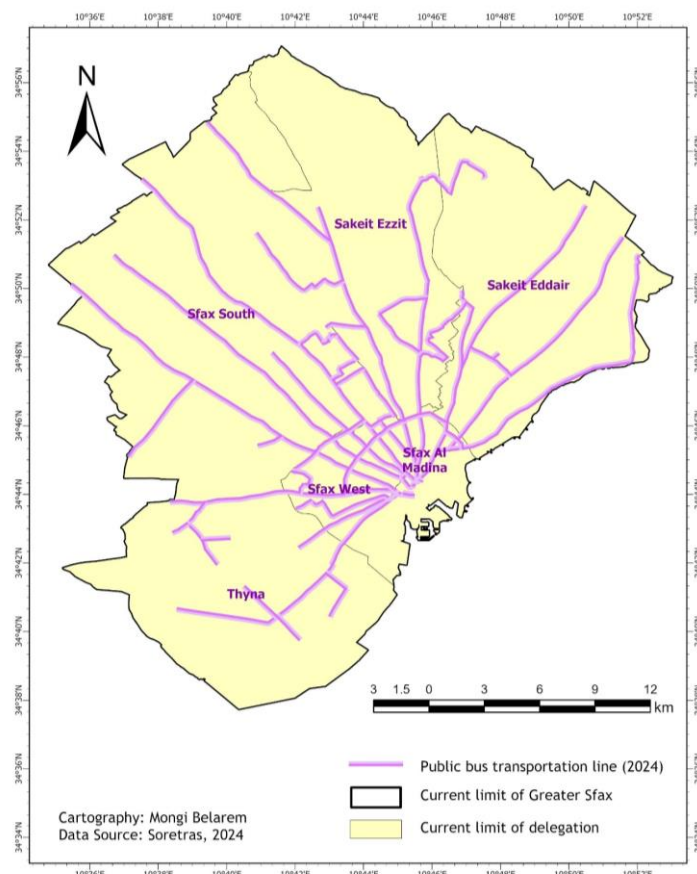
5.1.1.2. Classification of lines by number of stations

The number of bus stations in 2024 is around 1,402 (round trip). If we refer to the number of stations for classification of lines, we get five groups as follows: the first group includes only the line of El Kassasat which consists of 114 stations. The second group comprises seven main lines (33% of the total number of lines): the number of stations ranges from 84 to 102. They are, from the largest to the smallest number of stations: Bou Ali 102, Gremda 100, El Aïn and Les Facultés 96, Ziadi 91, Menzel Chaker 86 and Lafrane 84. The third group also includes 30% of the total number of lines with seven lines: Sakiet Eddair 77, Tenour 76, Saltnia 72, Sidi Mansour 71, Thyna 68, El Matar and Mongi Slim 66. The fourth group also includes seven lines with a number of stations ranging from 35 to 55. This is the line of Sidi Abid 55, Caid M'hamad 54, Bouzayan 45, Soukra 43, Hached 40, El Bostan 39 and Mharza 35. Finally, the last group includes the Port line, the shortest line with only 11 stations.

5.1.1.3. Line typology: radials predominate

Several criteria are used for classifying public transit elements into different types [Belhareth T., 1990]. The criteria include:

- The mode of transport: bus, rail
- The service age which may "overlap" partially with the previous classification: omnibus, tramway, metro, commuter train, bus
- The length of the lines, with the areas served being separated according to their distance from the centre.
- The nature of the line: radial, circular, diametral....
- In this study, given the single-mode specificity of the Sfax network (public transit), we consider the last two criteria (length and nature of line layout). According to the criteria defined above, we can identify several types of lines. We limit ourselves here to the types existing in Sfax:
- Radial line: it provides the center/peripheries link in a radius. Combining several of them can facilitate the connection periphery/periphery.
- Tangential line: it provides the connection periphery/periphery without passing through the center.
- Circular line: it is characterized by its orthogonal structure with respect to radial lines and its greater or lesser distance from the city center. If this distance is large, the line works as a tangent line.
- Diametral line: it is a line that provides the periphery/ periphery connection but passing through the city center.
- Special line: it is a line intended for a very specific clientele (schoolchildren, high school students, students, workers, Industrial Society of Phosphoric Acid and Fertilizer (in french: Société Industrielle d'Acide Phosphorique et de Engrais), (SIAPE)... so its frequency is very limited over the day (1 or 2 times a day) [Belhareth T., 1990].
- According to Table 2, we note the dominance of radial lines with almost 60% followed by special 24%. These two types occupy almost 85% of all lines. On the other hand, we recorded the low proportion of circular lines (only three lines) with 10% and that of tangent lines (7%), which is only two lines.



**Figure8.** Urban transit system in the Greater Sfax region in 2024



### 5.1.2. Bus stations

#### 5.1.2.1. Spatial distribution of stations

The spatial distribution of bus stations (Figure 9) is a good indicator of the level of quality of public transport service . Indeed, the coverage of the bus spacer by bus stations quite close vertically and horizontally, with a fairly high frequency of bus passage, ensures good accessibility . However, the further the stations are apart, the more frequent the bus service decreases and the lower the level of accessibility.

In Sfax, the spatial distribution of bus stations is far from covering populated areas with the same degrees. At the radial scale, the stations are closer in the first two crowns. Beyond the Km 4, the stations become more and more distant to a very important distance level that sometimes exceeds 1000 meters between two successive stations. If we look at the spatial distribution of the population, it appears to be inversely related to the distance from the city center which is logical. Indeed, the further we get from the center of the city, the lower the population density becomes. On the contrary, the closer we get to the city center, the higher the density becomes, but with exceptions especially at the level of the hyper center where the density is low compared to the other sectors of the first and second crown.

At the radial scale, the distribution of stations shows a large aspect of imbalance, revealing a malfunction of the public transport system. Indeed, the stations are very far apart from each other especially away from the city center. But what makes the situation worse is that the connections at this level are very insufficient, with a very small number of circular lines.

Bus stations are usually further apart from each other as they move away from the city center. In the first two crowns, the average distance between the two successive stations varies between 250 and 350 meters.

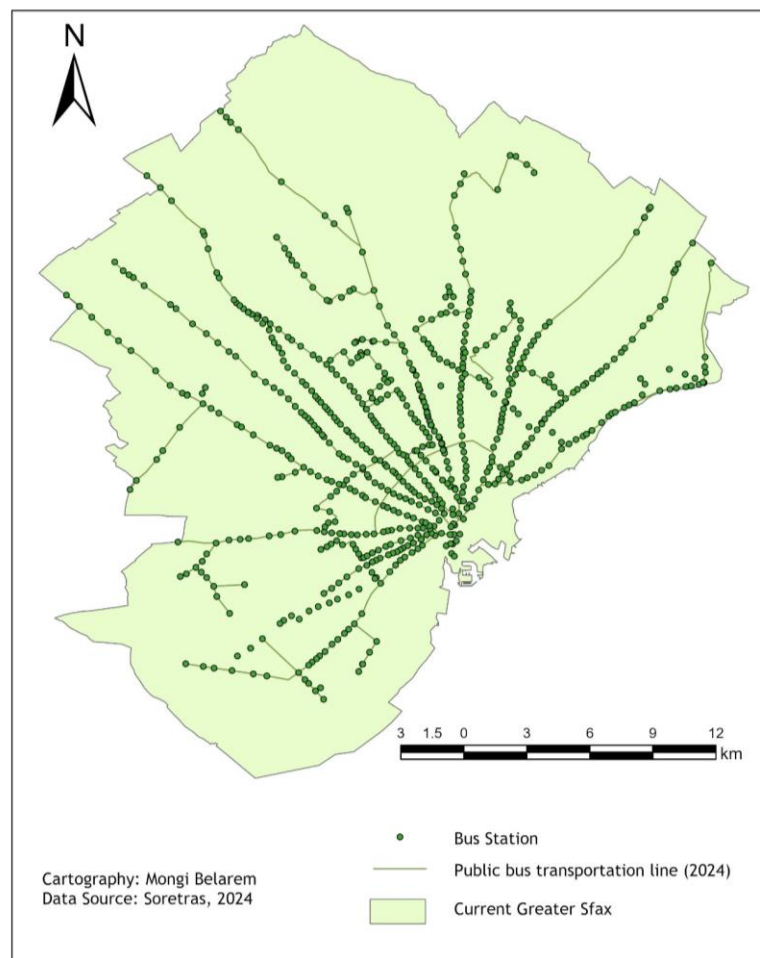


Figure9. Spatial distribution of SORTAS bus stations in the Greater Sfax in 2006.

In the third ring, the stations move away from each other with an average interval of 500 to 600 m. Beyond this ring and especially outside the communal space, the average distance between bus stations becomes even greater and sometimes exceeds a kilometer.

This trend towards distance from the stations is more pronounced at the level of ring roads. Indeed, because of the radio concentric-in g "finger" pattern, the distance between two neighboring stations, moving away from the city center, becomes more important. This distance reaches its maximum between the Road of Menzel Chaker and that of El Matar on one side, the road of El Aïn and that of Menzel Chaker on the other...

The spatial distribution of bus stations is explained, in part, by the distribution of population numbers and densities. Indeed, the 643,852 inhabitants of the Grand Sfax are spread over a space of about 22000 ha, which corresponds to an average density of 29 inhabitants per hectare in 2023.

At the level of delegations, the densest delegation is that of Sfax El Gharbia with 70 inhabitant/ha followed by that of Sfax El Madina with 34 inhabitants/ha. These are the two central delegations which are the densest. On the other hand, the peripheral area is experiencing spontaneous urbanization and is characterized by a rather loose fabric, reflecting a weakness in population densities, especially compared to the central areas. The densities of all peripheral delegations are below 11 inhabitants/ha (figure 10).

At the communal level, the distribution of the population between the different communes is not homogeneous. The municipality of Sfax is the most populated; In 2023, it has a population of 286,636 inhabitants spread over seven boroughs. It includes, except for the district of Sidi Mansour, 44% of the population against 66% for the peripheral urban area. It is characterized by population densities (arrondissements) of more than 45 inhab/ha. On the other hand, the peripheral municipalities all have densities below 45 inhab/ha. Indeed, the municipalities of Sakiet Ezzit, Sakiet Eddaïr, El Aïn and Gremda have areas that are close to each other (between 1300 and 1500 ha) with populations of nearly 45,000, 40,000, 38,000 and 36,000 inhabitants respectively; they have relatively low densities (between 26 and 30 inhab/ha). The municipality of Chihia also has a low density (32 inhab/ha). Finally, the municipality of Thyna, the youngest, has almost the same population as Chihia but is spread over a more extensive space, so with a very low density (9 inhab/ha). Thus, the Sfaxian agglomeration seems to be very extensive with very loose population loads, even at the communal level, and it is reasonable to think that the maintenance of such a trend would accentuate the under-equipment characteristic of the city of Sfax. It is both under densified and very spread out. It will be increasingly difficult to equip it with transport infrastructures and maintain a correct regular maintenance schedule, which implies a priori difficulties of circulation and movement.

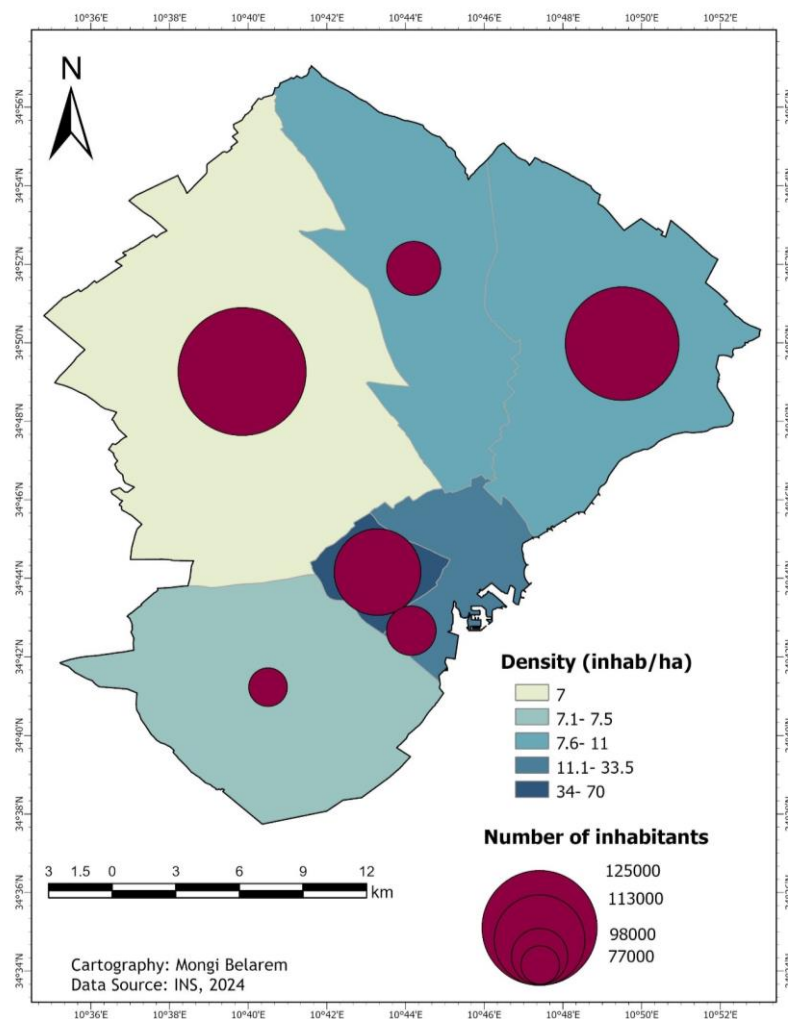
### *5.1.2.2. Evolution of the number of stations*

The total number of bus stations increased from 1,670 at the end of 1994 to 1,408 in 1999 following the removal of 262 stations from the four secondary lines. Between 2001 and 2006, the number of stations increased from 1,408 to 1,587. The lines that have seen an increase in the number of stations are: El Bostan, Saltnia, Sakiet Eddair, Gremda, Lafrane, El Aïn, El Matar, Thyna and Ziadi. It should be noted that this increase in the number of stations is achieved on all lines by lengthening the lines and not by adding additional stations between existing ones.

### **5.1.3. The model for the growth of the collective transport network**

Based on this analysis, four stages have been identified as the main features of the growth of the Faxing network:

- The linear network which is constituted by the last two connections of the center with the peripheries has been known since the 1920s.
- The unipolar radial network was known during the 1940s. Indeed, radial lines are multiplying by strengthening the center/periphery link.
- During the 1950s, Sfax experienced the multipolar radial network.
- Finally, although the Sfax network has become multipolar and has developed spatially especially in the last 20 years, it remains until today unimodal.



**Figure10.** Population size and density distribution in the Grand Sfax by delegation in 2023

## 6. CONCLUSION

Based on this analysis, we note that the public transport system by bus in the Greater Sfax is characterized by the dominance of radio concentric lines converging in the city center with a lack of circular lines. This network is almost modelled on the road one with a weakness on the part of the circular and tangent lines. It is also characterized very slow evolution, in fact, for almost 40 years it has not been well developed. This development is still far from covering the travel needs of all the population of the Greater Sfax which has undergone a significant spatial, demographic and economic activity change. Faced with this critical situation, SORETRAS must intervene to develop its network.

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