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NEW CHALLENGES FOR XXI CENTURY CITIES

Global warming, ageing of population, reduction of energy consumption, immigration flows, optimization of land use, technological innovation

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The cover image shows older people climbing Via Raffaele Morghen's stairs in Naples (Source: TeMA Journal Editorial Staff).

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Gender analysis of urban mobility behaviors in the Tunisian Sahel region

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Abstract
The integration of gender into questions of everyday mobility has been the focus of scientific research for several years. Despite the breadth of this topic, few studies on gender mobility are conducted in southern countries. This article attempts to fill this knowledge gap and paint a portrait of women's travel behavior in Tunisia. The study area is the Tunisian Sahel, which was studied as part of a household travel survey conducted in 2019. Based on 2,021 observations, a descriptive analysis of mobility behavior was carried out, providing information about the main travel patterns for both genders in this region. Our analysis deviates from the traditional approach of categorizing women as a unified group, and examining their mobility on an individual basis by considering their income levels. Significant differences were observed between the two genders, which are influenced by the socio-cultural context of Tunisian women and their financial situation. The majority of women are less mobile than men, as more complex journeys are limited to the vicinity of home, and they often rely on public transport. As financial conditions improve for women, travel tends to become easier. Comparing the analytical results of our study with scientific references reveals numerous similarities and differences.

Keywords
Mobility; Gender; Income; Equity; Distance; Time; Costs

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1. Introduction

The new structure of modern cities emphasizes the central role of mobility in them. With the vast expansion of urban areas and the spatial disparity of essential activities, mobility becomes a necessity that influences an individual's right to the city and shapes its participation in communal activities (Lucas et al., 2016; Thynell, 2016; Boisjoly & Yengoh, 2017; Kett et al., 2020; Pirra et al., 2021; Joshi & Bailey, 2023). However, given this importance, mobility tends to be very different across different social groups, whether for economic, physical, cultural or even psychological reasons. This idea has consequently led to unequal access to various opportunities in the city (Maksim, 2011; Heinen, 2016; Boisjoly & Yengoh, 2017; Pirra et al., 2021), which is particularly the case for women who continue to face significant challenges in accessing various transportation options that affect their participation in society (Sane, 2022). Therefore, forming a gender perspective on mobility in urban environments without gender neutrality represents a crucial step towards understanding these barriers with the aim of reducing gender differences and inequalities (Bellmann et al., 2020; Gauvin et al., 2020).

The connection between mobility and gender has been the focus of research since the 1970s (Law, 1999), and studies fields have been mainly limited to developed countries (Miralles-Guasch et al., 2016; Lee, 2017; Uteng & Tuner, 2019; Gauvin et al., 2020; Hidayati et al., 2020; Kawgan-Kagan, 2020; Pirra et al., 2021; Rodríguez De La Rosa et al., 2022; Chen et al., 2023; Chidambaram & Scheiner, 2023). Largely due to the unavailability of data, gender mobility has rarely been studied in southern contexts, even though greater mobility differences exist between both genders, where women face many challenges in accessing transportation facilities, coupled with sociocultural constraints that significantly impact their right to the city (Adeel et al., 2017; Nasrin & Bunker, 2021; Howe, 2022; Kacharo et al., 2022; Macedo et al., 2022; Porter et al., 2022; Alizadeh & Sharifi, 2023; Murphy et al., 2023; Parker & Rubin, 2023; Vanderschuren et al., 2023; Nasrin & Chowdhury, 2024). According to this fact, this article seeks to fill this gap by examining the mobility practices of men and women in the Sahel, and being among the first references to analyze the relationship between gender and mobility in Tunisia.

Tunisia is located in North Africa and has been one of the most progressive countries in terms of women's rights since its independence in 1956 (Nillesen et al., 2021; Kashina, 2021). Despite all efforts, Tunisian women still face inequality in both the private and public spheres, especially in the interior and the south, and are even seen as second-class citizens living in the shadow of men as the main breadwinners, according to the conservative consciousness of the Tunisians' social and cultural heritage and deviate from the progressive legal framework (Abbott, 2017; Nillesen et al., 2021; Kashina, 2021; Murphy et al., 2023): a situation that is intensifying after the Arab Spring and the rise of Islamic groups are attempting to impose a sharia-based religious identity on Tunisian society (Hitman, 2018).

In this socio-cultural environment, increasing restrictions on female mobility are evident, underpinned by security issues (particularly harassment) that limit women's travel, their participation in social and economic life, and even their choice of clothing, leading to further family restrictions through permissions and companionship. These restrictions influence women's travel behavior (choice of mode of transport, purpose of the trip, distance travelled, transport costs, etc.) and also lead to the differences in daily mobility between both genders.

Against this background, the aim of our study is to analyze the everyday journeys of women in the Tunisian transport system and to examine the similarities as well as differences in mobility patterns compared to men according to different income categories. Therefore, we seek to answer the following questions: What are the differences in mobility patterns between men and women in Tunisia in terms of mode choice, travel purpose, travel volume, time, distance, and cost? How does the financial situation affect the mobility of Tunisian women? Our research is organized as follows: Section 2 presents a literature review of the main ideas arising

from the articulation between mobility and gender. Section 3 is dedicated to presenting the data collection technique as well as our research area and the variables to be analyzed. The results obtained will be the subject of Section 4. The fifth part concludes with a summary of the main findings and suggestions for further research.

2. Literature review

While the focus is on examining the issues related to gender differences, several studies have focused on analyzing travel behavior based on the differences between men and women (Mahadevia & Advani, 2016; Maciejewska, 2019; Nasrin & Bunker, 2021; Kacharo et al., 2022; Macedo et al., 2022; Porter et al., 2022; Alizadeh & Sharifi, 2023; Murphy et al., 2023; Parker & Rubin, 2023; Nasrin & Chowdhury, 2024). They repeatedly find a visible connection between mobility and gender, with some assuming that this connection reflects the existing inequalities and inequities in our contemporary society. Certainly, mobility is both a necessity and a means of preserving the right to collective life in cities characterized by geographical sprawl and dispersion of activities. However, this meaning does not hide its discriminatory nature, linked to unequal access to transport facilities and, consequently, to urban facilities (Maksim, 2011; Porter et al., 2022; Murphy et al., 2023).

Biological and behavioral differences between men and women, as well as the cultural context they experience, lead to different access to opportunities within the city. This imbalance particularly disadvantages women in a transport system that is primarily geared towards men (Babinard, 2011; Pojani, 2011; Uteng, 2011; Basaric et al., 2016; Heinen, 2016; Cook & Butz, 2018; Nasrin & Bunker, 2021; Rodríguez De La Rosa et al., 2022; Jain & Geetam, 2020; Senikidou et al., 2022; Parker & Rubin, 2023; Pourhashem et al., 2022; Porter et al., 2022; Alizadeh & Sharifi, 2023; Murphy et al., 2023; Nasrin & Chowdhury, 2024). Therefore, we move from an inequality issue to a social justice issue and evaluate women's travel from an equity perspective.

Women's mobility has been studied in the literature in two main categories (Maciejewska, 2019). The first category focuses specifically on women's travel behavior with an emphasis on social justice and environmental sustainability (Delbosc & Currie, 2011; Pojani, 2011; Uteng & Tuner, 2019; Iqbal et al., 2020; Hidayati et al., 2020; Porter et al., 2022; Murphy et al., 2023). The second highlights gender differences in mobility between men and women (Onadja et al., 2013; Zunzunegui et al., 2015; Miralles-Guasch et al., 2016; Basaric et al., 2016; Lee, 2017; McLaren, 2018; Craig & Van Tienoven, 2019; Maciejewska, 2019; Uteng & Turner, 2019; Adom-Asamoah et al., 2020; Bellmann et al., 2020; Gauvin et al., 2020; Hidayati et al., 2020; Nasrin & Bunker, 2021; Jain & Geetam, 2020; Parker & Rubin, 2023; Pourhashem et al., 2022; Nasrin & Chowdhury, 2024).

Our work falls into the second category and aims to analyze the position of women in the Tunisian transport system by comparing their mobility behavior with that of men.

The main findings in the literature suggest that women typically travel shorter distances, often closer to home and for optional reasons (Scheiner, 2010; Frändberg & Vilhelmson, 2011; Nasrin & Bunker, 2021; Pirra et al., 2021; Rodríguez De La Rosa et al., 2022; Parker & Rubin, 2023). Women's trips are chained and involve multiple activities, making them more complex than men's trips (Jain et al., 2011; Brown et al., 2014; Basaric et al., 2016; Miralles-Guasch et al., 2016; Scheiner & Holz-Rau, 2017; Vanderschuren et al., 2019; Bellmann et al., 2020; Gauvin et al., 2020; Dingil et al., 2021; Nasrin & Bunker, 2021; Pirra et al., 2021; Rodríguez De La Rosa et al., 2022; Parker & Rubin, 2023).

Regarding transportation choice, women tend to walk and use public transportation more often (Levy, 2016; Scheiner, 2014; Basaric et al., 2016; Miralles-Guasch et al., 2016; Greed, 2019; Uteng & Turner, 2019; Bellmann et al., 2020; Havet et al., 2021; Nasrin & Bunker, 2021; Pirra et al., 2021; Abdullah et al., 2022; Chidambaram & Scheiner, 2023; Murphy et al., 2023) and have limited access to private car, which are more commonly used by men as they have the primary privilege for car use within a household (Boarnet & Hsu,

2015; Levy, 2016; Mahadevia & Advani, 2016; Miralles-Guasch et al., 2016; Singh, 2019; Dingil, et al., 2021; Havet et al., 2021; Nasrin & Bunker, 2021; Pirra et al., 2021; Chidambaram & Scheiner, 2023). Some explain this by the diversity of natural preferences between the two sexes and by women being less interested in modes and activities that are largely carried out by men (Miralles-Guasch et al., 2016; Nasrin & Bunker, 2021). These differences have their roots in social identity and culture, which is formed either within the family or at school (Sultana & Mateo-Babiano, 2017; Nasrin & Bunker, 2021; Porter et al., 2022; Murphy et al., 2023) and portray men in a position of strength at the expense of women. This fact is supported by the unequal distribution of roles between the two genders in the household or society globally, as well as women's limited access to resources (reflected in their lower income) (Kwan & Kotsev, 2015; Parker & Rubin, 2023; Nasrin & Bunker, 2021). This reality leads to increased responsibilities for women, including travel related to household tasks and accompanying children or even the elderly (Sánchez de Madariaga, 2013; Scheiner & Christian Holz-Rau, 2017; Motte-Baumvol et al., 2017, Havet et al., 2021; Chidambaram & Scheiner, 2023; Pirra et al., 2021; Scheiner & Holz-Rau, 2017; Abdullah et al., 2022; Loukaitou-Sideris & Ceccato, 2020), and they find themselves very constrained in terms of time, which limits the work opportunities that may be available to them (Kim et al., 2012; McQuaid & Chen, 2012; Scheiner & Holz-Rau, 2012; Craig & Powell, 2013; Chidambaram & Scheiner, 2023; Havet et al., 2021; Fan, 2015; Pirra et al., 2021).

These results likely differ from one geographical context to another and consequently from one culture to another (Hanson, 2010; Adeel et al., 2017; Maciejewska, 2019; Hidayati et al., 2020; Xu, 2020; Pirra et al., 2021), directing several works towards analyzing this perception with the aim to fully understand the mobility behavior of both genders. The consideration of sociodemographic characteristics in addition to gender such as age, income or marital status (Onadja et al., 2013; Zunzunegui et al., 2015; Basaric et al., 2016; Adeel et al., 2017; Pirra et al., 2021; Nasrin & Bunker, 2021) proves to be an essential addition to the analysis.

To address this issue, we decided to expand our analysis by including the income aspect to examine its impact on women's urban mobility and identify differences compared to men. This idea has been the subject of various studies in the literature, mainly focused on developing countries (Uteng, 2011; Gera & Hasdell, 2020; Jain & Geetam, 2020; King et al., 2021; Olivieri & Fageda, 2021; Nasrin & Chowdhury, 2024). According to these references, women's mobility characteristics are described by their financial situation, which not only determines their choice of mode of transport but also shapes the extent of their opportunities (Uteng, 2011; Gera & Hasdell, 2020; Jain & Geetam, 2020; King et al., 2021; Nasrin & Chowdhury, 2024). Given limited affordability, women choose walking to meet their mobility needs and are less inclined to own a vehicle or a driver's license (Lecompte & Bocarejo, 2017; Gera & Hasdell, 2020). This situation changes as income increases, as women tend to use more motorized transport (Lecompte & Bocarejo, 2017; Saigal et al., 2021).

The study on gender issues in transport in the context of Tunisia was presented in an exploratory study by the CODATU association (Cooperation for Urban Mobility in Developing Countries) in 2017, focusing on the masculinity of the transport sector and violence against women in public spaces, especially on public transport. A recent study by Porter et al. (2022) in the low-income neighborhoods of Tunis has drawn attention to the safety challenges faced by young women in two different periods (pre- and post-COVID-19). Another recent study was conducted by Murphy et al. (2023) with the aim of studying the daily journeys of women living in socioeconomically marginalized neighborhoods of Grand Tunis. In contrast, limited research on women as transport users or even employees have been published in Tunisia, and some of it has been conducted on a large scale involving the MENA region (Delatte et al., 2018). For example, the World Bank study on the challenges and opportunities of mobility from a gender perspective in MENA countries (World Bank, 2012) focused on women's mobility patterns without including Tunisia in this research. This serves as motivation for us to delve deeper into this topic and provide insights into the position of women in the Tunisian transport system. Despite efforts to support women's rights and promote their place in society, little action has been

taken due to an inherited repressive regime that neglects recognition of women's needs in development strategies and disadvantages them (Kallander, 2021; Murphy et al., 2023). Numerically, this situation was expressed by the fact that according to Global Gender Gap Reports, Tunisia ranked 120th among 156 countries in 2021 (after ranking 90th in 2006) (Murphy et al., 2023). Furthermore, Tunisian women are less present in the labor market than men, with a participation rate of 25.5% (58% in the informal segment) compared to 68% of men (World Bank, 2022; World Economic Forum, 2022). Combined with unequal wages and the unfair cultural roles assigned to them (carrying household responsibilities around 33-50% of their day) (The New Arab, 2023), many Tunisian women still find it difficult to achieve financial freedom. This reality forces low-income females to use the least safe and convenient modes of transportation and to adapt their mobility needs to avoid unsafe stations and neighborhoods, even if it means spending additional time to reach their destination (Murphy et al., 2023). Safety remains one of the biggest challenges for Tunisian women (with or without financial relief) when accessing and using transportation in Tunisia. It influences their choice of transport, the way they reach transport stations, their travel time and even the way they dress (to prevent petty crime) (Murphy et al., 2023).

3. Data and analysis variables

In this section, we highlight the methodology used in our study by presenting the data collection approach, the study area and the analysis variables used.

3.1 Data collection

This study uses data from a survey conducted in 2019 in the Tunisian Sahel region. The questionnaire was carried out as part of a master's research with the aim of defining a real state of daily mobility practices in the Greater Sahel region and highlighting the existing socio-demographic and spatial gaps by providing answers to questions such as: How do the inhabitants of the Sahel region move around? what are their mobility patterns? what modes of transport do they use? how often? for what purpose? for how much cost, time and distance? how do they rate the quality of the transport supply available to them? What variability can be observed between the different socio-demographic categories serving this region? And what are the spatial gaps in mobility and access to social life between the different governorates and even the different delegations that make up the Sahel region?

The survey consists of four parts, which make it possible to provide information both on the socio-demographic characteristics of the respondents, the needs and characteristics of mobility, the total number of trips made daily and the level of participation in social life related to the available transport service. For this research we will use the sections on the characteristics and mobility needs of the inhabitants of the Sahel, as well as the peculiarities of their daily travels (The survey questionnaire is presented in Appendix A-1).

The total sample collected for our study consisted of 2,021 respondents selected from a total population of 1,206,763 individuals aged 15 to 60 years and older (INS, 2014), using the stratified probability sampling technique. According to this sampling method, a heterogeneous population is first divided into homogeneous strata based on preselected characteristics and then independent samples are selected from each of these subgroups. In simpler terms, it involves defining distinct and mutually exclusive strata within the target population based on a specific variable such as gender, age, region, household status, income, etc. Independent sampling can then be performed using any sampling method that may vary from one subgroup to another.

The main reason for choosing this method is its efficiency in sample definition. It allows the determination of an appropriate sample size for each subgroup within the target population, ensuring precise and accurate representation.

For this study, stratification was carried out according to spatial context (governorates/delegations), gender and age of the Tunisian Sahel population. This approach allows us to recruit the appropriate number of people to be interviewed within a specific gender, age group and residence in a specific delegation of a specific governorate. Appendix A-2 provides a representation of stratified sampling in Sousse Governorate. The overall sample was evenly distributed between women (51.4%) and men (48.6%). This parity is due to the comparatively higher proportion of women in the Sahel compared to men (51% women versus 49% men). Below we present a statistical distribution of the sociodemographic characteristics of our sample (Tab.1).

		Tunisian Sahel Region (2,021)		**Women (1,038)**		**Men (983)**	
Age	**15-19 years old**	235	11.6%	117	11.3%	118	12%
	20-29 years old	504	25%	258	24.9%	246	25%
	30-39 years old	428	21.1%	225	21.7%	203	20.7%
	4049 years old	337	16.7%	168	16.2%	169	17.2%
	50-59 years old	256	12.6%	130	12.5%	126	12.8%
	60 years and older	261	13%	140	13.5%	121	12.3%
Socio-professional category	**High school student**	236	11.7%	127	12.2%	109	11.1%
	Teaching	33	1.6%	16	1.5%	17	1.7%
	Student	206	10.2%	122	11.8%	84	8.5%
	Private job	898	44.4%	341	32.9%	557	56.7%
	Public job	130	6.4%	60	5.8%	70	7.1%
	Liberal profession	30	1.5%	21	2%	9	0.9%
	Retired	161	8.1%	47	4.5%	114	11.6%
	Unemployed	327	16.1%	304	29.3%	23	2.3%
Marital status	**Single**	812	40.1%	390	37.6%	422	43%
	Divorced	48	2.4%	32	3%	16	1.6%
	Married	1050	52%	514	49.5%	536	54.5%
	Widow(er)	111	5.5%	102	9.9%	9	0.9%
Income	**Low-income (0-1050 dinars)**	1629	80.6%	944	91%	685	69.6%
	Middle-income (1050-2100 dinars)	308	15.2%	85	8.2%	223	22.7%
	High-income (+2100 dinars)	84	4.2%	9	0.8%	75	7.7%
Household size	**Small household (1-4 persons)**	1205	59.6%	604	58%	601	61.1%
	Big household (5-10 persons)	816	40.4%	434	42%	382	38.9%

Tab.1 Sociodemographic characteristics of the study sample

To ensure the legitimacy of our work, we informed the relevant authorities in each of the delegations visited about the purpose of our study.

In order to attract the largest possible number of participants with different profiles, we held meetings on the streets and in public places (as a privileged target group) in urban and rural contexts, e.g. bus stops, train stations, public transport terminals, parking lots, Shopping areas, parks, coffee shops, sports complexes, farmers markets, administrative facilities, schools and universities, etc. Once a person agrees to participate in our survey, the total duration of the questionnaire was estimated at 15 to 20 minutes.

The statistical reference unit of our study is the person surveyed. Seven researchers were involved in conducting this survey: three professional researchers with experience at the National Institute of Statistics (INS) and four master's research students.

The aim was to cover two to three delegations per day (depending on the specifics of the region served). Two teams, each consisting of three to four people, were assigned to a specific study area. Quotas were established based on the age and gender of participants assigned to each interviewer. This approach allowed us to adhere to the predetermined sampling quotas and organize the questionnaire with optimal efficiency. The survey lasted one and a half month from January 29, 2019, not counting Sundays and Mondays, school vacations and public holidays. To maintain the specified sample size, discrepant observations were first identified and excluded. These observations were then collected again during the specified time period. Thus, the pre-determined total number of 2,021 respondents was successfully reached, respecting the specific quotas established for each delegation visited. Given the lack of systematic data on urban mobility in the Tunisian Sahel context (and even at the national level), this database represents a detailed reference for travel patterns and aims to provide an overview of what is actually happening in terms of mobility in the region.

3.2 Study area

The Tunisian Sahel represents 4% of the country's total area and covers 6,659 km^2. Administratively, it includes 40 delegations grouped in three governorates: Sousse (the most populous), Monastir (the main industrial pole) and Mahdia (the most spatially extensive), which are home to more than 15.3% of the country's total population, which makes it the second national metropolis according to the figures of the General Commission for Regional Development (CGDR).

The Tunisian Sahel has a strategic geographical location and serves as an intermediate passage between the southern and northern regions of the country. This is also supported by a well-developed infrastructure, which makes traveling between these two ends increasingly easier. This advantage positions the Sahel as a historical research laboratory for urban mobility studies and travel behavior surveys.

In Appendix A-3 we present the urban setting of our study area[1], illustrating the infrastructure and key public facilities in the region.

As for road transport, the Tunisian Sahel is connected by a network of 1,812,761 km of national, regional and local roads that serve the various delegations in the region. This infrastructure is reinforced by different categories of transport (individual, collective and semi-collective) that serve the region at urban, suburban, regional and rural levels.

In addition, the region serves as a central hub in the Tunisian highway network, with the city of M'saken (a delegation in Sousse Governorate) taking center stage. The A1 motorway stretches 140 km north to Tunis and 98 km south to Sfax.

[1] From the cartographic atlas of the Ministry of Equipment, Housing and Spatial Planning (2019)

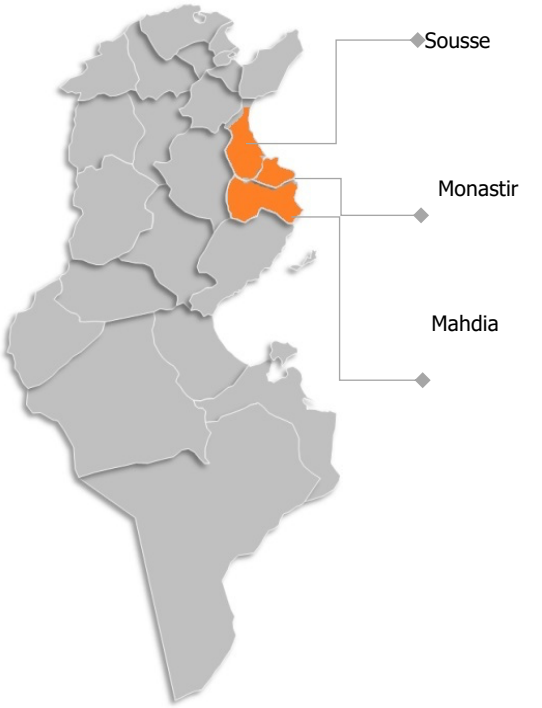
Sahel region (Tunisia map)	Governorates	Demographic characteristics
	Sousse	Total population in 2023 (estimated): 753,370 Area (km^2): 2,669 Population evolution rate (2014-2023): 11.61% Classified road network (2021): 596.81 km Urbanisation rate (2014): 81.1%
	Monastir	Total population in 2023 (estimated): 611,118 Area: 1,024 km^2 Population evolution rate (2014-2023): 11.35% Classified road network (2021): 516.5 km Urbanisation rate (2014): 100%
	Mahdia	Total population in 2023 (estimated): 448,273 Area: 2,966 Km^2 Population evolution rate (2014-2023): 9.12% Classified road network (2021): 569.92 km Urbanisation rate (2014): 45.7%

Fig.1 The Tunisian Sahel region

In addition to the road infrastructure, the greater Sahel area is also crossed by a regional railway line with a length of 72.5 km. Managed by the National Company of Tunisian Railways (SNCFT), this railway (known as the Sahel Metro (the tram)) serves as an important and widely used public transport in the region, connecting Mahdia to Sousse via Monastir. At the national level, all three governorates offer comprehensive rail transport for both passenger and freight transport.

This service is represented by line No. 5, which connects major coastal cities with Tunis, Sfax, Gabès and the southern regions of the country, including Gafsa and Tozeur.

It is worth noting that the Tunisian transport system has several deficiencies, mainly related to the regularity of modes of transport, their spatial availability, security of access, fare irregularities and the behavior of drivers. One of the notable features of Tunisian transport is the very limited presence of informal modes of transport compared to Asia, Africa or even the South American continent. Furthermore, bicycles are relatively rare on the streets of Tunisia, as this mode of transport is ingrained in the culture as a symbol of lower economic status (Poussel, 2018). Depending on the spatial configuration of the delegation (urban or rural), the presence of adequate transport stations is not for everyone, even access to these is characterized by poor infrastructure for the majority of Sahel delegations (particularly in rural areas). These restrictions lead to security problems and open the possibility for petty crimes, which is primarily supported by women (Murphy et al., 2023).

3.3 The analysis variables

We focus on a variety of variables that show the behavioral characteristics of everyday mobility of women and men in the Sahel, its spatial and temporal dimensions, as well as the volume of daily trips and their monetization (Tab.2).

Behavioral features of mobility
Modal choice
Trip purpose
Volume of travel
Daily travel rate
Daily expenses (dinars)
Daily expenses/travel (dinars)
Spatial dimension of mobility
Total daily distance traveled (km)
Distance to transportation (km)
Cost per kilometer (dinars/km)
Temporal dimension of mobility
Access time to transportation (minutes)
Waiting time for the means of transport (minutes)
Time budget (minutes)
Average duration of each trip (minutes)
Hourly cost (dinars/hour)

Tab.2 Analysis variables by category

Here we define a daily trip as the journey between a starting point and a destination. Cost per kilometer is a monetary quantification of kilometers traveled per day and is measured by the ratio between daily expenses and the number of kilometers (distance) traveled across all modes of transport. Regarding the time aspect, the time budget measures the total time a person invests in their trips and considers the time in the vehicle in addition to the access and waiting time. The average duration of each trip is measured by the ratio between the time budget and the average number of daily trips. Finally, hourly costs quantify each hour spent on transportation and are measured by the ratio of daily expenses to time budget multiplied by 60.

4. Results and discussion

In this section we will outline the survey results and attempt to identify gender differences in mobility patterns in the Sahel. Our analysis begins by highlighting these differences by looking at women as a unique category and then examining how income affects their travel behavior.

4.1 Modal choice

Before presenting the results regarding modal choice by gender, we first categorize transportation modes into three groups:

- Individual modes including two-wheel drive, animal, truck, van, walking, private taxi, and private car;
- Public modes covering bus, work-bus, tram, and train;
- Semi-collective modes, a specificity of the Tunisian transport routine, including clandestine, the 'Louage' (connects intercity and inter-governorate), and the collective taxi (8-seater car that connects urban and rural areas in the governorate).

Bus transport is one of the most used modes of transport in the study area, as it is cheaper than the private "yellow" taxi (which is also not 100% spatially available), but its availability appears to be irregular and scarce in many areas of the region and extremely crowded. In the second row there are the shared taxis and the "Louage", which are a semi-collective means of transport in Tunisia and wait at fixed stops until they are full

and then travel on fixed routes. Due to the behavior of the driver, this mode is less safe than others, and train stations are so crowded, especially during rush hour, that they are a place for harassment and robbery.
The tram (which crosses the region from Mahdia to Sousse via Monastir), on the other hand, represents one of the most reliable means of transport due to its low cost, its availability and its ability to reach the intended destination on time. In contrast, the train (which is usually used for used for long distances) is exactly the opposite, as it has the most delays and traffic jams (most of the time passengers can't find a place to sit and can stay standing the whole time).
Transportation problems are not limited to public transport, in fact even private taxis in Tunisia have some deficiencies. In addition to price fraud, taxis refuse to offer door-to-door service either because they plan their trips according to their needs or on the grounds that some areas (low-income neighborhoods) are not safe or poorly accessible (damaged infrastructure, which is particularly worse during heavy rain when it becomes more difficult for cars and even people to move).
For the clandestine mode of transport, this has the same characteristics as the Louage and collective taxi, but with the only one difference: *it is illegal*. Owners of private cars with 7 to 9 seats act as passenger transporters with a variable tariff depending on the importance of the offer. This transport scheme is presented in particular in the Monastir delegations.
Based on this categorization, it can be seen that four out of five daily trips made by men (81.2%) using individual means of transport, compared to only 11% using semi-collective modes of transport. Collective modes make up only 7.9%. For women, private transport accounts for only 61% of trips. The differentiation is balanced by greater use of public transport (13.4%) and semi-public transport, which account for a quarter of their transport choice (Tab.3).

	Total sample		**Low-income**		**Middle-income**		**High-income**	
	Women	**Men**	**Women**	**Men**	**Women**	**Men**	**Women**	**Men**
2-wheel drive	2,5%	**17%**	2.8%	**19.5%**		**12.4%**		**8.5%**
Animal	0,2%	0,2%	0.5%	0.2%				
Bicycle	0,4%	2,6%	0.2%	3.5%		0.9%		
Bus	**10,2%**	**6,2%**	11.1%	8%	2%	2.8%		0.7%
Work bus	1,2%	0,5%	1.3%	0.4%		0.7%		
Truck	0%	0,3%		0.3%		0.6%		
Van	0%	0,5%		0.4%		0.7%		0.7%
Clandestine	0,8%	0,1%	0.8%	0.2%	1%			
'Louage'	**9,2%**	3,7%	9.1%	3.9%	10.3%	3%	**7.1%**	3.3%
Walking	**38,9%**	**33,7%**	**40.1%**	**38.2%**	**28.5%**	**24.7%**	**21.4%**	**19.9%**
Metro	1,8%	1%	1.9%	1.1%	1.3%	0.8%		
Collective cab	**15,6%**	**7,1%**	**16.3%**	7.9%	**9.3%**	5.5%	**7.1%**	4.6%
Individual cab	2,9%	1,3%	2.7%	1.5%	5.6%	0.7%		0.7%
Train	0,1%	0,2%	0.1%	0.1%	0.7%	0.6%		
Private car (as a driver)	**6,8%**	**22,4%**	**3.9%**	**10.4%**	**31.1%**	**45.1%**	**57.1%**	**61.9%**
Private car (as a passenger)	**9,3%**	**3,2%**	**9.2%**	**4.3%**	**10.3%**	**1.1%**	**7.1%**	

Tab.3 Modal distribution by mode character and income category for both sexes

The table above clearly shows how women and men in the Sahel move differently, use different means of transport and face different restrictions in their daily movements. The statistical results highlight the dominance of two modes of transport: walking, which is used more often by women (38.9%) than by men (33.7%), and the private car, with one in four trips for men (of which 87.5% are drivers) and only one in six trips are for women (with around 57.7% as passengers) (Bellmann et al., 2020; Kawgan-Kagan, 2020; Havet

et al., 2021; Nasrin & Bunker, 2021 ; Pirra et al., 2021; Abdullah et al., 2022; Chidambaram & Scheiner, 2023; Murphy et al., 2023). This is due to the fact that women are less likely to have a driving license compared to men (Fig.2).

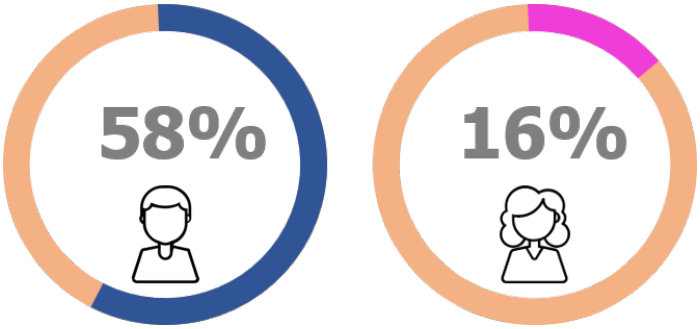


Fig.2 Driver License possession for Men and Women

Women in the study area are often perceived by their families as weak and vulnerable individuals when they travel alone. For this reason, they are mostly accompanied by a male family member, which limits their travel and even their choice of mode of transport (limited access to private vehicle) (Nasrin & Bunker, 2021; Parker & Rubin, 2023; Porter et al., 2022; Murphy et al., 2023).

Despite its modest modal share (2.4%), bicycle use is six times higher among men than among women (0.4%) (Pojani, 2011). For Tunisian women, cycling is considered a culturally inappropriate practice (Porter et al., 2022). These types of restrictions have given women a natural preference for less masculine modes of transport (Miralles-Guasch et al., 2016) and make them highly dependent on public transport.

For women, the shared taxi comes third and covers 15.6% of their trips, followed by the bus (10.2%) and the 'louage' (9.2%). For men, the two-wheeled vehicle is in third place with a share of 17% and justifies the gap between the shares of the individual means of transport, followed by the shared taxi (7.1%) and the bus (6.2%). When using public transport, women face particular problems, particularly harassment and sexual assault, whether through taunting gestures, verbal insults, physical abuse, or a combination of these behaviors. The most stressful experiences tend to occur on very congested public transport, especially when men are in close proximity to women or at night when the availability of transport services is scarce (Nasrin & Bunker, 2021; Pira et al., 2021; Kacharo et al., 2022; Porter et al., 2022; Murphy et al., 2023; Nasrin & Chowdhury, 2024).

According to Gekoski et al. (2017), this phenomenon seems to be related to gender norms that classify some public institutions as male-dominated and limit the place of women in the country's economic and social development.

Contrary to popular belief, the use of the clandestine mode is eight times more common among women (0.8%) than men (0.1%). The low use of this mode of transport is due to its small presence in the Sahel. As already mentioned, this type of transport is used exclusively in the Monastir Governorate (specifically in the Sahline and Werdanine delegations). Compared to other continents such as Asia and Africa, there is relatively little informal transport in the Tunisian transport system (Murphy et al., 2023).

The two findings and the dominance of motorized modes for both men (63.5%) and women (60.4%) are also reflected in the work of Miralles-Guasch et al. (2016), Greed (2019) and Uteng & Turner (2019), which look at northern countries from both urban and rural perspectives.

The observed mode choices for women and men in the Sahel region provide insight into what actually happens in people's daily mobility. Recognizing these patterns is crucial for urban planning to mitigate inequalities between the two genders when navigating urban spaces.

Looking at the financial situation, walking remains the most frequently used mode of transport (also for men) by women in the Tunisian Sahel with a share of 40.1%, followed by shared taxis (16.3%) and private cars (mainly as a passenger (9.2%)) (Lecompte & Bocarejo, 2017; Saigal et al., 2021). For low-income men, mobility is much easier when they use more private means such as two-wheelers (19.5%) and cars, mostly as drivers (10.4%). As income increases, the use of private cars is preferred for both genders (Lecompte & Bocarejo, 2017; Nasrin & Bunker, 2021; Saigal et al., 2021; Nasrin & Chowdhury, 2024). In fact, as affordability increases, women can hold a driver's license and own a private car (Tab.4).

		Low-income		**Middle-income**		**High-income**	
Gender		**Women**	**Men**	**Women**	**Men**	**Women**	**Men**
Driver license possession	**Yes**	12%	46%	53%	83%	56%	85%
	No	88%	54%	47%	17%	44%	15%
Vehicle possession	**Private car**	3%	13%	22%	62%	44%	72%
	Family car	31%	23%	46%	4%	56%	7%
	No	66%	64%	32%	34%		21%

Tab.4 Driver license possession and vehicle ownership by income category for both sexes

As shown in the table above, Sahelian women tend to use their own car and distance themselves from family influence as their financial comfort increases (similar to men, with higher rates than women). While men continue to use private transportation as their income increases, women, on the other hand, still use public transportation. In the middle-income group, women consistently choose shared taxis, although the rate is significantly lower compared to the low-income group (9.3%), and this percentage falls further among those with higher financial comfort (7.1%, similar to the 'louage').

As already mentioned, clandestine mode is used more often by women than men. This is the case of females with low incomes in Monastir (0.8%) and even of women with a significantly better financial situation (middle income) who are looking for economical transport according to the offer available in their area of residence

4.2 Trip purpose

The travel purposes most frequently mentioned by our respondents are 11: work, study, administrative matters (travel for public administrations (city administration, post office, police, etc.)), professional matters (travel related to professional purposes)), accompaniment, shopping, leisure, Health and care, personal (e.g. visits to family/friends, visits to places of worship).

	Total sample		**Low-income**		**Middle-income**		**High-income**	
	Women	**Men**	**Women**	**Men**	**Women**	**Men**	**Women**	**Men**
Work	**26,2%**	**36,2%**	**23.8%**	**32%**	**48.5%**	**42.3%**	**76.9%**	**55.3%**
Study	**19,7%**	**12%**	**21.8%**	**17.2%**	0.6%	0.9%		
Administration	4,7%	1,6%	5%	1.1%	2.3%	3.3%		1.2%
Professional Affairs	0,5%	1%	0.3%	1%		1.3%		
Accompaniment	8,1%	3,2%	7.6%	2%	**12.9%**	6%	**15.4%**	5.3%
Shopping	**17,5%**	**9,1%**	**17.4%**	**8.1%**	**19.3%**	**11.1%**		**10.6%**
Leisure	5,3%	**28,8%**	5.5%	**30.9%**	2.9%	**25%**	**7.7%**	**21.2%**
Health and care	**7%**	1,2%	7.4%	1.5%	2.9%	0.7%		0.6%
Personal	11,1%	7%	**11.2%**	6.2%	10.6%	9.4%		6%

Tab.5 Distribution of trips purpose per income category for both genders

The elementary distribution of the trip purpose (Tab. 5) shows that one of three trips made by men (36.2%) is for work reasons, compared to only one of four trips by women (26.2%). This is consistent with the unemployment rates reported in Tunisia in the current decade, which disproportionately affect women: the unemployment rate for women in 2018 was almost twice that of men (22.7% versus 12.5%) (INS, 2019). Our finding is in line with the results of the empirical literature, which recognizes that the responsibilities carried limit the time spent on accessing the labor market (Loukaitou-Sideris & Ceccato, 2020; Dingil et al., 2021; Nasrin & Bunker, 2021; Pirra et al., 2021; Abdullah et al., 2022; Rodríguez De La Rosa et al., 2022; Parker & Rubin, 2023). Women are likely work in small businesses (bakeries, small factories, kindergartens, etc.) and have little chance of getting high-paying jobs because these are predominantly occupied by men. Despite the low proportion of women in the Tunisian workforce, progress has been made such that their employment rate is above the average of Arab countries (28.1% compared to 21.2% in 2021 (Kashina, 2021).

In second place, we note that about 20% of women's trips are made for educational purposes, while for men the leisure and recreational motive stands out, which accounts for over 28% of their total trips (while for women it represents only 5.3% of their daily trips). Conversely, education is the third most important reason for men with a share of 12%. These results can be explained objectively by the significant difference in the female enrollment rate at the university level (Almost 60% of students are female (Tab.1 in Section 3)) and subjectively by the conservative and sometimes restrictive culture towards women in certain delegations in the Tunisian Sahel, which is mainly characterized by traditional Muslim values and customs that determine the majority of women's student behaviors, especially after the 2011 revolution (when Muslim conservation was strengthened) (Porter et al., 2022; Murphy et al., 2023).

Daily shopping is in third place for 17.5% of women, while for men it is only 9.1%, followed by private trips (11.1%), companionship (8.1%) and health/care rides (7%). Despite the increasing presence of gender equality movements, Tunisian societal norms still dedicate women's lives to the home, raising and accompanying children on their daily journeys, caring for their husbands, and accompanying the elderly (Porter et al., 2022; Murphy et al., 2023).

Looking at income, it seems that for both genders, work trips are the most important activity for using the Tunisian transport system, increasing as the financial situation improves. For low-income women, study motives come second, accounting for 21.8% of all trips, as this category is predominantly students. For men, leisure represents a primary activity, particularly for the low-income group (30.9% of all trips). The same classification of motives for the overall sample also applies to the low-income category. As income increases, there is a proportional shift in travel priorities. In fact, for middle-income women, shopping comes second (19.3%), followed by companionship for 12.9%. The latter is more likely to be observed among women who are financially better off. These results show that women, regardless of their financial status, are still bound by cultural norms that dictate the division of household responsibilities. While men travel mainly for leisure activities (after work), women take on the role of shopping and caregiving (Nasrin & Bunker, 2021; Pirra et al., 2021; Nasrin & Chowdhury, 2024).

4.3 Travel dimensions and rates

When it comes to daily trips (Tab.6), men are significantly more mobile than women, at a rate of about 4.1 trips per day, compared to only 3.2 trips for women. This difference between the two genders remains true even when income is considered. In this context, our results show that the middle-income category has the highest travel rate compared to other income groups for both women (3.4 trips/day) and men (4.2 trips/day). On the other hand, high-income women tend to take the fewest trips, making around 3.1 trips per day.

Men's dominance in daily travel is associated with higher daily expenditures than women's, whether for the total number of trips made (4.9 dinars per day (equivalent to US$1.79)) or for each trip (1.43 dinars/trip/day).

In addition to the total distance traveled: Women travel only a few kilometers, with an average of around 22.11 km/day, while men cover 27.13 km/day. This discrepancy is consistent with other empirical studies (Dingil et al., 2021; Nasrin & Bunker, 2021; Pirra et al., 2021; Abdullah et al., 2022; Rodríguez De La Rosa et al., 2022; Parker & Rubin, 2023), and it becomes more explicit on year basis. In fact, men cover an average of more than 9,900 km per year, covering 1.24 times more distance than women, who limit themselves to an average of 8,070 km. Women's mobility is primarily about family obligations that require the combination of several trips closer to their home. This fact becomes clearer as we move further into the southern part of the region and throughout the country, where authority in the family is vested in men, who are essentially the breadwinners of the workforce (Abbott, 2017; Murphy et al., 2023).

Volume & Distance	**Daily travle rate**	**Daily distance travelled (km)**	**Distance to transportation (km)**	
Total sample	**3.6**	**24.55**	**0.57**	
Women	**3.2**	**22.11**	**0.61**	
Low-income	3.2	21.81	0.61	
Middle-income	3.4	26	0.61	
High-income	3.1	17.2	0.36	
Men	**4.1**	**27.13**	**0.53**	
Low-income	4	20.91	0.57	
Middle-income	4.2	39.73	0.44	
High-income	4.1	46.44	0.48	
Time aspect	**Access time to transportation (minutes)**	**Waiting time for the means of transport (minutes)**	**Time budget (minutes)**	**Average duration of each trip (minutes)**
Total Sample	**9**	**11**	**80**	**26**
Women	**10**	**12**	**82**	**30**
Low-income	10	12	82	30
Middle-income	8	11	78	28
High-income	5	10	57	22
Men	**7**	**10**	**77**	**23**
Low-income	8	10	75	22
Middle-income	5	7	82	24
High-income	6	9	86	29
Cost aspect	**Daily expenses (dinars)**	**Daily expenses/trip (dinars)**	**Cost per kilometer (dinars/km)**	**Hourly cost (dinars/hour)**
Total Sample	**3.61**	**1.15**	**0.52**	**6**
Women	**2.38**	**0.89**	**0.37**	**2.7**
Low-income	2.18	0.84	0.34	2.36
Middle-income	4.2	1.33	0.66	5.51
High-income	7.98	2.38	0.73	7.21
Men	**4.9**	**1.43**	**0.67**	**6.4**
Low-income	3.12	0.85	0.52	4.07
Middle-income	7.98	2.39	0.92	10.04
High-income	12	3.84	1.28	16.27

Tab.6 Mobility indicators for both gender and income category

In terms of financial situation, men's daily distance traveled increases as income increases, moving from 20.91 km/day to 46.44 km/day for the high-income category. A classification that continues to be respected for daily

expenses (even for women). In contrast, improved financial conditions for females result in shorter distances of about 17.2 km per day. Furthermore, it appears that low-income women travel more kilometers than men in the same category (21.81 km/day versus 20.91 km/day) (Nasrin & Bunker, 2021; Nasrin & Chowdhury, 2024).

A person in the Sahel pays an average of 0.52 dinars per kilometer traveled. These unit costs are cheaper for women than for men, whose average cost per kilometer is 29% higher than average, rising to 0.67 dinars. In other words, the cost per kilometer is 81% more expensive for men than for women. A sum that increases with income for both genders, where women with high incomes spending 0.73 dinars per kilometer traveled, compared to 0.34 dinars/km for women with modest financial resources.

The distances to the various means of transport used daily are comparable (0.61 km vs. 0.53). However, the cumulative annual difference puts the woman at a disadvantage of almost 30 km. The built environment in many areas of the Sahel (particularly in low-income neighborhoods) is poorly managed (not all areas have train stations and not all existing train stations have shelters, and they are on main roads far from residential areas: people have to walk an average of 570 meters to use an irregular and unsecured transport service provided over damaged infrastructure) and poses many safety problems for women who prefer to walk further kilometers to a safer neighborhood to use transport, or a Ask a family member with a vehicle to take them there (Porter et al., 2022; Murphy et al., 2023). This reality is particularly evident among low- and even middle-income women, who travel a distance of 0.61 km (corresponding to the overall average observed among women). In developing countries, the transportation system is mainly characterized by deteriorating transportation infrastructure, long distances between home and train stations, and accessibility issues (Dingil et al., 2021; Pirra et al., 2021; Alizadeh & Sharifi 2023). A condition that occurs primarily in low-income neighborhoods (Porter et al., 2022; Murphy et al., 2023). On the other hand, accounting for income in our analysis uncovered a case where men travel a greater distance to access transportation than women. This is an example of the high-income category, where men travel 0.48 km to use transportation while women travel only 0.36 km.

When it comes to time, women invest the most in access to available transport options (access and waiting times) and even in the entire journey (average length of each journey traveled). However, men bear higher hourly costs than women, with more than 6.4 dinars per hour, compared to only 2.7 dinars. On average, women reserve 5 minutes more per day for rides than men. Given the average rate for both genders and at the level of a single trip, this gap is more noticeable and is 7 minutes (26 min vs. 19 min), which is almost 37% of the average trip time for women. The difficulty of women's mobility is most evident from this temporal perspective (as in the case of Abdullah et al., 2022 study). Taking income into account, improved financial conditions make traveling much easier for this population group. According to Tab.6, high-income women spend the least amount of time accessing public transportation at about 5 minutes, while low-income females struggle with twice as much time (10 minutes).

For both genders, low income tends to lead to longer access times to transportation and even longer waiting times for transportation (Gera & Hasdell, 2020). Ironically, it appears that low-income men spend an average of 10 minutes patiently waiting for transportation, which takes the same amount of time for high-income women (underscoring the clear hierarchy between the two genders). Notably, middle-income men experience the lowest time loss in access (5 minutes) and waiting for transport (7 minutes). Despite the aforementioned observation that women generally spend more time in transportation than men (time budget and average duration per trip), income considerations reveal further variation between the two genders. While women's time budget decreases as their income increases, the opposite is the case for men. It appears that low-income women spend about 1 hour and 22 minutes as much on transportation as middle-income men (a duration relatively close to that of high-income men (1 hour and 26 minutes)).

The transposition of this finding to the average duration per trip, present a relatively equal differences between the income groups of the two genders. For this variable, low- and middle-income women spend a longer time on each trip than their male counterparts, 30 and 28 minutes per trip, respectively.
Conversely, well-financed women invest only 22 minutes per trip, which is less than the 29 minutes spent by high-income men. Since men spend the most per hour traveled, these costs increase in proportion to financial comfort for both genders. For low-income women, the cost is 2.36 dinars/hour, for the middle-income group, 5.51 dinars/hour, and for women with significant financial relief, 7.21 dinars/hour. For men in this income category there are also costs of 16.27 dinars per hour traveled.

5. Conclusion

Within the context of no gender-neutral cities, women's travel behavior has been the focus of several research studies, highlighting the differences in mobility patterns between the two genders as a result of the inherent cultural role distribution in which predominantly women assume most of the household duties. A circumstance that is most evident in developing countries, where women encounter inadequate transportation and are constrained by limited financial resources and societal norms (Nasrin & Chowdhury, 2024).
The aim of this research was to analyze women's mobility in the Tunisian Sahel and examine the impact of financial status on their travel habits compared to men. The initial results of the descriptive analysis of variables, addressing multiple dimensions of mobility, revealed notable differences between the two genders. These differences are consistent with those documented in the literature and facilitate the integration of our geographical study into the limited empirical research on the case of Tunisia.
According to the various findings, women in the Sahel appear to spend the most time accessing transport and making their daily journeys, with a greater average distance. On the other hand, men travel more than women, with almost 420,000 trips per day, for almost every mode and travel purpose, incurring much higher transportation costs. Measured by the modal split, women use public and semi-public transport significantly more often than men. The travel motives are predominantly optional for both genders and are in similar proportions. The table presented below provides a summary of the variations in various variables when comparing the values recorded for women with those for men.

	Average variation women vs men
Daily travel rate	-22.0%
Number of daily trips	-17.4%
Daily expenses (dinars)	-51.4%
Daily expenses/travel (dinars)	-37.7%
Daily distance travelled (km)	-18.5%
Distance to transportation (km)	+15.1%
Cost per kilometer (dinars/km)	-44.8%
Access time to transportation (minutes)	+42.8%
Waiting time for the means of transport (minutes)	+20.0%
Time budget (minutes)	+6.5%
Average duration of each trip (minutes)	+30.4%
Hourly cost (dinars/hour)	-57.8%

Tab.7 Summary of the variable's variation between women and men

When it comes to economic status, limited income puts women in the Sahel at a disadvantage. This limitation forces them to walk and use mostly poor transport services, forcing them to endure the misbehavior of drivers and to confront the security issues they encounter. As financial wealth increases, women tend to have a

driver's license and own their own car. Improving financial conditions leads to greater choice of transportation options, easier access to transportation in time and space, greater affordability, and even less time spent on transportation for females in our study area.

These results highlight the position of women in the Tunisian transport sector, which is mainly linked to the socio-cultural context and Tunisian consciousness, and consider them as an essential research target whose mobility patterns must be carefully taken into account when drafting urban policies and public decisions. Expanding our study can integrate a more detailed analysis of the socio-cultural perspectives in which women live by opting even for a finer spatial scale involving country delegations. The analysis of mobility practices in relation to gender, taking into account other socio-demographic characteristics such as age or socio-professional status or other criteria related to the transport system such as security or even public investment, represents an interesting axis that can be carried out in a developing country such as Tunisia.

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Appendix

Appendix A-1: The questionnaire

Urban Mobility in the Tunisian Sahel Region

Respondents & Households

1. Gender
○ 1. Male ○ 2. Female

2. Age
○ 1. 15-19
○ 2. 20-29
○ 3. 30-39
○ 4. 40-49
○ 5. 50-59
○ 6. 60 et + (Specify) _____

3. Socio-professional category
○ 1. High school student
○ 2. Vocational training
○ 3. University student
○ 4. Farmer
○ 5. Craftsman
○ 6. Tradesman
○ 7. Liberal professions
○ 8. Company directors
○ 9. Public sector employee
○ 10. Private sector employee
○ 11. Public worker
○ 12. Private worker
○ 13. Retired
○ 14. Unemployed

4. Marital status
○ 1. Married ○ 2. Divorced ○ 3. Widow (er)
○ 4. Single

5. Specify the number of individuals in your household: ☐

6. Do you have a special status among this list?
☐ 1. Pregnant woman ☐ 2. M/F disabled
You can check several boxes.

7. What is your income?
○ 1. No income ○ 2. <=350 DNT ○ 3. 350-750 DNT
○ 4. 750-1050 DNT ○ 5. 1050-1400 DNT ○ 6. 1400-1750 DNT
○ 7. 1750-2100 DNT ○ 8. 2100-2450 DNT ○ 9. 2450-2800 DNT
10. +2800 DNT

8. Could you provide an estimate of your monthly household spending? ☐

9. You live in: ☐

10. What type of accommodation do you live in?
○ 1. Apartment ○ 2. House ○ 3. Studio
○ 4. Other (Specify)

11. Do you own or rent this property?
○ 1. Ownership ○ 2. Renting ○ 3. Other (specify)

12. If renting, please specify the rent in dnt: ☐

Mobility Conditions

13. Do you have a driver's license?
○ 1. Yes ○ 2. No

14. How many licensed drivers are in your household? ☐

15. Do you have a car?
○ 1. No ○ 2. Private car ○ 3. Rented
○ 4. Family car ○ 5. Other (Specify)

16. How many cars do you have in your household? ☐

17. Do you have access to the car when you need it?
○ 1. Yes ○ 2. Rarely ○ 3. Not at all

18. On average, how many trips do you make per day? ☐

Les besoins du transport

19. Which means of transport do you use most frequently?
☐ 1. Private car ☐ 2. 'Louage'
☐ 3. Collective cab ☐ 4. Bus
☐ 5. Individual cab ☐ 6. Train
☐ 7. Metro ☐ 8. Bicycle
☐ 9. Walking ☐ 10. Two wheels
☐ 11. other
You can check several boxes (5 amaximum).

20. How much do you spend on average each day to travel? ☐

21. Why do you choose this means of transport to travel?

- ☐ 1. Lack of alternative
- ☐ 2. Short trip (quick trip)
- ☐ 3. Lower cost
- ☐ 4. Sense of security
- ☐ 5. High reliability
- ☐ 6. Transport of luggage and bulky items
- ☐ 7. Others

You can check several boxes (4 maximum).

22. If money is not a limitation, what mode of transportation would you opt for?

- ○ 1. Private car
- ○ 2. 'Louage'
- ○ 3. Collective cab
- ○ 4. Bus
- ○ 5. Individual cab
- ○ 6. Train
- ○ 7. Metro
- ○ 8. Bicycle
- ○ 9. Walking
- ○ 10. Two wheels
- ○ 11. Others

23. Do you have a bus or metro pass?

- ○ 1. No
- ○ 2. Weekly
- ○ 3. Monthly
- ○ 4. Quarterly
- ○ 5. Half-yearly
- ○ 6. Annual

24. How often do you use prefered transportation per week?

- ○ 1. 1 day
- ○ 2. 2 days
- ○ 3. 3 days
- ○ 4. 4 days
- ○ 5. 5 days
- ○ 6. 6 days
- ○ 7. 7 (everyday)

25. What is the number of cancelled Trips due to lack of transport/week? ☐

Travel Features

26. For what reason/activity do you use transportation?

- ☐ 1. Work
- ☐ 2. Study
- ☐ 3. Training
- ☐ 4. Accompaniment
- ☐ 5. Health & care
- ☐ 6. Leisure
- ☐ 7. Everyday shopping
- ☐ 8. Administration
- ☐ 9. Professional affairs
- ☐ 10. Occasional shopping
- ☐ 11. Visits to worships places
- ☐ 12. Visiting family/friends
- ☐ 13. Others

You can check several boxes (6 maximum).

27. What was the average time in minutes to reach the chosen means of transport? ☐

28. What is the average distance in meters between your home and the nearest suitable transport station? ☐

29. What was the average waiting time in minutes for transportation means? ☐

30. Which of the following are you able to do?

- ○ 1. Walking for 1 km or less
- ○ 2. Cycling for 2 km or less
- ○ 3. Read and communicate in Arabic
- ○ 4. Read and communicate in French
- ○ 5. Speak in everyday language (for people other than Tunisian nationals)

31. Is transport in your area available? (1: not available --> 5: available)

○ 1.1 ○ 2.2 ○ 3.3 ○ 4.4 ○ 5.5

32. Do you find transport in the Sahel region easy to use? (1: not at all-->5: completely)

○ 1.1 ○ 2.2 ○ 3.3 ○ 4.4 ○ 5.5

33. How would you rate the cost of transport in the Sahel region? (1: not at all expensive --> 5: extremely expensive)

○ 1.1 ○ 2.2 ○ 3.3 ○ 4.4 ○ 5.5

34. Is the place where you take public transport well designed? (1: very badly designed --> 5: very well designed)

○ 1.1 ○ 2.2 ○ 3.3 ○ 4.4 ○ 5.5

35. Is the means of transport used safe? (1: not at all --> 5: absolutely)

○ 1.1 ○ 2.2 ○ 3.3 ○ 4.4 ○ 5.5

36. Does the means of transport used arrive on time? (1: not at all --> 5: absolutely)

○ 1.1 ○ 2.2 ○ 3.3 ○ 4.4 ○ 5.5

37. Is there a queue to access your means of transport? (1: not at all --> 5: absolutely)

○ 1.1 ○ 2.2 ○ 3.3 ○ 4.4 ○ 5.5

38. How would you rate the availability of your mean of transport? (1: availability problems --> 5: always available)

○ 1.1 ○ 2.2 ○ 3.3 ○ 4.4 ○ 5.5

39. Does the mean of transport used provide service to your final destination?

○ 1. Yes ○ 2. No

40. Would you find it necessary to make a physical effort to access a mean of transport? (1: not at all--> 5: absoletly)
○ 1.1 ○ 2.2 ○ 3.3 ○ 4.4 ○ 5.5

41. Do you find that transport in Sahel is accessible for all? (1: not at all-->5: absolutely)
○ 1.1 ○ 2.2 ○ 3.3 ○ 4.4 ○ 5.5

42. How easy is it to access information where you take public transport? (1: lack of information--> 5: available and accessible information)
○ 1.1 ○ 2.2 ○ 3.3 ○ 4.4 ○ 5.5

43. How secure is access to transportation in the Sahel region? (1: not at all secure --> 5: absolutely secure)
○ 1.1 ○ 2.2 ○ 3.3 ○ 4.4 ○ 5.5

44. Can you trust the transportation mode to get you to your destination on time? (1: not at all --> 5: absolutely)
○ 1.1 ○ 2.2 ○ 3.3 ○ 4.4 ○ 5.5

45. Are satisfied with public transport frequencies? (1: not at all --> 5: absolutely)
○ 1.1 ○ 2.2 ○ 3.3 ○ 4.4 ○ 5.5

Social Exclusion Indicators

46. What is your average monthly transport budget in dnt? ____

47. Which of the following activities do you take part in?
○ 1. Family visitis
○ 2. Sport
○ 3. Manifestations
○ 4. Politics Events
○ 5. Associations
○ 6. Visits of worship places
○ 7. Volunteer or charity groups
○ 8. Friends meetings
○ 9. Work
○ 10. Training
○ 11. Other (Specify)

48. What factors prevent you from participating in other activities?
○ 1. Lack of money
○ 2. Lack of time due to work
○ 3. Lack of time due to responsabilities (Specify these responsabilities)
○ 4. Can't go out because of responsabilities (Specify these responsabilities)
○ 5. No vehicule
○ 6. Poor quality of public transport
○ 7. No one to go out with (social)
○ 8. Physical access problems
○ 9. Too ill / sick / disabled
○ 10. Too old (must be assisted)
○ 11. Fear of personal attack/ burglary / vandalism
○ 12. Feeling unwelcome (ethnicity)
○ 13. Feeling unwelcome (age)
○ 14. Feeling unwelcome (gender)
○ 15. Feeling unwelcome (disability)
○ 16. Feeling unwelcome

49. Does transport in the Sahel region present a barrier to participation in the following activities? (Moderate limit to participation (ML)/ Severe limit to participation (SL)/ Stops me getting involved (PP)

○ 1. Work place _____	○2. High school/university _____
○ 3. Store _____	○4. Hospital _____
○ 5. Police station _____	○ 6. ATM _____
○ 7. Museum _____	○ 8. Cinema _____
○ 9. Social clubs _____	○ 10. Parcs _____
○ 11. The post office _____	○ 12. Library _____
○ 13. Associations _____	○ 14. Worship place _____

50. Does the increase in fuel price affect how often you use your car?
○ 1. Yes ○ 2. No

51. What prevent you from using public transport (more)?
○ 1. Crime
○ 2. Transport availability
○ 3. Transport prices
○ 4. Difficulties in accessing transport
○ 5. Parking problems (availability or cost)
○ 6. Personnel disability
○ 7. Age
○ 8. No accompanying person
○ 9. Other (Specify)

	What mean of transport do you use? (*)	For what reason/activity do you use this mean of transport? (*)	How do you estimate the journey distance in meters?	What was the average journey time in minutes?	If you use more than one transportation, how long was the transfer time?	WHt was the average diffusion time in minutes?
Trip 1						
Trip 2						
Trip 3						
Trip 4						
Trip 5						
Trip 6						
Trip 7						
Trip 8						
Trip 9						
Trip 10						

1. Private car (as driver)
2. Private car (as passengar)
3. "Louage"
4. Collective cab
5. Bus
6. Individual cab
7. Train
8. Metro
9. Bicycle
10. Walking
11. Two wheels
12. Other (Specify)

1. Home
2. Work
3. Study
4. Training
5. Accompaniment
6. Health and care
7. Leisure
8. Everyday shopping
9. Administration
10. Professional affairs
11. Occasional shopping
12. Visits of worship places
13. Visits of family/friends
14. Other (Specify)

For household members, please specify the number of individuals, their gender and age:

	Gender	Age
individual 1		
individual 2		
individual 3		
individual 4		
individual 5		
individual 6		
individual 7		
individual 8		
individual 9		
individual 10		

Appendix A-2: Starified sampling of the governorate of Sousse

Delegations	Sousse												Total
	15 - 19 years old		20 - 29 years old		30 - 39 years old		40 - 49 years old		50 - 59 years old		>=60 years old		
	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women	
Sousse Medina	3	3	6	6	6	6	3	3	3	2	2	2	43
Sousse Riadh	4	4	9	7	7	7	6	6	3	4	3	3	63
Sousse Jawhara	4	4	10	10	9	10	7	7	6	6	6	6	83
Sousse Sidi Abedelhamid	4	3	6	7	6	6	4	4	3	3	2	3	50
Hammam Sousse	3	3	6	6	6	6	3	3	3	2	2	2	43
Akouda	2	2	5	5	5	5	4	3	3	3	3	3	43
Kalaâ Kebira	3	3	7	7	6	6	5	4	4	4	3	4	54
Sid Bou Ali	2	2	5	6	5	5	4	3	3	3	3	3	43
Hergla	2	2	5	5	4	5	4	3	3	3	3	3	43
Enfidha	2	2	6	6	5	5	4	4	3	3	3	3	46
Bouficha	2	2	5	5	5	5	4	3	3	3	3	3	43
Kondar	2	2	6	5	5	5	4	4	3	3	2	3	43
Sidi El Hèni	2	2	5	5	4	5	4	4	2	3	3	3	43
Msaken	5	5	10	12	9	11	7	8	6	6	5	6	90
Kalaâ Seghira	2	2	5	5	5	5	4	3	3	3	3	3	43
Zaouia Ksiba Thrayet	3	3	6	6	6	6	3	3	2	2	2	2	43
Total	47	45	101	103	90	95	67	66	52	52	47	51	816

Appendix A-3: The urban frame of the Sahel region

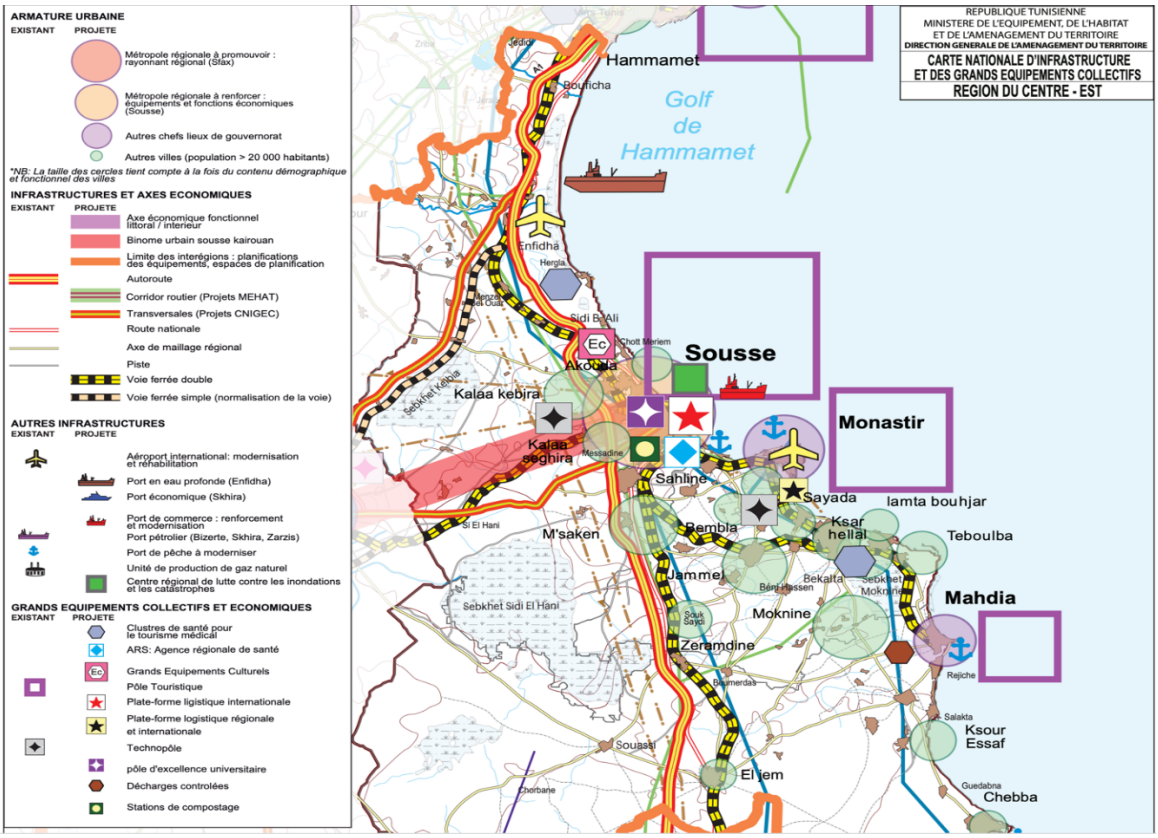

Image Sources

Fig.1: Personal elaboration;

Fig.2: Personal elaboration;

Author's profile

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Mehdi El Kébir holds two research masters' degrees. The first degree was obtained from the Higher Institute of Transport and Logistics of the University of Sousse and the second degree from the Higher School of Economics and Commercial Sciences of the University of Tunis. El Kébir has a multidisciplinary profile and is currently pursuing a PhD in Transport Studies and Regional Economics. He is interested in the vulnerability issues of mobility behavior and territorial studies. In his role as a temporary university assistant, he teaches tutorials and courses for undergraduate students. During his research career, he published two first papers (with three more in progress) and participated in half a dozen international symposia and indexed scientific conferences.

Aymen Ghédira

Aymen Ghédira is an urban transport modeler and planner who holds two PhDs from Grenoble Alps University (Territory Sciences) and University of Sousse (Public Management) and is an Associate Professor at the Higher Institute of Transport and Logistics. In addition to teaching urban and regional planning courses, he also teaches courses on sustainable mobility. Since 2010 he has been a visiting professor at the Polytechnic School of the ULB Brussels and gives seminars and training courses in transport management and logistics for international master's students. He is a member, co-founder and coordinator of many territorial development organizations. He is also spokesman for the Tunisian School of Politics (TSoP),

the Decentralization Training and Support Center (CFAD) and the Baladyia Seminar of the Robert Bosch Foundation GIZ. As project manager, Ghédira was, between 2018 and 2021 responsible for the integrated urban development program of Sousse in Tunisia, funded by Swiss State Secretariat for Economic Affairs (SECO), and covering urban planning (1), mobility and transport (2), energy efficiency (3) and GIS (4) areas. In his current position at Ingérop, he leads transport and mobility projects in the French context. A large number of his publications deal with public and political decision-making processes related to urban transport and local and regional development with an interdisciplinary and applied perspective.