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# THE ISSUE OF MOBILITY AND THE ROAD NETWORK WITHIN CITIES AND THEIR SURROUNDING AREAS: CASE STUDY OF THE CITY OF SOUR EL GHOZLANE, BOUIRA PROVINCE, ALGERIA

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**Abstract:** This paper examines urban transport issues in the historic city of Sour El-Ghozlane, located in the interior region of Algeria. It focuses on the limitations of transport infrastructure and the city's isolation due to a surrounding wall constructed during the Roman period in the 16th century BC, later restored between 1846 and 1862. While this wall has contributed to Sour El- Ghozlane 's status as a prime tourist destination, it has also created challenges in mobility, which has hindered local development. The ease of movement and road network density are crucial for facilitating economic, social, and cultural exchanges between urban and rural areas, which is essential for local growth. Like many Algerian cities, Sour El-Ghozlane has experienced significant urban and population expansion, leading to increased traffic congestion and an insufficient road network that no longer meets the needs of both drivers and pedestrians. Data from surveys and traffic statistics highlight the urgent need for improvements in transportation connectivity, road management, and infrastructure. The study proposes solutions such as creating a more organized road network, enhancing traffic signal systems, and designing consistent intersections. It also recommends urban planning measures like road expansion, tree planting, and promoting alternative fuel use and soft mobility. Furthermore, the planned railway line project is expected to stimulate regional and economic growth while preserving the city's historical heritage and addressing modern transportation needs. The development of an efficient road network is crucial for sustainable and inclusive local development and will promote the growth of domestic tourism in Algeria. The relationship between technological development and heritage preservation, as demonstrated by the challenges facing ancient cities such as Sour al-Ghozlane, is a topic of wide debate in contemporary academic circles. Through this scholarly article, which is primarily based on a field study of the road network and passenger and pedestrian traffic, we conclude that the shape and size of the road network in ancient urban areas have become unsuitable for modern transportation. They cannot accommodate the large flows of passengers and pedestrians resulting from population growth, nor do they accommodate the various reasons for travel (work, tourism, shopping, etc.). Therefore, developing the old centers of historic cities requires prioritizing investment in transportation.

**Keywords:** urban mobility, sustainable mobility, transport sustainability, networks, local development, historic center, Bouira province, Sour El Ghozlane city, intra-muros area, heritage and tourism, tourist city

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## INTRODUCTION

Urban mobility has become a critical issue as cities worldwide face significant transformations in lifestyle and travel practices (Abbas et al., 2023)**.** These changes, resulting from rapid urbanization (Pandey et al., 2025) technological progress, and social dynamics, demand creative ways to analyze and control movement within urban areas (Müggenburg, 2015). The term urban mobility has emerged to capture complex travel practices and the close relationship between urban change and movement (Cascetta et al., 2007). Urbanization, defined as the increase in the proportion of people living in towns and cities (Siwei & Yongsheng, 2025), often leads to profound shifts in land use, economic activity, and social practices. This phenomenon is most commonly encountered in smaller urban centers, like Sour El Ghozlane, where rapid urbanization (Abbas et al., 2023), due to population growth, rural exodus (Zerrougui, 2025), and infrastructure development, has created unique challenges. These are resulting in higher housing demand, decentralization of projects away from the downtown area as well as a growing disconnection between the historic city center and its periphery (Young & Keil, 2010).

Sour El Ghozlane in addition to its main cultural and tourist heritage has been afflicted with urban movement problems including traffic jams and the lack of infrastructure to handle the modern requirements (Montoya et al., 2024). However,

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the city's center area, characterized by historical elements, such as the rampart and gate, is a vital junction between its historical and contemporary sections. However, the urban sprawl, the degradation of the center facilities, and the lack of public spaces have made the city less accessible and make it lose its potential as a regional hub.

This study aims to address these concerns by proposing sustainable mobility (Banister, 2008) strategies that combine heritage preservation with urban growth and tourism promotion (Young & Keil, 2010). Through a detailed analysis of the site and its surroundings, this research aims to bridge the gap between the historic and modern city while fostering sustainable growth (Park et al., 2025). Specifically, the study investigates:

- How Sour El Ghozlane can integrate innovative transportation models (Shamsuddoha et al., 2025) to improve mobility while preserving its historical character.
- The relationship between road networks, urban density, and sustainable development in the context of smaller historic cities (Kasture & Dhagat, 2025).
- The revitalization strategy for the historic city center and improving its role as a functional, vibrant and touristic urban space.

## LITERATURE REVIEW

Urban transport is the lifeblood of cities (Wilkinson, 2003) Urban transport sustainability is of prime importance for achieving desired urban outcomes which impact economic, social and accessibility dimensions (Tong & Yorke-Smith, 2025). In many of the growing cities, everyday mobility is influenced by several factors which hinder sustainable and smart transport operations (Badassa, 2020). *Urban transport* is *vital* for connecting people to jobs, education, healthcare, and other *essential services* in *cities. This connectivity reflects the intrinsic relationship between transportation and urban planning*, meaning there is an interaction between land use and transportation (Shervin, 2025). The evolution of urban public transportation, which began in the 1960s (Puspitasari et al., 2025), has transcended borders and significantly impacted major cities. This transformation has prompted renovations and expansions of existing transportation networks. Essential modes, such as bicycles (Monteagudo et al., 2025) and walking, must be integrated into road network modeling and traffic planning. With the rapid growth of the urban population, the demand for transportation infrastructure has increased, emphasizing the need for effective mobility solutions to address congestion, enhance accessibility, and promote sustainable transportation (Ying Liu & Wei Su, 2021).

### Key Dimensions of Urban Transport

Infrastructure is increasingly recognized as a fixed foundation for spatial mobility, encompassing both physical dimensions, such as transportation networks and facilities and conceptual dimensions, including the policies and social frameworks (Kherigi, 2025). Accessibility, defined as the ability to reach destinations or services-varies according to transportation modes and associated costs. While everything could theoretically be accessible, the economic implications raise critical questions about the true price of mobility. Addressing urban transportation issues requires an analysis of spatial, temporal, and economic factors (Perveen et al., 2020):

1. **Spatial Dynamics**: Structure of the network (Weiyao & Li, 2025), center-periphery relationship, urbanization induced by transportation roads, etc.
2. **Temporal Dimensions**: Historical time (urban planning and history), economic time (investment amortization), and daily time (time wasted in transportation).
3. **Economic Factors**: The cost of investments, the price paid by the user, and the charges borne by the community (Weiyao & Li, 2025).

Other dimensions, seemingly immeasurable, are linked to these three major aspects:

- **Quality of Transportation Services**: Encompassing various aspects such as physical comfort, aesthetics, regularity, etc.
- **Externalities**: Negative impacts associated with transportation systems, including noise pollution, air quality degradation, safety concerns, and traffic congestion. By integrating these dimensions, this report aims to provide a comprehensive understanding of the complexities inherent in urban transportation systems. According to the report of (Lamri et al., 2020), these dimensions constitute the challenges of transportation policy. Existing or recently constructed road networks often fail to account for the growth in automobile usage, resulting in doubled or even tripled travel times due to narrow roads and a lack of parking areas, thus hindering traffic, especially during peak hours. The city is a collection of buildings, structures, and communication networks that facilitate functions, work, rest, and leisure for the population.

### Urban Mobility in Historical Contexts

Managing urban mobility in ancient city centers is complicated due to the requirement to maintain heritage while providing modern transportation options. The actions of urban mobility management have a direct impact on the preservation and protection of historical sites. The need of a Mobility Plan in historic towns is directly linked to the quest for territorial ordering and the appreciation of historical and cultural heritage that such cities represent (Dias et al., 2014)**.**

Mobility plans in historic towns must integrate territorial planning with the protection of cultural and historical assets. Similarly (Moreno et al., 2025) underline the role of accessibility in maintaining the socio-economic and cultural heritage of historical sites. Sour El Ghozlane, a dynamic city and the cultural, economic, and financial capital of the Bouira province, continues to evolve by adapting its past to the present in order to shape its future, transforming it into a major urban center (Anis & Şeyda, 2025). Sour El Ghozlane, especially its "intra-muros" area (The Latin expression) "intra-muros" means within the walls, as of a city (Dictionary.com, 2024) , represents a vital intersection of historical preservation and urban usability. At the center of this part of the city stands a Roman-era wall, with large stone gates, showcasing the

city's ancient past. The area reflects the long history of the region, influenced by many civilizations, including the Romans, Byzantines, and Islamic dynasties. Originally called Auzia, the city was later renamed Aumale during French colonization before becoming Sour El Ghozlane, meaning "Fort of the Gazelles". Despite the fact that the intra-muros area is a key historical site, it faces modern issues like limited mobility due to the wall's design and minimal commercial activity. It remains an administrative center, but these challenges raise the question of how to improve accessibility and commerce while maintaining the area's rich heritage. These problems require the evolution of wise strategies to enhance accessibility, support the sustainable and cultural tourism, and revive the historical core while respecting historical heritage.

**Global Relevance of the Case Study**

The issues that the city of Sour El Ghozlane faces, are not unique only for this city, but could be pushed by any city. Historic urban centers worldwide struggle to balance heritage preservation with modern urban demands, making this study relevant at a global level. By investigating the integration of sustainable transport solutions and heritage conservation strategies, this research aims to contribute to the broader discourse on urban mobility and provide actionable insights for similar cities. This review reflects the research's objectives by summarizing the most important aspects of urban mobility, sustainability, and heritage preservation (Banister, 2008). The knowledge derived from the literature enables the creation of direct exploration of solutions to Sour El Ghozlane 's mobility challenges (Hussien et al., 2025).

## METHODOLOGY

This study will primarily rely on data collected from various libraries (the University of Science and Technology Houari Boumediene and the Faculty of Geography and Territorial Planning Libraries) as well as various articles from various scientific journals including the Geojournal of Tourism and Geoscience as well as urban surveys. It was used a descriptive analytical approach to examine the geographical field, focusing on mobility and transportation within the city of Sour El Ghozlane, with particular attention to road networks and mobility within the intra-muros area and its periphery. Our analysis was based on a research sample of over 1000 individuals distributed across five zones within the urban agglomeration of Sour El Ghozlane. The surveys include the following steps:

1. **Descriptive Analysis of Questionnaire Variables:** We will analyze the variables included in the questionnaire to understand the characteristics of the sample population. This step will provide a detailed overview of the demographic and socio-economic profiles of the respondents.
2. **Analysis of Questionnaire Themes:** By calculating weighted averages and standard deviations, we aim to assess the perceptions of respondents regarding mobility and the road network in both the city center and its periphery. This will help us understand the general sentiment towards current transportation conditions.
3. **ANOVA Analysis:** We will employ ANOVA (Analysis of Variance) to identify significant differences between the main themes of the study, such as traffic plans, and between intra-muros and peripheral zones. This analysis will help determine how different factors influence mobility and road network effectiveness.

The comprehensive approach outlined will enable us to assess the current state of mobility and transportation networks in Sour El Ghozlane and provide valuable insights for future urban planning and policy-making.

## STUDY AREA

The city of Sour El Ghozlane, Figure 1, historically known as the ancient city of Ksar, is an intra-muros settlement with a rich history. Originally a Roman fortress named AUZIA, established in 16 B.C. under Emperor Augustus, it served as a site of worship for the god Auzia as it was mentioned in the book of Ibn Khaldoun.

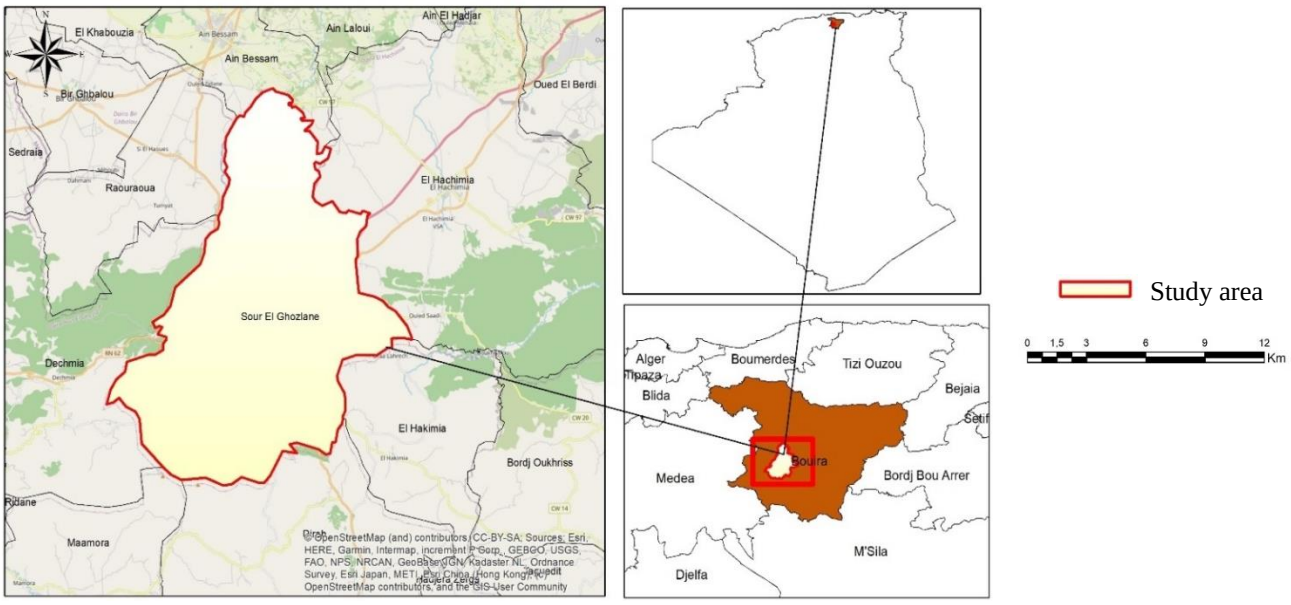


Figure 1. The geographical location of Sour El Ghozlane

During the Roman period, the site had a military function, defined by its southern, eastern, and western walls and the decumanus axis in the northern part (SID, 2025)**.** On May 27, 1843, the Duke of Aumale, son of King Louis-Philippe, laid the first stone of a new center (IBN-Khaldoun, 1854). The city was officially named Aumale on November 15, 1846.

Sour El Ghozlane has a long history as a garrison city, administrative center, and military establishment under various colonizers: Romans, Turks, and French, due to its strategic location and site morphology. The city retained its military function during the colonial period, which continued until the late 1990s after independence (CNERU, 2022).

During French colonial rule, the city was renamed Aumale. The name originated from an event. The intra-muros area of Sour El Ghozlane is situated on a small plateau that gently slopes from south to north. It spans 1,100 meters in length and up to 400 meters in width, surrounded by rocks and woods. The old ksar (intra-muros) covers an area of 37.70 hectares (Bousbaa, 2019). The city is located in the Bibans mountain range at an average altitude of 889 meters above sea level, at 36 degrees 9 minutes northern latitude and 0 degrees 21 minutes eastern longitude. Since the 1980s, the city has stabilized and now acts as a relay between the North and the High Plateaus (SID, 2025). In its regional context, the intra-muros area of Sour El Ghozlane is a vital exchange hub between the north and south, as well as the east and west. It is strategically positioned at the wilaya level, with excellent accessibility: 30 km south of the wilaya capital, Bouira, 80 km southeast of the national capital, Algiers (as the crow flies), and 130 km by road. Accessibility is reinforced by the East-West Highway and National Route No. 8, which connects Algiers to the tourist city of Boussâada, 130 km to the south. National Road No. 62 connects the wilayas of Médéa and Sétif, while the CW 127 links the city to the wilaya of Bouira. Sour El Ghozlane's strategic location facilitates smooth exchanges between the East and West and between the North and South (CENEAP, 2022).

## MATERIALS AND METHODS

### Urban Analysis: Field Study

Urban planning is the science of city development (Gulnara et al., 2024,)**,** focusing on studying and improving the creation and growth of cities. It involves specialists from various fields, including engineering, geography surveying, economics, sociology, landscape architecture, technical ecology, and legal and political sciences.

Analysis is a crucial step in the urban and architectural design process. It involves studying the city's structure (Zheng et al., 2025), breaking down urban space into its main components, and defining directions for development. This process is inherently linked to urban planning, which involves developing urban planning tools (Delavar et al., 2025).

The study area is served by several key roads:

- **NR 8:** This inter-urban axis connects Algiers to Boussaâda, passing through the Tablat Gorges and crossing the Wilaya of Bouira, including Sour-El-Ghozlane. It is economically significant for the region and city.
- **NR62:** Connects Sour-El-Ghozlane to M'hir (Wilaya of Bordj Bou Arreridj), passing through Bordj Okhriss to the east.
- **Bypass Road:** Constructed to alleviate traffic congestion in SEG and manage main vehicle flow, situated to the east.
- **PR 127:** Part of the inter-urban network, linking Sour-El-Ghozlane to the capital of Bouira via the commune of El Hachimia.
- **PR 20:** Connects Sour-El-Ghozlane to Berrouaghia to the west, passing through Dechmia. This two-lane road handles significant traffic and supports economic exchanges, notably with industries like industrial cement Groupe of Algeria & ENAD National Company for Detergents & Cleaning Products.
- **Bypass Road (repeated):** Mentioned again as part of the network designed to relieve congestion.

**Suburban Network:** Consists of roads ensuring connections between the city and secondary settlements and hamlets.

### Roads, Facilities and Squares

Sour El Ghozlane faces significant challenges due to the increasing number of demolitions compared to conservation efforts. The municipality has not made sufficient interventions to protect this historic center; instead, proposals aim to replace the old center with new projects, such as housing and facilities.

Despite these challenges, several important facilities have been created in the old core of the city of Sour El Ghozlane. However, these facilities are often designed to serve the wider regional and national population rather than address the specific needs of the local population, resulting in intensive and diverse movements.

The city has expanded rapidly within the constraints of its fortified walls and is now divided into two main areas: the functional area to the south and the residential area to the north. Between these two areas lies a rectangular square that is both a public square and a green space, with the headquarters of the public administration at the western end (built in 1951) and the Ibn Badis School (formerly Victor Hugo, during the colonial period) at the eastern end (built in 1950).

The road network in Sour El Ghozlane is crucial for the city's image and morphology, categorizing the streets into three types: the primary network, which includes major roads like R.N.8, growth axes, and boulevards; the secondary network, consisting of less important roads that connect various areas; and the tertiary network, which includes alleys, lanes, and urban passages serving residential neighborhoods. Key streets in the city include **Mazani Mokhtar Street**, a central road extending from Bab Boussaâda to Bab Al-Jazair, which experiences heavy traffic and congestion, particularly at intersections. **Boulevard Emir Abd El Khader** is a historic road that connects the north to the south, accommodating commercial establishments and other facilities. **Boulevard 1st November** marks the boundary between the colonial fabric and the western extension, supporting institutional facilities and significant urban points. Road **Ghomari Slimane** and Road **Hamiche Menade** serve as key transverse east-west structuring streets. Squares have lengthy been essential city spaces, evolving from historical Greece and Rome via the Renaissance and Baroque durations, serving diverse public functions (Morris, 2013)**.** In the study area, tremendous squares include Independence place, the town's administrative hub

with a mosque, Berriche place, linking military and civilian areas, and Place of Marché, a business area connecting administrative and residential zones. Square of El Attique Mosque marks the transition from colonial to northern growth regions, while Place of Armes, as soon as an army web page, now hosts public activities.

**Historical contents: gates, walls, equipment**

Between 1846 and 1862, a fortification wall (Figure 2) was constructed around the city, approximately 6.7 km long and built using dressed stone. The Roman-inspired wall included 17 bastions and loopholes (Figure 3), serving as a protective structure for the old Ksar.

- Gates: The wall included five gates that connected the city with the surrounding areas:
- Northern Gate (Porte d'Alger): Completed in 1855.
- Southern Gate (Porte de Boussaâda): Completed in 1856.
- Eastern Gate (Porte de Sétif): Completed in 1857.
- Western Gate (Porte de Médéa).
- Fifth Gate: A smaller gate located behind the hospital, linking to surrounding neighborhoods.

The fortifications around the city included various military equipment, such as watchtowers, bastions, and loopholes for defensive purposes. These structures were essential for controlling access to the city and defending it from external threats. (Figure 4) below illustrates roads, facilities and historical contents of the historical center.

Figure 2. The wall of Sour El Ghozlane (Source: Authors, 2024)

Figure 3. The height of the wall
of Sour El Ghozlane (Source: Authors, 2024)

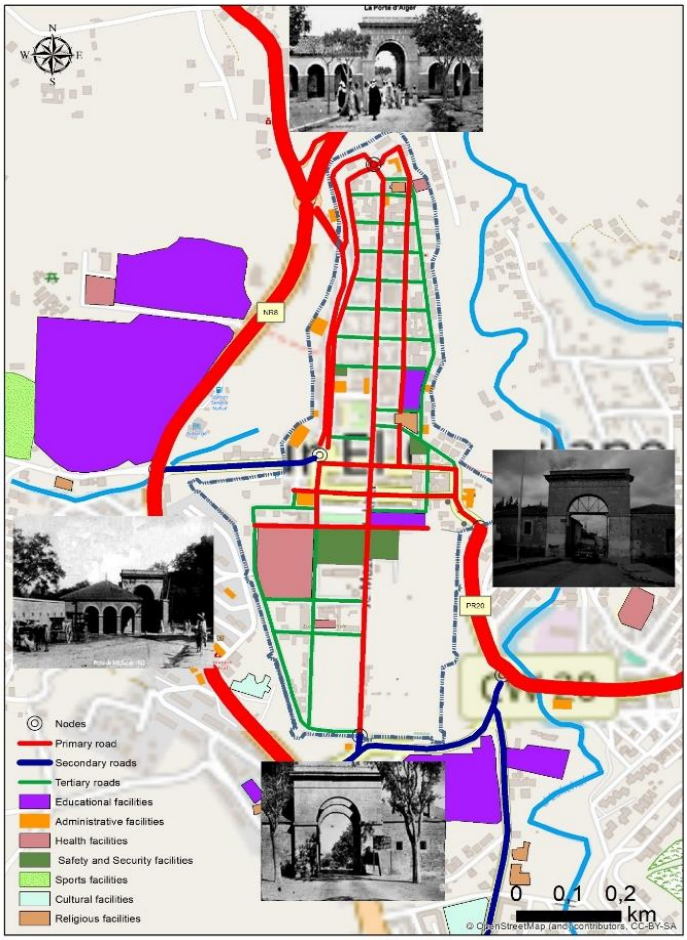


Figure 4. Roads, facilities and historical contents
of the Historical Center (Source: (Monograph, 2025)

**RESULTS AND DISCUSSION**

**Breakdown of the study area into zones**

Objective of the Survey: The O/D survey aims to understand movement habits of individuals within the study area by evaluating key characteristics such as: The origin and destination of trips; The purpose of trips; The quality of service.

Execution of the Survey: The O/D survey involves interviewing a sample of passengers using buses, taxis, and other modes of transport at major stops in Sour El Ghozlane. Participants are asked detailed questions to gather representative data. The study area is segmented into different zones for detailed analysis:

- Internal Zones: Representing neighborhoods within the city.
- Adjacent Communes: Covering nearby municipalities.
- Other Communes in the Wilaya of Bouira: Including other communes within the Wilaya.

- Other Wilayas: Covering regions outside the Wilaya of Bouira. This segmentation helps in locating and explaining the structure of trips (origins and destinations) of transport users recorded during the surveys.

**Organization of public transport in the study area (field study)**

The field study used a questionnaire distributed to a random sample of travelers across urban lines. Results were analyzed using SPSS Transportation modes and passenger numbers vary within the city and between surrounding municipalities (Figure 5).

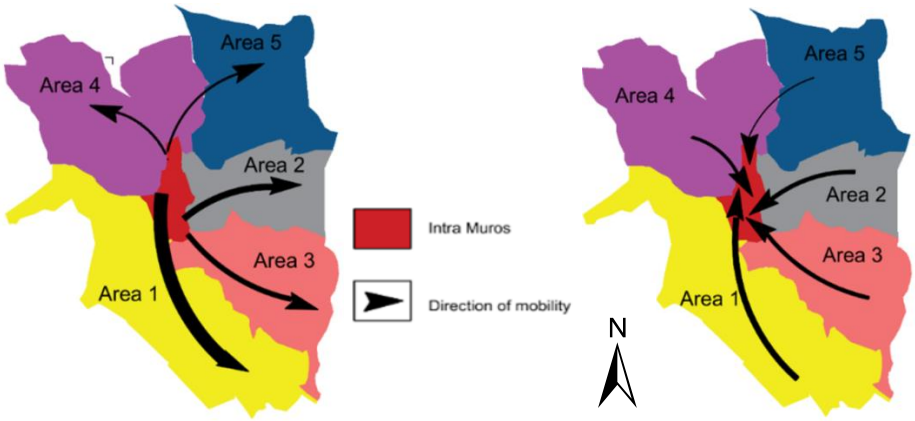


Figure 5. Means of transportation and numbers of passengers within the city and between surrounding municipalities

**Observations from the Survey**

- "Capsule" Buses: Common in the area, with the largest number of passengers using the line between the city center and Ain Amor (Area 1). This line benefits from a bus station in Ain Amor.
- City Center to Neighborhoods:
  - Area 2: Connects with the city center, where administrative facilities are concentrated.
  - El Djebsa (Area 3): Has a significant passenger flow, with buses filling up every 5 minutes.
  - City Center to Haouch EL Wassfan (Area 4): Serviced by around 34 buses, though not all operate daily. Buses fill up in about 20 minutes, with an average of 3 buses per hour.
- Transportation to Neighboring Municipalities:
  - AinBessam and BirGbalou: Key lines for residents due to the area's agricultural and trade importance. Taxis are available every 20 minutes for shopping and medical treatment.
  - Bordj Khriss: Although administratively independent since 2000, it maintains strong familial and historical ties with Sour El Ghozlane.
- Western and Eastern Sides:
  - Western Destinations: Few buses or taxis to Jawab, Dechmia, and Maamora, leading to unauthorized transit options.
  - Eastern Side (Hakimia): Similar issues with unauthorized transportation.

Regional Connections:

- Bouira: 90% of the population's movements before 6 a.m. are towards the capital, with the remainder divided among work, study, medical exams, or shopping.
- Sidi Issa (Wilaya of M'sila): Most trips are aimed at reaching this Wilaya, particularly for students at the University of M'sila.
- SEG - El Harrach: This line sees over ten taxis departing before 6 a.m. due to historical connections and commuting needs.
- SEG - Larbaa: Commuters face difficulties due to the station's distance from other transportation modes (Table 1).

Table 1. The destinations and the means of transport used (Source: Field survey 2024)

| Means of transport | Destination | Nº of Departing Passenger | Nº of Arriving Passenger |
|---|---|---|---|
| **TAXI** | HARACH | 140 | 70 |
| | AI BESSAM +BIR GHBALOU | 378 | 280 |
| | BOREDJ KHRISS | 75 | 126 |
| | Dechmia | 69 | 61 |
| | Mammoura | 55 | 42 |
| **Total** | | **717** | **579** |
| **BUS** | Bouira | 696 | 464 |
| | Sidi Aissa | 725 | 435 |
| | Larbaa | 453 | 230 |
| **total** | | **1874** | **1129** |
| **CAPSULES** | Ain amor | 648 | 324 |
| | Amara belkcem | 342 | 216 |
| | Djebsa | 270 | 195 |
| | Draa lahmr | 134 | 189 |
| | Takwin | 68 | 95 |
| **Total** | | **1462** | **1019** |
| | | **Total 1= 4053 Passenger** | **Total 2 = 2727 Passenger** |
| **Total Departing and Arriving passengers** | | **6780 Passenger** | |

**Analysis of the transport system**

Passenger Traffic: Peak Hours: The bus station experiences high passenger volume, with 1,874 travelers during peak times. Of these, 1,129 are incoming passengers, indicating SEG's role as a major entry point for suburban traffic.

Urban Parking: Current Challenges: Urban parking faces significant economic, social, and technical challenges, impacting the city's functionality. Parking issues are not adequately addressed, suggesting a need for improved management and organizational strategies.

Road Infrastructure and Mobility:

- Supply and Demand Alignment: The road infrastructure is under strain, requiring a better alignment between mobility supply and demand. The concept of "mobility," which emerged in the 1920s, involves changes in spatial position and social dynamics, reflecting broader social changes.
- Saturation and Modal Shift: The saturation of the road network calls for immediate action. There is a recognized need to shift towards public transportation and soft mobility options to alleviate congestion and improve urban functionality.

Urban Traffic Plan: Strategic Planning: According to the Algerian national center for urban studies and research, to tackle these issues, the urban traffic plan aims to organize travel and manage traffic flows on a regional scale within SEG. This plan is aligned with urban planning and strategic documents, including the PDAU and the POS.

Modalities of the Concept of Mobility

- Mobility as a Socio-Spatial Phenomenon
- Dual Capacity: This modality recognizes mobility as having two intertwined dimensions:
  - Physical Movement: The ability to change locations.
  - Transformative Capacity: The potential to adapt, change status, or gain new skills.
- Interconnected Dimensions: Both dimensions are critical, as physical movement often leads to or accompanies personal and social transformation.
- Mobility as an Analytical Indicator
- Social Dynamics Insight: Mobility can be used to analyze and understand social realities:
  - Family Relationships: Measuring mobility can reveal patterns in family interactions, such as who travels the most or least and how often family meetings occur.
  - Work-Life Balance: It helps assess pressures faced by individuals, such as working parents balancing their professional and personal lives.
- Mobility as a Social Norm
- Fundamental Right: Mobility is recognized as a fundamental human right, as stated in Article 13 of the Universal Declaration of Human Rights, which ensures freedom of movement.
- Social Norm in Western Societies: In modern contexts, mobility is often seen as a social norm:
  - Rapid and Long-Distance Travel: This form of mobility is associated with personal freedom and the ability to establish contacts without spatial or temporal limitations.
  - Democratization of Mobility: The ideal of reversible mobility, where individuals can easily move and connect with others, reflects broader societal values.

**Analysis of the sample's demographic data**

A total of 6,780 passengers were interviewed during this survey. (Table 2) shows the age and the situation of interviewed passengers, because, mobility services in future should be better oriented to the needs of the large customer groups of active elderly people and families (Stark & Gebhardt, 2025).

Table 2. Number of passengers, by age group, social and professional category (Source: Field survey 2024)

| Age Group | Student | Government Employee | Housewife | Retiree | Unemployed | Other | Total | % |
|---|---|---|---|---|---|---|---|---|
| **18 to 25 years** | 3.160 | 440 | 67 | 0 | 306 | 34 | 4,007 | 59.00% |
| **26 to 40 years** | 0 | 170 | 1.120 | 66 | 33 | 0 | 1.389 | 20.50% |
| **41 to 60 years** | 0 | 270 | 474 | 271 | 0 | 0 | 1.015 | 15.00% |
| **61 and above** | 0 | 0 | 64 | 305 | 0 | 0 | 369 | 5.50% |
| **Total** | **3.330** | **1.830** | **671** | **576** | **339** | **34** | **6.780** | **100.00%** |
| **%** | **49.00%** | **27.00%** | **10.00%** | **8.50%** | **5.00%** | **0.50%** | **100%** | |

**Descriptive analysis of transportation means and mobility reasons**

In analyzing the transportation system within the study area, the data reveals several significant insights. The bus is the most commonly used mode of transport, accounting for 48.50% of travel, followed by taxis at 36.50%, and private vehicles at 13.50%. The primary reasons for using various transportation modes include the need for proximity (28.6%), cost considerations (23.5%), and the lack of alternative options (48%). Speed is prioritized by 22% of travelers, while safety is the least cited reason, influencing only 1% of users. In terms of usage frequency, a substantial 87.5% of travelers use transportation several times a week, with 24% using it daily.

Travel times vary, with the majority of journeys taking between 30 minutes and 1 hour. However, 22.5% of trips last between 15 and 30 minutes, and 21.5% exceed 1 hour, and finally we have 12.5% of the passengers surveyed, whose daily trip lasts less than 15 minutes (Figure 6). These patterns underscore the critical role of proximity and cost in transportation choices and highlight the need for improvements in reliability and alternative transport options to address the high percentage of users who have no choice but to use available services (Stępnicka et al., 2025).

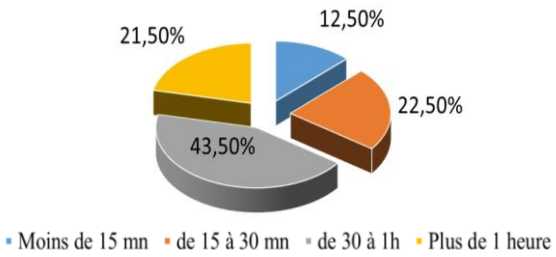

Figure 6. The time required for each journey

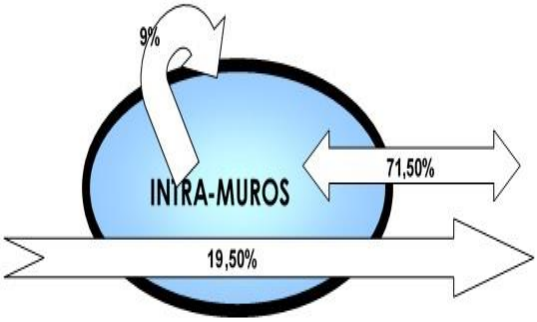

Figure 7. Characteristics of passenger traffic

**Characteristics of travel**

➢ Reasons for Daily Travel: The analysis of daily travel characteristics reveals several key patterns and trends. Home emerges as the most common origin and destination for travel, with 4.896 travelers starting from home and 1.292 ending their journeys there. This suggests that home is a central hub for travel activity.

Study-related travel ranks second, with 748 travelers beginning their trips for educational purposes and 1.700 ending at educational destinations. Work-related travel is third, with 646 travelers starting from and 1.462 ending at work locations, highlighting the significant role of employment in daily travel

➢ Characteristics of Passenger Traffic: The characteristics of passenger traffic further illuminate travel behaviors. Exchange traffic, where travelers switch from one mode or road to another.

Constitutes the majority, representing 71.50% of the total traffic. Transit traffic, which involves travelers passing through the study area without stopping, accounts for 19.50%. Loop traffic, involving travelers who return to their starting point, makes up 9% of the total (Figure 7). These figures underscore the importance of efficient interchange and transit systems in managing passenger flow and optimizing travel efficiency within the area.

**Urban transport and mobility**

Historically, urban regulations aimed to widen roads to accommodate vehicles and pedestrians better. In ancient Rome (William, 2010), roads were designed with a width of 12 meters, and during the day, car and freight circulation was prohibited to prioritize pedestrians and horsemen. As cities expanded beyond their walls, new suburbs and hamlets emerged, leading to the development of wider, straighter streets in newly built areas.

In Sour El Ghozlane, the city's vast expanse, with new facilities located outside the old walls, necessitates extensive travel for residents. This has led to a progressive dynamic in the city that requires immediate attention from urban planning professionals to improve transport infrastructure and alleviate congestion (Liu et al., 2025).

**Space allocation and urban planning**

Urban planning in Sour El Ghozlane follows distinct principles for space allocation:

- **Western Part:** Reserved for health-related activities, including an expanded hospital, a paramedical school, and related housing.
- **Central Part:** Dedicated to public facilities to preserve the city's central axis.
- **Eastern Part:** Allocated for university and commercial activities, linking academic and public spaces effectively.

**Public squares and green spaces**

- **Place d'Armes:** This historic site, once surrounded by Aumale's rampart and superimposed on the Roman wall, has evolved significantly. Initially home to Victor Hugo primary school and Isly garden, it served military purposes until 1990. Recent developments have preserved parts of this historical site while transforming the area into a vibrant public space.
- **Pedestrian Axis:** A newly developed pedestrian path connects the historical Place d'Armes with modern amenities, including the youth center, garden, museum, mosque, and paramedical school. This path creates a historical discovery promenade, integrating the city's rich history with contemporary urban planning.

These initiatives are designed to enhance connectivity, address the city's transport deficiencies, and integrate historical and modern elements into Sour El Ghozlane's urban fabric.

**Recommendations**

The analysis presented is based on comprehensive field visits, surveys among public transport users, and traffic counts at key intersections in Sour El Ghozlane. This data has been pivotal in developing a robust database to evaluate demand and network utilization.

**Proposals for an efficient road network and traffic management:**

1. Structuring the Road Network: To moderate traffic congestion in Sour El Ghozlane, it is necessary to develop key roads and build bypasses around the city center. This would help to regulate traffic near historical places while yet allowing for natural traffic flow. A bypass will help to improve air quality, reduce noise, and ensure safer passage for both pedestrians and vehicles. Classify and optimize the road network: Roads will be classified on a more strategic functional manner into primary, secondary, and tertiary types, with specific design features applicable to each category, the primary roads should cater to

motorized traffic, providing enhanced signage, wider lanes, and segregated roads for buses and trams. Local accessibility is to be made available on a secondary road by prioritizing pedestrian routes providing for cycle lanes on tertiary roads (Sachar, 2025). This will help in urban mobility developments as it would ease movement both for drivers and pedestrians.

2. Expand and Modernize Public Transport: It is important to enhance bus and tram roads beyond towns like Gueltat Zergua to reach adjoining villages. Electric (Budnitz et al., 2025) or hybrid buses can help lessen environmental pollution and might increase system efficiency. This network expansion should be complemented by an on-demand shuttle service with better last-mile connectivity in the areas that need it, so that they may have better flexibility during off-peak hours. Establish BRT and Integration of Transport Modes.

3. In order to provide more efficient urban mobility, it is necessary to introduce a BRT system with dedicated lanes that would offer quicker and more reliable service. The system shall be well integrated with trams and buses with easy transfers between modes. This is aimed at providing better and quicker bus services on dedicated roads with priority lanes to ease congestion and provide a more dependable service for commuters.

4. Smart mobility solutions: Intelligent Traffic Management: Use of intelligent traffic management systems working based on real-time data in radar mode in dynamic modifications of traffic lights will help enhancing traffic flow, reducing congestion, and emissions. Upon the integration of sensors, smart traffic lights would open up space for prioritizing movements of public transport and emergency vehicles to support the complete urban mobility network (Labri & Baziz, 2022). Mobility as a Service: The urban ONE platform aims to integrate all forms of transport, including buses, trams, bike-sharing, and car-sharing, into one application. Residents and visitors can plan their journeys, book a vehicle, and pay through one single application. MaaS makes the public transport system easier to understand and that much more attractive to tourists and newcomers.

5. Sustainable Transport and Green Mobility: Encourage Cycling and Walking: Expand cycling infrastructure by adding dedicated lanes to major roads (Alkhatib et al., 2022). Set up a public bike-sharing system. An expansion of pedestrian-friendly zones and a network of walking paths, particularly in historic areas like intra-muros, pushes people to walk or cycle instead of opting to go by car. Less traffic and improvement to the environmental footprint of the city will result. Urban Green Spaces and Green Corridors: Integrate green spaces with urban transportation. These open spaces should become the nodes that actually connect to different modes of travel, such as biking or even pedestrian routes. Green corridors can be created on the roads, so transportation can improve air quality, reduce heat islands, developing an amiable and sustainable environment for all.

6. Heritage and tourist sites Preservation and Smart Design Integration: The historical and tourist character of Sour El Ghozlane needs to be conserved, and at the same time, modern solutions must be integrated in urban development. With the usage of smart technologies Integrating Sustainability into Heritage Sites: Install modern sustainability features like solar panels, efficient systems, and climate control technologies in historical buildings. These would allow the preservation of cultural heritage while ensuring that the city operates smoothly and adheres to modern energy-efficient standards.

7. Policy and Governance: Implement Sustainable Mobility Policies: Local authorities should adopt policies that promote public transportation, the use of bicycles, and walking. These policies could establish financial incentives for the usage of eco-friendly transport, stricter regulatory emissions on vehicles, and subsidies for public transport. Such incentives would reduce dependence on private cars while lowering pollution levels (Jiao et al., 2025). Stakeholder Engagement: Public engagement is necessary in the creation of systems of transport that serve all citizens. Urban planners should be brought into consultation with residents and local businesses, allowing for strategies to be worked out in light of broader community interests. This would ensure that the public transport system is accessible and satisfies the needs of local residents and visitors.

**8.** Long-Term Vision: Railway Connectivity: Sour El Ghozlane's strategic position in Bouira wilaya, combined with its historical importance, underscores the need for modern transport infrastructure to support regional development. The long-awaited railway connection to Bouira and Constantine is expected to boost regional prosperity and facilitate commerce.Regional Mobility Hub: Sour El Ghozlane can become a regional mobility hub, connecting different transport modes (train, bus, tram, bicycle-sharing). This mobility hub could also include logistics centers for regional commerce, enhancing Sour El Ghozlane 's role in facilitating trade and economic (Alves et al., 2023).

## CONCLUSION

Finally, we can say that Sour El Ghozlane is a historical and tourist city par excellence, and it must be preserved in light of the development of modern means of transportation. Therefore, there is a need to develop smart mobility solutions that contribute to the integration between traditional transport infrastructure, green spaces, and urban development to improve mobility, reduce congestion, and promote sustainable development. These will need active cooperation from local authorities, urban planners, and the community for effective implementation.

If this recommendation is adopted, Sour El Ghozlane can be assured of its growth in modernity without affecting its rich historical heritage, this heritage site, therefore, has great tourist potential that could be used to foster local development in an effective manner. Thus, this attracts visitors, offering opportunities, not only for economic growth, but also for job creation and the preservation of cultural landmarks, enabling sustainable tourism and the safeguarding of traditions. The cultural heritage and tourism development are necessary for sustainability, since social and economic growth are acknowledged as unfolding beneath the built environment or heritage (Yiamjanya, 2024).

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