EVALUATING PUBLIC TRANSPORT ACCESSIBILITY LEVELS AND THE POTENTIAL FOR A 20-MINUTE CITY IN ALI MENDJELI, ALGERIA USING A GEOGRAPHIC INFORMATION SYSTEM (GIS)

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Abstract

This study examines the accessibility of transportation, in Ali Mendjeli, Algeria using the concept of a "20-minute city" where essential amenities reachable within a 20-minute walk or bike ride. By utilizing Geographic Information System (GIS) technology and the Public Transport Accessibility Level (PTAL) method we analyze pedestrian access to transport hubs, service frequency and travel durations while considering footpath infrastructure and peak usage times. The PTAL maps generated reveal variations between the connected city center and the accessible peripheries. Our investigation delves into how this data can inform enhancements to transport links, expansion of services in underserved regions and promotion of access to opportunities. Through assessing the convenience of reaching destinations within 20 minutes this research offers insights for fostering a convenient and inclusive urban setting in Ali Mendjeli. The outcomes highlight challenges as prospects in realizing the vision of a 20 minute city through sustainable transportation options targeted improvements and incorporating accessibility, into urban planning strategies and regulations.

Keywords: 20 Minute City, Public Transport Accessibility Level (PTAL), GIS , Ali Mendjeli, sustainable urban mobility.

1. INTRODUCTION

The rise of cities has resulted in people living in urban areas offering both advantages and difficulties. (UN Habitat, 2022). While cities promote growth and a rich cultural life they also face issues, like traffic jams, pollution, social disparities and inefficient land usage (Litman, 2017). As the population expands it is increasingly important to focus on development. (Allam et al., 2020) (Moreno et al., 2021).

Establishing a 20-minute city relies heavily on how efficient and accessible public transportation systems. A reliable public transport system provides an alternative, to cars reducing traffic congestion and its adverse effects, on the environment and society. It also encourages inclusivity by making sure that individuals of varying incomes, ages and physical abilities can conveniently access services and opportunities. (Lucas, 2012).

To ensure the success of a 20-minute city it is crucial to establish public transportation networks. A trustworthy public transit network provides residents with an option to reduce reliance, on vehicles thus alleviating traffic congestion and its negative impact, on the environment and community. Additionally, it fosters inclusivity by guaranteeing that individuals of varying income brackets, ages and physical capabilities can readily access services and opportunities. (Lucas, 2012).

Hence, it's crucial to assess and understand the availability of transportation to determine the viability of a 20-minute city and devise approaches to improve mobility and overall well-being. Geographic Information Systems (GIS) offer resources for analyzing data that highlight accessibility patterns and identifying regions lacking access (Geurs & van Wee, 2004). Through the use of GIS technology urban planners and policymakers can gain insights, into the distribution of public transport access in areas and its influence, on urban development.

Ali Mendjeli, a city located in Algeria presents a scenario for exploring the challenges and opportunities of creating a 20-minute city amidst rapid urban growth. Originally founded as part of Constantine in the 1990s Ali Mendjeli has experienced population growth and urban development. The downtown area reaps the rewards of transportation connections. The emerging neighborhoods, on the outskirts face challenges due to limited accessibility leading to unequal spatial conditions that hinder the realization of a vision for a 20-minute city. In Ali Mendjeli public transportation primarily comprises buses and trams with efforts to improve and expand these services. However persistent issues related to service frequency, route coverage and alignment with planning goals highlight the need to assess transportation accessibility, in Ali Mendjeli and develop strategies to rectify existing deficiencies while promoting fairness.

In the region of Ali Mendjeli there is an exploration, into the feasibility of establishing a 20 minute city amidst its expansion as studied by (Cherrad and Benmechiche ,2019). In the 1990s Ali Mendjeli, a part of Constantine experienced growth, in its population and urban infrastructure. While the central area provides transportation options the newer surrounding neighborhoods are encountering connectivity issues that create disparities and impede the realization of the 20-minute city concept. Our research will delve into how these discoveries influence planning and decision making in Ali Mendjeli. This involves devising strategies to enhance transportation connectivity extend services to underserved areas and promote mobility options. By assessing accessibility to destinations within a 20-minute timeframe our study aims to offer insights, for nurturing a sustainable and inclusive urban landscape that resonates with the vision of a 20-minute city.

2. RESEARCH ISSUES AND HYPOTHESES

This study investigates the following research issues:

Spatial Distribution of Public Transport Accessibility: How does public transport accessibility vary across different areas of Ali Mendjeli? Are there significant disparities between the city center and the peripheral urban extensions? What factors contribute to these disparities?

Potential for a 20-Minute City: To what extent does the existing public transport network in Ali Mendjeli support the principles of the 20-minute city? Which areas show the greatest potential for achieving this vision, and which areas face significant challenges?

Policy Implications: How can the findings of this study inform urban planning and policy interventions aimed at improving public transport accessibility and creating a more sustainable and equitable urban environment in Ali Mendjeli?

We hypothesize that:

There exists a significant disparity in public transport accessibility between the city center and the peripheral areas of Ali Mendjeli.

The existing public transport network in Ali Mendjeli does not fully support the principles of the 20-minute city, particularly in the newer urban extensions.

Improving public transport accessibility is crucial for achieving the vision of a 20-minute city in Ali Mendjeli and requires targeted interventions such as infrastructure investments, service expansions, integration with land-use planning, and policies that promote modal shift.

This research project aims to achieve the following objectives;

- Measure and visually represent the status of public transportation accessibility, in Ali Mendjeli using GIS technology and the Public Transport Accessibility Level (PTAL) approach. This involves analyzing information like the locations of public transport stops, frequency of services and walking distances to evaluate accessibility levels in parts of the city.
- Identify and examine the factors that contribute to differences in public transportation accessibility within Ali Mendjeli. This includes studying land use patterns, population density, availability of infrastructure and provision of services to understand the root causes of accessibility disparities.
- Assess the feasibility of creating a 20-minute city concept in Ali Mendjeli based on the existing public transportation system and land use patterns. This assessment involves evaluating how close residential areas are to amenities and services well as pinpointing areas with high potential for realizing the vision of a 20-minute city.
- Put forward data supported suggestions for urban planning and policy interventions designed to enhance public transportation accessibility and encourage sustainable urban growth in Ali Mendjeli. These recommendations encompass proposing strategies for investing in infrastructure expanding services adjusting land use planning and implementing policies that promote a shift, towards public transportation usage and active modes of mobility.

3. METHODOLOGY

3.1. Adaptation to the Algerian Context:

This research modifies the Public Transport Accessibility Level (PTAL) approach, initially created by Transport, for London to suit the circumstances of Ali Mendjeli, Algeria. The adjustments involve:

- The peak hour timing, for analysis is set between 7;30 AM and 8;30 AM as from 4;30 PM to 5;30 PM taking into account local commuting trends and past research.
- Adjusting the walking speed to 3.6 km/h due to the absence of designated pedestrian infrastructure and potential obstacles based on real world observations.
- A reliability factor (K) : of one minute is allocated for trams and two and a half minutes for buses factoring in the differing reliability levels of each transportation mode, in Ali Mendjeli .

Table. 1: Comparison between London and Ali Mendjeli (PTAL Input Parameters)

Parameter	**London**	**Ali Mendjeli**
Peak hour	8 :15 AM–9 :15 AM	7 :30 AM–8 :30 AM 16:30 – 17:30
Walk speed	4.8 km/h 80 m/min	3.6 km/h 60 m/min
Reliability (K) Bus Tram	 2.0 min 0.75 min	 2.5 min 1.0min
Max walk time Bus Tram	 8 min 12 min	 10 min 15 min
Max walk distance Bus Tram	 640 m 960 m	 600 m 900 m

- Grid Approach: Due to the unavailability of detailed building footprint data, a 500m² grid is overlaid on the study area. The centroid of each grid cell serves as a Point of Interest (POI) for accessibility calculations, ensuring comprehensive coverage of the city.

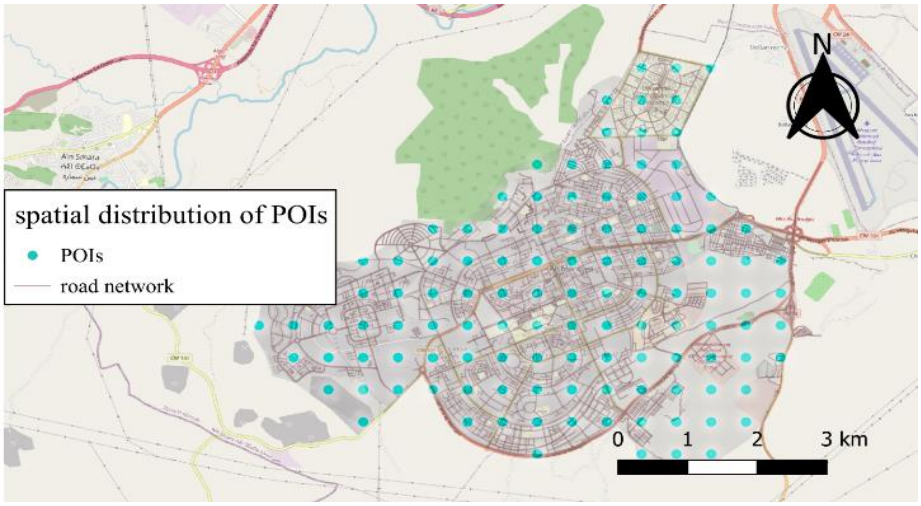


Figure 1: Spatial Distribution of Points of Interest (POIs) in the Study Area
The map shows figure.1 the streets and locations labeled as "POIs" or Points of Interest scattered throughout what seems to be a city or urban area.

3.2. Data Collection:

1- Public Transport Network Data:

- Routes and schedules: Obtain data on bus and tram routes, including stops, frequencies, and operating hours. This information we have acquired from through field surveys (April 2022-june 2022).
- Network maps: Collect digital maps of the public transport network, including bus stops, tram stations, and routes, field surveys (April 2022-june 2022).

2- Urban Amenities Data:

Points of Interest (POIs): Gather data on the location and type of essential amenities, we have classified them on categories, we have obtained from open data portals, and through field surveys.

Table. 2: Number of Amenities by Category in the Study Area

amenities	**number**
administrative	585
commercial	4070
educational	855
hospital	15
hotel	100
leisure	635
mosque	350
restaurant	890
service	835
Total general	**8335**

3.3. GIS Tools and Analysis:

1- GIS Software:

QGIS: A powerful open-source GIS software suitable for data analysis, visualization, and map creation.

ArcGIS: A comprehensive commercial GIS software with advanced functionalities for spatial analysis and modeling.

2- PTAL Calculation and Mapping:

Step 1: Specify the types of public transport stops considered as SAPs (e.g., bus stops, tram stations). Mention that the selection of SAPs is based on a field survey conducted in 2022.

Step 2: Explain how the actual road network distance is measured (e.g., using GIS tools, network analysis) and how the walk time is calculated based on the assumed walking speed of 3.6 km/h.

Step 3: Define the "valid routes" considered in this step (e.g., routes operating during the peak hour) and elaborate on how the average waiting time (AWT) is calculated. Include the formula for AWT with a clear explanation of each variable:

AWT = (0.5 * Headway) + K

Where:

Headway: The time interval between consecutive vehicles on a specific route.

K: The reliability factor, which accounts for potential delays and variations in service.

Step 4: Explain how the total access time (TAT) is calculated by adding the walk access time (WAT) and the average waiting time (AWT).

Step 5: Clarify the concept of Equivalent Doorstep Frequency (EDF) and its purpose in representing accessibility. Provide the formula for EDF:

EDF = 30 / TAT

Where:

30: Represents the reference time period in minutes.

TAT: The total access time calculated in Step 4.

Step 6: Explain how the Accessibility Index (AI) is calculated for each POI, considering the EDF of the most frequent route and applying a weighting factor for alternative routes. Provide the formula for AI:

AI = Σ (EDF_i * W_i)

Where:

EDF_i : The Doorstep Frequency Equivalent of route i

W_i : while the weighting factor, for route i (1.0 for the route and 0.5 for other routes).

3.4. Include Visual Aids:

- Accessibility Maps: To enhance understanding visual aids like Accessibility Maps can be utilized to illustrate variations Accessibility Maps PTAL across neighborhoods highlighting regions with both good and poor accessibility.
- For a 20 Minute City Analysis;
- Service Area Analysis: involves using GIS tools to create service area polygons around amenities indicating areas reachable within a 20 minute walk or bike ride.
- Overlay Analysis :entails merging service area polygons with PTAL maps to pinpoint locations where public transport can aid in realizing the 20 minute city concept.

- Spatial Statistics : calculations include determining statistics like the percentage of amenities within a 20 minute walk or bike ride distance, from SAPs.

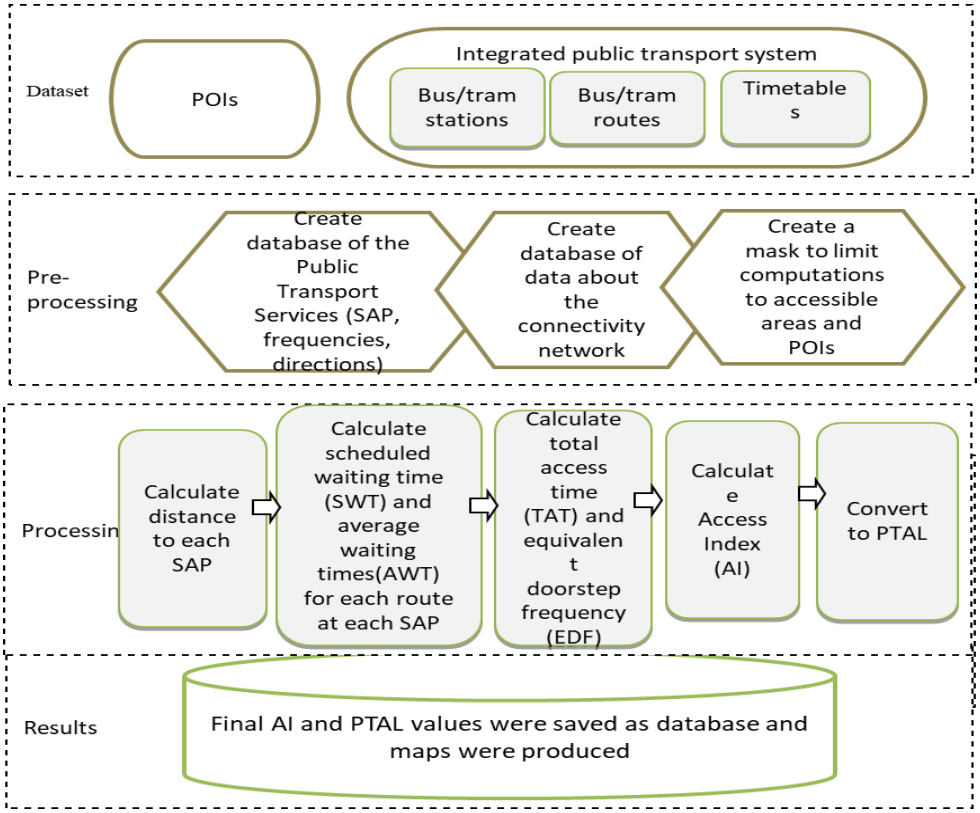


Figure 2: Methodology for Calculating Public Transport Accessibility Levels (PTAL) and Access Index (AI)

Figure.2 details the procedures and computations required to establish public transportation accessibility metrics such, as PTAL and Access Index. This involves utilizing input data sets related to points of interest, transportation networks/schedules and executing tasks like database creation, distance calculations wait times assessment, access time estimations ultimately transforming the outcomes into PTAL and AI metrics.

4. RESULTS AND DISCUSSIONS

4.1. Ali Mendjeli City's Spatio-Temporal Evolution and Public Transport Development

The map shows how Ali Mendjelis public transportation network has evolved over time along, with Marc Cotes analysis of the citys development stages. This provides a foundation for grasping the citys growth path and its impact, on realizing a 20-minute city concept.

1. Early Stages and Geographers' Vision (1980s-1990s):

According to Cote (2006) Ali Mendjeli was created by geographers, with a vision to tackle the urbanization issues in Constantine. The early focus was on setting up the layout and necessary infrastructure. The 2002 map illustrates this phase displaying

a developed area centered around the core (NU6) and the start of a basic public transportation network, within the city mainly comprising bus routes.
2. Architects' Shaping and Policy-Driven Growth (1990s-2010s):
During this era the impact of architects is clearly seen in how the city was designed, moving away, from the development seen in traditional Algerian cities. The map shows a growth radiating from the city center with the creation of neighborhoods (NU1, NU2, NU3) and the expansion of the public transportation network to accommodate these areas.
During Cotes "policy time", from 2000 to 2010 there was an increase in population due to housing policies. This sudden growth probably put a strain on the existing infrastructure and services including transportation. The 2013 map indicates expansion. It also suggests possible issues with accessibility, in outlying areas particularly since the public transportation system mainly depends on bus routes.
3. The Living City and Emerging Technologies (2010s-Present):
Changing Trends; Cotes depiction of the communitys evolution signals a shift, toward a livelier and varied urban landscape. The rise of institutions, commercial centers and contemporary facilities mirrors the evolving desires and ambitions of the expanding populace. A comparison, between the maps of 2018 and 2022 showcases this transformation highlighting heightened concentration and progress spreading towards the western outskirts.

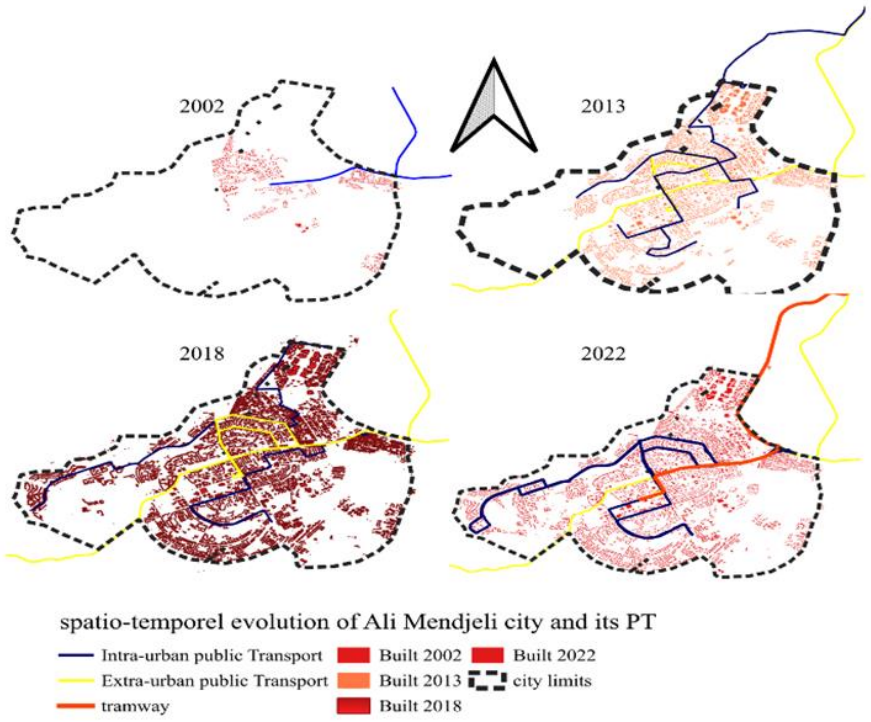


Figure 3: Spatio-temporal Evolution of Urban Growth and Public Transport Network in Ali Mendjeli City

The illustration shows how the urban area, in Ali Mendjeli city has expanded spatially across years (2002, 2013, 2018 2022) along with the progress of the public transportation system comprising inner city transport, inter city transport and the tram system. It also includes markings indicating the city boundaries for context.

This figures.3 concisely describes the visualization of development and transportation network changes, in Ali Mendjeli over time.

The tramway line introduced on the 2022 map, in Ali Mendjelis public transportation network serves **as a catalyst**, for progress. This efficient mode of transportation enhances connectivity. Has the potential to influence development by adhering to Transit Oriented Development (TOD) principles.

Ali Mendjelis progress reflects the idea of growth, which involves the emergence of various hubs of activity, within a city lessening the focus on a singular core and fostering a more equitable development approach (Kloosterman & Musterd 2001).

The city's initiatives to enhance transportation and encourage forms of mobility are in line with the values of sustainable urban mobility prioritizing the reduction of reliance, on cars and endorsing eco friendly modes of transportation (European Commission, 2013).

Ali Mendjelis changing landscape involves a mix of city planning, policies and population changes. Though progress has been made in enhancing transportation fully realizing the 20 minute city concept necessitates growth, coordination, with land usage plans and a dedication to encouraging walking and biking. By incorporating ideas from Marc Cote and other development and transportation studies this research can play a role, in shaping an enjoyable tomorrow for Ali Mendjeli.

4.2. Ali Mendjeli's Public Transport Network and Preliminary Accessibility

- **Public Transport Infrastructure:**

Bacbone Tramway; With ten tram stops the tramway serves as a backbone of the citys public transportation network running in an east west direction as depicted in the diagram., suggests it serves as a central corridor connecting different parts of Ali Mendjeli.

Bus Network Coverage: With 78 bus stops, the bus network appears to provide more localized coverage, potentially reaching areas not directly served by the tramway. However, the text mentions that recent urban expansion has led to some areas, particularly in the south and west, being beyond the 600-meter threshold for PTAL calculations, indicating potential accessibility gaps.

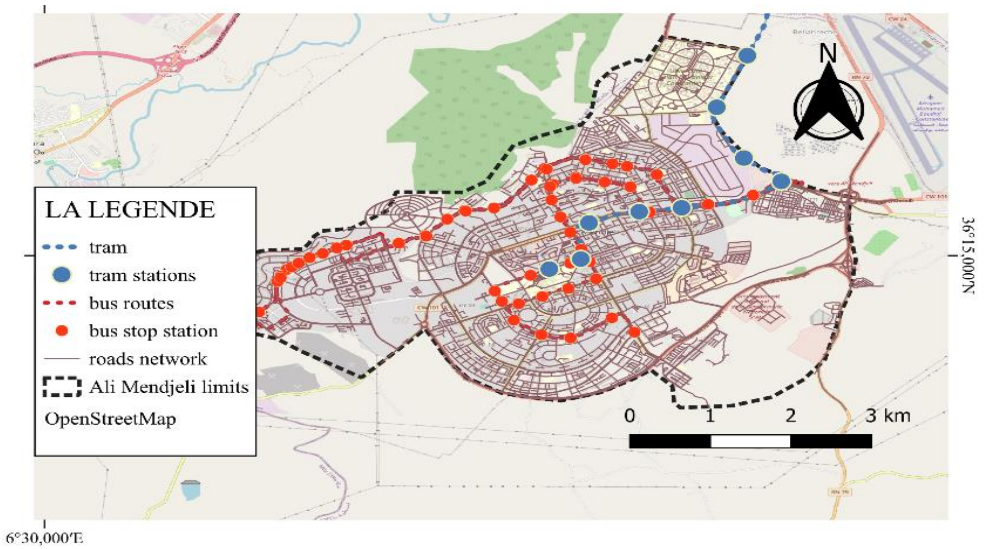


Figure 4: Public Transportation Network in Ali Mendjeli

This map figure.4 displays the public transportation system, in Ali Mendjeli featuring the tram lines (marked in blue) tram stations (dots) bus routes (highlighted in red) and bus stop stations (dots). It also showcases the road layout. Outlines the city boundaries giving a snapshot of the transit infrastructure coverage throughout the region.

- **Service Frequency and Routes:**

Table 2 reveals the frequency of both tram and bus services during the morning peak hour. The tram operates with a frequency of 8 minutes, suggesting a relatively reliable and frequent service along its route. Bus frequencies vary depending on the route, with R2 having the highest frequency (33 departures per hour) and R3 having the lowest (18 departures per hour). This variation suggests potential differences in service quality and accessibility depending on the specific bus route and neighborhood.

Route	**Direction**	**Frequency**
Tram	Bimodal urban station	8
R1	Bimodal urban station – UV 21	15
R2	Tram-UV21	33
R3	Tram-UV20	18
R4	Bimodal urban station-tram	21

Table. 3 : Bus Route Frequencies in Ali Mendjeli

The table.3 appears to show bus routes or lines their destinations or directions. How often (potentially, in minutes) the buses operate on each route. Naming it "Bus Route Frequencies" neatly summarizes the details outlined in the table headings.

Figure 5 provides a visual representation of travel time to the closest public transport station, highlighting potential accessibility disparities within Ali Mendjeli. The city center and areas along the tramway corridor appear to have the best accessibility, with travel times of less than 5 minutes to the nearest station.
Areas of Concern: The map shows that the southern and western parts of the city, which coincide with the areas mentioned as being beyond the 600-meter threshold for PTAL calculations, experience longer travel times, ranging from 10 to 20 minutes, indicating potential accessibility challenges for residents in these areas.

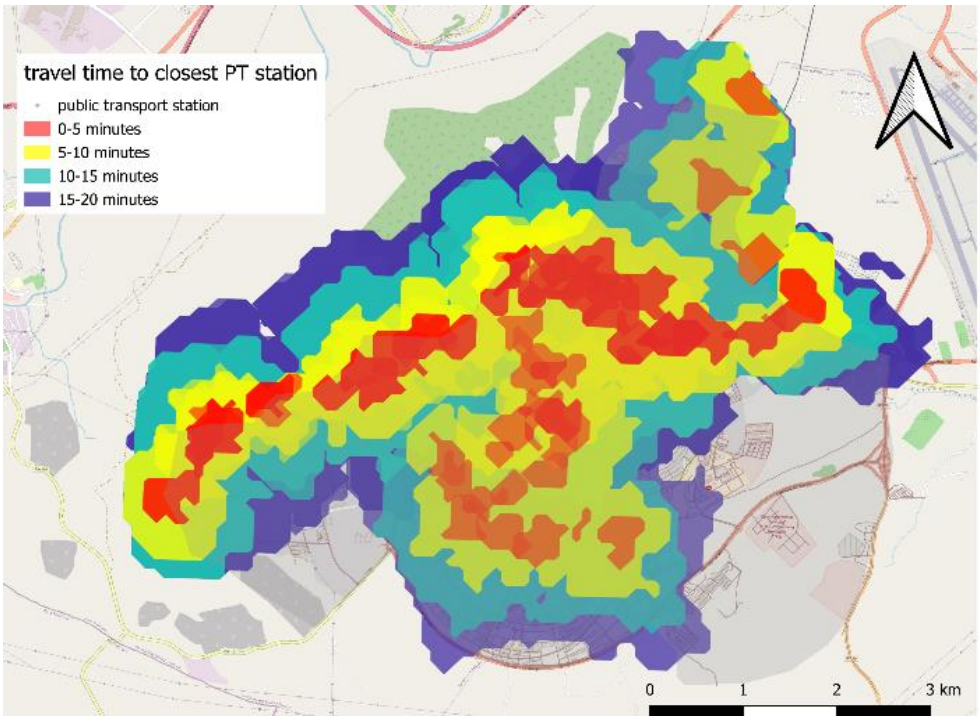


Figure 5: Walking Access Time to Nearest Public Transport Station in Ali Mendjeli

The map **figure.5** displays zones, in Ali Mendjeli indicating how long it takes to walk to the nearest public transport station. The legend shows walking time ranges of 0 5 minutes, 5 10 minutes 10 15 minutes and 15 20 minutes. This analysis helps show how easily pedestrians can access transportation in neighborhoods, throughout the city.

4.3. Accessibility Index (AI) for Buses and Trams:

Bus Accessibility:

The map reveals a distinct cluster of high bus accessibility (AI values between 6.00 and 8.00) surrounding the urban core (NU6) and the Ali Mendjeli bus station. This indicates that residents in these central areas enjoy excellent access to bus services, likely due to a combination of factors such as:

- High service frequency: Buses serving this area are likely to have frequent departures, minimizing waiting times for passengers.
- Dense network of routes: A variety of bus routes likely converge in the city center, providing connections to various destinations within Ali Mendjeli.

- Short walking distances: The proximity of bus stops to residential and commercial areas ensures convenient access for residents and visitors.
- Moderate Accessibility Zone:vExtending outwards from the city center, a larger portion of Ali Mendjeli exhibits moderate bus accessibility (AI values between 4.01 and 6.00). These areas, located primarily in the west, southeast, and north of the city, still offer relatively good access to the bus network, but with potentially less frequent service or longer walking distances to bus stops compared to the central core.
- Peripheral Areas with Limited Accessibility: The remaining areas of Ali Mendjeli, particularly in the peripheral zones, show lower AI values (0.01 to 4.00), indicating limited bus accessibility. Residents in these areas likely face challenges such as:
- Longer walking distances: Bus stops might be sparsely distributed, requiring residents to walk longer distances to access the bus network.
- Lower service frequency: Bus routes serving these areas might have lower frequencies, leading to longer waiting times and inconvenience for passengers.
- Limited route options: Fewer bus routes might serve these areas, potentially restricting access to certain destinations within the city.

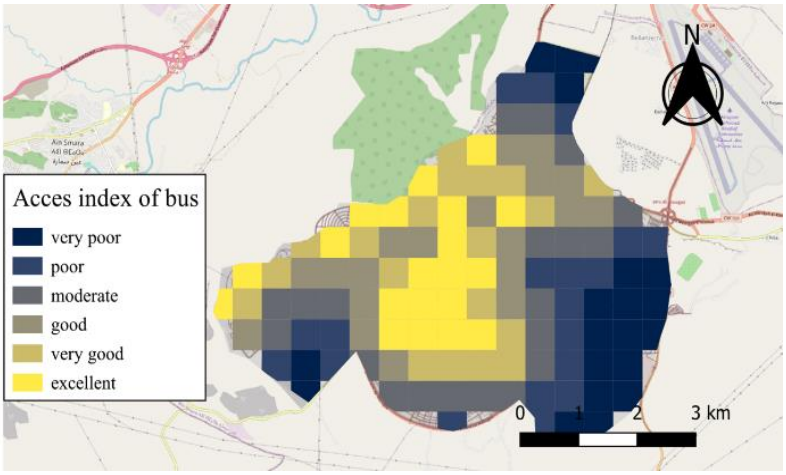


Figure 6: Access Index of Bus" based on the text label

The map shows color coded zones in the area probably denoting levels of bus accessibility indicated by categories, like "very poor" to "excellent", in the legend.

Tram Accessibility:

The map clearly demonstrates a tram-centric accessibility pattern, with high AI values concentrated around each of the ten tram stations. This is a direct consequence of the tram's linear route and the defined maximum walking distance of 900 meters for PTAL calculations. Residents living within this catchment area of the tram stations enjoy excellent to good accessibility levels, indicating convenient access to the tram service and potentially shorter travel times.

Varying Accessibility Levels:

- Excellent Accessibility: The areas immediately surrounding the tram stations, covering approximately 385 hectares or 15.77% of Ali Mendjeli, exhibit the highest AI values (5.50 to 7.80), representing excellent accessibility to the tram network.

- Good Accessibility: Expanding outwards from the tram stations, a larger portion of the city (920 hectares or 37.69%) experiences good accessibility levels (AI values between 2.51 and 5.50). These areas, often located near universities, malls, and the main boulevard, benefit from the tram's reach while still within a reasonable walking distance.
- Low Accessibility: The remaining areas, primarily the southern and western urban extensions, encompassing a significant portion of Ali Mendjeli (1130 hectares or 46.5%), show the lowest AI values (0.01 to 2.50). Residents in these areas face challenges due to their distance from the tram line, indicating limited access to this mode of public transport.

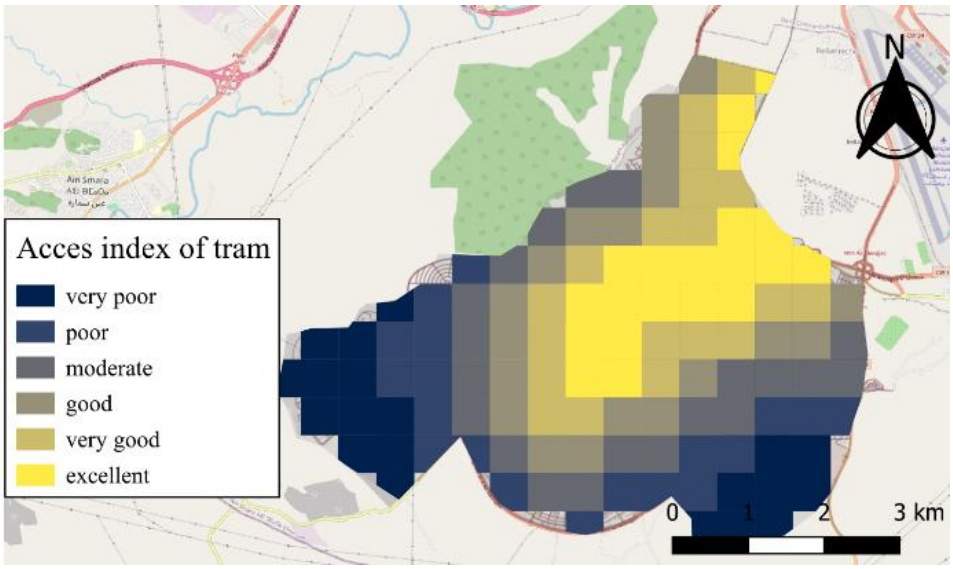


Figure 7: Access Index of Tram

The map, in figure 7 shows color coded zones or sections in the area indicating levels of accessibility or service quality for the tram system. These levels range from " poor" to "excellent" as, per the legend categories.

Centralized High Accessibility: The map clearly demonstrates a centralized pattern of high accessibility, with the city center and areas along the central boulevard exhibiting predominantly good and excellent PTAL scores. This suggests that these areas benefit from both convenient access to bus and tram services, making them well-connected to various destinations within Ali Mendjeli.

Peripheral Accessibility Challenges: As we move outwards from the city center, the PTAL scores gradually decrease, with peripheral areas, especially in the south and west, showing predominantly moderate to poor accessibility levels. This indicates that residents in these areas face limitations in accessing public transport, potentially leading to increased reliance on private vehicles and longer travel times.

4.4. Analysis of PTAL Results and Discussion of Implications for Ali Mendjeli

- **PTAL Distribution and Disparities:**

Spatial Disparities: The overall PTAL map (Figure 6), which combines the AI values for both buses and trams, highlights significant disparities in public transport accessibility across Ali Mendjeli.

High Accessibility Zones: The city center (NU6, NU7, NU8, NU5), particularly around the bimodal bus and tram station (NU2) ,along the central boulevard and around the universities (NU3), exhibits the highest PTAL values, indicating excellent accessibility and the potential for realizing the 20-minute city concept in these areas.
Low Accessibility Zones: The peripheral areas, especially in the south and west, experience significantly lower PTAL values, ranging from poor to very poor. This suggests that residents in these areas face challenges in accessing public transport and are likely more reliant on private vehicles

- **Factors Contributing to Accessibility:**

Tramway as a Backbone: The introduction of the tramway is recognized as a significant factor in improving accessibility, especially in the central corridor. The study acknowledges the role of intermodality between tram and bus services in enhancing connectivity.
Bus Network Coverage: While the bus network provides wider coverage than the tram, the analysis identifies limitations in service frequency and route options in peripheral areas, contributing to lower accessibility levels.
Recent Developments and Taxi Services: The study acknowledges the expansion of taxi services and the rearrangement of bus routes to complement the tramway. This demonstrates the city's efforts to adapt and improve the public transport system.
This map Figure 8 shows how public transportation access varies in Ali Mendjeli, Algeria using a classification method. The colors, on the map indicate levels of accessibility ranging from 'very poor' to 'excellent' based on the proximity and frequency of public transportation services. By visualizing this data it highlights how accessibility changes from the city center towards the outskirts clearly identifying areas that require infrastructure enhancements to meet the goal of creating a 20 minute city.

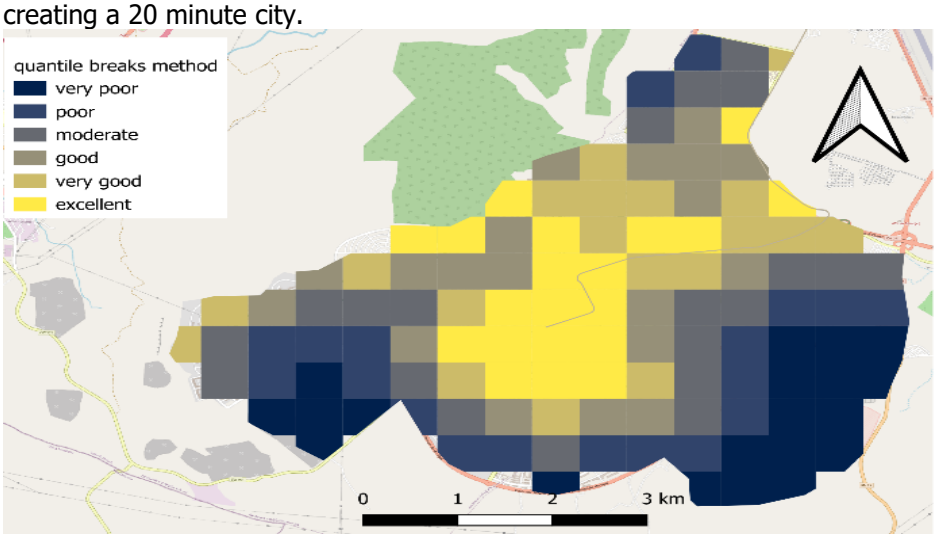


Figure 8: Public Transport Accessibility Levels in Ali Mendjeli: A GIS-Based Quantile Breaks Analysi

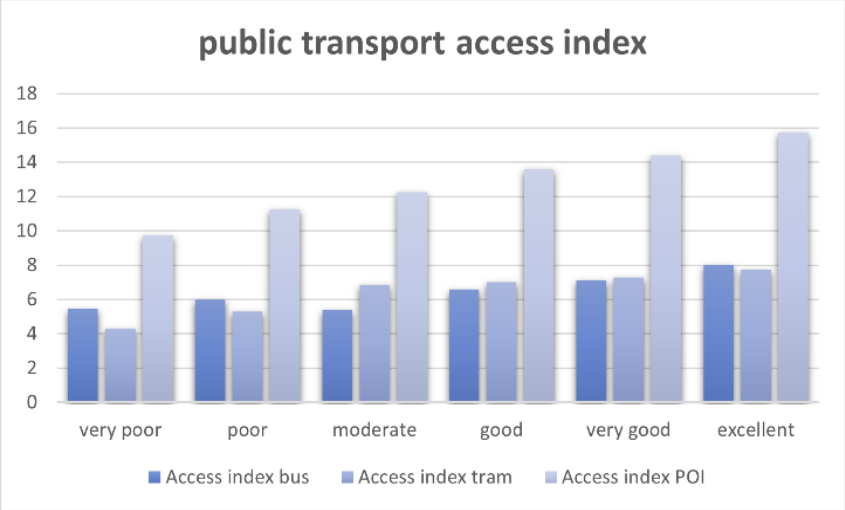


Figure 9: Comparison of Public Transport and Points of Interest Accessibility by Quality Levels in Ali Mendjeli

This bar graph Figure 9 displays the public transportation access rating, in Ali Mendjeli, classified by quality levels ranging from 'very poor' to 'excellent'. It contrasts the accessibility metrics for bus and tram services along with points of interest (POIs) demonstrating a spread across the categories. The graph showcases how types of public transportation relate to their accessibility pointing out areas for enhancing urban mobility and access, to necessary services and facilities.
Accessibility Index Distribution: The bar chart showcases the distribution of Accessibility Index (AI) values for bus, tram, and overall Point of Interest (POI) accessibility. The ascending trend from "very poor" to "excellent" indicates a general increase in accessibility levels as we move towards higher PTAL categories.
Disparity Between Modes: There's a noticeable disparity between bus and tram accessibility. Tram scores are consistently higher than bus scores, especially in the "good," "very good," and "excellent" categories. This suggests that the tram system provides superior accessibility compared to the bus network, likely due to factors like higher frequency, speed, and more direct routes.
The combined POI accessibility index demonstrates a relatively balanced distribution, with moderate to good accessibility levels across most categories. However, the significantly higher value for "excellent" indicates that areas with the best accessibility are concentrated, likely around the tram line and in the city center.

4.5. Spatial Distribution of Urban Amenities and Public Transport Accessibility in Ali Mendjeli, Algeria: Challenges and Opportunities for a 20-Minute City

Centralized Accessibility: The map clearly illustrates the concentration of amenities within areas exhibiting "excellent" and "very good" PTAL scores, primarily located in the city center and along the central corridor. This pattern aligns with the principles of a 20-minute city, suggesting that residents in these areas benefit from convenient access to a wide range of services and opportunities, such as:
Commercial Activities: The abundance of commercial establishments indicates a vibrant retail environment and easy access to shopping and other commercial services.

Educational Institutions: The presence of educational facilities suggests good accessibility to schools, universities, and other learning opportunities, promoting educational attainment and social mobility.
Administrative Services: Access to administrative offices and services contributes to convenience and efficiency for residents in their daily lives.
In contrast the map shows a difference, in the outskirts in the southern and western regions, where facilities are limited and PTAL ratings are classified as "poor" or "very poor." This underscores the challenges that residents, in these areas encounter when trying to access services:
Limited-Service Availability; The absence of amenities implies that residents might have to travel to access services, like grocery stores, healthcare facilities or recreational areas.
Reliance on Transportation; The low PTAL scores indicate a lack of public transportation options, which could result in increased reliance on cars and the associated financial and environmental impacts.
Concerns About Social Equality; The unequal distribution of amenities raises worries about fairness and equal access to opportunities for residents living in parts of the city.
Spatial Layout and City Development; The map also shows patterns that reflect the citys growth and planning history;
Linear Focus; The clustering of amenities along the central corridor suggests an emphasis on linear development along major transport routes possibly influenced by the tramway line and its accessibility advantages.
Radial Expansion; The presence of isolated areas with scores and more amenities on the outskirts indicates a trend toward outward expansion but with limited connections, to the wider public transport network.

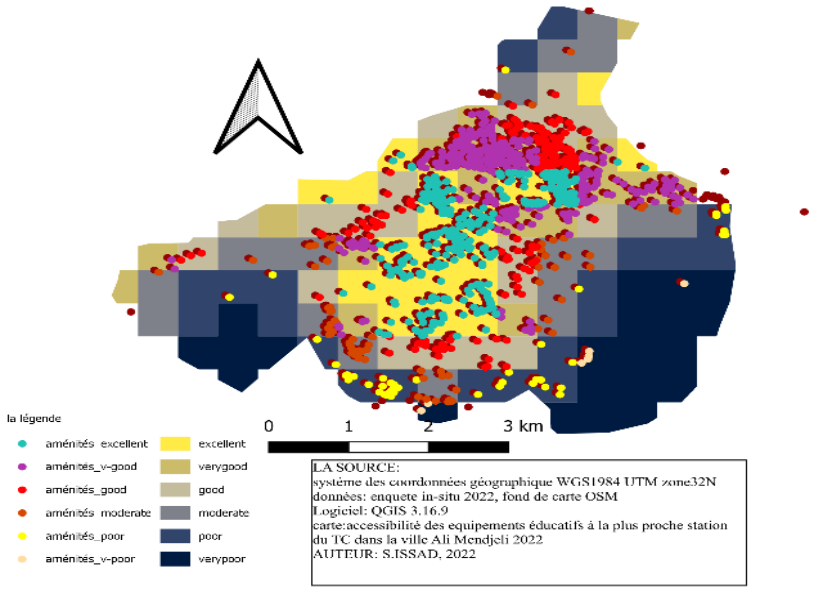


Figure 10: Spatial Distribution of Amenities Accessibility Relative to Public Transport in Ali Mendjeli

This map Figure 10 shows how easy it is to reach facilities, from transport stations in Ali Mendjeli with a focus on educational institutions. The colors represent levels

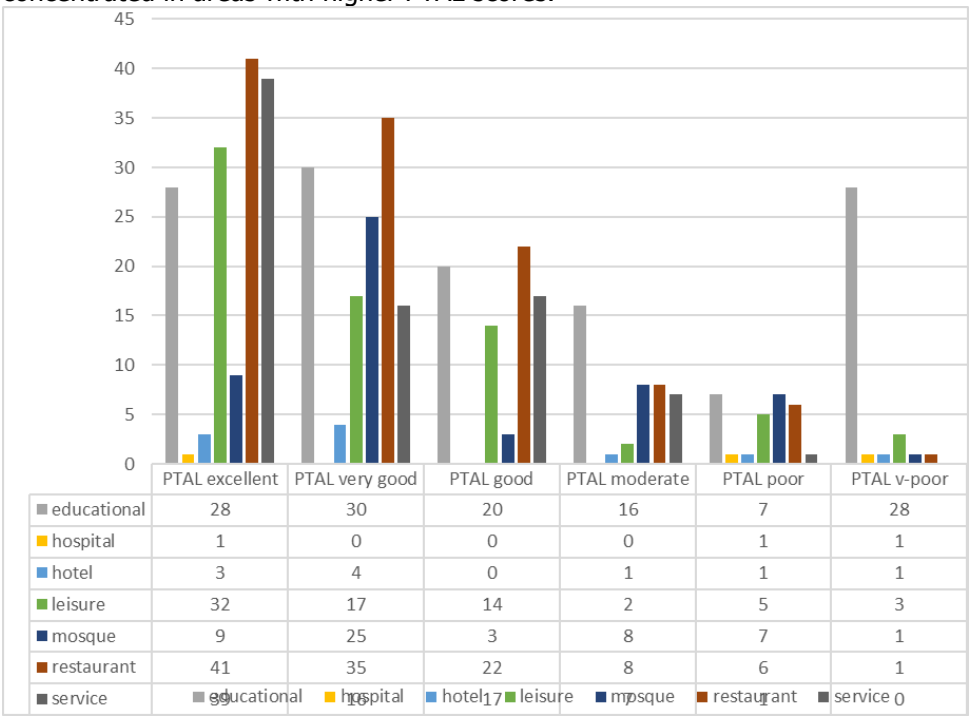
of accessibility from 'very poor' to 'excellent' layered over a background that shows the connectivity of transportation. It gives a look at how accessibility changes across parts of the city pinpointing areas with many accessible amenities and those needing improvements to meet the goal of a 20 minute city. The map highlights the connection between city infrastructure and essential services serving as a tool, for planning and development.

Commercial Dominance Across Levels PTAL: Commercial businesses are widespread, across all levels. Their representation dwindles in less accessible areas. This implies that although commercial ventures are citywide residents in regions with PTAL ratings might have fewer choices than those, in well linked areas.

Shifting Distribution of Educational Facilities: The proportion of educational facilities remains relatively stable across excellent, very good, and good PTAL areas, indicating consistent access to education in these well-connected parts of the city. However, their presence diminishes considerably in moderate, poor, and very poor PTAL areas, suggesting potential challenges for residents in these areas regarding access to educational opportunities.

Limited Healthcare Accessibility: Hospitals have a consistently low representation across all PTAL categories, highlighting a potential accessibility gap for healthcare services throughout the city. This raises concerns about equitable access to healthcare for residents, particularly those in areas with lower PTAL scores.

Varied Distribution of Other Amenities: The distribution of other amenities, such as hotels, leisure facilities, places of worship (mosques), restaurants, and services, varies across PTAL levels. Some categories, like restaurants, show a relatively consistent presence, while others, like hotels and leisure facilities, are more concentrated in areas with higher PTAL scores.



	PTAL excellent	PTAL very good	PTAL good	PTAL moderate	PTAL poor	PTAL v-poor
educational	28	30	20	16	7	28
hospital	1	0	0	0	1	1
hotel	3	4	0	1	1	1
leisure	32	17	14	2	5	3
mosque	9	25	3	8	7	1
restaurant	41	35	22	8	6	1
service	39	16	17	7	1	0

Figure 11: Public Transport Accessibility Level (PTAL) and Amenity Distribution in Ali Mendjeli

This bar graph Figure 11 shows how different amenities are spread out in Ali Mendjeli based on the Public Transport Accessibility Level (PTAL) ranging from 'excellent', to 'very poor'. Each bar represents the number of a type of amenity such as schools, hospitals and eateries in each PTAL group. The data indicates that while places like restaurants are plentiful in areas with 'excellent' PTAL crucial services like hospitals are lacking across all levels. This information could help guide enhancements in public transportation services and urban development to ensure access, to essential amenities.

4.6. Discussion and Policy Implications

Challenges for 20-Minute City: The PTAL analysis reveals that achieving a 20-minute city across the entire Ali Mendjeli might be challenging due to the existing disparities in public transport accessibility. The peripheral areas require significant improvements to ensure residents have convenient access to essential amenities and services within a short travel time.

Expansion and Integration: Expanding the public transport network, particularly in underserved areas, is crucial. This could involve extending the tramway line, increasing bus service frequency and coverage, or introducing new modes of transport. Additionally, improving integration between bus and tram networks can enhance connectivity and reduce travel times.

Transit-Oriented Development (TOD): Promoting TOD around existing and future public transport hubs can create walkable, mixed-use neighborhoods where residents have easy access to daily needs and rely less on private vehicles.

Active Mobility Infrastructure: To enhance mobility, it's crucial to invest in pedestrian and cycling infrastructure, in regions well served by public transportation. This not offers residents choices, for short journeys but also encourages healthier and more eco-friendly lifestyles.

Policy interventions: To promote the use of transportation and encourage a move, towards mobility, , like offering fare discounts introducing comprehensive ticketing systems, managing parking effectively and establishing car free zones can be implemented .

Equity and Social Inclusion: Considering equity and social inclusion is key when evaluating the effects of PTAL and the idea of a 20 minute city, on demographics and income brackets. It is vital to guarantee access, to transportation and facilities to foster a genuinely inclusive urban environment.

Data Limitations: Limitations of the methodology include its emphasis, on peak hour travel and its incapacity to encompass all facets of accessibility. Supplemental examinations and qualitative data can offer a insight into the mobility requirements and encounters of residents.

Future Growth and Development: For the progress of Ali Mendjeli it is crucial to strategize for public transportation requirements and guarantee that the expansion adheres to the vision of a 20 minute city and sustainable urban development principles.

5. CONCLUSION

Ali Mendjeli could surpass the idea of a 20-minute city. Set an example, for fair urban development in the area. Through the adoption of cutting-edge technologies planning based on data and a focus on people the city has the opportunity to establish an inclusive community, for everyone residing there.

To make the vision of a 20-minute city a reality it's important to prioritize fairness and inclusivity. It's vital that everyone, in the city no matter their status or where they live has access to opportunities and essential services. This is key, to building an fair community.
Embracing Future Changes; It's crucial for the city to stay flexible and open, to trends, in transportation, technology and population dynamics. This way the transportation system and city layout can meet the demands and obstacles effectively.
Ali Mendjeli has the opportunity to lead the way, in development by establishing a vibrant 20-minute city that can serve as a blueprint for other cities in the area and, beyond.

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