

Original scientific paper

UDC 911.375.12(65)
<https://doi.org/10.2298/GSGD2401207B>

Received: December 31, 2023

Corrected: February 26, 2024

Accepted: March 09, 2024

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URBAN FORM AND DAILY MOBILITY ON THE OUTSKIRTS OF CONSTANTINE (ALGERIA): CASE OF THE NEW TOWN OF ALI MENDJELI

Abstract: This article presents the results of research into the impact of urban form on mobility practices in the outskirts of Constantine, which has experienced spectacular urban growth in recent years. Like other Algerian cities, Ali Mendjeli is one of the most unusual urban forms to have arisen from the saturation of the mother city, and has undergone rapid urban expansion, marked by the concentration of major facilities and services. This has led to several urban dysfunctions, reflected in longer distances travelled, strong growth in the number of journeys and increased use of the car, resulting in saturation of the road network and the inefficiency of public transport, which can no longer cope with high demand, and the emergence of informal transport. In fact, the household travel survey carried out in 2020/2021 revealed that the distance between home and work increases with distance from the town center, with a correlation coefficient of $R^2 = 0.78$. In addition, the urban layout of Ali Mendjeli is difficult to navigate on foot, with the private car the most dominant modal share, and public transport is still in deficit due to the poor quality of its offer.

Key words: urban form, mobility patterns, urban sprawl, motorization, transport, Ali Mendjeli

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Introduction

Urban sprawl and mobility are two phenomena that have been around for a long time, and are now the subject of sustained attention by numerous researchers, including: (Orfeuil, 2000; Pouyanne, 2004; Allain, 2004; Le Néchet, 2010; Gérard, 2013; Huck, 2014; Pelé, 2018).

The phenomenon of urban sprawl appears as a spatial translation of the disproportionate expansion of cities, where most authors emphasize the low density and vast extent of territories to define it (Simard, 2014). This explains the emergence of numerous terms and qualifiers in the scientific literature: the scattered city (Bauer & Roux, 1976), the crumbling city (Charmes, 2011), leapfrogging (Arellano & Cladera, 2012), the diffuse city (Pinson & Thomann, 2002), uncontrollable process (Djellouli et al., 2010) and the compact city (Pouyanne, 2004).

Its relationship with mobility is compounded by its impact on the city. Several authors have shown that the mismatch between workplaces and residential areas leads to housing being located farther from the city center, which in turn can increase the distance, length, duration and cost of journeys, and thus the number of trips made, leading to the need to use motorized modes of transport for long distances (Wiel, 2010; Aguilera & Mignot 2002; Yves, 2016). In general, compact cities make greater use of public transport, while sprawling cities are more car-independent (Bonafous, 1996). This mode of transport plays a fundamental role in the spatial transformation of cities (Claval, 1968; Dupuy, 1995; Mirabel & Reymond, 2013). Clearly, several researchers have pointed out that the heavy use of the car has a strong influence on the spatial configuration of cities, and conversely, the layout of urban spaces largely explains the profile of urban travel (Mirabel & Reymond 2013). The challenge, then, is to determine the extent to which actions on urban form can help to promote strategies for getting closer to the place, as well as travel that is less dependent on the private car, and therefore less energy-consuming and less polluting (Frank et al., 1999).

In this context, the relationships between urban form and mobility are quite strong, but they are also very complex because they are very difficult to isolate. For this reason, they deserve the attention of several researchers.

Algerian cities, like those in many developing countries, are undergoing profound economic and social change, accompanied by rapid urbanization and demographic growth, creating an acute imbalance between the increase in travel demand and the qualitative and quantitative inadequacy of public transport provision.

On a national scale, the wilaya of Constantine is one of Algeria's largest metropolitan areas. This territory, which is made up of five districts, has undergone major urban transformations, in particular the high demand for land and housing due to strong demographic growth. As a result, this metropolis has undergone spectacular growth to meet the housing needs of its inhabitants (Benmachiche, 2019). This rapid expansion has taken various urban forms, the most unique and unprecedented of which is the new town of Ali Mendjeli. This growth has also had many repercussions in terms of mobility: journeys have become longer, and the current public transport offer appears more than inadequate and inefficient in the face of the high demand for travel; the number of cars on the road was estimated at 93,039 in 2015, and will continue to rise, reaching 211,705 in 2020, which is also seen as a consequence of the metropolis' strong growth.

The site was chosen for the new town of Ali Mendjeli, one of the metropolis's most innovative urban forms, located to the southwest of Constantine, which has experienced unprece-

dened spatial and demographic growth. Its population, estimated at 64,120 in 2008, is expected to reach 461,885 by 2020 (Urbaco, 2020). In the space of two decades, the city, with its facilities and appeal beyond the wilaya, has been completely built out, and extensions outside its original perimeter have been initiated. This metamorphosis of the city's urban organization has also generated new forms of daily mobility, notably the lengthening of distances to the city center and the high demand for transport, especially public transport. Faced with this dysfunction, the public authorities have implemented solutions to meet mobility needs and keep pace with the city's development, by introducing new modes of transport, such as the tramway, and reorganizing public transport, such as the new redeployment plan.

This article aims to understand the impact of the urban form created by urban sprawl on mobility practices in the town of Ali Mendjeli, and to identify dysfunctions through a vision of the urban planning-transport interface. To this end, we mobilize the results of the field survey we carried out in 2021/2022 on household travel behavior and interpret them in the light of data on the urban form of the city of Ali Mendjli, using the most conventional indicators such as population density.

Urban context of Ali Mendjeli

The new town of Ali Mendjeli is one of Algeria's unprecedented experiments in contemporary urban development. It is part of the development policy set out in the master plan for the development and urban planning of the Constantine group and approved by executive decree n°98/83 of February 25, 1998 (Lakehal, 2013). The creation of a city ex nihilo independent of the mother city is envisaged to absorb the problems that arise in the city of Constantine, and for the purpose of rebalancing urban growth within the metropolis by limiting the size of agglomerations to prevent (Nadra Nait Amar, 2013).

Situated on the Ain El Bey plateau, 20 km as the crow flies to the South of Constantine city center, the new town is bordered by El Khroub to the East and AinSmara to the West (Figure1). With an altitude of 800 meters and a surface area of 1,500 hectares.

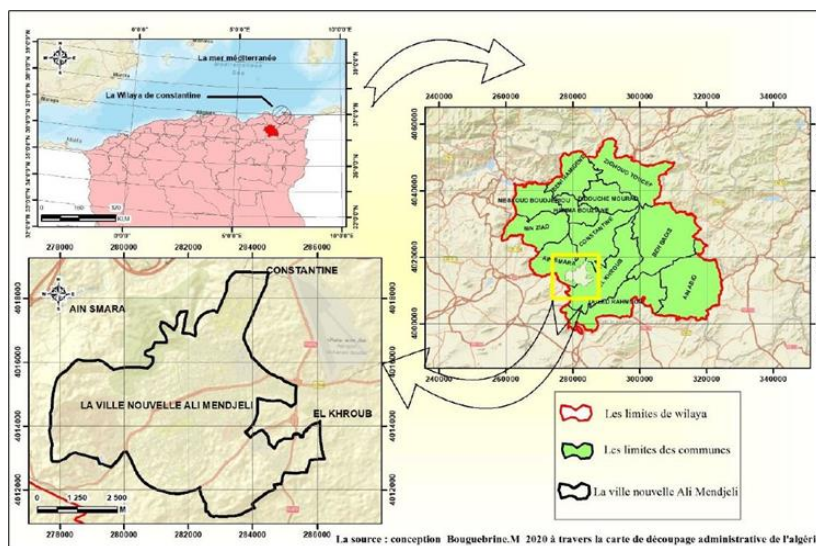


Fig. 1. Situation of the new town Ali Mendjeli (Source: Bouguebrine,2022)

This new urbanity is structured by a dense, polyfunctional main center (neighborhood units 6 and 7), around which gravitate 20 Neighborhood Units, numbered from 1 to 20 (Lakehal, 2015) its formation and urbanization process went through three main moments (Figure 2). First, from 1985 to 1999, the town's surface area increased from 0.03 to 0.51 km (Benmachiche, 2019). Urbanization during this period took the form of neighborhood unit 6 and a small part of the business park to the north of the town. Second, from 1999 to 2010, the built-up area grew steadily, reaching 7.12 km with a very high annual growth rate of 118.53% (Benmachiche, 2019) The local authorities initiated several large-scale projects and facilities that energized several of the neighborhood units that make up the new town (Lakehal, 2020). And third from 2010 to 2019, In this period, the built-up area accelerated sharply, reaching over 11.84 km² (Benmachiche, 2019). In addition, urbanization spread over the two extensions, south and west, which have been incorporated into the master plan.

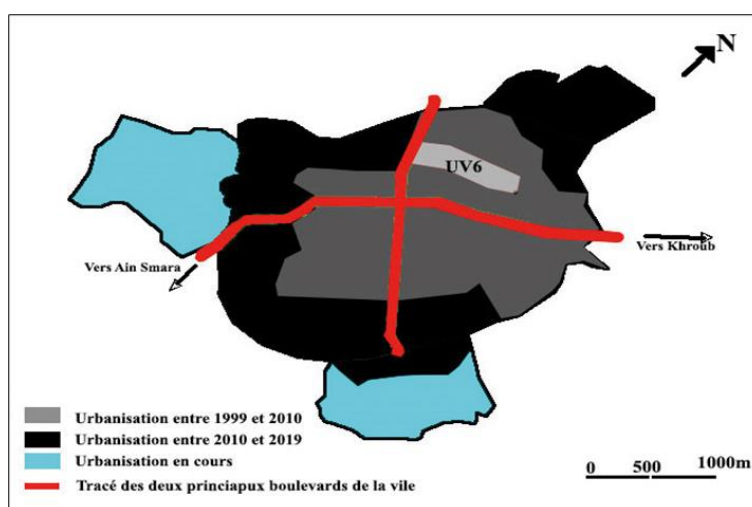


Fig. 2. The urbanization process of the new Ali Mendjeli town (Source: Lakehal, 2020)

Today, the new town is no longer a dormitory town; it has become one of the largest urban hubs in the Wilaya of Constantine, hosting new public facilities of great local and national importance, such as the university town, the Mall, the regional hospital, etc (Belguidoum, 2021). This enables it to exert a polarity over territories on a regional and national scale, justified by the number of incoming journeys (Acherarad & Boukerzaza, 2020).

Like all Algerian cities, the new town has seen considerable demographic growth, mainly due to the relocation of residents from Constantine and its surrounding area. This population growth, estimated by Department of programming and budget monitoring for the wilaya of Constantine (Ministère des Finances et al., 2020) at over 350,000 in 2010, will rise to 461,885 by 2020 (Figure 3). This explains why, in just 10 years, the city's population has multiplied by 6, which has also led to a sharp increase in the amount of land earmarked for the future, as well as the urbanizable surface area, which has risen from 1,500 ha in 2010 to over 4,400 ha in 2021.

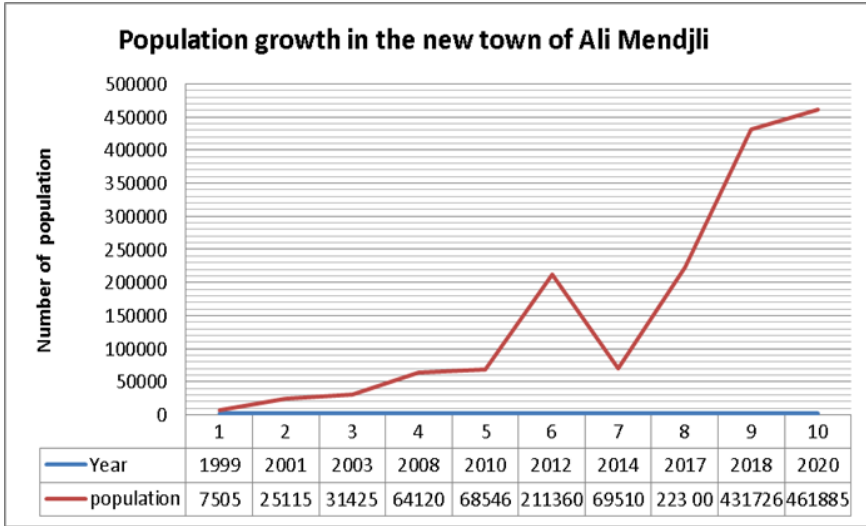


Fig. 3. Population trends in the new Ali Mendjeli town (Source: Urbaco 2020+authors' treatment 2022)

Population density differs considerably from one neighborhood unit to another. There are 3 categories, as illustrated in (figure 4) : the first category comprises neighborhood units (1,6,8,9,16,17,18,20,extension of neighborhood unit 20) with a high density of over 300 inhabitants/hectare (564.56 inhabitants/hectare), the second category comprises neighborhood units (Western extension, 2,13,14,5,7,15,10,19,extension of neighborhood unit 5) with an average density of between 100 and 300 inhabitants/hectare, And finally, the third category features three neighborhood units (4, 12 and southern extension) with densities ranging from 00 to 100 inhabitants/hectare.) The distribution of population density in the town of Ali Mendjeli is therefore completely heterogeneous.

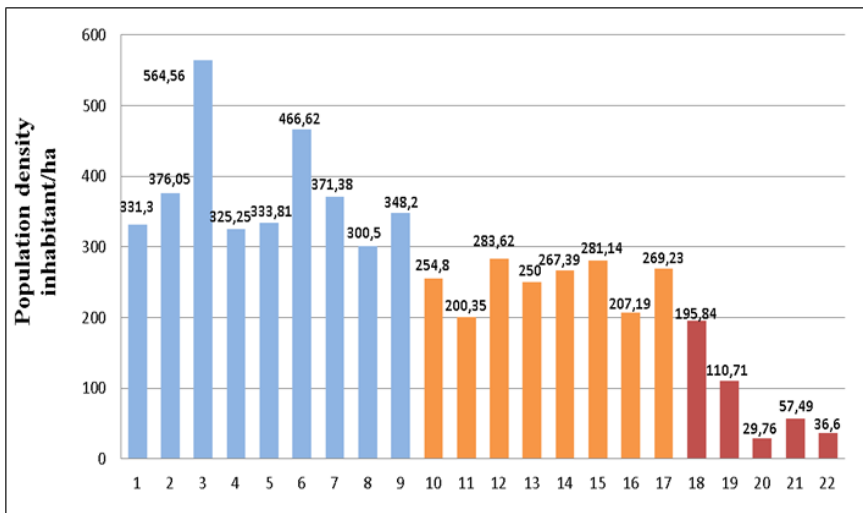


Fig. 4. Population density distribution in the new Ali Mendjeli town (Source: Authors, 2022)

In this context, the rapid expansion of the new town of Ali Mendjli is seen as the real cause of a spatial imbalance between the town center (neighborhoods units 6 and 7) and these extensions. In this case, the absence of coordination mechanisms and the co-production of transport-urban planning are directly reflected in the poor spatial organization of activities, facilities and flow-generating services, mainly grouped in the town center.

As a result, the new town is becoming an unbalanced urban space, with a dissociation between residential and employment areas, creating several problems in terms of daily commuting. The most obvious of which are: longer distances travelled, a growing number of journeys, high demand for transport, and so on.

Faced with this, the city of Ali Mendjeli is covered by a tramway line linking Ali Mendjeli to Constantine city center. Within the city, several bus routes serve all neighborhood units and link them to the tramway terminus, due to open in 2019 (Lakehal, 2020). Despite the reinforcement of the city by a tramway line, the current transport offer remains limited in the face of the high demand for transport, it does not sufficiently cover all neighborhood units and does not ensure an equitable service throughout the city, particularly in the new peripheral extensions to the south and west. As a result, the inhabitants of Ali Mendjeli use their cars as an alternative means of meeting their travel needs.

In this respect, it can be said that the daily mobility patterns of Ali Mendjeli's inhabitants are essentially linked to the city's spatial morphology, which is constantly changing.

Material and methods

The constraint of a lack of up-to-date statistical data led us to opt for a quantitative analysis approach based on a field survey using questionnaires, in order to gather the quantitative data required for our analysis.

This approach enables us to address the issue of the impact of urban form on mobility behavior in the local urban context of the Ali Mendjeli new town and is also used to analyze trends in mobility factors (population, motorization rate, distance travelled, journey time, etc.), and to assess the performance of the mobility system in a new town.

Our survey is based on a standard household survey method, in the sense that it follows the HTS method (household travel survey). It was carried out in 2021/2022 when the city's population was 461885 inhabitants divided into 25000 households, i.e. 5.4 person per household. The survey lasted 5 months, from October 2021 to February 2022, and was based on a sample of 441 households and 808 people, randomly selected according to the specific characteristics of the city, and calculated with a margin of error of plus or minus 5% and a confidence interval of 95%. Questionnaires were distributed to 17 neighborhood units (table 1), and distributed to household members over 18 years of age, i.e. the population that makes daily trips.

In addition, the results of this survey are processed using Spss statistical software, which makes it easier to read and interpret the data. A statistical approach based on correlations is used to identify the various relationships between urban form and daily mobility behavior.

Tab. 1. Share of survey population

Neighborhood unit (NU)	Household questionnaires distributed	Household questionnaires retained	Person questionnaires distributed	questionnaires retained persons
NU 01	60	27	105	56
NU 02	42	14	72	35
NU 04	30	18	68	47
NU 05	43	16	81	30
NU 06	44	21	86	42
NU 07	56	25	92	55
NU 08	52	17	107	36
NU 09	62	24	119	54
NU 10	31	12	69	26
NU 13	50	20	96	48
NU 14	46	19	80	24
NU 15	39	23	77	33
NU 16	54	20	101	45
NU 17	66	35	111	52
NU 18	81	45	159	71
Extension of NU 20	75	37	122	59
Southern extension	112	68	221	95
Total	943	441	1766	808

Source: Field survey 2021/2022

Results and discussion

Mobility and travel patterns in Ali Mendjli

Distribution of the survey population by gender, age group and socio-professional category

In the new town of Ali Mendjeli, 808 people were surveyed, 37.50% of them women and 62.50% men. The results (table 2). Show that men are more mobile than women. Indeed, except for the 60+ age group, the average level of mobility exceeds 3.2 trips/day for men versus 2.4 trips/day for women.

Tab. 2. Average mobility by gender

Sex	Frequency	Percentage %	Average rate of mobility (rides per day)
Men	505	62.50	3.2
Women	303	37.50	2.4

Source: Authors, 2022

Of the 808 people surveyed, the breakdown by age group is as follows (Figure 5): 212 people between 18 and 24 years of age, i.s. 26% of the total, with a ratio of 3 trips/day. The majority of people in this age bracket are students.

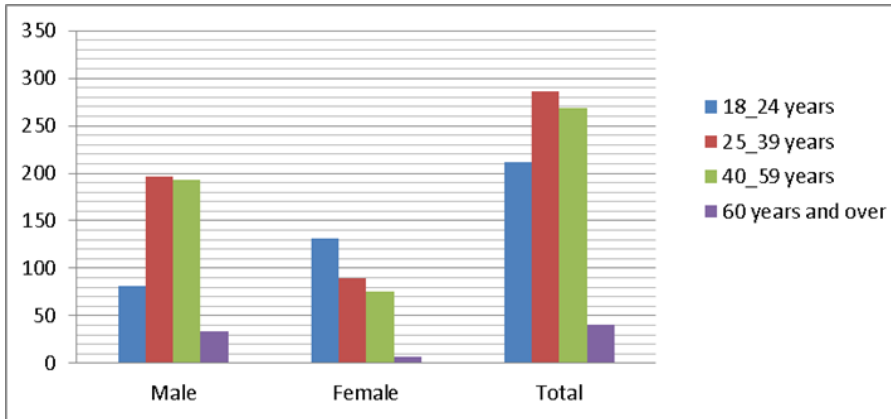


Fig. 5. Distribution of population by gender and age group of survey respondents (Source: Authors, 2022)

People in the 25-39 and 40-59 age brackets represent over 69% of the total population for both categories (Figure5). They have the highest level of mobility, with more than 3.4 trips per day. This high level of mobility can be explained by the dominance of a working population made up mainly of employees in different sectors of activity, who in most cases own a vehicle.

Unlike the over-60s, who travel less, their ratio does not exceed 1.4 trips/day. This age group is represented by 41 people (Figure5), i.s. 5% of the total population. It is mainly made up of people who do not carry out any activity requiring daily travel, which explains the dominance of retired people.

To repeat the formula used in a previous study (Olvera et al., 2002), the "modal hierarchy" is above all a "social hierarchy". Our survey confirms this aspect (Figure 6) with an in-depth analysis of socio-professional categories, including the inactive population.

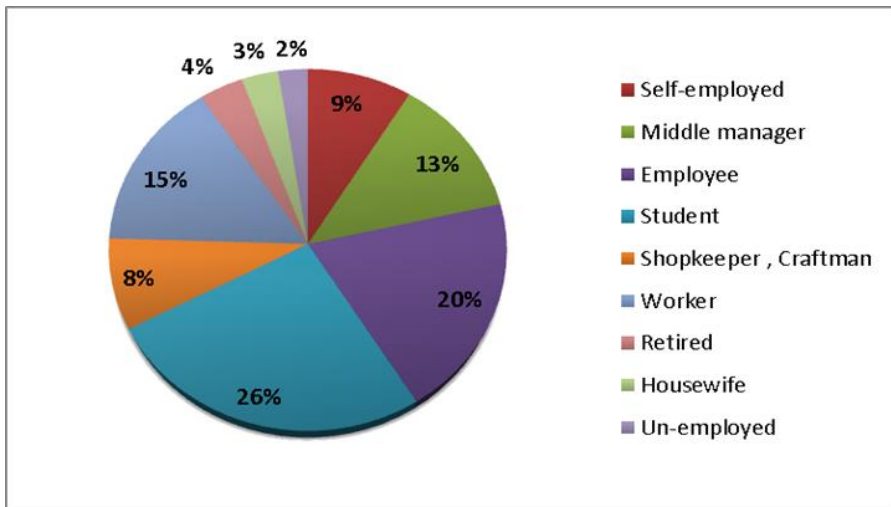


Fig. 6. Distribution of respondents by socio-professional category (Source: Authors, 2022)

In fact, the composition of the sample interviewed, as shown in (Figure 6) is as follows: nearly 26% are students, 20% employees, 15% workers, 13% middle managers and 17% self-employed and shopkeepers. The remaining 9% of the population surveyed is divided between retired people, housewives, and the unemployed, both accounting for almost 5%.

Modal split of journeys by motive

A study of the modal share of journeys (Table3) shows that the private car is predominant in Ali Mendjeli. In fact, the rate of car use (31%) is higher than that of public transport (20%). The tramway accounts for 12%, but is less frequented within the city, in contrast to journeys between the new town and downtown Constantine.

There was also significant use of taxis and clandestine taxis (21%) for various travel purposes. Conversely, walking is less common (8%), and it may be that the survey population actually walks less than stated.

University transport comes last with a lower representation (7%), and is considered a special mode of transport, intended just for university students.

Tab. 3. Modal share of persons surveyed

Means of transport	Trips	Percent
Private car	416	31%
Tramway	161	12%
Bus	267	20,2%
Taxi	144	11%
Clandestine taxi	139	10%
Walking	106	8%
University transport	91	7%
Total	1324	100%

Source: Authors 2022

And concerning the distribution of modes of transport according to motive (Figure 7), the private car appears to be the means of transport most used not only for work (44%), but also for secondary motives (shopping, family visits, leisure,). The use of this mode of transport is very much in demand among the most privileged socio-professional categories (self-employed, shopkeepers, middle managers and employees) due to their financial capacities, enabling them to have an individual vehicle.

Public transport (bus and tramway) is also frequently used for work and other purposes. And for study-related journeys, we found that university transport and the tramway are the two modes most used by students. For this mode of transport (public transport), we found that the population that uses it most is those with limited and low incomes, such as workers, employees and the unemployed.

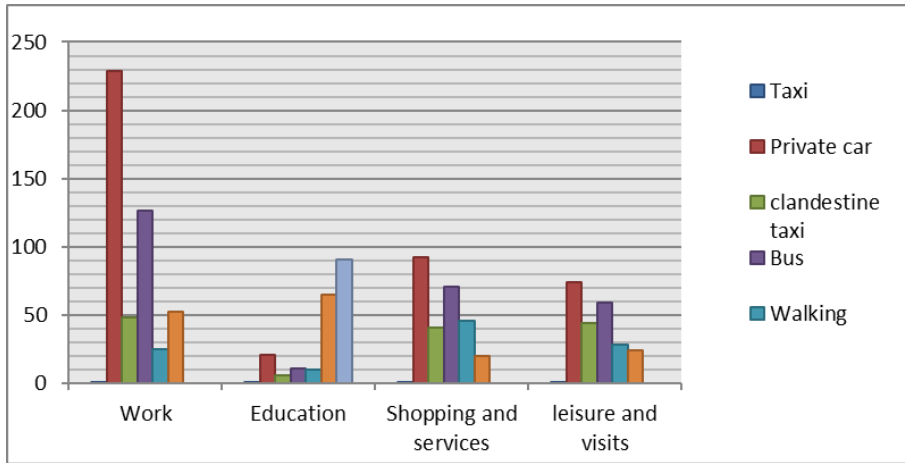


Fig. 7. Means of transport used according to trip purpose

Unsurprisingly, other motorized modes such as taxis and clandestine taxis are used widely for a variety of reasons, with the exception of study-related journeys. This can be explained by the lack of public transport, although the city has a tramway. And certain neighborhoods units (extension of neighborhood unit 20, southern extension) are only served by clandestine taxis.

In contrast to other modes of transport, walking is in the minority among the people surveyed, who only walk for short trips for occasional reasons (shopping, family visits, leisure...). This mode of transport is mainly used in the town center, as the urban fabric in this area is characterized by an almost orthogonal grid of roads, offering a high level of connectivity between routes and facilitating access to destinations (Boukelouha & Gauthier, 2020).

Motorization rate per neighborhood unit and its relationship to monthly household income

According to the National Statistics Office, the Wilaya of Constantine has seen a sharp increase in the number of cars in recent years. It is estimated to have 93,039 cars, and has continued to grow, reaching 211,705 in 2020. This strong growth is underpinned by dysfunctional public transport systems, improved quality of life for residents, a relative drop in the purchase price of vehicles, and affordable fuel prices, particularly diesel (Boubakour, 2008).

According to our survey, the motorization rate of households in the new town confirms the latest statistical figures. In fact, (Figure 8) illustrates that the motorization rate in the new town averages between 0.98 cars/household for neighborhood unit n°5, and 0.19 cars/household for neighborhood unit n° 8. This rate is positively correlated with household income and the lack of public transport.

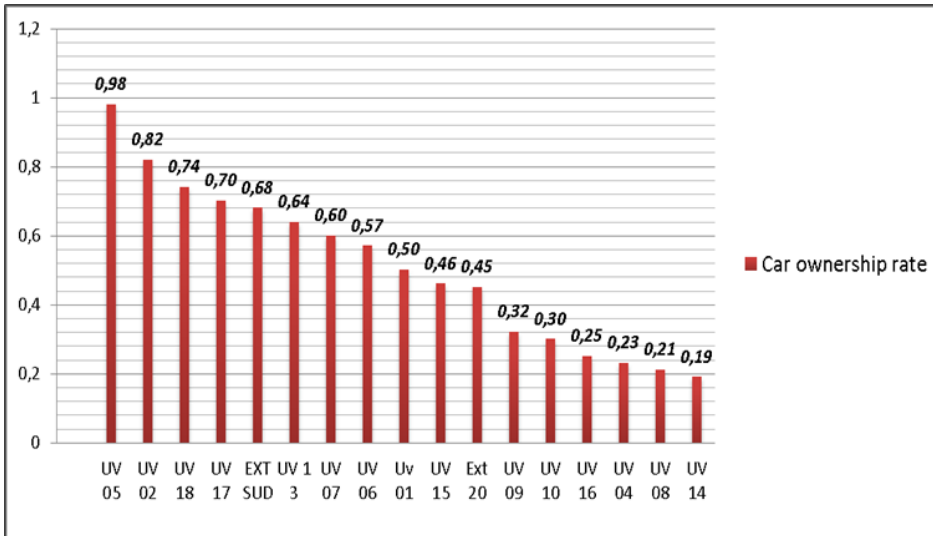


Fig. 8. Household motorization rate at Ali Mendjeli

According to the (figure 9), we can clearly see that neighborhood units N°05 and N°02 have a higher proportion of households with incomes of over 50,000 da/month, and the same households have the highest motorization rate (figure 8), in contrast to neighborhood units N°14 and N°08, which have large populations with lower incomes (25,000 Da on average) and the lowest motorization rate (figure8). We can therefore confirm that there is a very strong link between household income and the motorization rate.

The rate of motorization in the new town of Ali Mendjeli is also more closely linked to longer travel distances, a consequence of the creation of a peripheral urbanity, which is considered an offspring of the city of Constantine (Benmachiche, 2019).

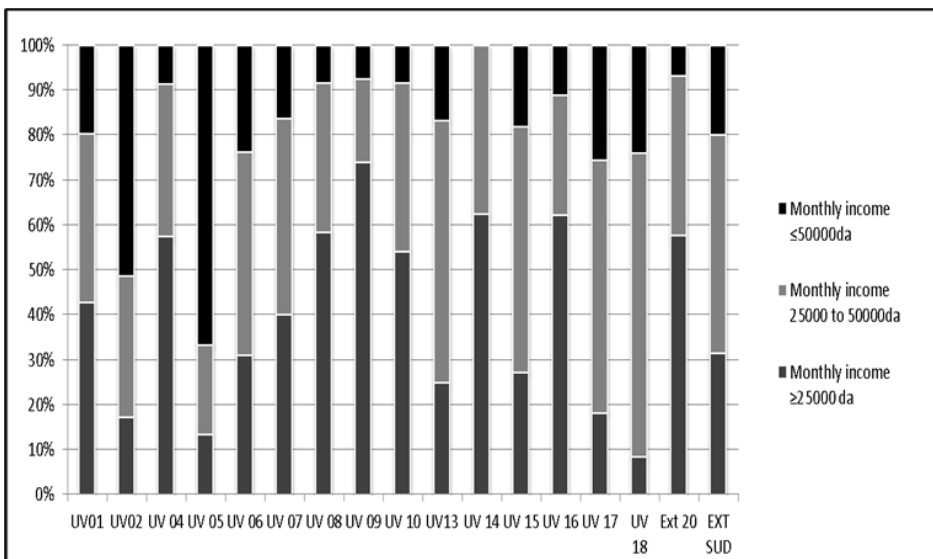


Fig. 9. Monthly household income per neighbourhood unit

Public transport: a limited offer of unsatisfactory quality

At present, the new Ali Mendjeli town is covered by a new transport network developed around a tramway line, which is the feeder axis for all bus lines. The network is primarily designed to accommodate grid interlacing, with all lines meeting at interchange points with the "tramway line" drawdown axis.

This new redeployment plan revolves around three new urban transport lines, enabling residents of the city's outlying areas to use the tramway station to travel to the center of Ali Mendjeli or the city of Constantine.

These include the Ali Mendjeli bus station line to the western extension of the same town and its housing estates, the bus station-service to the southern extension via neighborhood units 17, 18, 19, and 20, and the bus station line to University 3, to provide transport for residents of the housing estates around University 3. In addition, there are 10 intercity transport lines linking the new town of Ali Mendjeli with neighboring communes and urban centers: the town of Constantine, the town of el-Khroub and the town of Ain Smara.

Despite the implementation of a new plan to redeploy transport resources within the city's urban fabric, the transport system as a whole remains fallible and dysfunctional. According to the field survey, the city is very poorly served by the various operators, but the quality of service diminishes as you move away from neighborhood units 6, 7 and 8.

The shortage of transport services in Ali Mendjeli is compounded by the dominance of informal cabs (Figure 10). In this niche, the latter is the only alternative for users travelling between the various neighboring units, as well as attractive areas of the town such as Le Mall. The latter occupies most of the city's car parks and parking spaces, and is generally found lined up on almost all the main roads, and sometimes even side by side with taxis.



Fig. 10. Clandestine taxi ranks and taxis at Ali Mendjeli

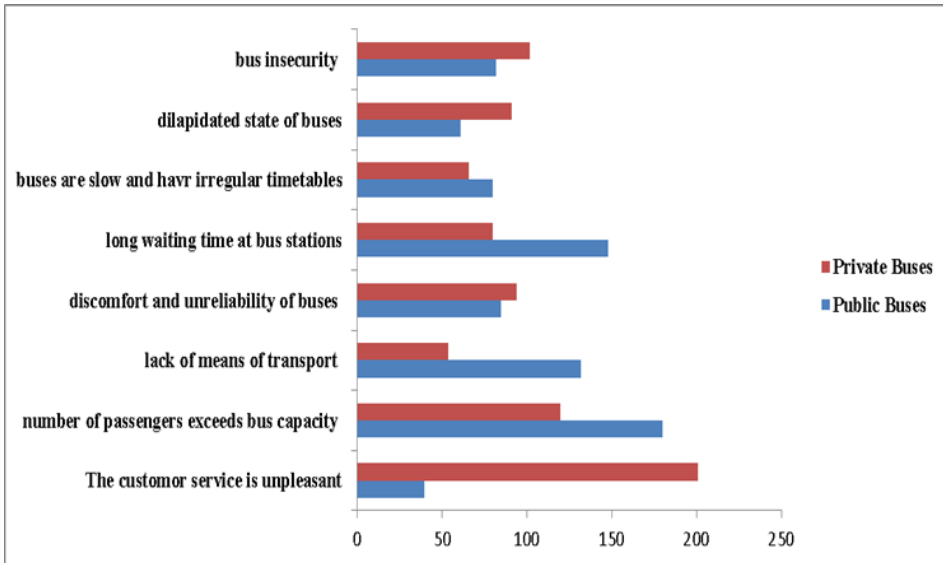


Fig. 11. Quality of public and private transport services

Unsurprisingly, the informal taxi is the means of transport most used by Ali Mendjeli residents, who make more than 139 journeys a day, and it could be that respondents use this mode of transport more frequently than has been claimed, particularly in neighborhoods units poorly served by public transport (14, 18, 20, 16, 17, southern extension).

Moreover, the city's public transport offer shows a high degree of user dissatisfaction in terms of service quality, with 60% of those questioned declaring that the quality of public and private transport service falls far short of their aspirations.

And from (Figure11) we can note that user dissatisfaction is essentially due to the lack of comfort and safety, as well as the waiting time spent at stations concerning the public transport sector, while for the private sector, we highlight the dilapidated state of the buses and in particular the malpractices of the operators.

Links between determinants of urban form and mobility behavior

A number of researchers have looked at how to study the links between mobility and urban form, either on a local scale or on a metropolitan scale, where they have used diversity and design density as indicators of urban form, and, as far as mobility is concerned, the modal share of journeys and distances travelled as indicators (Le Néchet & Aguiléra, 2012).

However, the following data were used as indicators of urban form: population density and distance to the center of the metropolis, as well as the proportion of trips made by car and commuting distance (average distance as the crow flies from home to work) as indicators of mobility. Examination of the results concerning the relationship between population density and the proportion of journeys made by private car clearly reveals a correlation, but when it comes to the relationship between distance from the center (of the parent city Constantine) and average commuting distance, the analysis of the results reveals a strong positive correlation between the two indicators.

Applying the correlational method to the results (figure12&13) illustrates that car use increases with decreasing density, and is given by a correlation coefficient $R = -0.55$, unlike commuting distance, which increases with distance from the city center and is given by a correlation coefficient $R^2 = 0.78$.

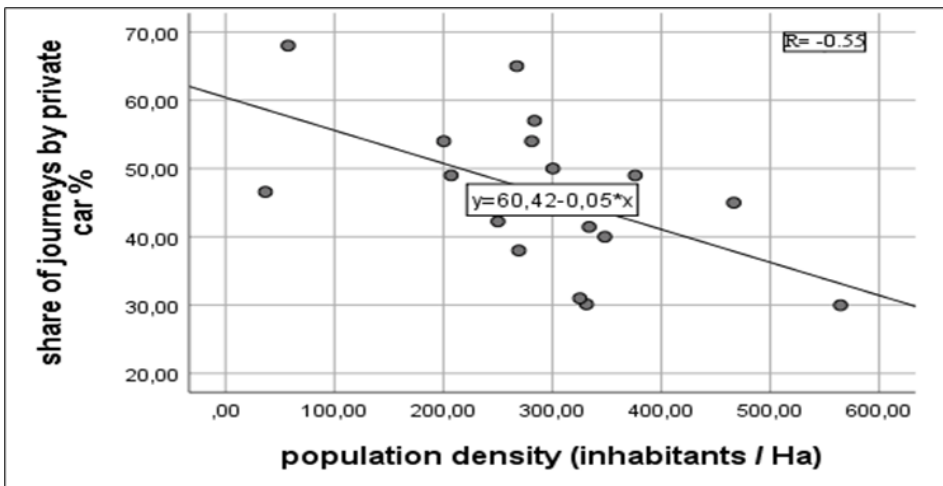


Fig. 12. correlation between density and share of journeys by private car

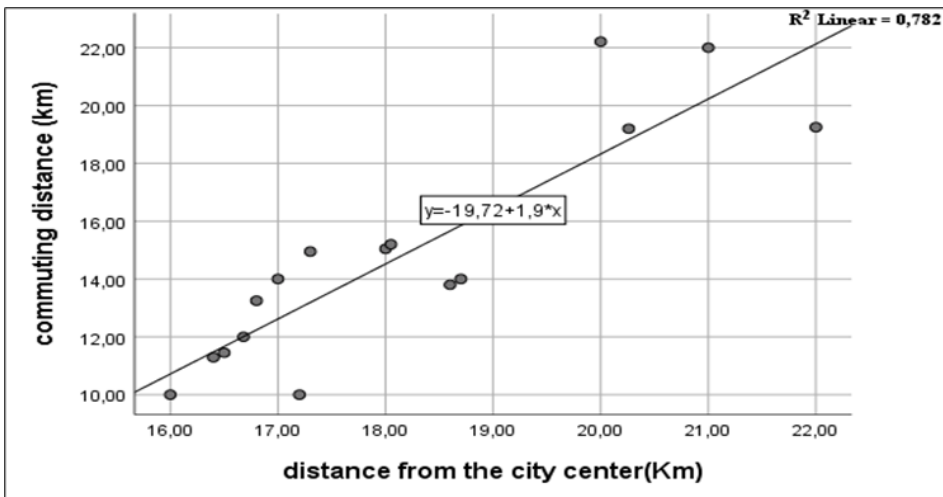


Fig. 13. correlation between distance to city center and distance traveled

This analysis leads us to say that density affects the lengthening of distances traveled and the increased use of the car. So low densities and the absence of a functional mix in the city justify the heavy reliance on private cars to commute to Ali Mendjeli.

On the other hand, the new town belongs to a polycentric metropolitan context, where the distance to Constantine's city center is 20km, which would induce high distances and a large number of journeys, especially (home-work). Consequently, this has led to heavy use of the car, thus confirming our findings and the results of several studies on the links between metropolitan polycentrism and mobility. For example, in

the study by (Schwanen et al., 2004), which compares the main cities in the Netherlands, polycentrism appears to be significantly linked to longer distances and greater use of private cars, as is also appreciated by the existence of a high proportion of commuter trips to the periphery, as well as by the increase in journey times for residents in the Netherlands.

Conclusion

At the end of this work, which we carried out in the new town of Ali Mendjeli, we came to an understanding of mobility practices in the town under study. The results obtained through this survey have enabled us to understand the links between urban form and daily travel behavior, from which we have drawn the following points:

The urban morphology of the new town of Ali Mendjeli is difficult to navigate on foot, despite the high potential of a few meshed fabric configurations located in the town center (neighborhoods units 6, 7). On the other hand, in the rest of the neighboring units, particularly the two extensions (south and west), private cars are the inevitable alternative for short trips, even on a neighborhood scale.

Also, on the scale of the Constantine metropolis, the new Ali Mendjeli town is part of a polycentric metropolitan context, where the distance to the city center of the parent city generates significant distances that translate into a greater travel range.

Car use increases with distance from the center and the favorable situation of residents, unlike public transport, but also and above all due to the decoupling of residential and employment areas.

The implementation of a new plan for the redeployment of means of transport within the town of Ali Mendjeli has not been able to resolve the public transport deficit and keep pace with the town's rapid expansion. This has resulted in poor links and connectivity between the various neighboring units and to other areas, which has also favored the use of private cars and the galloping use of informal cabs as the only alternative for impoverished residents. It was also noted that 40% of the city's households use private cars for their daily journeys, while the remainder use informal cabs due to the unavailability of public transport.

In conclusion, we can emphasize that the urban configuration of the new town is generally symptomatic of motorized modes of transport, and with its rapid expansion due essentially to the various housing developments, dependence on the car is set to increase. At the same time, the public transport network needs to be updated and upgraded to keep pace with this rapid sprawl.

Faced with this situation, the implementation of effective mechanisms to improve mobility conditions in the city, such as the proper management of the public transport network, appears to be more than a necessary solution. However, these measures can only be concrete and effective if they are based on coordination between urban planning and urban transport, and in particular on collaboration between the city's various stakeholders (local authorities, private operators, users-citizens, associations and scientific experts).

Conflicts of Interest: The authors declare no conflict of interest.

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