

IMPACT OF URBAN EXPANSION ON URBAN TRANSPORT IN THE CITY, STUDY CASE: CITY OF BORDJ BOU ARRERIDJ, ALGERIA

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Abstract: Urban transport is one of the most dynamic and a vital element within the urban sphere, as it has a significant impact on the growth and development of cities in all respects; it determines the size and direction of urbanization and directs it properly as well. Bordj Bou Arreridj is an Algerian city that witnessed a spectacular urban expansion, which resulted in great difficulties in terms of urban transport. This resulted in the inability to fulfill the role assigned to it, especially with regard to the urban expansion of the city, given the insufficient means of urban transport, especially collective ones - Old urban bus barns – and thus, meeting the growing demand for transport due to the large demographic growth. In addition to that, the fragility of the urban transport system as a whole has led to lack of harmony and interconnectedness of all parts of the city, and to the imbalance in the management of the sector. The study concluded that the urban area of the city is characterized by an important network of roads and streets that ensure good connectivity between its parts, but the existing urban transport network does not cover all its components (49% is the covered area in the city), as some areas lack urban transport service, especially those located on its suburbs as a result of the rapid urbanization. In order to redress this phenomenon, it was necessary to reconsider the general urban transportation system on both management and organizational sides, taking into account all urban components of the city, especially future expansions, in order to reach a harmonious and interconnected city under a balanced and effective transportation system.

Key words: urban expansion, urban transport, city, Bordj Bou Arreridj

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INTRODUCTION

Transportation is an important part in most of the ancient societies, and will remain so in the future. Transportation and its systems are an accurate measure and an equitable indicator of the extent of the development and growth of states and peoples.

Urban transport is also one of the main pillars of the peoples' daily lives of any given city, as it greatly contributes to the evolution of societies, boosts economy and bolsters social prosperity.

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However, it has witnessed, at the present time, the world cities deeply suffer from many complex problems, including traffic jam and high levels of pollution in urban centers. Those problems became more and more drastically alarming because of the excessive increase in the population of the city urban centers, causing motionless as well as creating suffocating condition in the streets due to the traffic congestion, which forced residents of city centers to spread around the outskirts. This situation widened the urban area of the outskirts, which in return, made it difficult to link outskirts to each other, as well as to the city center, leading to the emergence of areas that enjoy vitality and dynamism; an advantage that other parts unfortunately don't.

The city expansion and its urban development cannot possibly happen without an effective urban transportation system that connects all parts of the city to each other. In many modern studies that deal with subjects related to transportation and mobility within urban areas, researchers have urgently raised topics that aimed primarily at improving the conditions for the better movement of persons within the urban area.

The main purpose of this study is to determine the causes of the deterioration of urban transport and the extent of its impact on the urban expansion of the city; and therefore, to highlight the interactive relationship between urban expansion and urban transport.

MATERIALS AND METHODS

To accomplish this study, the descriptive approach has been adopted to accurately describe the phenomenon by supporting the study theoretical section with concepts and fundamentals using a set of different references, as well as a data analytical approach. To collect and analyze these data, the focus was on field investigation "survey method" through a question form and interviews, especially with administrators and officials specialized in transportation, as well as the simple observation. As for the selection of the samples, two methods were followed; the first one is a selected sample that represents both private and public urban transport workers (196 forms), and the second one, a random sample representing urban transport bus users. So we relied on a 15% proportion of the number of passengers per urban bus, the sample size was as follows:

$$E = N \times 15\%$$

E: The sample volume

N: The number of places available in buses.

Hence, the sample size was 1477,80 ~1500 Form

In order to study the phenomenon of the general trend of the city's expansion spatially, we relied on the spatial analysis of geographic information systems, using the ArcGIS program, where we will obtain the oval shape of the standard deviation (Dr Rasha Sabar Nofal, 2020), which determines the direction and size of urban expansion.

RESULTS

This element is to present the results of the field work by diagnosing the reality of urban transport in the city of Bordj Bou Arreridj in light of the great urban expansion that it is witnessing, so the work was made on two levels; the first one, related to the urban aspect, and the second one, deals with the urban transportation. Then, the findings will be discussed.

The city of Bordj Bou Arreridj is an Algerian city, located on the western side of the eastern high plateaus between longitudes 4°44' and 4°47'50" East and latitudes 36°02'55" and 36°05'40" North, with an altitude of 928 Meters from sea level, on an area estimated at: 18.93 km², bounded by:

North: Ain Zerika village. East: Akhrouf village and the southern village.

South: Solite village. West: Lashbour village (Figure 1).

What distinguishes the field of study Bordj Bou Arreridj is its diversity of agricultural and industrial activities, equipment and service (Nacer, F & Dridi, H. 2021) on the one hand, and on the second is the good connection with road facilities especially the east-west highway with a length of

92 km, in addition to the national roads N°05, N°45, N°76 and N°106, and a set of state roads N°42, 43 and 44. The city has a strategic position in regional and national relations, linking the East with the West and the North with the South. This connectivity had a clear impact on the dynamic movement within the city, in addition to the city being an industrial pole par excellence, as it is considered the capital of the electronic industry at the national and even African level, which highlights the large volume of movement within it.

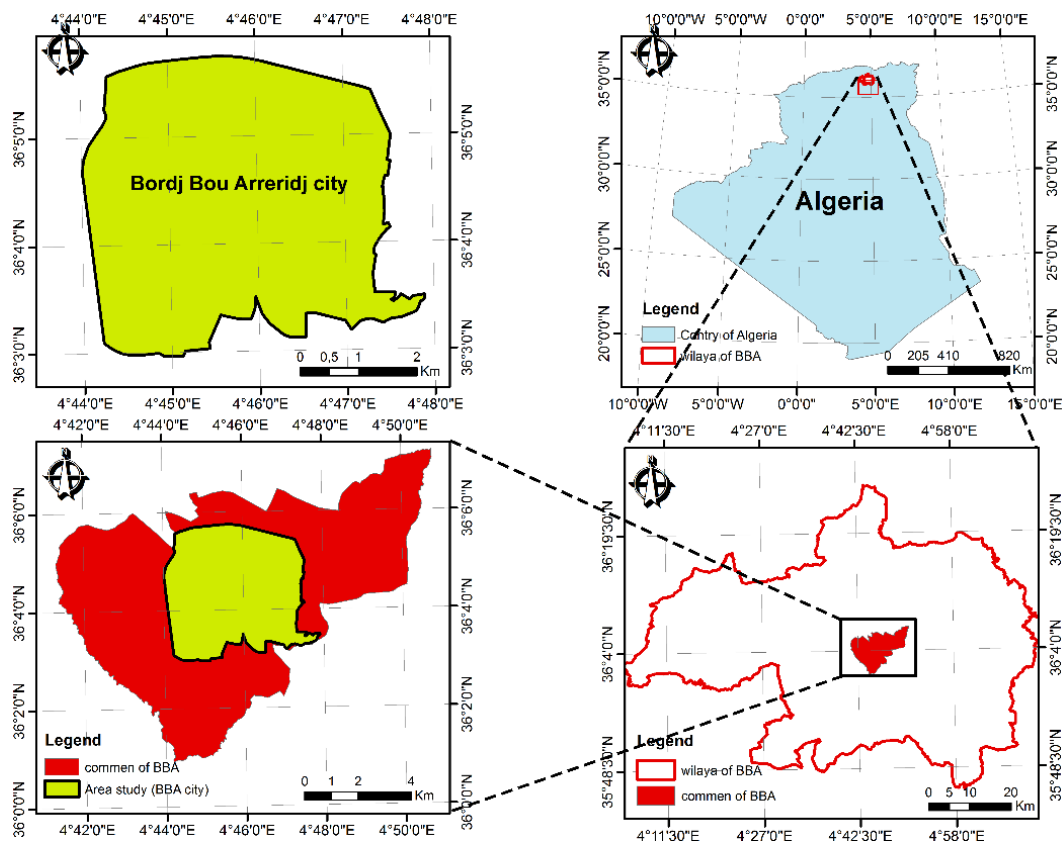


Figure 1. Location of the field of study City of Bordj Bou Arreridj
(Source: Treatment of the researchers, 2019)

The general plan of the city is of the planned type where the government intervene in directing, organizing and equipping the urban construction with public utilities (Abdallah A, 2001)

Defining the general plan of the city of Bordj Bou Arreridj is somewhat difficult at first glance, but one can find out that it is about a clear radiographic plan, as there is the city center, from which all the main roads branch radially, with semicircular streets crossing these roads.

The general structure of the city depends mainly on five main axes; which are the national road N° 05 that connects the east and the west, called Houari Boumediene Street, the national road N°76 linking the city to its north, the national road N°45 linking the city and its south, the national road N°106 that connects the city to Bejaia, the state road N°42, which also connects the city to its south, in addition to the municipal road linking Bordj Bou Arreridj and Bir al-Sanab; the city is structured on these major axes. While all other secondary roads are combined for traffic in the city, which gave these roads great importance, both in terms of urban organization and traffic.

These roads are the axes that direct the urban growth of the city. most of the commercial, service and even industrial activities are concentrated on them, which made movement on them very

intensive, increasing their capacity, and increasing pressure on them, making it difficult for residents of some neighboring areas to reach their homes or places of work without delay (The master plan for the preparation and reconstruction of Bordj Bou Arreridj-Final Report, 2014).

Urban expansion consists of a rational expansion out of the city whether horizontally or vertically, and a natural reflection of the growth and the city increasing needs for new areas, in order to meet these needs in the short, medium and long term (Abdel Fattah M.O, 2003).

The first nucleus of the city of Bordj Bou Arreridj was formed in the city center since the colonial period, then the city witnessed a rapid urban expansion after independence in all directions, and some chaotic neighborhoods appeared, after that, the first urban residential area appeared in the east, west and the northern side, after which the urban growth of the city stopped in the east, south and west, due to the obstacles preventing urban sprawl (Figure 2).

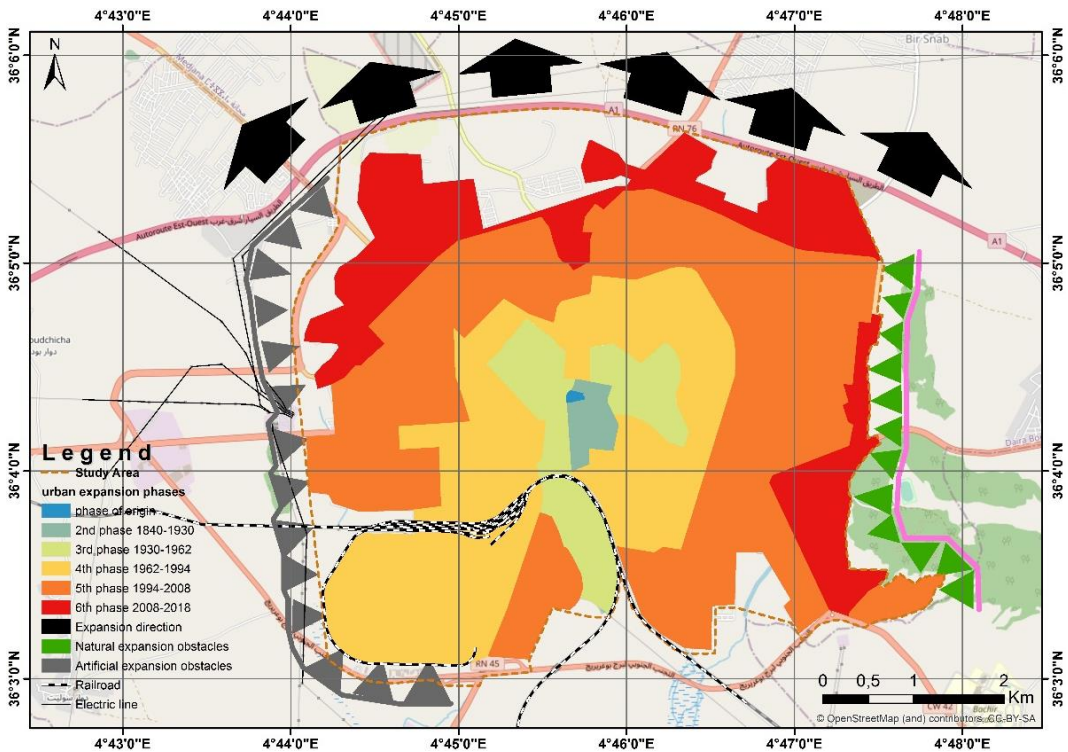


Figure 2. The Phases of urban expansion of Bordj Bou Arreridj city -Directions and obstacles- (Source: Treatment of the researchers 2019)

The analysis of the physical characteristics of the road network in Bordj Bou Areridj is based on the collection of information and observations from the field. The analysis includes the number of roads and the direction of flow, the width of the roads and sidewalks and the condition of the roads and sidewalks coverage. In our research, we relied on statistics taken from the traffic plan for the city of Bordj Bou Areridj, giving us some indicators on the current road conditions.

The city of Bordj Bou Areridj includes an important network of roads that qualifies it to play a major role in the development of the national economy and connects it with the various neighboring provinces. The length of the urban network is 303.50 km, in addition to the East-West Highway that passes along the city of Bordj Bou Areridj from the north side; these roads are distributed as follows:

- Main roads: which guarantee the connection between the city and its surrounding areas and allow linking the distribution roads.

- Distribution roads: allow connection or exchange between the city center and the rest of its surrounding neighborhoods.
- Interconnection roads: allow access to residential neighborhoods. This type of network has no difficulty in moving.

The spatial analysis using GIS technique, where the oval shape of the standard deviation appears, and depending on the structured roads of the city, the trend of the expansion phenomenon towards the northwest with an angle of inclination of 105 degrees (Figure 3).

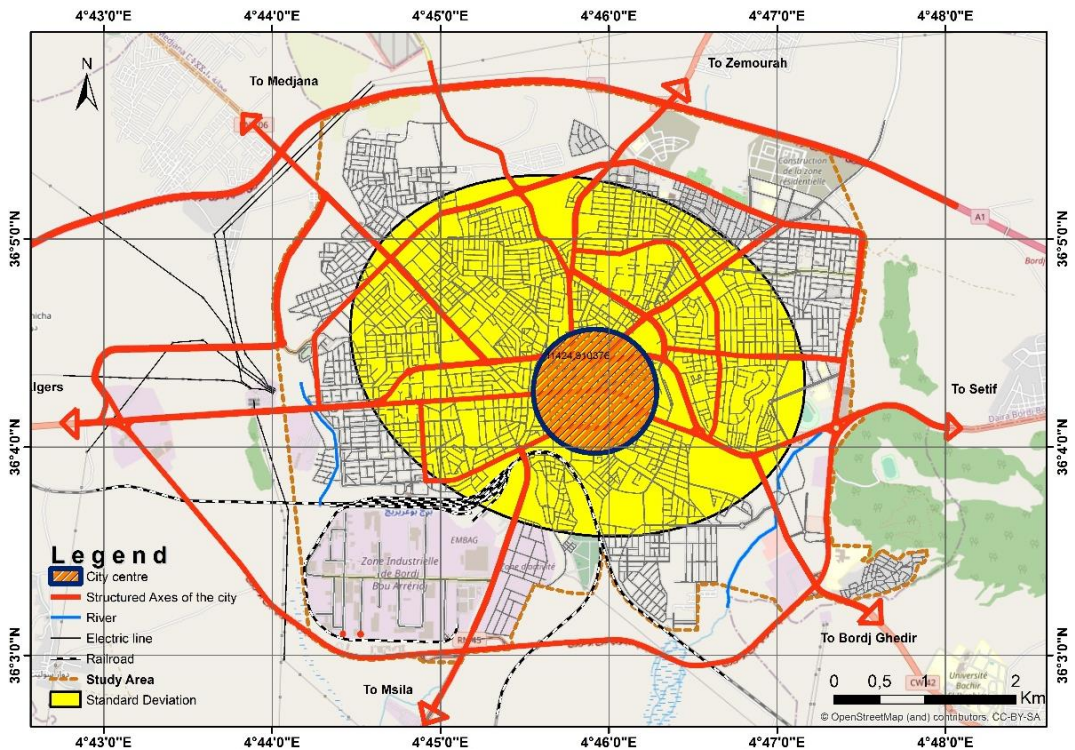


Figure 3. City plan and the trend of expansion (Standard Deviation)
(Source: Treatment of the researchers 2019)

The condition of the sidewalks is mostly good, but during the frequent field visits, especially inside the urban center, we noticed some bad behavior from vendors who display various commodities along with the sidewalks, which makes it necessary for pedestrians to walk on side of the road, causing injuries and accidents.

The city has a large number of roads and streets with different mechanical movement in their directions, which are subject to the traffic system in the city on one hand, and to the daily activities of residents and attractions on the other hand, most of which are in the city center.

In the field inspection of the various roads, we found that the mechanical movement is concentrated in high density along Houari Boumediene Street, as it is the main axis (formerly National Road N°05) and along August 20 Street, Prince Abdelkader Street, and Abdelkader Al Bariki Street. In addition to the national road N°106, the national road N°45 towards the activities zone, the northern, and the southern avoidance roads (heavy weight roads).

The city is a hotspot that causes a lot of traffic accidents and extends the waiting time, the road infrastructure and the transport network have not been able to handle traffic flow, especially during rush hours. (Abdelmoumene, M., & Mahdi, K. 2020), this is due to the absence of well-studied, or even special lines that allow the movement to be distributed and directed.

Due to the centralization of the various facilities intended by most of the residents of the city center on Houari Boumediene Street, the density of pedestrian traffic is high in this area and its vicinity, the conflicts of pedestrian /mechanical movement (causes of traffic accidents).

To find out the density of pedestrian movement in places crowded with residents, we conducted a field survey of some of these areas:

- Near of the market: highly crowded with pedestrian movement caused by shoppers;
- Said Zarooqi High School (Entry and exit of teachers and schoolboys),
- The municipality (City Hall) of Bordj Bou Arreridj
- Bouzidi Lakhdar and the August 20 stadiums (in time of sports demonstrations).

There is a collective urban transport barn in the city of Bordj Bou Arreridj, with 196 buses distributed on both private and public customers (Table 1):

Table 1. Collective urban transport barns
(Data source: Transportation Plan Final Report, September 2019, p. 5)

	Number	Number of Vehicles	Number of Available Places
Private Customers	158	176	7816
Public Customers	001	020	2036
Total	159	196	9852

There is a barn for this number of new and old mass transit buses. Although this barn came into service 14 years ago on average, it is somewhat old. Only 61% of the barn area is in service: This reflected negatively on the urban transport service, in addition to its many faults, which affects the control of covering the needs of transportation in a fixed size, especially at peak times.

The urban transport planning process aims at laying down the necessary rules to ensure the permanent stability of transportation systems compatible with the continuous urban development in accordance with programs and goals that meet as much as possible the residents' desires to move smoothly, safely, and with an appropriate level of service (Sabah, 2002)

Fourteen (14) lines, distributed cover the urban transport network in Bordj Bou Arreridj. According to specific directions, some lines are saturated and others limited (Table 2):

Table 2. Lines and directions of urban transport in Bordj Bou Arreridj city
(Data source: Transportation Plan Final Report, September 2019, p. 5-10)

Line N°	Origin	Path length	Destination	Bus stop
01	the University	7 Km	Northern Village	15
03	700 dwellings avenue	10 Km	Axis of rotation Philips	15
05	Passenger transport terminal	9 Km	Industrial zone	16
06	Boumzoug Bashir district	8 Km	Northern Village	22
07	Ouine Zerika	10 Km	700 dwellings District	16
09	Hadaj flats	17 Km	Passenger transport terminal	20
10	Ain ben Oumrane, eastern side	7 Km	130 housing District	21
14	Ain ben Oumrane, western side	5 Km	City1008	7
15	Farhat Abbas High School	11 Km	Passenger transport terminal	31
16A	Passenger transport terminal	14 Km	Passenger transport terminal	33
16B	Passenger transport terminal	13 Km	Passenger transport terminal	29
1A	the University	8 Km	northern village Ouine Zerika	16
3A	El amasser	5 Km	Abdel Moumen Elwiam tunnel	11
12A	700 dwellings	9 Km	Northern Village	25
14 urban lines		133 Km		277

Through the field research conducted on the first category of the "private and public" transporters sample, estimated at 196 buses, it was noted that most of lines are very appropriate

except for 39%; This category represents the connecting tracks between the city center and the suburbs, due to the overlapping of the lines, in addition to the presence of unprepared parking spaces, most of which are located on the road sides, and some random parking spaces (table 3).

Table 3. Transporters' opinion on the used line
(Data source: Investigation Field (Researchers, 2019))

Line	Number of buses	Rate %
Appropriate	120	61
Inappropriate	76	39
Total	196	100

However, the number of buses is considered insufficient due to the increasing demand for transportation caused by the great demographic growth that the city is witnessing on one hand and the expansion of its geographical area on the other hand; so it is necessary to reconsider the number of buses and the organization of lines .

There are two types of plans for the management and organization of urban transport in the city. The first one is overall, which is the transport plan according to (Law N°01-13, 2001) and it is defined as a technical means in which field programs and investments are established in studied time horizons, and the management of various transport systems which is more comprehensive than the study of base structures, and The second traffic and circulation plan was completed according to (Law N°01-14, 2001) and aims to regulate movement and traffic within the geographical area of the city.

According to the table 4, the first most used means of transportation by urban transport users is the bus, as being an appropriate and popular means for people with limited income, at 60%. Then, walking comes second at 20%, and the taxi at 15%, that the high-income category uses the most, each type of transport has its own gathering and dispersion areas (Atoui, 2001)

Table 4. The means used for transportation
(Data source: Investigation Field (Researchers, 2019))

Means of transportation	Sample	Rate %
Bus	900	60
Taxi	225	15
Walk	300	20
Other	75	5
Total	1.500	100

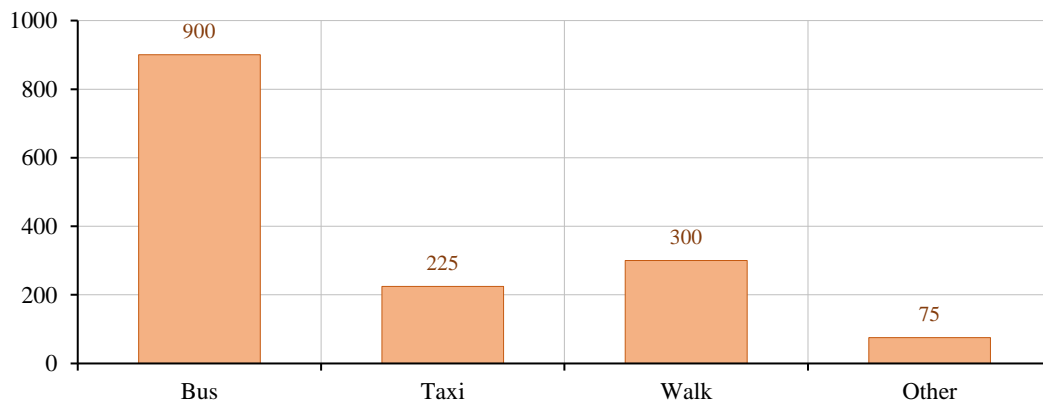


Figure 4. Means used by Users of urban transportation
(Source: Treatment of the researchers 2019)

The house-work transportation constitute most of the movements within the city, especially during peak hours, there the workers choose the type of means of their transportation, which depends on their financial condition and the distance traveled (the private car, or the collective transportation), In the second place come the transportation for study. Primary school students move on foot to near the education centers. As for university and secondary students, they use mechanical means of transportation, most of which are mass transit buses, then comes the transportation for other purposes such as shopping, treatment and picnics (Ali, 1994) (Figure 5).

The return to modes of transport public was more than necessary to reduce the effect of the "all car" (Diabi et al ,2021)

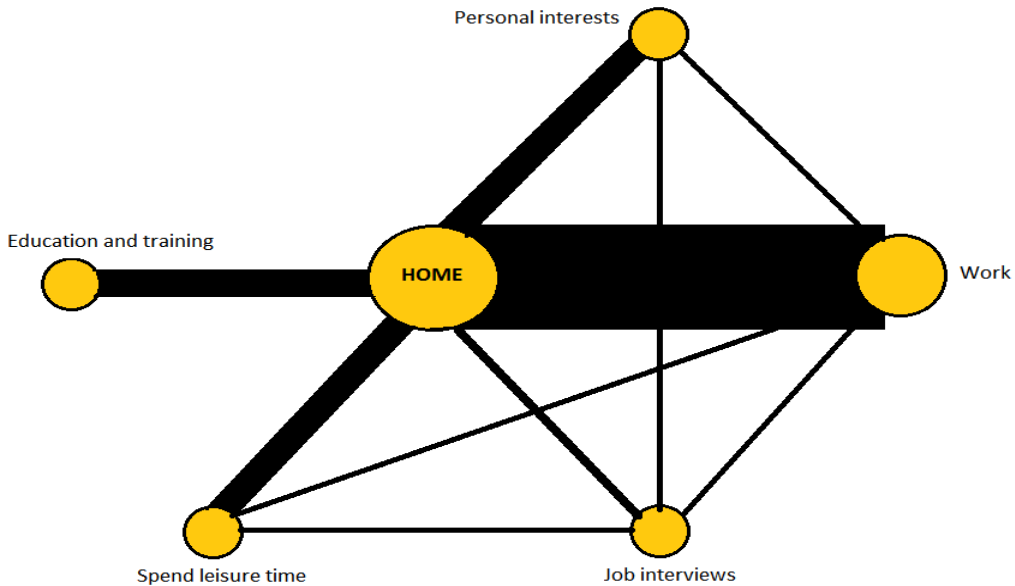


Figure 5. The most important urban transportation within the city
(Source: Ali M.A .H,1994)

The most of the daily movement of the population revolves mainly around a work-study-shopping triangle where we find that 41% of the studied sample move for work, the category of students comes second at 22%, then that for shopping purposes in third place at 19% (Table 5).

Table 5. Reasons for daily travels
(Data source: Investigation Field (Researchers, 2019))

Reason	Sample	Rate %
Work	615	41
Study	330	22
Treatment (Health)	180	12
Shopping	285	19
Picnics	90	6
Total	1500	100

Through the field research that we conducted on the studied sample, it became clear that there are three categories of inhabitants on the outskirts of the city; the first category, that includes residents who live in the area between the city center and the periphery represents 17% declared that transportation is available. The second category that includes residents who live in the nearby representing 23%, indicates that the transport service is available but not enough sufficient. Those

who live in the far suburbs, at 53%, represent the largest and most affected category from urban transport services; they complain that there is no means of transportation (Table 6).

Table 6. Availability of suburban transportation
(Data source: Investigation Field (Researchers, 2019))

Opinion	Sample	Rate %
Available	250	17
Available but not enough	350	23
Not available	800	53
No answer	100	7
Total	1500	100

Urban transport affects and is directly affected by the expansion of the city and its urban growth; it is considered as the main factor in linking the various segments of society, and has also a major role in linking all parts of the urban environment with each other (linking the center with the outskirts of a given city and linking the outskirts with each other), achieving thus coherence and harmony in the city, and suppressing marginal or isolated neighborhoods.

The absence of lines on some important axes, obliging the residents to walk a long distance to get the bus stop they need, or to use taxis to reach their destinations. Although this network has a significant (14 lines, 196 buses), it only covers 49% of the total area of the city, i.e. 51% is not covered by urban transport services (Figure 6, Table 7).

Table 7. Urban transport network and coverage ratio
(Data source: Investigation Field Researchers, 2019)

Coverage ratio %	Covered area	Total area city	Length (km)	N° of buses	N° of lines
49	10.80 Km ²	22 Km ²	133	196	14



Figure 6. Coverage of urban transport networks in Bordj Bou Arreridj city
(Source: Treatment of the researchers 2019)

In order to reach a balanced urban development, it is necessary to know the extent of the disruption of this system suffers from in order to draw up a strategy that achieves a state of harmony among its components in order to reach a developed urban system (Achraf, 2021)

The goal of development of urban public transportation today is not only to meet the required traffic capacity, but also to improve the quality of service, in order to provide secure, fast, comfortable, and convenient transportation (Huiyu and Hongwei. 2020).

The transformations that currently characterize urban mobility (increase in the distances to be traveled and in the number of trips, improvement in the quality of the means of transport, etc.) are concomitant with urban dynamics (densification, sprawl, etc) (Ndeye, 2021).

DISCUSSION

The city is growing and expanding on the north and north-west (105-degree standard deviation) because there are natural obstacles on the east side such as the forest and on the south is a flood zone, and an artificial one on the west such as high-tension power lines,

This expansion has generated a great demand for urban transport, especially collective transport, as the available means transport (196 buses) is insufficient to respond at the increasing demand, which is explained by the low coverage rate estimated at only 49% of the urban area, while the largest percentage (51%) Not covered by urban transport services. The absence of lines on some important axes, obliging the residents to walk a long distance to get the bus stop they need, or to use taxis to reach their destinations.

Lack of accuracy in choosing the lines for the collective transportation, as we find some of them reach saturation such as overlapping lines that pass through the urban center, while others are almost rare like those at the edges.

The old urban bus barns as the average age approximates 14 year, has significantly affected at the level of service (lack of comfort, and long trip time) reducing the use of this mode, and forcing some users to change the mode of transportation either by car or walking

The poor organization of the urban transport network in the city and the absence of transportation lines at suburbs, which makes it difficult for people to move around.

Reluctance of some private transporters to occupy the urban lines for the suburbs, on the pretext that there is little demand for transportation.

Absence of a specialized official body to supervise urban transport (the Directorate of transport is responsible for granting operating licenses only).

Accordingly, the results of the analysis have been included in the form of a general conception of the city plan, in which the extent and relationship between urban expansion to urban transport is highlighted, as the bigger the geographical area of the city, the somewhat less urban transport service becomes.

CONCLUSION:

This study concluded that urban transport affects and is affected by the urban expansion of the city, and that their relationship is complementary, as the urban transport network is the driving element in the city; it embraces most of the daily activities of the population, and bears a great pressure that exceeds its capacity in most cases, and the transport network extends over the most important traffic axes that cover all the urban fabric of the city. However, the deficit in the field of urban transport remain on the table, whether it is related to the insufficiency of its means or to the weakness of its system in achieving harmony and interconnection between the city center and the suburbs, which hinders urban transport in general from achieving its ultimate goal of linking parts of the city to each other to facilitate movement within it.

The study recommended encouraging the use of collective urban transport by:

Creating major parkings on the outskirts of the city in its four directions, and connecting the center with collective transport.

Restricting the passage of private vehicles in the city center, by completely preventing them or allowing them to move during limited hours outside peak periods.

Thinking about establishing new urban lines by advanced means of transportation, such as the tramway, especially since the region's topography allows it.

Allocating some narrow or crowded downtown streets to pedestrians only, and preventing all vehicles from entering, except for service vehicles (police, ambulance, fire ... etc.).

Establishing the principle of "polluter must be fined".

Creating a specialized body to oversee the management of urban transport (the principle of delegated management)

Assigning the exploitation of urban transport lines, especially collective transport, to a single institution that enables good control and optimum utilization of all lines (unifying the type of vehicles, unifying color, etc.)

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