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Economic, sustainable and energy issues related to urban mobility: Household survey approach (case of the city of Bejaia)

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Abstract ;

The purpose of this study is to present some results of a field survey for urban transport users and to make a diagnosis of the socio-economic context and its influences on mobility behaviour and energy transition in the city of Bejaia. The main results show that in order to ensure a transition to a more sustainable and environmentally friendly mobility system, it is important to develop public transport, and active modes and electric motorization, to reduce automobile propensity and autosolism. We also need to develop new energy sources such as LPG which makes it possible to eliminate harmful effects on the environment and contributes to the maintenance of energy independence in the Algerian context to ensure energy security.

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I. *Introduction*

Cities face the challenge of controlling and improving travel, which is one of their first challenges. Urban mobility plays a crucial role in the development of the city and the empowerment of the well-being of the resident population with a view to the sustainable development of urban areas, often perceived as a source of economic profitability for cities, and are a *major challenge* in shaping its development strategies on the one hand, it has negative impacts on social, territorial and environmental aspects. Urban displacement has become a central concern of Governments, not only to facilitate urban mobility, but also to mitigate environmental impacts and the fight against global warming. Mild transport responds in part to this dual role if it is well deployed.

In this context and within the framework of this article, an exploratory and descriptive study through a field survey was carried out in order to determine the factors that influence the mobility of Algerians in urban areas. It is also a question of understanding how to propose avenues that could constitute an alternative to the development of mobility and to ensure a better fluidity of urban movements in the light of the energy transition for sustainable mobility in Algeria. Thus, this user survey will be oriented towards the reasons for travel, preference of the modes used, average costs spent, energy transition to alternative modes.

II. *Literature review Economic, sustainable and energy issues related to urban mobility*

Urban mobility presents complex and varied economic, sustainable and energy challenges. (Dashdamirov & Javadli, 2023) emphasise the importance of public transport in meeting urban mobility needs, highlighting the different transport options and alternative energy sources. For its part, (Neil & Lee, 2010) confirms that the use of private cars has negative consequences, such as urban pollution, energy consumption, congestion and the resulting urban sprawl. A three-pronged approach to sustainable passenger mobility is proposed by (Dura & Weil, 2014), which focuses on technological advances, changes in user behaviour and the employability of information and communication technologies.

A more in-depth study is proposed by (DI Lorenzo, Mairinque, Andrade, Henrique, Valentim, & Josiane, 2023) emphasising the potential of electromobility to improve the energy efficiency of urban mobility in order to address the economic, sustainable and energy challenges of urban mobility.

On another side (Cascetta & Bruno, 2000) suggest that urban mobility is influenced by various factors such as income growth, lifestyle changes and the development of information and communication technologies. Urban mobility also influences urban sprawl, taking into account cultural, psychological and identity aspects. In some cities, the causes of difficulties are of a physico-spatial nature but mainly linked to organizational and

institutional factors. Thus, these elements play a crucial role in the complexity and dynamics of urban mobility (Aïchour, 2006).

A holistic approach is essential to move towards sustainable urban environments, including both energy consumption patterns, mobility patterns and sustainable mobility. However, this transition must obey the sole logic of using energy more rationally and responding more effectively to the problem of displacement. It is essential to combine mobility and energy infrastructure in order to solve this problem, with an emphasis on an ecological lifestyle and optimal use of infrastructure. In this way, it is possible to achieve this objective promoting the use of new technologies to encourage sobriety and the economic use of modes of transport; also, in the face of rising environmental demands and in a context where the motorization rate is constantly increasing, the search for other sources of non-fossil energy seems obvious. Thus, green, soft transport (e-mobility) could come as an alternative source. This is a successful bet for eco-efficiency in the energy transition to eliminate harmful effects on the environment.

III. *Methods and Materials:*

3.1. *Objectives of the study, type and conduct of the field survey*

In this article, we conducted a study among users of urban transport in all its modes within an Algerian city, in this case the city of Bejaia. Based on a representative sample of transport users in a coastal city, which includes a large number of constituent elements of a questionnaire with specific objectives related to the topic. Displacement issues are becoming increasingly complex, since urban rhythms are constantly changing, which will lead to the definition of the transport policy to be put in place in the light of the energy transition for sustainable mobility in Algeria, this also implies strategies and means to be put in place in line with the role of new technologies in improving urban mobility.

This study is consolidated by fieldwork using a questionnaire per survey. The latter is carried out with the transport users of the city of Bejaia, it aims to better understand the urban mobility of Algerians, in order to propose ways of improving and developing mobility and to ensure a better fluidity of urban movements.

In this connection, the city of Bejaia is the subject of research ranging from the treatment of transport and mobility problems to the study of different socio-economic factors without neglecting other factors (psychological) that explain mobility, in order to define strategies that can mitigate the impacts and contribute to a better articulation between existing means and the improvement of mobility. Therefore, this study is based on the analysis of data from a survey carried out on the basis of a questionnaire among transport users in the city of Bejaia.

As indicated, the objective of this survey is to provide answers to our research problem and to explain better the obstacles to travel and a comparison between the private and public

transport sector, which makes it possible to propose a more coherent and fluid urban displacement policy.

3.2. *Methodological tool and type of survey*

The methodology of this study is based on the hypothetico-deductive method and data from a questionnaire survey of urban transport users (all modes) in the city of Bejaia. The survey form consists of a series of questions related to the research topic and allows respondents to respond with a significant level of accuracy and objectivity, including an opportunity to illustrate their views so as to suggest support by citing their position. This user survey will focus on the reasons for travelling, the obstacles encountered, the preferred modes of transport and the average expenditure. As part of this study, we opted for the method of empirical and qualitative investigation. We found this to be the most appropriate method for our case following an exploratory research approach through a questionnaire.

3.3. *Conduct of the survey and conditions for its completion*

The investigation took place over a period of 08 months, from 10 January 2019 to 30 September 2019. After collection of the data, the processing was carried out using the software SPSS, software designed for this purpose. Descriptive statistics were first used to analyse the data collected, most often by presenting data in the form of tables and graphs. The closed questions allowed us to proceed to a flat sorting, then to a sorting of items resulting from a comparison of some results obtained, and then cross-sorting the tables and constructions of the graphs on the basis of the survey results, in order to carry out a more detailed analysis, while commenting on the various results obtained.

The survey is distributed by the research team to interested persons. We would also like to acknowledge the invaluable help of groups of students we have taught and inhabited the city. The distribution is done during TD sessions, which are in turn responsible for reaching their families, relatives, friends and neighbours, in order to have the maximum number of responses from different social strata. The questionnaire is also shared on the Google Forms website and on social networks, and we have a return of considerable responses, which are 129 responses.

The number of forms distributed relates to a corpus of 1200 completely anonymous copies. Most respondents demonstrated their commitment to responding favourably to our request and were very cooperative and expressed their views voluntarily. A total of 800 questionnaires were recovered.

Table 1: Counting of questionnaires (Survey results)

	Distributed	**Recovered**	**Google Forms**	**Rejected**	**Returned empty**	**Validated**
Population target	**1200**	800	129	96	51	**782**

Source: Based on survey results, author, 2019.

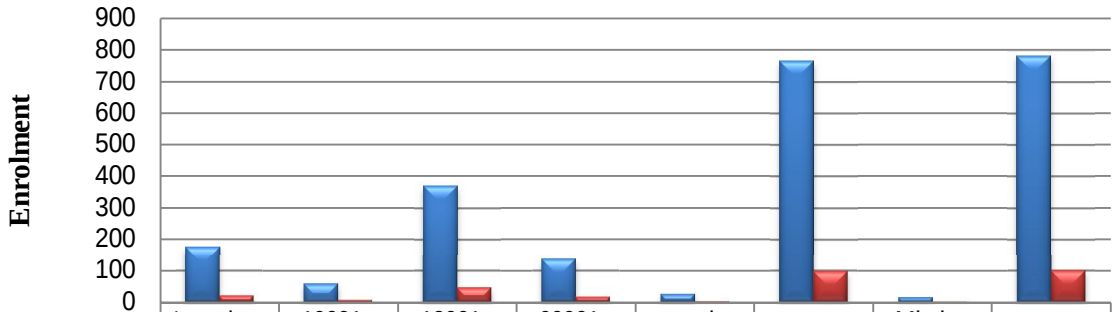
IV. *Results and Discussion:*

4.1. *Socio-economic profile of respondents*

The analysis of the results and their processing by the software SPSS makes it possible to have more illustrated graphs which tend to facilitate reading. Each graph is analyzed according to a flat sorting; through several parameters.

4.1.1. *Population surveyed by average income*

Graph 1: average income (per month in DA)



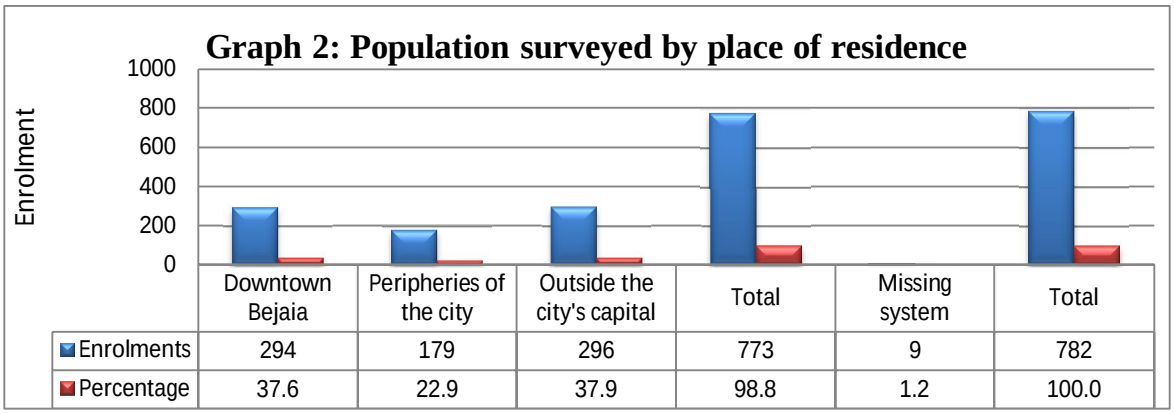
	Less than 10000	10001 - 18000	18001 - 60000	60001 - 100000	more than 100000	Total	Missing system	Total
Enrolments	175	58	370	135	27	765	17	782
Percentage	22.4	7.4	47.3	17.3	3.5	97.8	2.2	100.0

Source: Field survey, author, 2020

In order to know the behaviour of urban mobility, it is essential to situate the socio-economic categories according to the monthly income, this then raises the question of the impact of mobility on the household budget, and therefore reach conclusions that include, for sure, a social dimension by examining the behaviour of households, especially the poorest. The results of the survey show that the average income between 18.001DA and 60.000DA is the highest and represents the population of the middle class, knowing that the national average wage was estimated at 42,300 DA in 2020.(NSO, 2020).

4.1.2. *Population surveyed by place of residence*

Graph 2: Population surveyed by place of residence



	Downtown Bejaia	Peripheries of the city	Outside the city's capital	Total	Missing system	Total
Enrolments	294	179	296	773	9	782
Percentage	37.6	22.9	37.9	98.8	1.2	100.0

Source: Field survey, author, 2020

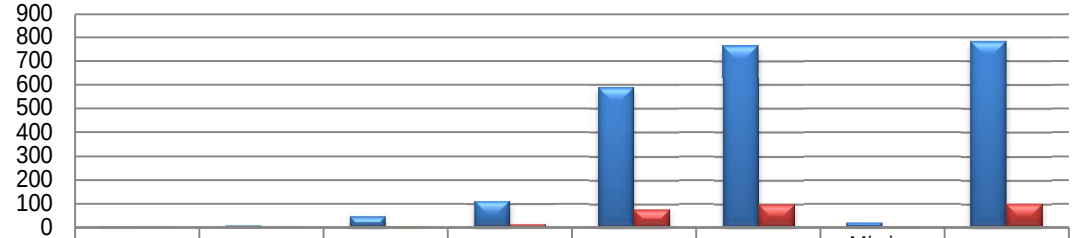
Since travel is not limited to the residents of the city or its outskirts, the results show that the number of respondents outside the city's capital is almost equal to those in the centre of the

city with a percentage of 37.9%. It is known that the city is the place of concentration of activities and the development of markets, it has promoted trade, prosperity, the sharing of knowledge and the well-being of the people who live there. The city is the engine of economic growth, because it represents a centre of attractiveness and innovation characterized particularly by the tertiary dimension of its economy and above all as a place of wealth creation. In the United States, 80% of the population is urban, of which 90% of the national income is created in these squares and which represent 20% of the country's surface area (Clement, 2005).

The high concentration of the population in the peripheries gives a significant percentage of the number of respondents with a rate of 22.9%. This result is explained by the high concentration of the population around the city, which is a new phenomenon in the structuring of urban space which has given rise to the development and extension of urban areas, particularly in peripheral areas; economic and/or social considerations have been at the root of all this.

4.1.3. *Population surveyed by level of study*

Graph 3: Population surveyed by level of education



	Illiterate	Primary	Secondary	Secondary	Academic	Total	Missing system	Total
Enrolments	5	10	47	111	590	763	19	782
Percentage	.6	1.3	6.0	14.2	75.4	97.6	2.4	100.0

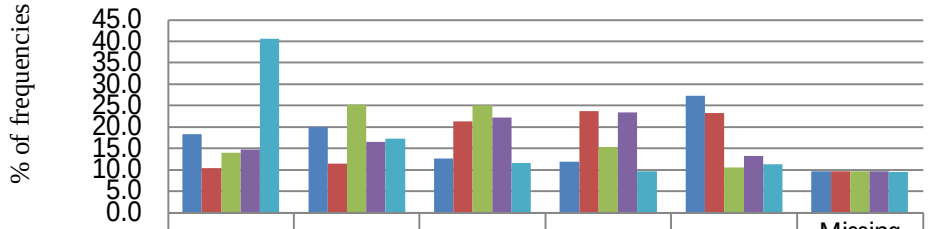
Source: Field survey, author, 2020

Regarding the level of education, we noted that the highest rate of responses was found among those with a university level with a rate of 75.4%. Certainly the objective is not only to target the actors according to this criterion previously mentioned or others, in particular the socio-professional category, but we have considered that they contain categories which can formulate answers objectively and therefore lead to conclusive results of the research.

4.2. *Patterns and modes of travel*

4.2.1. *The mode of travel often used*

Graph n ° 4: Importance of choice of mode of movement



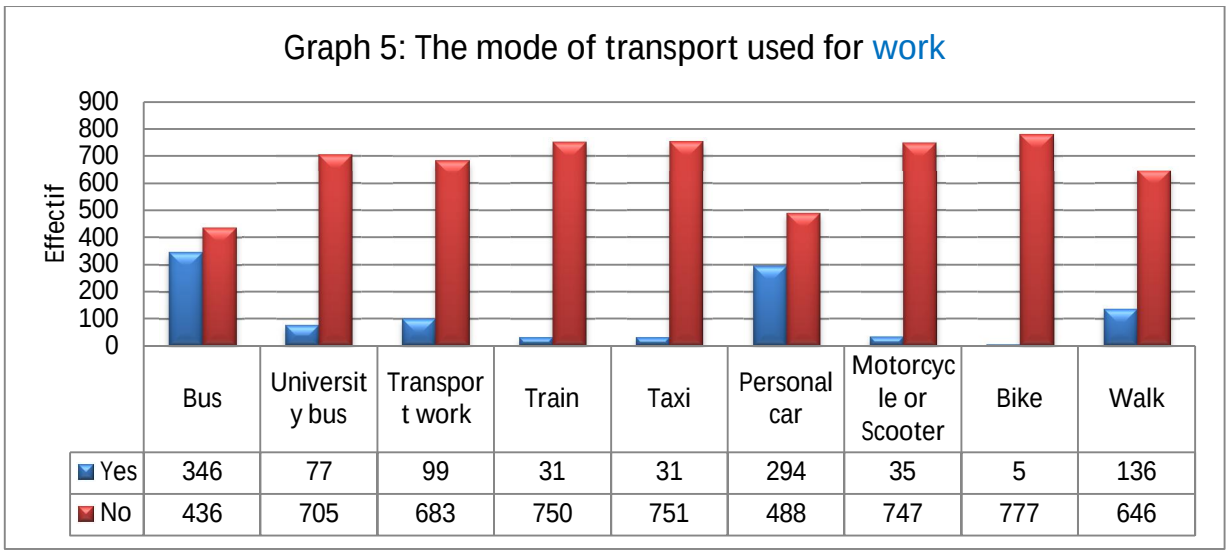
	01	02	03	04	05	Missing system
Your choice of mode of travel is explained by Price	18.3	19.9	12.7	11.9	27.4	9.7
Your choice of mode of travel is explained by Comfort	10.5	11.5	21.4	23.7	23.3	9.7
Your choice of mode of travel is explained by Rapidity	14.1	25.2	25.1	15.3	10.6	9.7
Your choice of mode of travel is explained by Security	14.8	16.5	22.3	23.4	13.3	9.7
Your choice of mode of travel is explained by Availability	40.5	17.3	11.6	9.7	11.3	9.6

Source: Field survey, author, 2020

Concerning the importance of the choice of mode of travel used according to proposed price indications, comfort, speed, security and availability, we found that respondents chose two key parameters: availability and speed, this, however, reinforces the belief that displacement is the primary concern of individuals, taking into account the time factor. In the city, the first problem faced by city dwellers is the availability of means of transport to arrive at the agreed time at the desired place, especially with regard to the reason for business travel. This creates significant congestion and traffic, especially during peak hours, when traffic congestion is observed in the main arteries of the city. To remedy this problem, if only partially to this situation, Emmanuel Munch and Laurent Proulhac propose in their article published in 2019 (Munch & Proulhac, 2019)flexible schedules as a lever for spreading flows.

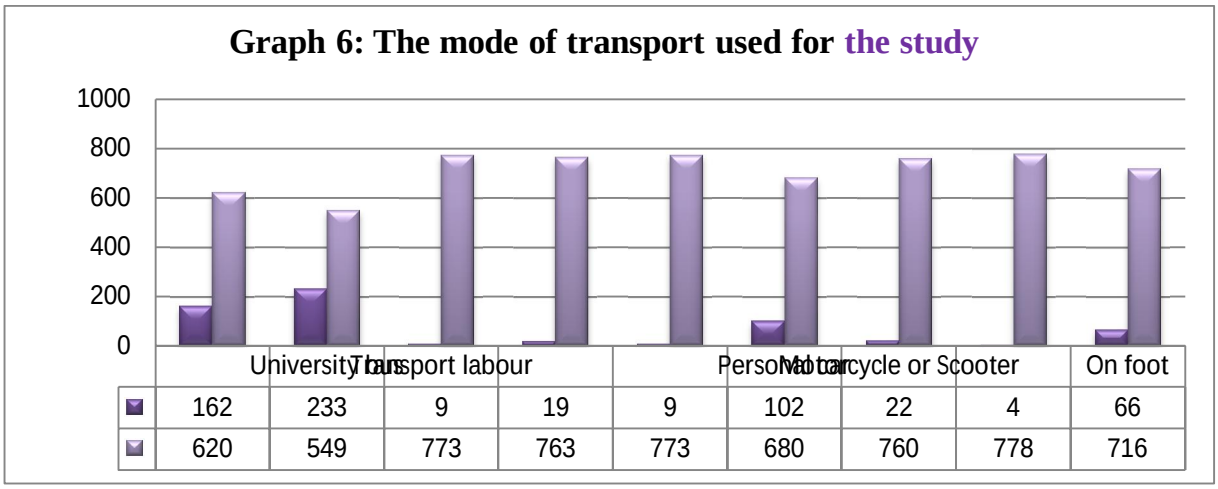
4.2.2. *The mode of travel often used for the reason*

The diversity of modes of transport and the reasons for travel mean that users are looking for the most efficient means of transport. In order to study the reasons for travel, respondents were asked questions about all modes used, and the following results were obtained:



Source: Field survey, author, 2020

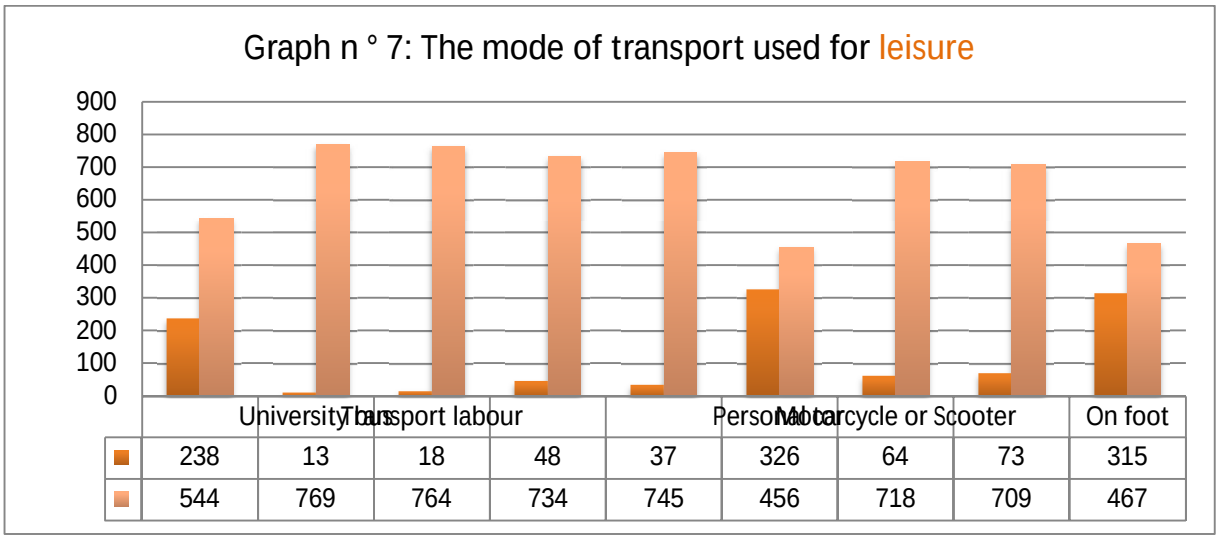
The mode of transport used for work is the bus and the personal car. The other modes their frequencies is minimal. The city is defined as a place of human grouping, resulting from a concentration of activities and dwellings, a privileged space of concentration of means of production, industries, services, capital, communications and information. This privileged place of the city makes a strong pressure on the means of transport, since journeys between the place of domicile and the place of pursuit of the professional activity are a daily obligation, what constrains users has taken either public transport, which is quite common, or the use of the personal car for those who own it.



Source: Field survey, authors, 2020

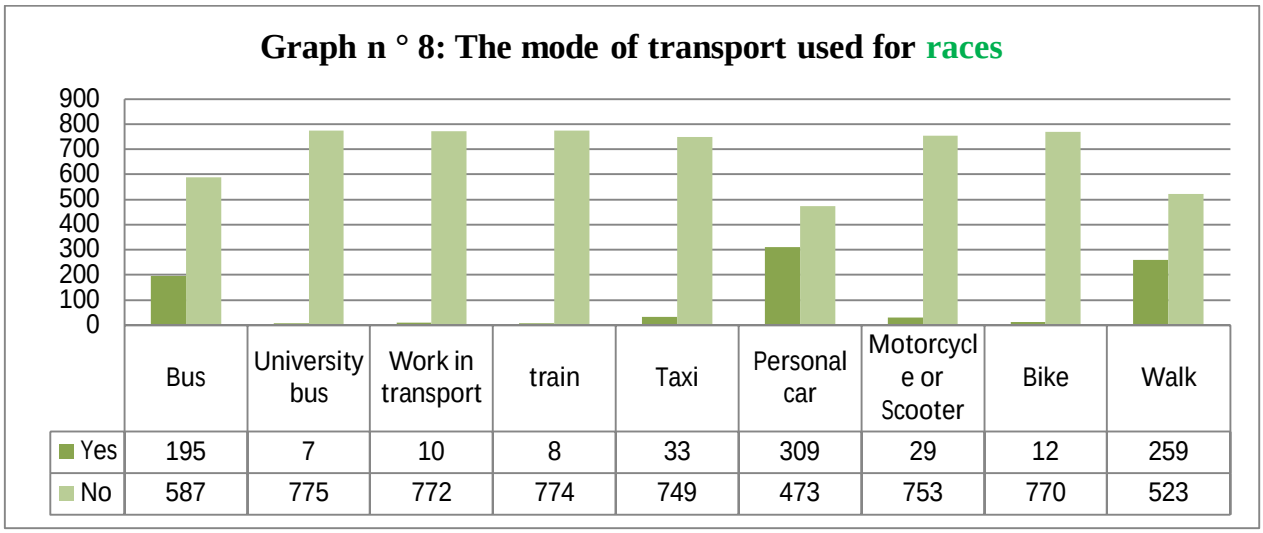
The reason for daily home-study trips is frequent, putting pressure on the means of transport. In France, students spend an average of one hour a day travelling(Belghith, Le Corgne, & Verley, 2013). The responses show that respondents use buses (urban transport) or university transport, the city of Bejaia has a multidisciplinary university, which now has more than 40,000 students. Also aware that schoolchildren benefit from school transport

provided by the municipality (APC Bejaia). The other means are really not borrowed with large frequencies with the exception of the personal car.



Source: Field survey, authors, 2020

Leisure is a luxury and travel for this attraction is only occasionally done especially on weekends. Interviewees see that the means of transport used are buses (30.43%), private cars (41.68%) and walking (40.28%). For the latter case, Bejaia has adequate spaces for walking (along the boulevard of the ALN) and many other places, it is the example of the waterfront of the city of Bejaia, called Promenade Léonardo Fibonnaci, with reference to the famous Italian mathematician of the Middle Ages, who had made it its place of privileged relaxation, the waterfront.

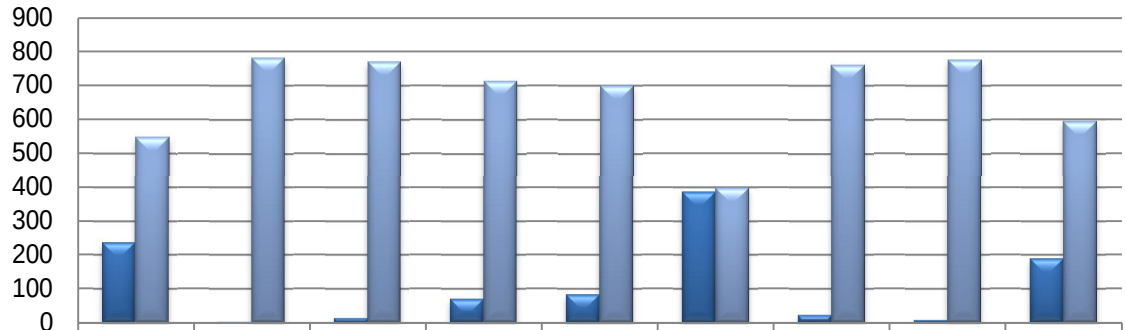


Source: Field survey, author, 2020

The three means of travel mentioned above (bus, personal car and walking) also dominate for the reason of travel to carry out races. The city of Bejaia is a dynamic city with a rapidly changing tertiary sector. This sector is currently in full growth, the wide range of tertiary activities, which include public services, production-related services, personal services,

leisure sectors and others. There are no areas of life that are not related to services in the tertiary sector, the city of Bejaia concentrates a wide range of functions and activities related to the service. Compared to all urban centers in the wilaya, it is home to most of the tertiary sector. As far as commercial activities are concerned, the distribution of different businesses depends on several factors, with population density being the most dominant choice. This activity covers the different types of similar trade (coffee, restaurant, sales shops, supermarkets, etc.). Paradoxically, this distribution is almost equitable, the paradox does not lie in the distribution itself, but rather in its strictly spontaneous nature. It is the result of the choice of the population and does not result from any development program or from any desire to organize the distribution of these activities.

Graph n ° 9: The mode of transport used for Family visits



	236	1	13	70	83	385	22	7	189
	546	781	769	712	699	397	760	775	593

Source: Field survey, author, 2020

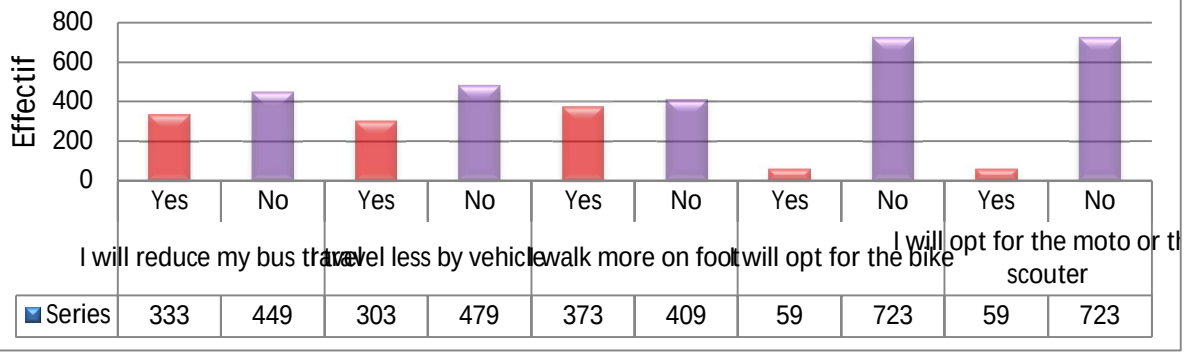
The results show that family visits are made overall by bus (30.17%) or by private car (49.32%), less for other modes of transport. Nevertheless, we note that walking is also used (24.16%), this is explained by the structure of the city where the spatial distribution of the city into residential areas allowed the reunification of families from the same regions. After independence, the rural population began to flock to the city in search of a better life and more remunerated employment in the industry, from 51,794 inhabitants in 1966 to 58,692 inhabitants in 1970. Indeed, from this year and like all the cities of the country, the city experienced a massive influx of rural population coming from the surrounding companions looking for a job, a schooling or a service. The population increased by nearly 72,669 in 1977. However, the marginalization of the southern slopes (Aït Slimane, Aït Bimoune...) which continue to flow massively to the city has caused a transfer of population growth to the suburbs and the emergence of peripheral poles (Tizi, Ihaddaden Oueda/Oufela, Tadjeboujt, Boukhiama, Dar Djbel) and to charge the general population with their own translation of family visits, whether cultural or religious.

4.3. Urban mobility and the energy transition

4.3.1. Urban displacement and the effects of rising fuel prices

In order to determine whether the increase in the price of fuel and the increase in the price of bus tickets have an impact on urban travel and mobility, we found it useful to ask users about their behaviour and the effects of this behaviour on their travel, after the counting, we obtained the following results:

Graph 10: Fuel prices (petrol/diesel) and the increase in the price of the bus ticket compared to the current price



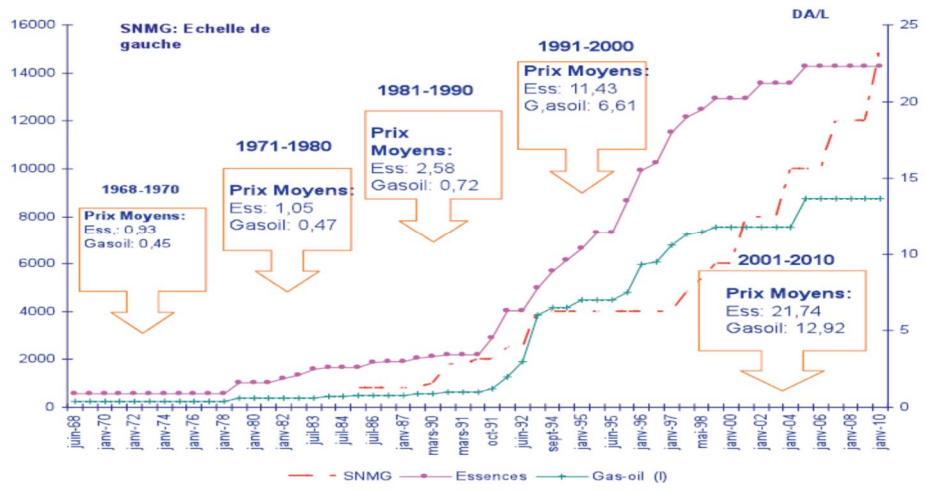
	I will reduce my bus travel		I will travel less by vehicle		I will walk more on foot		I will opt for the bike		I will opt for the moto or the scouter	
	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Series	333	449	303	479	373	409	59	723	59	723

Source: Field survey, author, 2020

In Algeria, a country whose foreign exchange earnings are totally dependent on oil prices, its fuel price has risen several times, sometimes so sharply due to the economic situation and the volatility of oil prices.(Report SONATRACH, 2011). This continued increase did not occur without affecting the displacement behaviour of households. Indeed, the analysis of the graph shows that respondents say they are willing to abandon their usual behaviour by using more bicycles, motorcycles and scooters, which are less energy-consuming modes of transport. Almost all respondents consider it appropriate to use walking. While this increase has led to some apparent behavioural impacts, the same is not true for car use, where households remain focused on the use of this medium.

In the case of the increase in bus tickets, households also consider that they regularly use this means of transport, given the advantages in terms of user costs which often remain within the reach of the average social strata compared to other modes of transport such as private cars.

Graph 11: Evolution of average prices of ground fuels VS SNMG

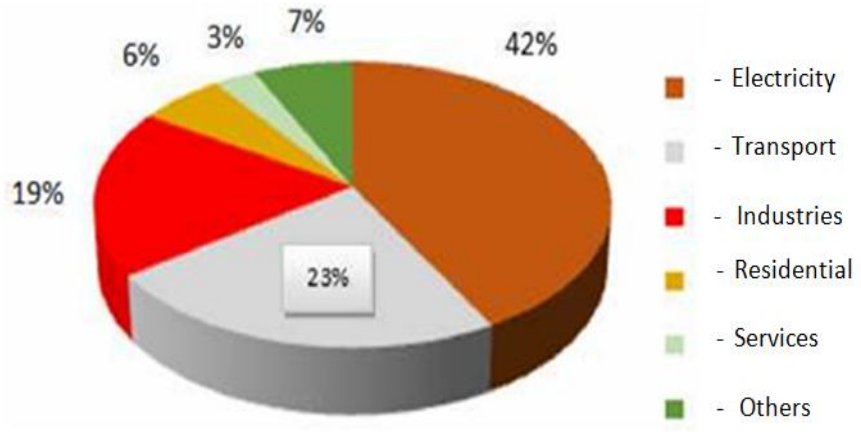


Source: SONATRACH Report (2011): Energy and Mining Sector Performance Reviews (1962-2010) . https ://www.energy.gov.dz/Media/gallery/review _ achievements _ eam _ 1962-2010 _ en _ edition _ 2011 _ 5**b43743a8176a.pdf**

4.3.2. LPG as an alternative source to fossil fuels

Today in the world energy reinvents itself, each country adopts strategies to ensure a smooth transition to renewable energies respectful of the environment, this is the example of the use and generalization of LPG (Liquefied Petroleum Gas) and electric energy. By 2050, all countries can increase the share of renewable energy in their total energy consumption (IRENA, 2018). It is known that the main sources of environmental pollution for the city are caused mainly by transport, which is known to be a source of greenhouse gas emissions, and are constantly increasing significantly, representing significant shares of all emissions as shown in the following figure:

Figure 1: Global CO2 emissions by sector in 2013



Source: Based on OECD/IEA International Energy Agency (2015) report*: "CO2 emissions from fuel combustion" H*igh lights, Edition 2015.

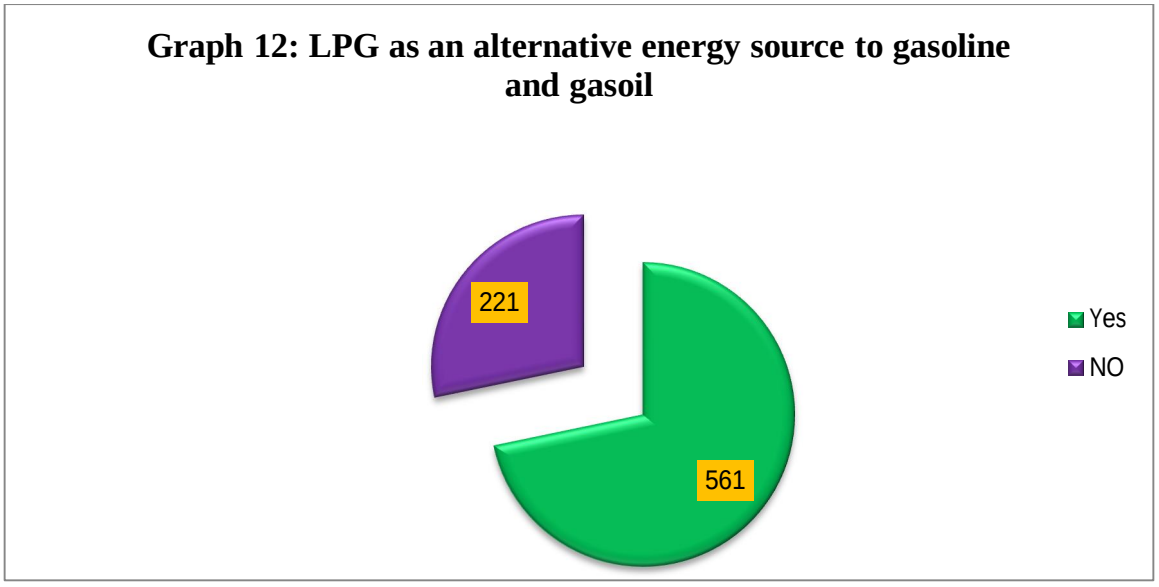
Transport is second in terms of CO2 emissions worldwide. We note that almost two thirds of emissions of these gases come from electricity (heat production) and transport, which account for 42% and 23% respectively. Some studies show that land transport (rail and road) accounts for half of emissions in the same transport sector worldwide (Savy, Buba, Daude, & Auverlot, 2010).

Algeria, like other countries, has put in place a strategy to ensure a transition to a clean and sustainable energy future. In this sense, 500.000 vehicles/years have been converted to LPG, to wait for 1 million vehicles by 2023. We recall that in 2020, there were 400,000 vehicles converted into LPG. Following the same policy, it was recently decided to abolish Super leaded petrol from 1 July 2021, which is considered very harmful to the environment.

Do these decisions have an impact on the mobility and behaviour of transport users? We have sent a series of questions, and we have received the following answers:

4.3.3. *LPG an alternative energy to gasoline and gasoil*

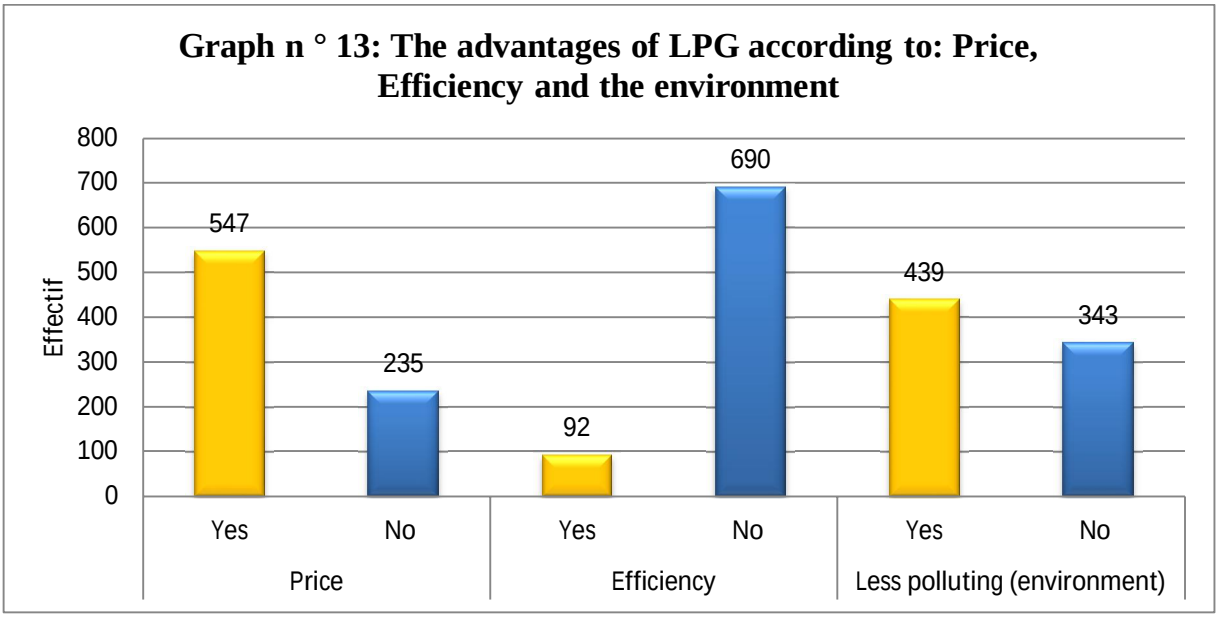
Graph 12: LPG as an alternative energy source to gasoline and gasoil



Source: Field survey, authors, 2020

The results show that most respondents (71.73%) were aware that LPG is an alternative to gasoline and diesel. The media also play an important role through awareness-raising companions, advertising spots to convince motorists to convert to this source of energy. Moreover, the public authorities show a willingness to accompany this operation, this has led to the creation of the Ministry of Energy Transition and Renewable Energy, and policymakers aim to reduce fossil fuel consumption through several renewable energy projects, in particular the conversion of vehicles to LPG consumption, which currently number 200.000 vehicles.(APS, 2022).

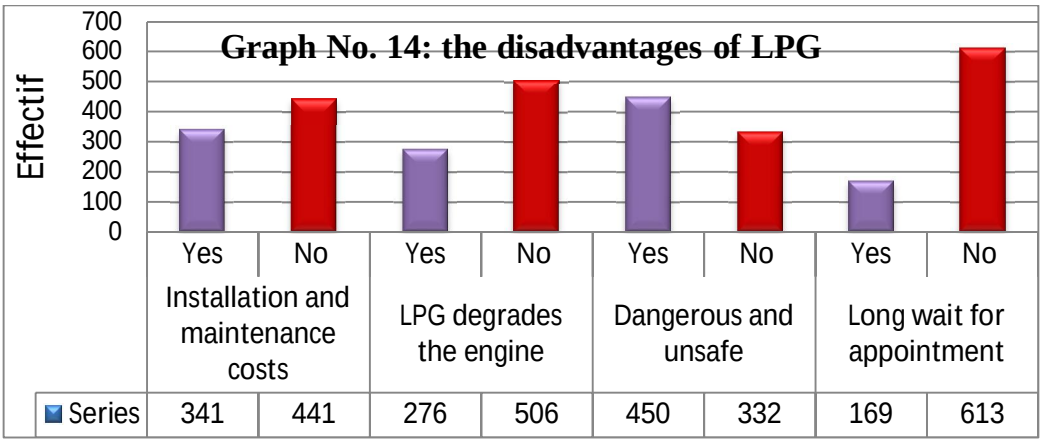
4.3.4. *The advantages of LPG*



Source: Field survey, authors, 2020

Regarding the benefits of LPG, respondents found that the price is advantageous compared to other energy sources, it is set at nine (9) DA/ liters. Algeria ranks first for the lowest LPG price in the world, followed by Kazakhstan at $0.21/ liters, while Azerbaijan ranks third at $0.26/ liters. Given that the world average price is $0.62/ liters (Global Petrol Prices). On the effectiveness issue, respondents found LPG to be less effective at 88.23%. The lack of knowledge of new installation techniques, particularly in terms of safety and efficiency (toric tank), has forced many car owners to convert to this energy, and suggests that this system is damaging the optimal operation of the engine. De facto, this explains this reluctance and this high response rate by "No." Regarding pollution, the respondents recognise that LPG is less polluting, this response is objective, indeed LPG does not contain lead, suffering or benzene, and does not produce harmful particles, which leads us to say that it is a sustainable and clean energy.

4.3.5. *Disadvantages of LPG*



Source: Field survey, authors, 2020

The question asked about the disadvantages of the LPG and about all the proposals made diverge. In fact, in terms of installation and maintenance costs, respondents see 56.39% constraints compared to 43.60% which they consider exorbitant. The only explanation for

this is that the Government's strategy includes a national programme to convert vehicles to LPG, and 50% financial support is provided to encourage owners to use LPG. For engine nuisances, most respondents did not see any drawbacks (64.70%), as new plant methods are currently being introduced and are proving to be more efficient, notably the LPG Kit Italy. On the question of whether LPG is dangerous and insecure, respondents consider it "yes" with a rate of 57.54% compared to 42.45% with "no" answers. The fact that LPG is a liquefied gas, many think it is more flammable, while in reality it is more secure, since a pressure and heat control valve is placed in the tank to avoid the risks associated with explosion and fire. The designers of these tanks consider them more secure than a gasoline tank. Finally, the expectations and appointments to convert to the LPG, the interviewees consider that they do not find difficulties (78.38%). The guardianship has set up several State-approved settlement centers and opened several training centers. A website [1]is created for this purpose, to facilitate contact and make appointments.

5. Conclusion

Urban mobility is a crucial issue for the future of any city, and our results show that in the city of Bejaia, buses and private vehicles are often used for travel. The car occupies an important place and the motorization rate is very high, this dependence on the automobile amplifies the negative externalities of the mobility system and generates pressing problems, notably interrupted congestion. In addition, shortfalls in public transportation, particularly urban transportation, are the main cause of this choice, and urban growth, so abrupt, has led to an increase in transportation needs, while the supply of transportation is inadequate without being able to cope with increasing travel pressures. In this case, this strong demand has subjected the urban transport system to high pressures, this pressure, results in a disorganization of the transport, and a growing pollution.

In a context of a more sustainable, efficient and environmentally friendly energy transition, LPG asserts itself as an alternative source to fossil energy. Despite some drawbacks, the results show that this new energy represents a major challenge to ensure a transition to a sustainable mobility system. However, it is noted that in cities, especially megacities, there is no fully energy efficient system, as transport, including public transport, is one of the main energy consumers in cities. De facto, it will be increasingly difficult to design a perfect system on a daily basis. At the same time, however, the improvement of the public transport network by means of alternative modes such as the development of capacity modes and the integration of public transport in clean sites TCSP (Baouni, 2015) and the use of electric buses can be alternative solutions and are therefore recommended for sustainable urban mobility.

[1]https://www.gpl-dz.com/

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