

Urban transport, systems and models: Innovations and Challenges in developed and developing countries. Case study of an Algerian city (Bejaia)

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Abstract:

This study explores sustainable urban transport systems and models worldwide. Emphasis is placed on a case study of the city of Bejaia, in order to assess the efficiency and sustainability of local transport and user satisfaction with capacity modes.

The research uses a microeconomic approach and a qualitative analysis based on a field survey. The results highlight the need to develop strategies to improve sustainable mobility in developing countries. The results also underline the need to develop strategies to improve sustainable mobility in the city of Bejaia by addressing their specific economic and social challenges.

Keywords: Urban Mobility, Sustainability, Urban System, Innovation

Jel Classification Codes: R41, Q42, Q01, H31

1. Introduction

Sustainable urban mobility and transport policies are complex issues that require integrated approaches. Sustainable mobility strategies have been implemented in many countries, but their success remains limited (Henrik, 2004). The profound change in the demand for transport services in terms of comfort, quality of services added to the emergence of Intelligent Transport Systems (ITS) which have increased their capacity tenfold and contributed to a significant reduction in their costs, are elements which have

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made the transport supply in turn undergo real changes in terms of both technical and organisational aspects. Today, depending on their activities, we can distinguish several models of transport systems in the world, including urban transport. These have evolved dramatically in recent decades, presenting both challenges and opportunities for developed and developing countries (Boutueil & Aguilera, 2018). In addition, modern economies rely on transport systems, which influence the connectivity and mobility of people around the world. There is a great disparity in the evolution of these systems between developed and developing countries, due to several economic, geographical and social factors specific to each nation (Remi Jedwab, Prakash Loungani and Anthony Yezer, 2021). In this context, the purpose of this study is to examine these models of transport systems in various countries, examining both the innovative approaches adopted by developed countries and the complex challenges faced by developing countries. Thus, our objective is to better understand the global dynamics that determine the future of urban mobility on a global scale by analyzing these disparities, taking as a case study the example of an Algerian city in this case the city of Bejaia through some results of a field survey of urban transport users in that city.

2. Methods and Materials

The purpose of this research would be to present some examples of transport systems in developed and developing countries, and to assess their influence on urban mobility and economic development. To clarify the purpose of this study, we ask the main question: **what distinguishes urban transport system models in developed and developing countries, and how do these disparities affect urban mobility?**

To answer this question, we adopted an approach based on a review of the literature on transport systems and their influence factors through examples such as the experience of a few developed and developing countries in order to make a comparison on transport systems, their elements of influence and technological advances. In addition, we have adopted a microeconomic approach, analysing qualitatively the data from a survey of transport users in the city of Bejaia. This methodology will allow us to

conduct a rigorous and comprehensive analysis of an urban transport system model at the local level and in different economic contexts and in different countries.

3. Experiences of some developed countries

Developed countries have taken a lead in all areas over developing countries, it is enough to see that they produce more than 50% of the world's wealth (OECD, 2018), historical reasons (colonization), technological (industrial revolution), cultural and/or civilizational were at the origin. In the field of transport, which has not, however, undergone a revolution affecting all modes, hence the improvement of quality, the search for comfort and the sustainable costs are emerging as not insignificant objectives.

This rapid change has affected all modes, and rail transport is the best example of this, once known as a sustainable mode of transport, since it emits less greenhouse gases, thus a most environmentally friendly mode of transport. The massification and densification of the hinterland framework requires, first of all, an enhanced connection to the road and rail networks. Rail freight is a lever for economic development and an effective means for public authorities to develop strategies to develop and revitalize territories and ensure their development. The use of this means allows a country to take advantage of this territorial dynamic and at the same time be a catalyst for its development through the offered and productive residential dynamics to make it more attractive and competitive. This is the example of the rise of railways in the United States of America in the second half of the nineteenth century. For example, the development of transcontinental links has played an important role in connecting the vast American hinterland to world markets. Today, after the railway boom of the 1840s, many innovations have emerged that characterize this sector, from the steam locomotive to today's electric train. In Canada, rail transport occupies a leading position in both passenger and freight transport, it holds one of the largest rail networks in the world with 48,000 kilometres of track, more than 60% of freight and 75 million passengers transit by rail (PGCR,

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2021), and the latter is operated by two private operators, Canadian National and Canadian Pacific. The role of the State in financing is not insignificant, since its role in helping to increase the competitiveness and sustainability of the sector, it has also provided a legal framework that makes it possible to have an impact on the local and national economy. To this end, in 1996 they promulgated a Transport Act covering the local rail freight sector. (CFIL) for the development of regional and local railways, and in 1977, the public authorities set up *VIA Rail*, a federal Crown corporation whose role is limited to the transport of inter-city passengers, which enshrines the essential nature of this service (Fig. 1). Other forms still exist, such as the company railway, the metropolitan transport network (gtr) and tourist trains.

Figure 1: VIA Rail Rail Corridors Linked to Quebec



Source: Transporting Quebec to Modernity: Sustainable Mobility Policy-2030

https://www.transports.gouv.qc.ca/fr/ministere/role_ministere/DocumentsPMD/PMD-05-cadre-

In European countries, transport plays a vital role, particularly in urban public transport. (Rapid Transit Bus) or BHNS (High Service Bus) as solutions to strengthen existing transport and above all to meet the old basic modes in urban public transport such as buses, tram only modes having the capacity to contribute to significant urban transformations.

A bus with a high level of service also called Busway or Transborder using trolleybuses, are characterized by the high frequency and the hourly amplitude, a route reserved with priority for three-colored lights, they are thermal engine, electric or hybrid. It focuses on some major advantages: fluidity, regularity, frequency and accessibility.

On the other hand, in terms of financing, transportation systems BHNS offer flexibility in terms of infrastructure and its operationalization, and consequently represent smaller budgets compared to other modes that require the construction of expensive structures.

Figure 2: Example of BHNS of Metz



Source: periodical newspaper : La gazette,

<https://www.gazettemoselle.fr/article/metz-metropole-le-transport-urbain-porteur-dune-ambition-environnementale>

In most cases, the BHNS line can carry up to 40,000 passengers a day, equivalent to a tram line, but with an overall difference in traffic. In addition, BHNS proves to be an ideal solution for a configuration of the agglomeration containing narrow routes such as historic districts.

As for BRT (Bus Rapid Transit), otherwise known as Busway or Transitway, it is a high-quality rapid transit system using modern buses with fast services compared to conventional, comfortable and cost-effective bus services. The first use was in Brazil in the city of Curitiba, which entered into service in 1974 by the integrated transport network under the name of "*Rede Integrada de Transporte*." For their traffic, they have the reserved lane, from the stops aligned to the centers to see it taken in order to avoid congestion and the queue (fig. 3).

Figure 3: Example of Downtown Los Angeles Bus BRT



Source: Eyes on the Street: Red Pavement Bus Lane Improvements in Downtown Los Angeles L.A. and East Hollywood, Joe Linton, on March 15, 2022

The tram occupies a place in the transport capacity, it is a modern mode of transport, comfortable and meeting the environmental requirements. Moreover, it is considered both as a tool for urban planning and as a tool for a mobility policy. In France, after the Second World War, this system disappeared in all cities giving way to traditional buses and cars. However, after the second oil shock in 1979, the idea of returning to this mode resurfaced, so that in 1985 the first city, Nantes, was equipped with a tram line followed by the city of Grenoble in 1987 (Sébastien & Harold, 2014). Today, the country has 26 tram networks carrying close to 3000 to 9000 passengers per hour and per direction during peak hours. The Ile-de-France network alone transports nearly 700,000 passengers daily, followed by Strasbourg with 300,000 passengers (Stambouli, 2007).

4. Experiences of the few developing countries

Developing countries are experiencing very significant and steady growth. According to the OECD (OECD, 2018), these countries will account for 60% of global GDP by 2030. Emerging economies, particularly in East and South Asia, took the lead with growth varying from 5.8% to 5.6% in 2018, respectively.

In the field of transport, progress is being made in both the vehicle and the infrastructure (structures and networks).

In China, transport is quite developed, has a most preforming system in the world linking the main cities and provinces. Rail, which occupies an

important place in travel, has been one of the main means of transport for decades. The country has more than 130,000 km of network, which puts it second after the United States. This position is strengthened especially with the widespread use of high-speed trains (TGV), from where the operational mileage of high-speed railways reached 29,000 km, ranking first in the world, the forecasts are for a length of 150,000 railway lines from 2020 onwards.

In urban transport, the Chinese model has operating lines in the form of urban metro and light rail transport in urban areas (Fig. 4). Thus, 37 cities have this system, such as Shanghai, Beijing and Guangzhou.

Figure 4: Urban rail transport in China



Source: ICYMI: Full speed ahead for China's urban rail lines

India, a large Asian country, also has one of the most developed transport systems to meet a demand of 1.383 billion people; in 2019 this sector represents 4.59% of the country's GDP (Road Transportyear Book, 2019-2020). Since the 90 years, economic growth has generated an increase in demand for transport infrastructure and services. However, this sector has not been able to keep pace with demand and is proving to be a brake on the economy. Urban mobility has generated dissatisfaction among users, as the high rate of urbanization affects the quality of services. Indeed, the motorization rate is double-digit as in most developing economies. For example, apart from the capital and 20 cities with more than 500,000

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inhabitants that have an organized transportation system, and only 3 to 4 cities that could qualify for a rapid transit system.

India is adopting a Rapid Transit System (BRTS Bus Rapid Transit System) which exists in several cities. In 2018, 166 cities in the world that has this transport system representing 4,606 km of tracks and about 32.2 million passengers per day. Latin America has the lion's share with 19.6 million passengers and 54 cities with BRT. Brazil leads with 10.7 million, followed by Colombia with 3.06 million and Mexico with 2.5 million. Indonesia is currently considered the country with the largest network of BRT in the world with 385 km with six integrated lines and operated by the company transJakarta (Fig.5) which has become the backbone of the city's public transport (Jauregui-Fung, 2022).

Figure 5: Example of TransJakarta bus BRT



Source : Busworld Asie du Sud-Est et l'expérience du plus long BRT TransJakarta au monde <https://www.sustainable-bus.com/news/busworld-south-east-asia-and-the-experience-of-transjakarta/>

In order to cope with the pressure on public transport, urban dwellers in Asian countries use other means of transport, motorcycles (both wheels). Vietnam is known as the country that has an important share in the two motorized wheels, the podium belongs to it, since it alone represents a share of 95% between Asia and Latin America, about 40 million scooters for 90 million inhabitants. The second place is occupied by Burma and the third by the Vatican with 83.5% and 82.9% respectively.

The Asian preference for two motorized wheels has pushed the authorities to implement new innovations and concerns the two environmentally

friendly electric wheels to ensure a low carbon displacement. Indeed, of the 34 million electric wheels sold in 2014, 28 million returned to the country of Asia compared to 100,000 in the United States and 800,000 in Europe.

The urban transport system in the Maghreb countries is based mainly on traditional transport (mini bus, collective taxi, artisanal transport, etc.). With the exception of large cities with more than 200,000 inhabitants, where all means of transport are available, the other regions are not equipped with these modes (trams, metro, BHNS). In these cities, the motorization rate is high, urban sprawl is at the origin of the motorized city. Cars have become the norm in terms of mobility. In addition, the lack of public transport (TC) has led to an intensive use of artisanal transport, which serves several neighbourhoods in the agglomerations. These are structured according to an unbalanced urban distribution and spread and a massive urbanization in total dichotomy with the rationalization of the space, especially in peripheral areas. These unregulated neighbourhoods are subject to a process of horizontality and densification. They also lack public services and water and sanitation networks. This situation leads not only to an excessive spread of the city, but also to a waste of space, a deterioration of the landscapes and urban living environment and above all the loss of the image of the city. The first most apparent result is that urban transport participates in determining the structure of the city, its configuration and the direction of its evolution.

5. Example of urban transport systems in Algeria (some results of the field survey in the city of Bejaia)

As part of this research, we conducted a study among users of urban transport in all its modes within an Algerian city, in this case the city of Bejaia. The objective of this study is to assess the level of user satisfaction with capacity modes and to understand mobility behaviour in the socio-economic context. The results provided recommendations for improving the quality and efficiency of the transport system.

5.1. Objectives, type and conduct of the field survey

Based on a representative sample of transport users in a coastal city, which includes a large number of constituent elements of a questionnaire with

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specific objectives related to the topic. Nevertheless, this exploratory study aims to determine the mode of travel often used, the number of cars owned by a household, and to measure the level of satisfaction for the metro, tram and cable car.

5.2. Sample selection, general characteristics of the target surveyed

The selection of the survey sample is based on several criteria:

- Frequent transport users in the city of Bejaia,
- Geographical location, that is, the people who live in the city and the adjacent areas who move to the city for multiple reasons.
- The different social and socio-occupational categories taking into account several parameters (age, income sex...)

The questionnaire is distributed by the research team to interested parties. 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 responses, more at least acceptable, which are 129 in number.

The number of forms distributed relates to a corpus of 1,200 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)

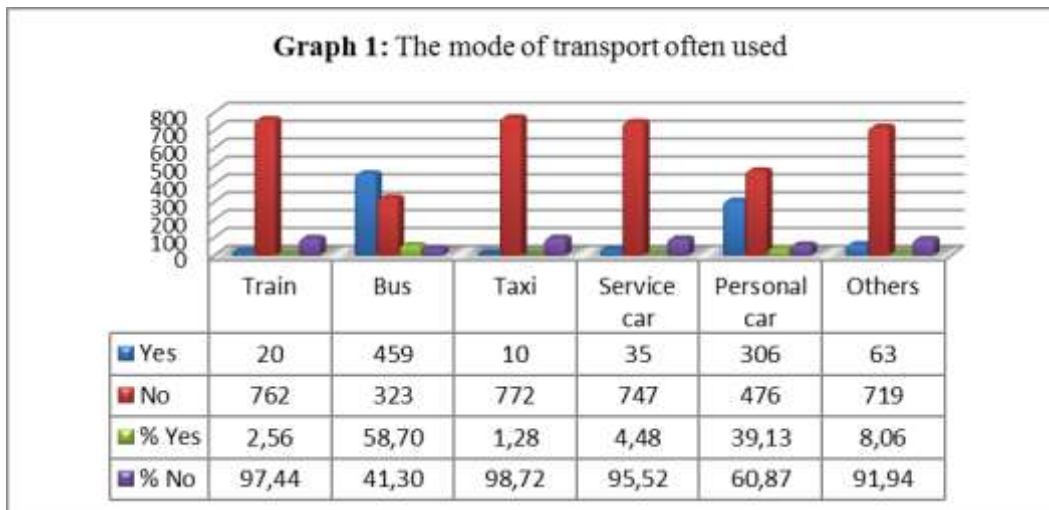
	Distributed	Recovered	Google Forms	Rejected	Returned empty	Validated
Target population	1200	800	129	96	51	782

Source: Based on survey results, authors, 2019.

5.3. Results and Discussion

The behaviour of mobility with regard to socio-economic parameters requires knowledge of the mode and type of movement carried out and the obstacles encountered. These parameters make it possible to obtain information on which there would be conclusions on mobility behaviour and to understand the issues involved in a city undergoing considerable changes in its configuration and everything related to its structure, its economic and social dynamics, its organisation and its spread. The following graphs illustrate the importance of these elements in the opinion of the subjects surveyed.

5.3.1. The mode of travel often used



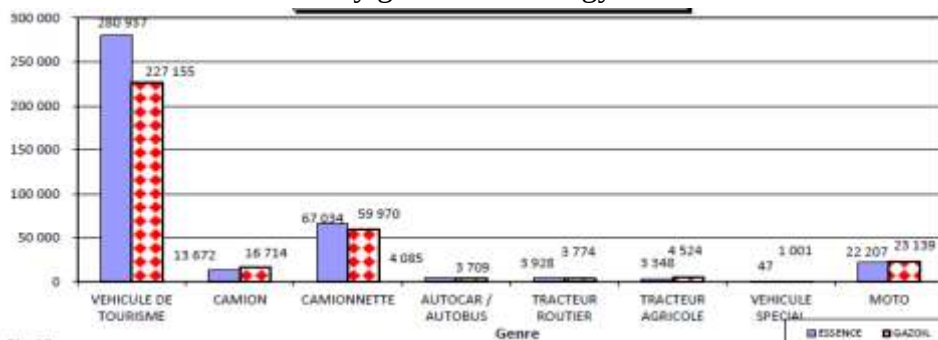
Source: Field survey, authors, 2020

Respondents consider that the mode of travel often used for their travel is the bus with a rate of 58.70%, comes in second place the personal car with a rate of 39.13%, the other modes their share is negligible not exceeding 9%. Public transport by bus is often considered to be the most widely used means of travel in the city; it is recognised that the organisation of urban transport is an effective means and an indispensable response for the proper functioning and influence of the city, and the urban transport system is an integral part of improving mobility aimed at reducing congestion, but also at eliminating environmental impacts and reducing accidents. However, the use of this means is closely linked to a better quality of service of urban

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transport, to ensure better mobility. In Bejaia city, the private sector provides 80% of transport services, while the public operator, ETUB, provides only 20%. The dominance of private operators in transport services is common in most Algerian cities, with the exception of Algiers, where the public operator is dominant. But overall, the inefficient public transport system in Bejaia has led to unreliable and costly urban travel, especially for low-income people and schoolchildren, and has not facilitated alternative modes of transport such as walking or cycling (Merzoug Slimane, Belkhiri Aimad Edine, Hammami Cylia et Mehidi Ludmila, 2023) As for the personal car, due to public transport deficiencies, households consider the acquisition of this means of transport is a necessity earlier than a luxury, it is the dominant mode of transport (Bounouni & Baouni, 2019). This situation has exploded the car fleet in Algeria, according to the ONS, at the end of 2018 the number of cars is estimated at 6,4 million, in particular passenger vehicles, as shown in graph 2, which shows the relatively high number of new passenger vehicles acquired during the first half of 2018, estimated at 508,092 cars.

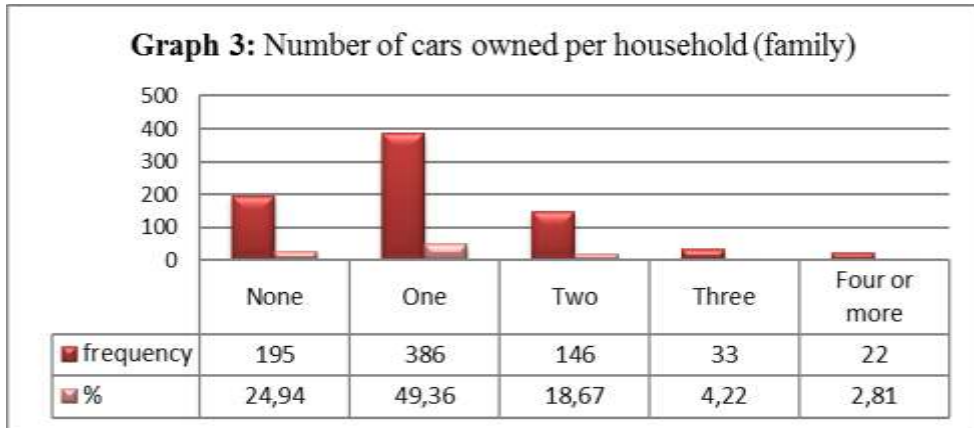
Graph 2: Distribution of registrations of new vehicles in the first half of the year 2018 by gender and energy source



Source: ONS Report n ° 860 "Motor vehicle registrations (first half of 2018)."

<https://www.ons.dz/IMG/pdf/immats12018.pdf>

5.3.2. The number of cars owned by a household



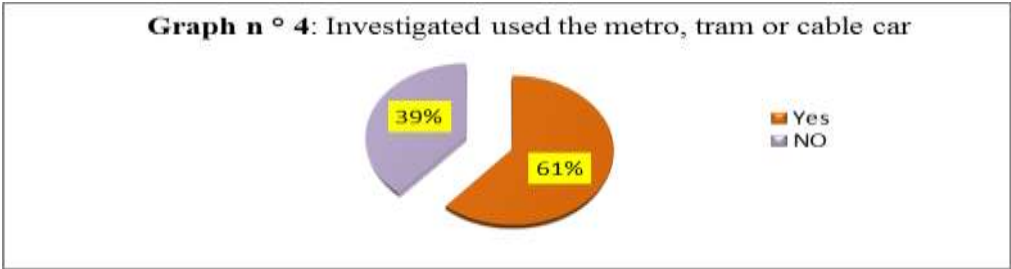
Source: Field survey, authors, 2020

Faced with the lack of urban transport in the city, cars have become the norm in terms of mobility, which explains the relatively high rate of families owning at least one car (49.36%). The city of Bejaia has a high motorization rate, since its spreading is at the origin of the motorized city (urban spread dependent on the automobile). Unlike developed countries, the preference for personal cars is considered a luxury, today, in these countries on average half of households own two cars, as in Belgium, where 54% of couples with children own two or more cars (Belgian Office of Brussels-Statbel, 2021). In France, 37% of households have at least two cars in 2017, with a motorization rate of 84% (INSEE, 2018).

On the other hand, the survey data show that at the same time, the rate of families without cars is relatively high (24.94%). This is explained by the high cost of owning a car, which represents a significant budget. Since mobility can account for up to 30% of household income, households make use of urban transport, which is an important social issue, since it ensures that all social strata travel at a reasonable price. This alternative mode to the private car therefore makes it possible to lighten their loads. It helps to alleviate urban poverty and social exclusion through the creation of stable and skilled jobs, the fight against spatial and social segregation through planning policy to serve the most marginalized areas of the city.

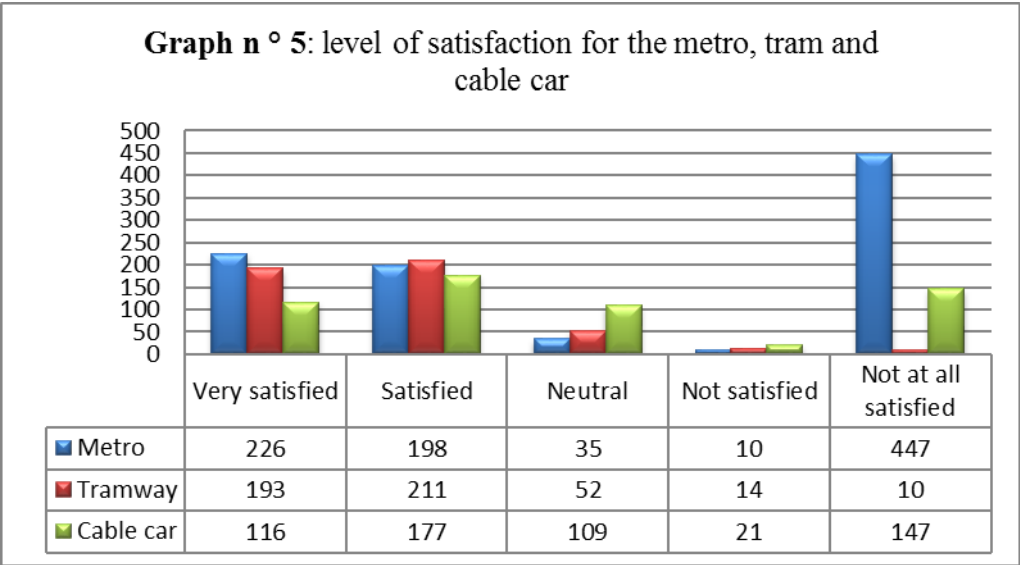
5.3.3. Use of metro, tram or cable car

The question for the interviewees whether they have already used the metro, tram or cable car, and in the case of a positive answer, we asked them to express their satisfaction with their use. We achieved the following results:



Source: Field survey, authors, 2020

It is known that mobility is strongly linked to the use of means of transport, such as Tramway and the metro, especially in large cities. Respondents surveyed, most of whom reported using this transportation infrastructure at a rate of 61%. Knowing that in Algeria only the capital that has a metro and some wilayates having seen recently, from 2015 the entry into operation of a tram. The next question is how satisfied they are even though their deployment is outside the city under investigation. The results are presented in the following graph:



Source: Field survey, authors, 2020

Regarding the use of the metro, opinions are divided almost equally between those who are not satisfied and those who are satisfied. Indeed, thanks to the Algiers metro, the only existing infrastructure, user traffic has been on an upward trend since it was put into operation¹, and will increase in the coming years, thanks to the extension to new areas of the outlying neighbourhoods of the Algeris. The possible non-satisfaction is related to the quality of services (non-respect of time, overloaded during peak hours, is not within the reach of all scholarships...)². As for the use of the tram, a large number of respondents felt that they were satisfied with its use. Indeed, this mode of transport capacity is known as an efficient mode, it has already demonstrated its efficiency in Algerian cities that have acquired it. In Bejaia, it is planned to implement a tram on the main traffic corridors (rue de la Liberté, Krim Belkacem, and/or rue des Aurés), but due to budgetary restrictions, the project was cancelled, while this mode of transport constitutes an engine of urban development and an effective solution for travel problems (Merzoug, 2017).

The European countries saw the revival of urban public transport in the 90 years, among these modes the tram which has experienced a considerable increase in recent years after a period of decline in the 70-80 years. Its beginnings date back to the 1830s in the United States, after which Europe invested in these projects following the increasing saturation of urban roads. In response, policymakers have identified the need to reinvigorate mobility and transport policy. Trams play an important role thanks to their advantages, including urban rehabilitation and the establishment of a balanced urban system, and contribute, *inter alia*, to reducing road congestion, which makes them an indispensable tool for urban development and the sustainability of cities. It is more suitable for medium-sized cities where urban space is scarce to consider building a metro (Rubén C. Lois González, Miguel PazosOtón, Jean-Pierre Wolff, 2013).

Annual ¹attendance increased from 11.3 million in 2012 to 40 million in 2018 (RATP El Djazair).

²A household survey in the future will determine the exact reasons for the non-satisfaction of users.

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For the use of cable cars, opinions are also shared between those who are satisfied and not satisfied. This mode of transport does not offer the same advantages as other modes of transport in terms of capacity and services. However, it is a means of facilitating mobility and reducing travel-related problems.

In general, public transport in clean sites (TCSP) represented by the metro and tram can be alternative solutions by integrating the various modes of transport for mass transport into the network, on the one hand, and ensuring complementarity with other modes of transport, on the other (Baouni, 2015).

6. Conclusion

At the end of this study, we highlighted the different urban transport models that aim to improve urban mobility. Cities around the world face a crucial challenge: sustainable urban mobility, which requires comprehensive planning and innovative policies. By integrating efficient transport models, the process for sustainable urban mobility can be improved, promoting green transport, improving energy efficiency, promoting exclusivity and reducing congestion, while supporting economic growth.

Urban development has led to a rapid increase in the number of passengers and freight in urban areas. In most cities, mobility of people or freight is a priority for public authorities in order to streamline traffic and avoid inconvenience to both users and businesses. The efficiency of transport systems depends mainly on the satisfaction of people's movements and the achievement of economies of scale. This includes the use of more environmentally friendly, cheaper and efficient modes of transport such as trams, buses and urban ferries. This takes into account factors such as city structure, density, household income, level of development and mastery of technology.

The governance of transport, particularly in urban centers, through the establishment of regulatory measures for management, planning, financing and integrated decision-making by the competent bodies, makes it possible to better manage urban transport, the objective of which is to reduce congestion and the emission of greenhouse gases. For this reason, each

country is aware of the central role that transport can play in economic dynamism and in meeting travel needs. Choices of mode of transport are linked to several parameters related to the structure of the city, the experiences of developed and developing countries show that the characteristic feature is the strategies to be implemented in order to cope with rapidly increasing urban mobility. Developed countries use capacity modes such as rail, metro Tramway, BHNS, BRT}. On the other hand, other countries with a limited level of development use traditional means of transport in densely populated urban centers (mini buses, collective taxis, etc.). Asian cities and in view of the acceleration of urban growth and to cope with the inadequacy of their public transport network use motorized or electrified two-wheeled transport (motorcycle, bicycle or electric scooter). The city of Bejaia, which for several years has experienced an upward increase in its urban population from 149,254 in 2000 to 194,277 in 2022 (DPSB, 2000-2021), suffers from a lack of organization and management of its urban transport system. Today, practical solutions to traffic-related problems must be geared towards meeting travel needs and increasing the fluidity of the various transport networks. The results show that the very limited use of capacity modes of transport (e.g. a tram) due in particular to economic constraints, inadequate infrastructure and the scarcity of urban space.

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