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Indicators for the evaluation of sustainable mobility in Algiers metropolis by 2035

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Abstract **–** Sustainable mobility has become a pressing issue for cities worldwide, including Algiers, the capital city of Algeria. The city is currently facing challenges related to traffic congestion, air pollution, and greenhouse gas emissions. In response, the Algerian government has developed the Master Plan for Urban Development and Planning (Plan Directeur d'Aménagement et d'Urbanisme PDAU) and the Strategic Plan for Algiers (Plan Stratégique d'Alger PSA) to guide sustainable urban development in the city. To support the implementation of these plans, this study aimed to develop an inventory of indicators for the evaluation of sustainable mobility in Algiers based on the objectives of the PDAU and PSA to 2035. The study employed a mixed-methods approach, including a literature review and expert consultation to identify relevant indicators. The literature review revealed that several indicators have been used to evaluate sustainable mobility, including those related to accessibility, safety, air quality, and transport mode choice. Based on the literature review and expert consultation, the study identified 13 indicators for the evaluation of sustainable mobility in Algiers, which were classified into six categories: accessibility, safety, environmental impact, transport mode choice, land use, and economic performance.

The findings of the study can be used to inform the development of policies and strategies for sustainable mobility in Algiers. The inventory of indicators can also serve as a framework for monitoring and evaluating the progress of the PDAU and PSA in achieving their objectives related to sustainable mobility. Overall, this study contributes to the growing body of literature on sustainable urban mobility and provides insights into the specific context of Algiers.

Keywords – Sustainable Mobility, Algiers, PDAU, PSA, Evaluation Indicators

I. INTRODUCTION

In recent years, sustainable mobility has gained increasing attention as a critical issue for urban development worldwide. It has become clear that the traditional approach of relying on private car use is unsustainable due to negative impacts on the environment, public health, and social equity (Litman, 2020). Cities around the world are therefore seeking to develop sustainable mobility systems that prioritize public transportation, active transportation, and alternative modes of mobility (United Nations, 2019).

Algiers, the capital city of Algeria, is no exception to this trend. The city is currently facing significant challenges related to traffic congestion, air pollution, and greenhouse gas emissions (Benouar

et al., 2020). To address these challenges, the Algerian government has developed the Master Plan for Urban Development and Planning (Plan Directeur d'Aménagement et d'Urbanisme PDAU) and the Strategic Plan for Algiers (Plan Stratégique d'Alger PSA) to guide sustainable urban development in the city (Ministère de l'Habitat, de l'Urbanisme et de la Ville, 2018).

However, to effectively implement these plans, it is crucial to have a set of evaluation indicators to measure progress towards sustainable mobility goals (Bertolini & le Clercq, 2003). In this context, this study aims to develop an inventory of indicators for the evaluation of sustainable mobility in Algiers based on the objectives of the PDAU and PSA to 2035.

1. Urbain mobily in Algiers : reality and perspectives

Since its independence, Algiers has not stopped attracting the population from within the country, as for most of them, it represented the ideal city to live in with all the services it offers and better accessibility, reflected by a varied transport network.

However, the transport network has provided attractiveness and urban dynamism that we cannot find elsewhere. These urban phenomena are ensured by the various means of transport.

Therefore, this diversity in terms of means of transport is the result of the travel demand of the Algerian population, a population that has undergone several urban developments: urban sprawl, automobile dependence...

However, these urban developments have completely changed the lifestyle and travel of citizens. Thus, the study of new urban mobility in Algiers was deemed necessary for the establishment of strategies and for the understanding of transport needs.

Thus, two main household surveys (1990 and 2004) were carried out to understand mobility, travel motives, and modal distribution. Today, the capital is experiencing increased motorization linked to urban sprawl, which appeared on the one hand due to demographic pressure, and on the other hand due to planned relocation operations aimed at improving the standard of living by eradicating slums and wishing to make Algiers a metropolis.

Furthermore, the improvement of the quality of life and the evolution of household incomes, the importation of vehicles, the reduction of taxes, the cost of fuels, and the enthusiasm of Algerians for this mode of transportation have been the major issues of the automobile dependence in Algiers.

At present, urban mobility in Algiers has even undergone a scale upheaval and has become metropolitan. Thus, this transition from urban mobility to metropolitan mobility has only generated problems in terms of transport management and planning.

Faced with the problem of automobile dependence and the ambition to become a metropolis, Algiers attempted in its latest SDAAM[1] to develop, renovate, and reorganize transport modes to make its transport network more efficient and sustainable.

To do so, the implementation of TCSP[2] (Bus Rapid Transit) was carried out to improve road traffic within the metropolis. However, these TCSPs have suffered several problems since their implementation, which continue to decrease their performance and efficiency.

Among the problems encountered by the TCSP (Tabti-Talamali in 2018) are:

- The exploitation of TCSP lines by private bus transporters competing on profitable routes
- The lack of connection and interchange points between collective transport lines
- The weak restructuring of transport lines around the TCSP framework

[1] SDAAM : Schéma de Développement de l'Aire Métropolitaine d'Alger : Schema for the Development of the Metropolitan Area of Algiers

[2] TCSP : Transport en Commun sur Site Propre : Bus Rapid Transit

- The absence of control over road traffic
- Dysfunctions in traffic lights
- Archaic parking management
- Road safety problems
- The insufficient implementation of tariff measures with a single ticketing system across all operators.

Thus, the development of infrastructures is not the simple and unique solution to traffic problems in Algiers, as the problems in the capital are deeper than they appear and require more advanced solutions in terms of management and governance.

However, in its latest PSA and PDAU development plans for 2035, Algiers envisaged several solutions through several structuring projects that have already been adopted and aimed at several objectives.

Among all the projects, we note that the projects to extend the subway and the railway line contribute to improving sustainable mobility, while other actions encourage the use of automobiles.

However, projects alone are not enough to promote sustainable mobility in Algiers, and therefore the search for the issues of sustainable mobility in Algiers is necessary for understanding the situation and better finding solutions.

2. Toward a sustainable mobility: objectives of PDAU and PSA of algiers

To frame the post-independence urban dynamic, several urban planning instruments have been put in place to organize and plan the urbanization of Algiers after independence (see table 01).

Table 01: The different post-in depend urban plans and master plans of Algiers (from 1962 to 2015)

The plan	**The period**
The urban planning plan of the former colonial organizations CADAT and the ex-Plan Agency (Urban Planning Office of the Algiers Region)	1962 - 1968
The urban planning plan of COMEDOR with two structure schemes (the scheme developed by ECOTEC and the scheme proposed by Oscar Nemeyer)	1968 - 1975
The General Orientation Plan (POG)	1975 - 1986
The Director Urban Planning Plan (PUD)	1986 - 1990
The PDAU and POS	1990 - 2012
The Grand Urban Project GPU	1997 - 2000
The revision of the PDAU and the desire to create a metropolitan area	In 2015 by 2035

Source: Author, 2022

The desire to make Algiers a metropolis came after the abandonment of the GPU, where several equipment and housing programs were implemented based on land availability at a time when local authorities had no official urban planning instrument.

However, the need for urban regulation was felt around 2005 with the development in 2007 of a SNAT[3] which for the first time addressed the issue of the metropolization of Algiers. Thus, the elaboration of a SDAAM in 2008 constitutes a first response to this metropolization, on the one hand by the installation of a development commission and a Metropolitan Area Management Agency; and on the other hand, by the establishment of several objectives.

[3] SNAT : Schéma National d'Aménagement du Territoire : National Territorial Planning Scheme

Like the SDAAM, the examination of the different phases of the study of the PDAU of Algiers by 2035 allowed us to summarize the objectives of this instrument aimed at improving the quality of life and the international image of the capital. Among the objectives set by the PDAU of Algiers by 2035:

- Algiers as an international "capital", a hub connecting the national territory to the world.
- Algiers as an "urban region", a pivot for balanced and solidarity development of its territories.
- Algiers as a "pole of excellence", an engine and a showcase of tertiary development in Algeria.
- Algiers as "the White City", a city where modernity follows in the footsteps of history.
- Algiers a a "city in its own right", a territory managing its urban sprawl and organizing its extension
- Algiers as a "city of mobility and proximity", a pleasent city to live in.
- Algiers as a "sustainable city", an example in terms of nature preservation and protection against natural and technological risks.

However, the PDAU emphasized through its guidelines the project of metropolization for the strenghening of Algiers as a capital city and a territory of excellence as a fundamental condition for Algeria's success in the globalized world. Thus, as part of the metropolization of Algiers, the first step was the elaboration of a development plan for Algiers, followed by a master plan PSA in 2001, which accompanied the revision of the PDAU and whose objectives were to makeAlgiers an eco-metropolis of the 21st century with the establishment of an eco-thematix triangle of development for the capital, three axes of which were highlighted and details according to thematic plans.

Each thematic plan groups a certain number of structuring projects, even prioritized for the development of the eco-metropolis of Algiers. There are 82 projects, the implementation of which on the territory of Algiers appears strategic. According to the PDAU of Algiers, "they will provide immediate solutions that can be quickly executed, which address the urgent problems of the city of Algiers. They will trigger a process of change that will have a mimetic effect throughout the entire territory" (PDAU of Algiers, 2015). These projects, launched gradually over periods of 5 years, will contribute to the attractiveness and brand image of the capital Algiers and enable it to transition from a city to a global city in four stages:

- Step 01 between 2009 and 2014: Algiers, the fiftieth anniversary of independence
- Step 02 between 2015 and 2019: Algiers, the major international event
- Step 03 between 2020 and 2025: Algiers, the eco-metropolis of the Mediterranean
- Step 04 between 2025 and 2029: Algiers, a global city.

From now on, the flagship structuring project considered as the most important is the development of Algiers, the capital's first showcase. This project, which is progressing rapidly, has already received a lot of positive feedback, such as the return of the coastal city, which was slowly cut off from its sea by physical constraints (the Moutonnière). These new updated urban planning tools bring a new conception of the capital's image compared to previous urban planning tools that were once classical and whose objectives were the planning and organization of the urban area based on demographic needs. But unfortunately, these tools have encountered difficulties and limitations in their implementation, on the one hand, by the actors responsible for their initiation and, on the other hand, by the regulatory procedures that govern them (Laiche & Si-Mohamed, 2016). Therefore, to become a metropolis, Algiers must position itself on the international scene by establishing a mode of governance that allows for development and wealth creation in various sectors. Thus, the development of transportation infrastructure, through the improvement of mobility and accessibility conditions and the use of new sustainable modes of transportation, constitutes a major factor in the metropolization process by directing activities and people in the Algiers agglomeration.

3. Measuring Sustainable Mobility: The Vital Role of Indicators in Evaluating

Indicators play a crucial role in evaluating sustainable mobility, both globally and locally in cities like Algiers. According to Litman (2018), indicators can be used to track changes in various mobility-related factors such as travel behavior, mode choices, transportation infrastructure, and environmental impacts. These indicators are essential tools for measuring the effectiveness of policies and programs aimed at promoting sustainable mobility and reducing reliance on private automobiles.

There are several global and local indicators used to evaluate sustainable mobility. For example, the Sustainable Mobility Index developed by Arthur D. Little (ADL) who evaluates and ranks the mobility of 100 cities worldwide based on three dimensions: social sustainability, environmental sustainability, and economic sustainability (ADL, 2021). In Algeria, the Ministry of Transport and Public Works developed a set of mobility indicators to measure and evaluate the mobility situation in the country and identify areas for improvement (MTPT, 2016).

In Algiers, the local government has implemented a set of indicators to evaluate sustainable mobility. For instance, the Algiers Sustainable Mobility Plan (SMP) developed by the Algiers Metro Company includes indicators to measure the modal share of public transportation, the length of bike paths, and the reduction of greenhouse gas emissions (Algiers Metro Company, 2020). These indicators help the local government to assess the progress towards achieving their sustainable mobility goals and identify areas where they need to allocate resources and take action.

In summary, indicators play a crucial role in evaluating sustainable mobility, both globally and locally in Algiers. They provide a framework for measuring the effectiveness of policies and programs aimed at promoting sustainable mobility and reducing reliance on private automobiles. Through the use of indicators, policymakers can identify areas for improvement and allocate resources efficiently to achieve sustainable mobility goals.

II. MATERIALS AND METHOD

In order to find indicators for the evaluation of sustainable mobility in Algiers based on the objectives of the PDAU and PSA of Algiers by 2035, we followed a similar approach to that adopted in the development of indicators derived from the sustainable development goals (SDGs) adopted in September 2015 by the United Nations General Assembly.

We specify that the number of the Sustainable Development Goals (SDGs) were 17, with 169 targets and 230 monitoring indicators. These goals were at the heart of the 2030 Agenda "a master plan to achieve a better and more sustainable future for all and for the world by 2030" (UN, 2017).

These indicators, although indirectly mentioned in the agenda 2030, cover general themes such as access to services, road safety, sustainable transport, energy consumption, quality of road infrastructure, and partnership. These indicators thus remain general and applicable to diverse territories.

In this section of the article, we show how the objectives of the PDAU and PSA for the horizon of 2035, which were developed in detail in the theoretical part of the article, will be interpreted into indicators of sustainable mobility. This will be done by drawing inspiration from those established in Agenda 21, following the scheme presented in (see Figure 01).

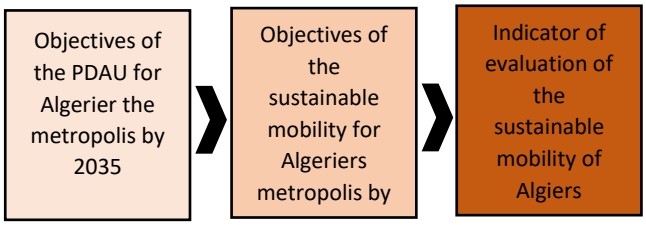

Figure 01: Process followed for the development of indicators for sustainable mobility in Algiers. Source: author, 2022

To implement our approach, we will take each objective of the PDAU for the horizon 2035 for the Algerian metropolis and deduce sustainable mobility objectives and thus, sustainable mobility indicators for the case of the Algerian metropolis.

III. RESULTS & DISCUSSION

1. **Evaluation indicators of the sustainable mobility from the objectives of the PDAU of Algiers**

The implementation of our approach allowed us, first, to deduce, based on the objectives of the PDAU for the year 2035, indicators for evaluating sustainable mobility for the case of the Algiers metropolis. That we detail in the table below (see table02).

From the table (see table 02) where indicators of evaluation of the sustainable mobility for Algiers were identified based on the objectives of the PDAU, we notice that the selected indicators fall under the following themes:

- International transport and metropolization,
- access to transport,
- modernity and sustainability of transport,
- energy consumption,
- proximity of travel.

These themes represent key issues for sustainable mobility in Algiers that can be evaluated by the selected indicators in order to achieve the objectives of the PDAU by 2035.

In addition to the objectives of the PDAU for 2035, the PSA which was established as a complement to the PDAU aimed to develop the capital on the principle of eco-metropolization.

Three thematic axes were therefore put in place for the development of the capital, with mobility and transport being addressed in the Mobility Plan which is part of the third eco-development theme with the following objectives:

- Definition of a new urban mobility strategy
- Macro-networking of the capital

Regarding the first objective which defines the new urban mobility strategy for Algiers, it aims to implement the principle of eco-mobility or sustainable mobility for Algiers. It should be noted that this strategy was already projected as an objective within the PDAU for Algiers by 2035.

The second objective concerns macro-networking, which aims to revise urban infrastructure in order to enhance structuring equipment at the intersection of major roads and near means of transport while promoting inter-modality in Algiers. Therefore, the accessibility measurement is the main evaluation indicator that can assess this second objective of macro-networking.

As shown in Figure 02 (see Figure 02), we can therefore deduce two main indicators for the evaluation of mobility in Algiers based on the two objectives of the Mobility Plan in the PSA by 2035.

In summary, the indicator derived from the PSA strategic plan for the horizon 2035 is the measure of accessibility. This will be added to the indicators derived from the objectives of the PDAU to ultimately reach 13 indicators of sustainable mobility for Algiers by 2035.

In conclusion, the objectives of the PDAU and PSA for the horizon 2035 have allowed us to derive 13 indicators of sustainable mobility addressing various themes, including **sustainable transportation** and **energy consumption**, which are not only present in both plans but also in different indicator systems around the world. This explains why the environmental aspect of transportation is the most important aspect when evaluating sustainable mobility, compared to the other two aspects of social and economic development.

For the case of Algiers, the emphasis on sustainability, ecology, and energy consumption for mobility in both plans perfectly explains that urban transportation in Algiers faces many environmental challenges in addition to problems of congestion and road safety.

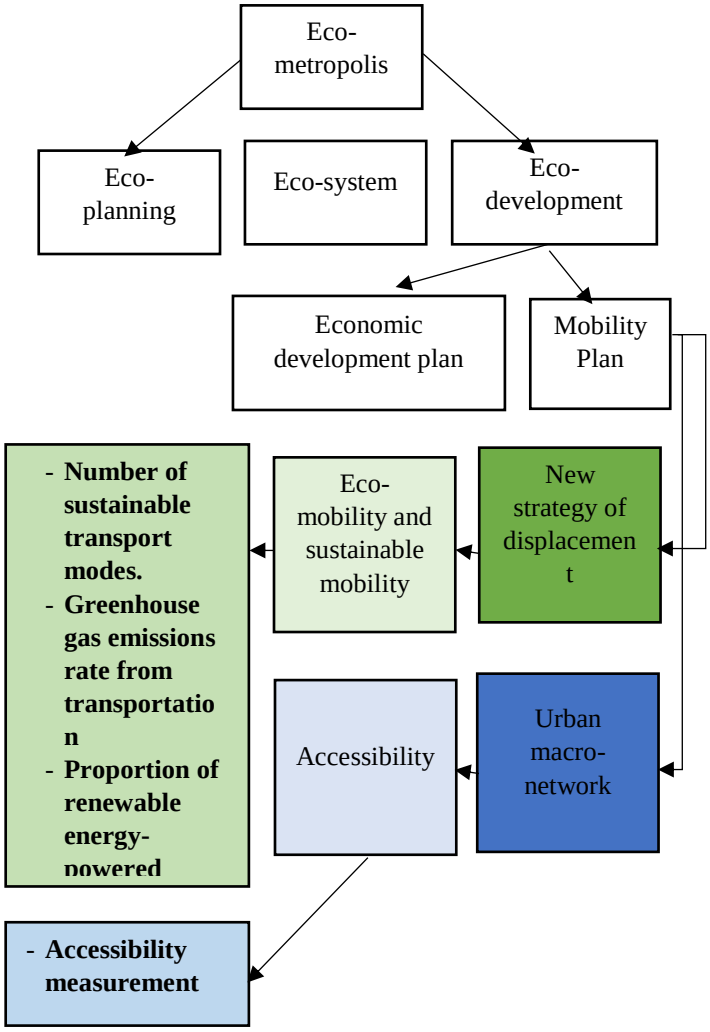

Figure 02: Process followed for the elaboration of indicators of evaluation of the sustainable mobility in Algiers from the objectives of the PSA of Algiers by 2035 Source: Author, 2022

Table 02: Indicators of evaluation of the sustainable mobility of Algiers deduced from the objectives of the PDAU

Objectives of the PDAU of Algiers metropolis by 2035	**Objectives of the sustainable mobility of Algiers metropolis by 2035**	**Indicators of evaluation of the sustainable mobility of Algiers metropolis by 2035**
Algiers as an international "capital", a hub connecting the national territory to the world.	By 2035, the goal is to equip Algiers with a transportation system of international quality and a road infrastructure befitting a metropolitan city.	- **Quality of transportation in international standards.** - **Quality of road infrastructure and transportation in international standards.**
Algiers as an "urban region", a pivot for balanced and solidarity development of its territories.	By 2035, the objective is to ensure access to transportation for everyone in order to achieve balanced development in terms of mobility throughout the urban territory of Algiers.	- **Proportion or percentage of the population with access to urban transportation.**
Algiers as a "pole of excellence", an engine and a showcase of tertiary development in Algeria.	By 2035, the plan is to strengthen and boost technological research in the field of sustainable transportation and mobility.	- **Technological advancement rate in the field of sustainable transportation and mobility.**
Algiers a a "city in its own right", a territory managing its urban sprawl and organizing its extension	By 2035, the aim is to reduce distances and decrease travel through a high-performance transportation system that controls urban sprawl.	- **Number of municipalities connected to each other and to the city center by transportation.** - **Number of trips provided by transportation for various reasons per day.**
Algiers as a "city of mobility and proximity", a pleasent city to live in.	By 2035, transportation in Algiers will be a driving force for development, modernity, quality, and proximity.	- **Motorization rate by sustainable transportation.** - **Quality of transportation in terms of movement.** - **Rate of modernity of transportation.**
Algiers as a "sustainable city", an example in terms of nature preservation and protection against natural and technological risks.	By 2035, Algiers will be a city of sustainable mobility.	- **Number of sustainable transportation modes.** - **Rate of greenhouse gas emissions by transportation.** - **Proportion of transportation using renewable energy.**

Source: Author, 2022

IV. **CONCLUSION**

In conclusion, the evaluation of sustainable mobility is crucial for cities around the world, including Algiers. The development of sustainable mobility requires the implementation of comprehensive plans that take into consideration the environmental, social, and economic aspects of mobility.

The PDAU and PSA strategic plans provide a solid foundation for the development of sustainable mobility in Algiers. These plans aim to improve accessibility, reduce traffic congestion, and promote the use of public transportation. The plans also emphasize the importance of sustainability and energy efficiency in the transportation sector.

To evaluate the effectiveness of these plans, 13 indicators of sustainable mobility were identified. These indicators cover a range of themes, including accessibility, energy consumption, and emissions reduction. By monitoring these indicators, Algiers can track progress towards the goals of the PDAU and PSA plans.

The development of sustainable mobility in Algiers will require significant investment in infrastructure and public transportation. The construction of new bike lanes, pedestrian areas, and public transportation systems will improve accessibility and reduce congestion. Encouraging the use of alternative modes of transportation, such as electric vehicles, will reduce emissions and improve air quality.

Furthermore, the development of sustainable mobility requires the active participation of residents and stakeholders. Engaging with communities to understand their transportation needs and concerns is essential to develop effective sustainable mobility plans. Providing education and awareness campaigns on sustainable transportation options can encourage residents to use alternative modes of transportation.

In summary, the development of sustainable mobility is essential for Algiers to achieve its social, economic, and environmental goals. The PDAU and PSA plans provide a strong foundation for the development of sustainable mobility in the city, and the 13 identified indicators of sustainable mobility will be instrumental in monitoring progress towards these goals. To succeed in this endeavor, Algiers must invest in infrastructure and public transportation, engage with communities, and encourage the use of alternative modes of transportation.

It is worth noting that sustainable mobility is not only essential for the environment, but also for social and economic development. Sustainable transportation promotes social inclusion by providing affordable and accessible transportation options for all residents. It also supports economic growth by improving access to job opportunities and reducing transportation costs for businesses.

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