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"Optimizing sustainable urban transportation with multimodal and intermodal networks at transit hubs"

P.F.E : MULTIMODAL EXCHANGE HUB IN THE NEW TOWN OF BOUINAN.

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"Professors can make such a profound impact on our lives and should be honored as heroes"

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Abstract :

This dissertation examines transportation, a fundamental pillar of urban organization, while emphasizing that current means of travel contribute significantly to environmental pollution. In order to reduce this impact, the adoption of sustainable means of transport is crucial. Thus, the construction of modern transport infrastructure in Algeria must be harmonious and equitably distributed throughout the territory, especially in cities such as Blida, which suffer from rural congestion.

Contemporary cities compete to attract and retain users, using urban attractiveness as a lever to achieve this objective. The improvement and promotion of local development strongly influence user perception and attendance. As part of our final study project, the proposed multimodal station in Bouinan presents itself as an essential platform for the transport sector, contributing to the sustainability of a rapidly expanding society.

This multimodal station, designed in accordance with technical standards and environmental considerations, will ensure sustainable and healthy travel in the new town of Bouinan, while organizing an urban centrality within one of its districts.

keywords: sustainable urban mobility, multimodal station, bioclimatic architecture, multimodality, soft mobility, Bouinan

Résumé :

Le présent mémoire examine le transport, un pilier fondamental de l'organisation urbaine, tout en soulignant que les moyens de déplacement actuels contribuent de manière significative à la pollution environnementale. Afin de réduire cet impact, l'adoption de moyens de transport durables est cruciale. Ainsi, la construction d'une infrastructure de transport moderne en Algérie doit être harmonieuse et équitablement répartie sur l'ensemble du territoire, notamment dans les villes telles que Blida, qui souffrent de congestion rurale.

Les villes contemporaines rivalisent pour attirer et retenir les usagers, utilisant l'attractivité urbaine comme levier pour atteindre cet objectif. L'amélioration et la promotion du développement local influencent fortement la perception et la fréquentation des usagers. Dans le cadre de notre projet de fin d'étude, la gare multimodale proposée à Bouinan se présente comme une plate-forme essentielle du secteur des transports, contribuant à la durabilité d'une société en pleine expansion.

Cette gare multimodale, conçue conformément aux normes techniques et aux considérations environnementales, assurera des déplacements durables et sains dans la nouvelle ville de Bouinan, tout en organisant une centralité urbaine au sein de l'un de ses quartiers.

mots-clés : mobilité urbaine durable, gare multimodale, architecture bioclimatique, multimodalité, mobilité douce, Bouinan

الملخص :

تتناول هذه الأطروحة وسائل النقل، وهي ركيزة أساسية للتنظيم تتكون التنمية المستدامة من ثلاث ركائز أساسية هي : الحضري، مع التأكيد على أن وسائل السفر الحالية تساهم بشكل كبير في التلوث البيئي. ومن أجل الحد من هذا التأثير، يعد اعتماد وسائل نقل مستدامة أمرًا بالغ الأهمية. وبالتالي، فإن بناء البنية التحتية الحديثة للنقل في الجزائر يجب أن يكون متناغما وموزعا بشكل عادل في جميع أنحاء الإقليم، وخاصة في مدن مثل البليدة، التي تعاني من الازدحام الريفي

وتتنافس المدن المعاصرة على جذب المستخدمين والاحتفاظ بهم، وذلك باستخدام الجاذبية الحضرية كرافعة لتحقيق هذا الهدف. إن تحسين وتعزيز التنمية المحلية يؤثر بقوة على تصور المستخدم وحضوره. كجزء من مشروع دراستنا النهائية، تقدم المحطة المتعددة الوسائط المقترحة في بوينان نفسها كمنصة أساسية لقطاع النقل، مما يساهم في استدامة مجتمع سريع التوسع

وستضمن هذه المحطة المتعددة الوسائط، المصممة وفقا للمعايير التقنية والاعتبارات البيئية، سفرا مستداما وصحيا في المدينة الجديدة لبوينان، مع تنظيم مركزية حضرية داخل إحدى مناطقها.

الكلمات الدلالية: التنقل الحضري المستدام، محطة متعددة الوسائط، محطة متعددة الوسائط، الهندسة المعمارية البيولوجية المناخية، تعدد الوسائط، التنقل بين الوسائط، التنقل الناعم، مدينة بوينان

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CHAPTER 01: INTRODUCTION

I. General introduction:

In a world that is increasingly aware of the environmental impact of its activities, architecture occupies a central position in the quest for sustainable development. The architecture, environment and technology option aims to respond to contemporary challenges by integrating environmentally-friendly practices while ensuring a high level of comfort that meets new standards. The construction sector is responsible for a significant proportion of greenhouse gas emissions, energy consumption and the exploitation of natural resources. It is therefore imperative to adopt innovative and sustainable approaches to the design and construction of buildings.

The E-Cow Built workshop is a pedagogical initiative integrated into the Master 2 program aimed at providing students with practical and theoretical skills in the field of sustainable architecture, ecological construction and cutting-edge technologies. The workshop is designed to combine theoretical aspects with practical experience, with a particular emphasis on innovation and sustainability.

This workshop focuses on two aspects of optimizing energy efficiency, not just the construction of new buildings. The energy rehabilitation of existing buildings is just as crucial, as it involves renovating structures to improve their thermal and energy performance. This can include insulating walls, roofs and floors, replacing windows with energy-efficient models, and installing more efficient heating, ventilation and air-conditioning systems. For this reason, some of the themes deal with the modernization of older buildings, not only to extend their lifespan, but also to improve the comfort of occupants and reduce energy costs.

The themes addressed by the various students focus on occupant comfort, which is an inseparable aspect of this approach, while others focus on LEED (Leadership in Energy and Environmental Design) or BREEAM (Building Research Establishment Environmental Assessment Method) certifications, emphasizing the quality of life inside buildings. This includes controlling temperature, air quality, acoustics and natural lighting. Advanced technologies make it possible to regulate these parameters intelligently, creating pleasant living and working environments while reducing energy consumption.

The various objectives of this workshop are to integrate the principles of sustainability and high energy performance right from the design stage, choosing materials with low environmental impact from the outset, designing structures optimized for energy efficiency and integrating energy management systems. Raising students' awareness of passive

strategies such as building orientation, shape and the use of technologies such as solar panels or heat pumps plays a crucial role in reducing the ecological footprint. In addition, modular construction and prefabrication techniques can reduce construction waste and improve the efficiency of the process.

The workshop also focuses on the use of digital tools, such as building information modelling (BIM) and building energy performance simulation, to optimize the design of buildings to maximize energy efficiency and assess their environmental impact using these different tools.

This approach makes it possible to anticipate and reduce environmental impacts right from the design and construction phases, as these technologies offer a global vision of the project and facilitate informed decision-making in terms of sustainability.

The architecture, environment and technology option is not limited to the adoption of new construction techniques or energy retrofitting. It also includes a broader consideration of urban and regional planning. Eco-neighborhoods and smart cities are emerging as integrated responses to the challenges of sustainable development, striving to optimize the use of resources, reduce car travel through a functional mix and promote soft modes of transport.

In conclusion, the integration of architecture, the environment and technology represents a necessary and ambitious response to the challenges of climate change and the energy transition. It requires a holistic approach, combining new construction and the rehabilitation of existing buildings, to create built environments that are sustainable, comfortable and resilient.

Dr.BENCHEKROUN Marwa

II. General thematic:

In a constantly changing world, it is essential to recognize the central role that humans play in building a sustainable and balanced future.

"*Meeting the demands of the present generations while preserving the rights of future generations to meet their own needs*." (Gro Harlem Brundtland[1] , 1987). Her famous saying lays down the official international definition of « *sustainable development* » and is now the reference for environmental policies.

For this reason, the approach to **sustainable development** on a global scale has become more and more favorable to local communities in many countries on all continents, due to 02 world's summits, the Earth Summit in Rio in 1992[2] and that of Johannesburg in 2002[3].

First, Rio's summit occurred in June 1992, in Rio de Janeiro, Brazil, and the Conference on Environment and Development adopted a declaration advancing the concept of human rights and the responsibilities of countries in the environmental field. This statement reflects two major concerns (see table n°01) that have emerged over the 20 years between these two conferences:

Table 1:Two main concerns of Rio's summit

Source: (UN organization, Rio declaration on environment and development principles of forest management)

2 major concerns	
The deterioration of the environment, particularly its capacity to support life, The increasingly evident interdependence between long-term economic progress and the need to protect the environment,	Action required to attain sustainability

[1] Norwegian doctor and feminist born in 1939, the labor Gro Harlem Brundtland was three times Prime Minister of Norway then President of the World Commission on Environment and Development from 1983 to 1987, the Brundtland Commission which officially defined the concept of "development sustainable" in its report Our Common Future.

[2] Rio's summit, known as the Planet Earth Summit – the Conference was on environment and development (UN organisation, rio declaration on environment and development principles of Forest management)

[3] Johannesburg's summit, the World Summit on Sustainable Development 2002, took place in South Africa, from 26 August to 4 September 2002. It was convened to discuss sustainable development organizations.

Second, Johannesburg summit; occurred in 2002 was about Sustainable Development, which adopted a political declaration and an implementation plan containing provisions covering measures to ensure sustainable development.

The main points discussed to ensure sustainable development (see figure02), was to improve the quality of life of the entire world population without increasing the use of natural resources beyond what the planet can support. Although different measures may be necessary in each region of the world, to establish a truly sustainable way of life, we must integrate three main fronts:

- economic growth and equity;
- conserve natural resources and the environment;
- social development. (UN Organization, 2002)

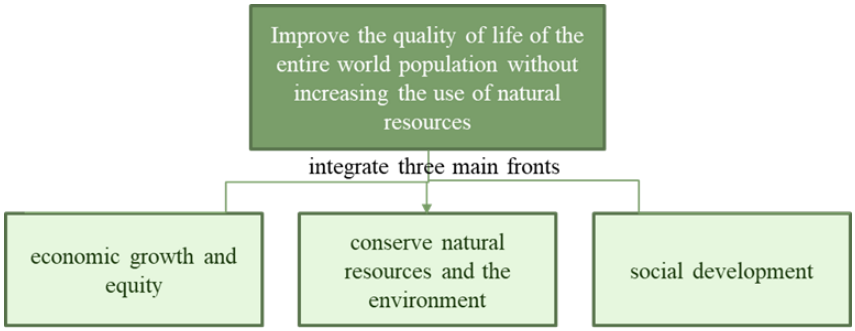


Diagram 1:The main points discussed to ensure sustainable development

Source: authors

Architecture is defined as the art of designing and building, expressing the ideas and convictions of the creator as well as the various social and cultural aspects specific to each environment and activity. Exploiting nature's diverse elements to improve living conditions in all environments is a challenge that mankind has risen to, leading him towards a bioclimatic architecture.

"*Bioclimatic architectural design is part of the contemporary issue of harmonious regional development and preservation of the natural environment. This approach, which is an integral part of sustainable development, optimizes comfort for residents, reduces energy consumption and improves the quality of life. health risks and minimizes the impact of buildings on the environment*." (Alain Liébard and André De Herde, 2005).

Bioclimatic and environmental approaches are fundamental principles of sustainable architecture, emerging from the philosophy of sustainable development, which aims to improve the quality of human life without compromising the natural environment or depleting its resources.

Architects and urban planners focus on creating comfortable living conditions (temperature, humidity, light, etc.) in a way that is as natural as possible. They favorite the use of architectural methods and renewable energy sources available on site (solar, geothermal, wind, hydraulic), limiting as much as possible the use of mechanized means and non-renewable energies external to the site, which are often associated with high costs and negative environmental impacts.

The reference to sustainability, now essential in many areas of public action, inevitably extends to transport via the notion of sustainable transport. (Corinne Meunier and Thomas Zéroual, 2006)

"*The thirst for mobility, this needs to always go to somewhere undoubtedly better, which we find in all societies, has pushed men to constantly imagine new means of transport which allow them to go further quickly and therefore further*" (François Plassard, 2003).

Firstly, man used to travel and go to different places on foot, then animals such as horse donkey…etc. Also, small handmade boats, in order to search for resources, survive and especially to satisfy his needs; as a result of his displacement, he created new cities in several spots of the world that were sustainable due to the non-motorized way of displacement. Additionally, this expansion and long distances made him think of transportation. However, the industrial revolution was the golden phase, new locomotives appeared. Since then, man has invented several means of transportation, which is motorized vehicles that have improved daily life use and the urban mobility especially the car. (L'atelier de généalogie Généavaunage)

We can say that mobility increases the performance and productivity of our society. Therefore, the mobility is all the actions involved in moving people and material objects. Where transport is the technical system directly dedicated to these movements. Accessibility and sustainable mobility are linked to the quality and efficiency required to reach a destination with reduced distances rather than to the equipment associated with transport. (Habitat III, 2015)

As a result, sustainable mobility or Eco-mobility therefore aims to ensure access to territories for all citizens while reducing the environmental impact of travel and a way of organizing travel while respecting the principles of sustainable development. (Jacobs, 1990).

As knows, transport in term of sustainability presents one of the major challenges in the cities, it has affected the environment badly which consequently created problems as increase in greenhouse gas (GHG) emissions and pollution, depletion of resources (especially fossils), climate change, local air pollution, occupation of natural spaces, Also other problems such as worsening of road congestion and land use associated with transport infrastructure, and social exclusion, increase in accidents and problems of health, reduced accessibility to basic services in some regions, etc. (Banisteret & al, 2011).

However, there is a wide set of tools available for implementing sustainable urban traffic systems, it is divided in three categories (Green & Wegner, 1997):

- ✓ The first category focus on the support of technological innovations which can reduce the harmful effects of transportation such as electrical cars.
- ✓ The second category consists of measure that aim to raise the standard of the current transport system in order to satisfy anticipated demand; it also includes measures that encourage the use of public transport, promote other forms of transport like cycling and walking.
- ✓ The third category mainly focuses on actions taken to reduce the need of transport. It mostly consists of concrete actions taken by legislators and urban planners to develop urban structures where driving is not necessary.(Daniel Štraub and Václav Jaroš, 2019)

Moreover, each municipality uses different tools depending on their needs and the quality of the local transport system, let's take for example some tools for sustainable transport, which they fall into two categories motivations and restrictions (see Figure n°03); some cities rebuild their overcrowded traffic infrastructure, while others try to keep cars out of the city center and encourage drivers to take public transportation, or they encourage other forms of transportation like walking and bicycling. (Daniel Štraub and Václav Jaroš, 2019)

According to some academics, its effectiveness in encouraging drivers to take public transportation is comparable to that of measures aimed at restricting the use of automobiles, such as raising fuel prices, improving the quality of public transportation, or implementing

other measures (Baum, 1973; Cevero, 1990; Haire & Machemehl, 1992; Litman, 2004; Chen et al., 2011; Cats et al., 2017).

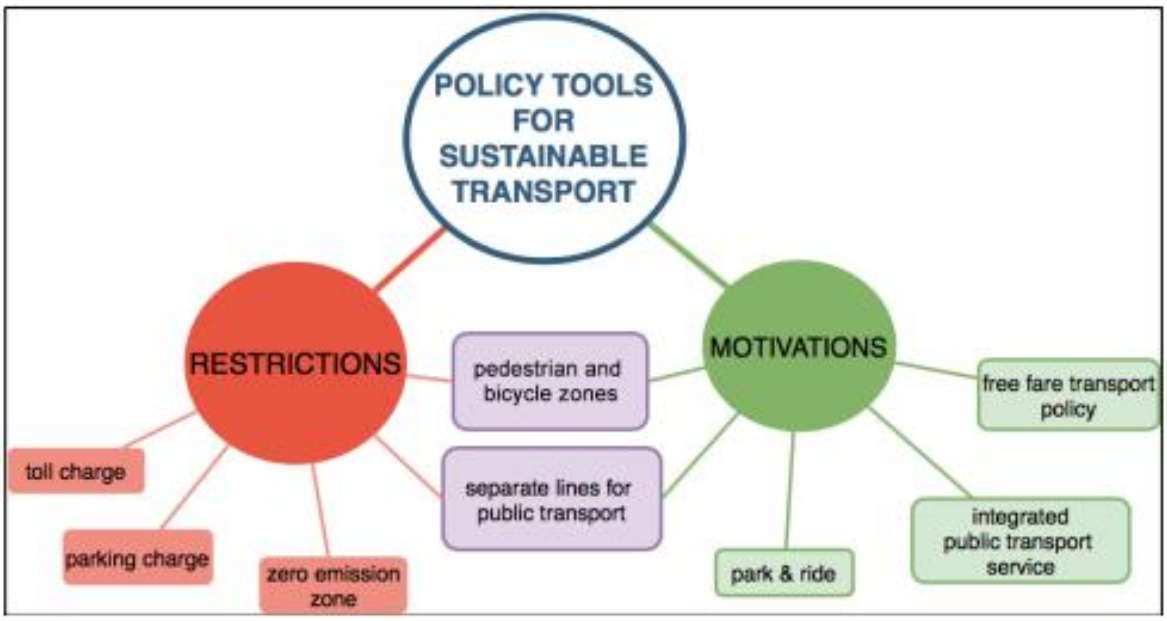


Figure 1:Policy tools for sustainable transport

Source: (Daniel Štraub and Václav Jaroš, 2019)

As we mentioned before, transport had affected our environment badly. A significant portion of Europe's greenhouse gas emissions are attributable to the transportation sector, with road transportation contributing the most to overall emissions. 72% of the transportation sector's total greenhouse gas emissions, both domestically and internationally, were caused by road travel in 2019. Therefore, adopting a sustainable road transport strategy can lead to decarbonization more quickly than making aviation companies and other businesses accountable for their climate record. Distrelec analyzed a number of European countries and their capitals to calculate which are sustainable and which still need improvement (Ken Berkley, 2002). (see Figure02).

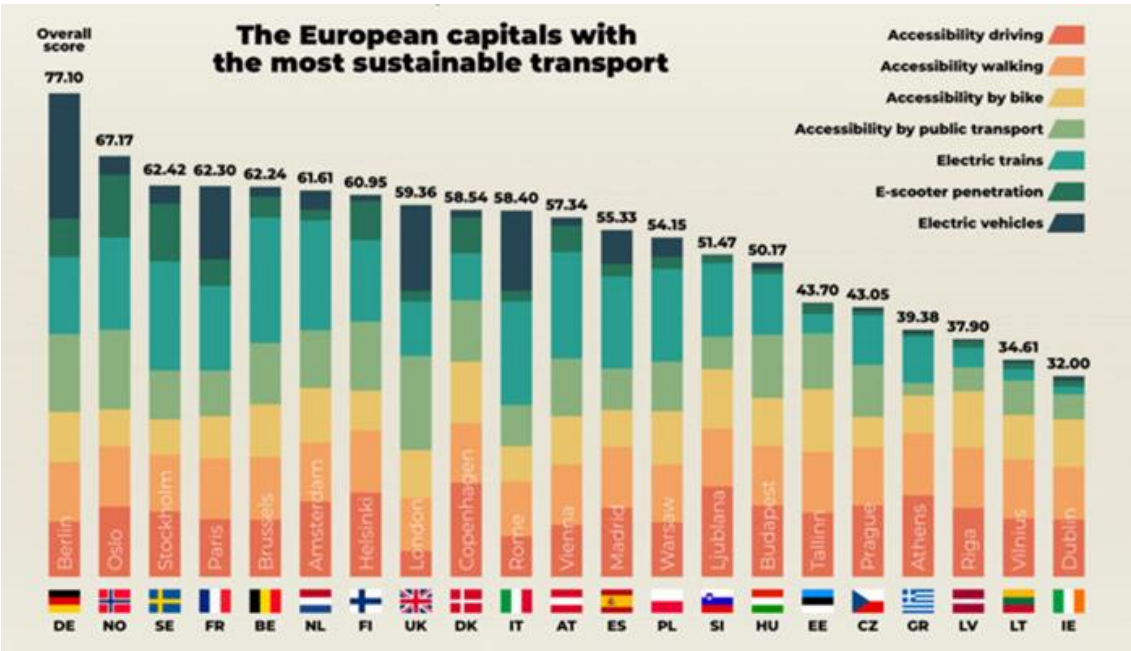


Figure 2: the European capitals with the most sustainable transport,

Source: Distrelec

When it came to sustainable transportation, Berlin scored the highestAs expected, the city has received high marks for public transportation, offering both residents and visitors an advanced and reasonably priced bus, commuter rail, and subway system for getting around the city. Due to its abundance of electric vehicles and convenient walking distance. Germany also receives points from individuals who prefer not to use public transportation. (Distrelec)We can take Berlin as a reference when it comes to sustainable transport.

Previous models of transport development used a unimodal strategy, planning and constructing road and rail projects independently with little thought given to how they might be integrated in the future. Several modes of transportation are used to move goods from their point of origin to their destination in intermodal or multimodal transport. Policy makers and transport planners have conducted extensive research on this type of transportation and are currently working on a number of policy projects aimed at advancing the idea and practice of multimodal and intermodal transportation. (IATSS Research ,2011)

Therefore, in transport and mobility research, the broad concept of multimodality is established to characterize individual travel behaviors, policy strategies, and transport systems (Chlond, 2011; Kuhnimhof et al., 2006). According to behavioral theory, multimodality is the adaptable or flexible use of multiple modes of transportation for all travel within a specific period (Buehler and Hamre, 2015, Nobis, 2007) or the use of several

modes by the same person during different trips, while inter-modality refers to the use of several modes during the same trip or the coordination of transport services by specific management and development of interfaces between different modes of travel (Certu,1999). Also, the development of intermodal transport requires transport links, nodes, and services. (IATSS Research ,2011)

These ways of transport aim of making travel faster, but also of making fewer polluting modes of transport attractive.

For that as a result, one of the most effective ways to solve these problems is to develop strategies and development scenarios and to re-emphasize transport management and multimodal transport to ensure sustainable mobility.

III. General problematic:

The rapid growth of Algeria's urban area has resulted in a rising demand for travel and a diversification of mobility. Yet, the public transport system has not kept up with this new demand, causing a widening gap between the growing transportation needs and the limited resources available. (Baouni & al, 2012).

In order to address this issue, the transportation sector in Algeria, as a public service, has undergone significant changes since the 1980s under the Transportation and Land Use Planning (TPL) framework. The services are regulated by specific legislation focusing on accessibility and convenience for all users. For instance, Law 13-01 aims to meet the transport needs of citizens in the most advantageous conditions for the national community and users, in terms of safety, availability, cost, accessibility, price, and quality of service. Similarly, Law 01-13 of 7 August 2001 directed and organized land transport, aiming to balance road and rail transport, focusing on the safety, costs, and quality of service.

On the other side, even though Trams, cable cars, and gondola transport, which are essential to urban transport systems, were not fully integrated into the 2005-2009 program. To address this issue, the 2010-2014 program introduced law no. 11-09 in 2011. This law aimed to promote the organization and direction of land transport (LOTT), complementing and amending the previous law no. 01-13. Notably, it recognized guided transport as an integral part of the designated land transport system.[4]

[4] Study of traffic and transport plans for the Algiers conurbation, Dessau/Soprin, 2005

Algerians are dependent on private vehicles, according to the 2005 study of traffic and transport plans for the Algiers conurbation(see figure 03) , the population of Algiers makes 5 million journeys a day, 56% of which are made on foot and 44% by motorized means, with 65% using public transport compared with 29% by private car and 6% by taxi, broken down as follows:

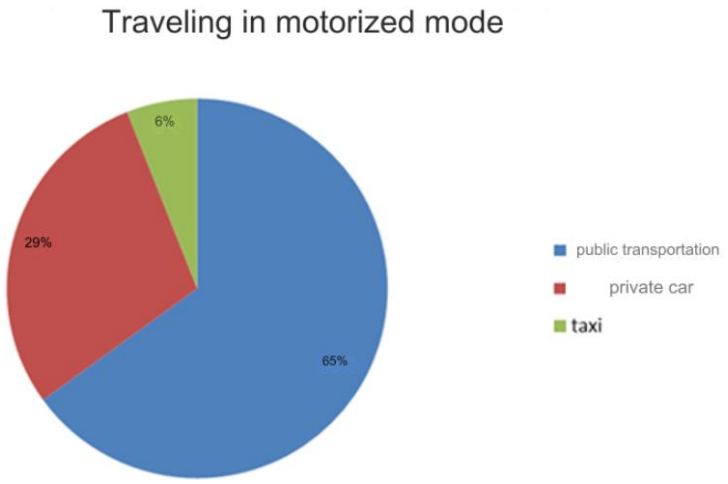


Figure 3:Diagram representing motorized travel of the Algiers population in 2005

Source: (Study of traffic and transports plans for the Algiers conurbation, Dessau/Soprin, 2005)

Despite its essential role in the Algerian economy, the transport sector represents a significant source of constantly evolving greenhouse gas emissions. Whether it is air or land pollution, immediate solutions do not exist, particularly given the legal vacuum existing in Algeria where the only legal text that has been promulgated is Executive Decree of 2003 No. 03/ 410, setting the threshold limits for smoke, toxic gas and noise emissions for motor vehicles (Baouni & al, 2012).

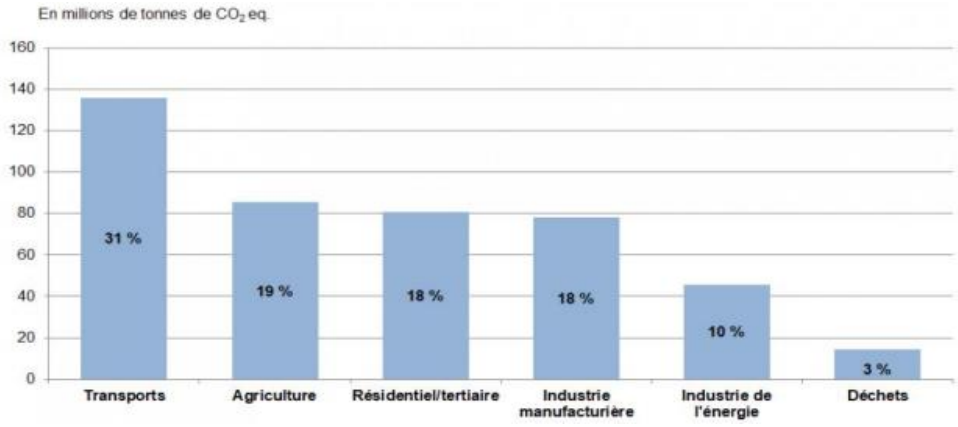


Figure 4:Sectoral breakdown of greenhouse gas emissions in Algeria in 2020

source: minister of renewable energy

In 2020, transport is the sector emitting the most GHGs in Algeria, with 136 Mt CO2 eq, or 31% of the national GHG inventory (see Figure 04). These figures can be used to guide public action in order to define priority areas for environmental protection (Djoudane & Mahoui, 2022).

Algeria has transformed from a pedestrian-friendly city with charming districts and cobblestone streets to a bustling city heavily reliant on cars. As a result, energy and space consumption, air pollution, noise, and social inequalities have all increased due to the expanding distance and volume of these journeys. It is clearly diagnosed in the SNAT2030. studies, urgently calls for global actions. Urban development understood as sustainable cannot be inconsistent, the implementation of such actions still depends on the tools available on the ground, as well as the adaptation and modernization of urban planning instruments in force since 1990 (PDAU and POS). Became totally ineffective despite efforts to improve (Azzag-Berezwoska, 2010).

And with all that have been said, we tend to ask the following research question:

“How can sustainable and energy efficiency strategies be employed to manage road congestion?”

IV. Specific problematic:

The impact of the aforementioned laws is evident in Algiers. However, Blida, despite being part of the Algiers metropolitan area, lags behind in terms of transportation development. Nevertheless, the wilaya of Blida has also experienced economic and social changes, resulting in the need for efficient collective transportation options for daily trips.

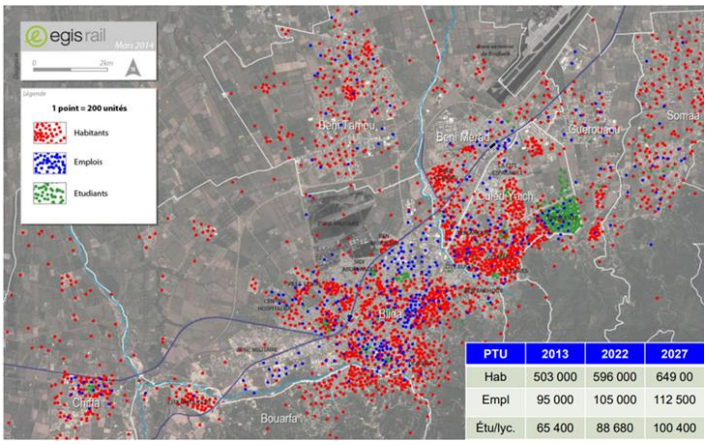


Figure 5:Principal generators of displacement

source : Etude de faisabilité de la ligne de tramway a Blida, 2014

The population of Blida makes approximately 483,573 daily journeys using various modes of transportation(see figure 05) , resulting in an average of 1.88 journeys per person. 67% of these journeys are made on foot, while 32% are made using motorized means. (Ministry of transport, algiers metro company, 2013)

The public transportation of Blida consists of: transportation by bus, transportation by Taxi cabs, transportation by train, transportation by cable cars... For the case of transportation by bus, in the past, before 2008 transportation was only provided by private companies; after 2008, a new public company named ETUB (Entreprise de Transport Urbain de Blida) was created with 30 Bus and by the year of 2020 it was about 50 bus was entered in the urban tissue of BLIDA, and that was the alternative of the privet transportation.

And for the case of transportation by taxi, that has played a huge role. It consists of having 3 taxis for 1000 habitants.

For the cable cars transportation, it links the town of Blida with the village of Chréa and comprises 138 cabins carrying 900 passengers per session. Finally, for the train system, it includes 91 km of upgraded track, with 37.50 km of double track, on fully electrified lines. There are 06 train stations in the wilaya, and passengers from the towns of Blida and Boufarik, which are within Algiers' area of influence, are the primary users of this mode of transport. However, when excluding long-distance travelers, the proportion of intra-wilaya transport remains low compared to bus transport. (Ministry of transport, wilaya of Blida, transport directorates, 2021)

Rapid urbanization has still not taken place with the desired degree of control, particularly in terms of compliance with urbanization rules and land-use planning standards, thus causing serious imbalances in the organization of our towns and cities. These apparent imbalances are generally aggravated for most of them by:

- Lack of planning and development strategy with pre-defined objectives;
- Weak coordination and the implementation of isolated actions to the detriment of overall action in terms of land-use planning, road management, public spaces, parking, traffic, and transport;
- Prioritizing modes of transportation based on private sector vehicles does not align with the need for efficient organization of mass transportation.

And that's what led to excessive consumption of space and energy, the negative impact of air pollution on the urban environment, and road congestion, all of this has led to waste of time, noise, and toxic gas emissions from motor vehicles. (Ministry of transport, wilaya of Blida, transport directorates, 2021)

Having become aware of the negative effects of this situation, it is essential to draw up a transport plan for the wilaya of Blida more specifically the new city of Bouinan in order to regulate this transport activity and better cater for the needs of the public.

With all that has been said, our objective in this research is to attain and aim to reach the answer to those specific questions:

1) What strategies can be utilized to implement innovative transportation solutions in the new city of Bouinan that prioritize sustainability and energy efficiency?

2) How can we improve the image of Bouinan new city in all of its economic, social, and environmental aspect

V. Hypothesis of research:

This subject encourages us to put forward several hypotheses in order to be able to better study and understand it. For this, we assume that:

- Perhaps Bioclimatic design can make a major contribution to improving comfort performance through: Utilizing eco-friendly and sustainable materials, along with renewable energy sources, in the construction of buildings in Bouinan will maybe result in improved thermal comfort and indoor air quality for occupants.
- Maybe by integrating thermal insulation and a combination of passive and active strategies in the design of buildings, will enhance the thermal comfort experience for users in Bouinan.

VI. Objectives of research:

- **Main objective:**

Through this study, we are interested in sustainable urban mobility management in Blida in the new town of Bouinan where our objective is to find a way to manage sustainable mobility through either multimodality or intramodality.

- **Secondary objectives:**

This project also aims to:

- ❖ Reducing energy needs and requirements in the station
- ❖ Improving comfort for station users
- ❖ Reducing the impact of transportation buildings on the environment.
- ❖ Improving thermal comfort in station areas
- ❖ The project will represent the image of the new town of Bouinan
- ❖ Creating an innovative means of transport in the new town of Bouinan in order to make a strong connection with surrounding states.

VII. Methodology of research:

The methodology we are going to follow is a mixture of the quantitative method and the qualitative method, for the quantitative one, it consists on the collection of quantifiable data leading to numerical results. It is a mathematization of reality. The qualitative method is an approach that prioritizes the interpretation and understanding of data that is not easily measurable or quantifiable. While it does not dismiss the relevance of numbers and statistics, it does not rely solely on them to draw conclusions. The main objective is to extract the meaning behind what has been expressed or observed. The primary qualitative methods employed are interviews, observation, and life stories. (Babasliman Nourelhouda, 2023)

Our work will be divided into two main sections:

- **Theoretical part**: this part will be divided into two steps:

a. **Documentation**: We will be providing a global understanding of the subject, which is based on an in-depth bibliographical search of books, theses, reports, articles, etc.…., and we will be able to identify the key theoretical aspects linked to our research theme, notably sustainable transport, sustainable urban development, multimodal and intermodal station, and sustainable development in general.

b. **Interview** (with the direction of transport of Blida): The main objective of the visit was to gain knowledge about the Blida tramway project, including all relevant documentation and studies. Additionally, we aimed to understand the government's intentions for improving the transportation system.

- **Practical part:** it consists of:

a. **Thematic researcher**: we will examine three examples of multimodal station projects, extracting all the important information related to both the quantitative and qualitative program, key concepts and their application in the projects, we will obtain information on the standards and requirements of the Algerian government, as well as, the interpretation of information collected from documentary research, site plans, cartographic documents, and survey carried out with the transport department.

b. **Urban analysis**: it will be done following the 3 scales: the city, the neighborhood, and the site scale. Also applying SWOT, and the systematic approach, and for the software, we will be using ArcGIS.

c. **Project presentation**: will include the program, the sketch, and the special and functional organization, accompanied by the graphic file. The software that will be used are, for the graphic part: Bim (Revit), Autocade, and Photoshop, for the 3d and animation: Lumion, Enscape, and Sketchup, and Design builder for the verification and simulation.

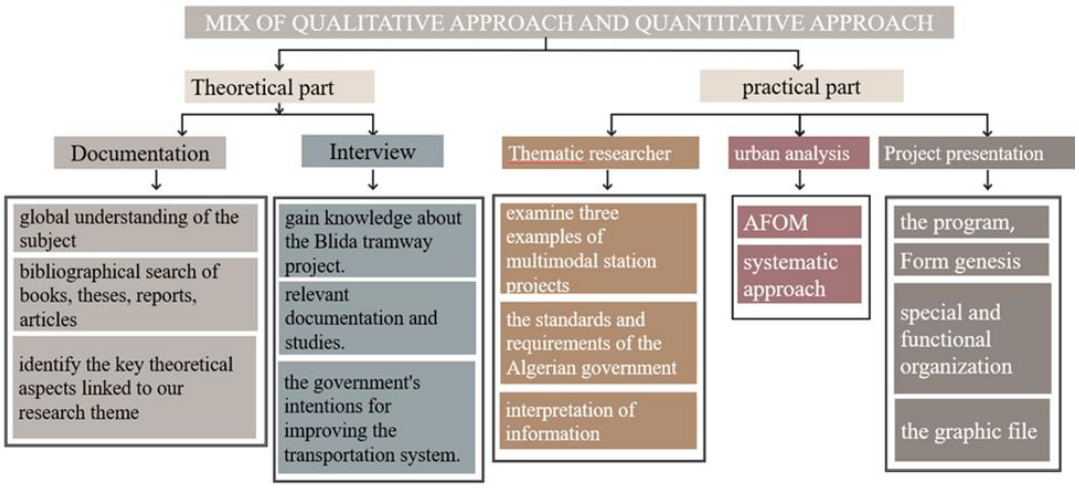


Diagram 2: methodology of this research

Source: authors

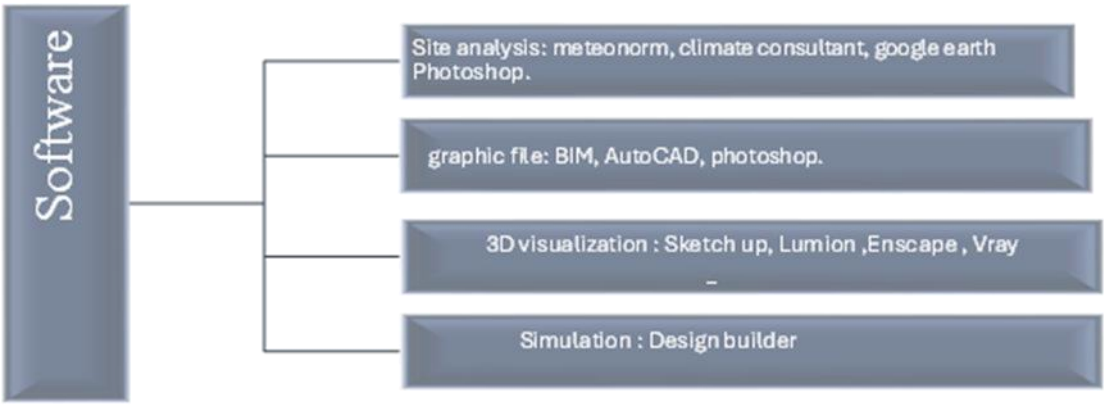


Diagram 3:the different tools used in this research

Source: authors

VIII. Thesis structure:

Our thesis is structured into four chapters:

Chapter I: introductory chapter:

This chapter includes the general thematic, the problem, the objectives, the hypotheses of the work, as well as the methodology and finally the structure of the thesis.

Chapter II: State of art:

The second chapter includes definitions of concepts and notions linked to the theme, which are: bioclimatic architecture, thermal comfort, energy efficiency, sustainable mobility, multimodality, intramodality, multimodal exchange hub. It will allow us to create a solid base of knowledge, plus the analysis of 3 projects, likely to help us in the design of our project.

Chapter III: Case of study:

The third chapter contains the case of study, it is divided into 3 parts; in the first part we will present the site analysis and the bioclimatic analysis, the second part concerns the stages of actions of the urban intervention and the last part will be the project concepts and geneses.

Chapter IV: Simulation

Devoted to the simulation of the thermal comfort of the project.

General conclusion:

Our thesis will end with a general conclusion in which we will present the synthesis and results of all the work.

CHAPTER 02: STATE OF ART

I.Introduction:

Thematic research plays an essential role in the architectural design process, as it enables us to understand the theme, know its origins and define the project's objectives and needs, thus establishing a program.

Our aim at this stage is to develop a coherent bioclimatic architectural project. Ecology and environmental preservation are currently at the forefront of the debate, especially in the wake of the economic and energy crisis following the covid 19 pandemic, as well as growing awareness of climate change. This is why we need to question our way of life and promote the development of ecological architecture that is functional, comfortable, economical in raw materials and respectful of the environment.

This research will focus on understanding the key concepts starting with sustainable development, sustainable mobility and multimodal and intermodal transport mode. Also, the driving forces behind the design of a transport station. By placing sustainability at the heart of its concerns, it should present an architecturally and ecologically sound façade. It is therefore imperative to present and define these concepts.

I. Cities and new towns:

1.1. Cities:

1.1.1. Definition of cities:

The city is in itself an economic and socio-cultural entity, as well as the site of a system of values and specific social relationships, and can be seen as the projection of society into space. It is a grouping of population and economic activities concentrated in a restricted area, which can be likened to a complex enterprise producing wealth. (CNES, 1998)

It is also part of a hierarchical urban network where economic, cultural and social relations.

1.1.2. City models:

a. Spread out city:

Californian model (Los Angeles) Private towns:

- ✓ Sprawl of housing and activities
- ✓ Low densities

- ✓ Car-based urban planning
- ✓ Residents move away from the repulsive centre to avoid social and ethnic promiscuity
- ✓ Neighbourhoods separated from each other and from the city
- ✓ Sustainable development called into question

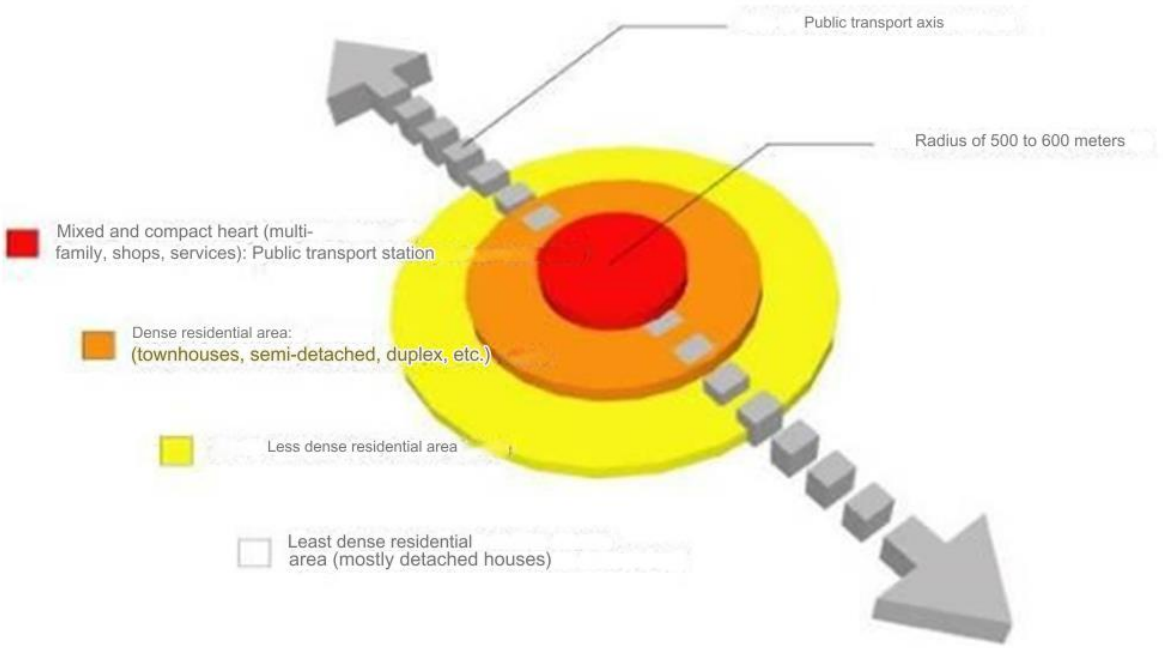


Figure 6:californian type of towns

Source: Master thesis of Kainno Imene and Meziane Hakim, translated by authors

b. Compact city:

Dutch model:

- ✓ Strong public regulation in terms of transport.
- ✓ Corresponds to a conception of life in society and the desire to live in an integrated society.
- ✓ Urban culture.
- ✓ Sustainable development.
- ✓ Balance and well-being.

c. Agglomeration:

A continuous urban area comprising the main town and its suburbs.

ONS definition: A conurbation is a group of 100 buildings, less than 200 m apart.

d. Metropolis:

Large city with a concentration of population, activities and wealth, and with an area of influence over large territories. Above all, it is a central place and a decision-making center.

e. Megacities:

Functionally linked urban groupings with a spatial demographic weight.

f. New town:

Town created from scratch close to a major conurbation in order to organize suburbanization and avoid urban sprawl. Urban planning tool.

g. Technopole:

A town that gives pride of place to executives, researchers, high-tech services and production.

1.2. New towns:

1.2.1. Definition of new town:

A town resulting from a political planning decision, achieved through the programmed implementation of a coherent series of urban planning choices. The planning includes the site, size, layout and distribution of the various functions and facilities. It is established close to another town to limit its expansion, by providing for simultaneous development of economic and residential functions (Vinccent Fouchier, 1999).

1.2.2. Objectives of new towns:

a. Town and country planning:

New towns were planned with the aim of structuring the growth of large conurbations. Conceived as a national policy directed by the State, they are aimed at regional development.

b. Polycentrism:

This concept combines a desire to direct growth towards selected sectors, to develop a certain urban density and to create living areas.

Polycentrism covers three complementary policies:

- ✓ Polarizing development in privileged areas.
- ✓ The creation of dense centers.
- ✓ The creation of catchment areas within the conurbation.

c. *Social mix:*

Promoting the coexistence of distinct social categories was one of the objectives behind the creation of new towns. The social mix is both:

- ✓ A state: the cohabitation of social groups with different characteristics in the same area.
- ✓ A process: facilitating the cohabitation within the same area of groups that are diverse in terms of age, nationality, professional status, income, etc., in order to achieve a better social mix. income in order to have a more balanced distribution of populations.

1.3. New towns in Algeria:

1.3.1. New towns of excellence to control urban expansion in the Littoral and Tell regions:

They promote the structured development of cities around metropolitan areas, by ensuring connectivity through high-quality tangible and intangible infrastructure. The New Towns of Sidi Abdellah and Bouinan, for example, will be home to a center of competitiveness and excellence. (SNAT 2008)

Figure 7: The new town of Bouinen

Source : https://dzentreprise.net/

Figure 8:the new town of sidi Abdallah

Source: https://elwatan-dz.com/

1.3.2. New towns to rebalance the region:

They are designed as centers of activity, services and population, capable of reversing the repulsive trends observed and stimulating a dynamic of attractiveness for the High hills region. For example, the New Town of Boughezoul will be home to a center of competitiveness and excellence. (SNAT 2008)

Figure 9:the new town of Boughezoul

Source: www.radiofrance.fr

1.3.3. New towns in support of sustainable development:

They have been set up in response to environmental issues or industrial risks, such as the New Town of Hassi Messaoud, and to enhance the attractiveness of developing towns in the south, such as Ouargla and Ghardaïa. (SNAT 2008)

Figure 10:the new town of hassi messaoud

Source: www.lexpressiondz.com

II. Sustainability:

2.1. Sustainable development:

"*Sustainability is harmony and equity projected into the future, a never-ending adventure where caution is the order of the day, a continuous struggle for the harmonious co-evolution of environment, economy and socio-culture*" (Mega and Pedersen, 1998)

Sustainable development was first mentioned in 1987 in the Brundtland Report of the United Nations Commission on Environment and Development (United Nations, 1987). The definitions contained in this report remain the most popular: "*sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs*"(Marc Pallemaerts, Armelle Gouritin, 2007). It's a global approach that involves multiple levels and aims to achieve a balance or compromise between local, regional, short-term, long-term, economic, social and environmental development.

2.1.1. The pillars of sustainable development:

One of the elements often present in conceptual models of sustainability are (the 3 pillars, i.e. environment, economy and society). In fact, the three-pillar principle was popularized at

the Rio Earth Summit. The Center for Sustainable Transportation is a perfect illustration of this principle.

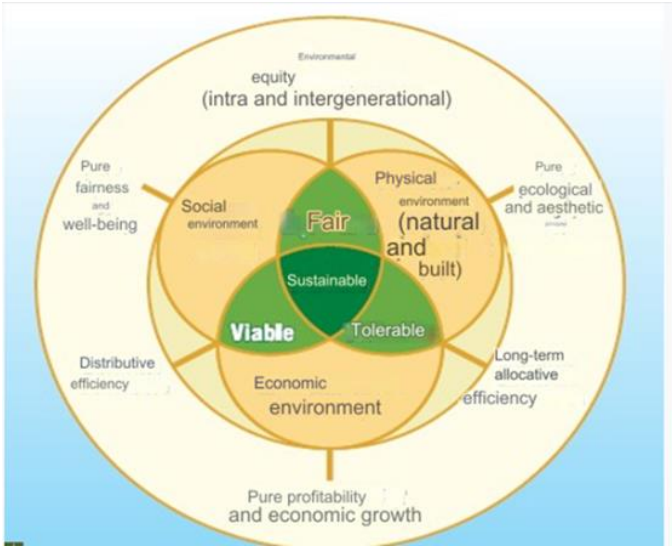


Figure 11:Three pillars representation of the sustainability concept

Source: Doctoral thesis of nicole Surchat Vial 2006, translated by authors

A balance between two pillars leads to partial sustainability, and a balance between all pillars leads to full sustainability.(see figure 11)

The conceptual model of the 3 pillars, established according to domains (economy, environment and society), is not unique. There are variants (see table34 in annex) , starting with:

- ✓ Some researchers - such as Maillefert, Petit and Rousseau (2010) - bring the fourth pillar of culture to the fore.
- ✓ Charlot-Valdieu and Outrequin (2011) add education, culture and participation to these three basic pillars.
- ✓ Ewa Azzag declared in her Book “Projet Urbain Durable” published in 2011 that there are 5 pillars instead of 3, starting with the pillar of : social, economic, ecological, cultural and spatial.

2.1.2. The principles of sustainable development:

The main ideas that underpin Agenda 21 and sustainable development initiatives were agreed upon in Rio. Some are taken from contemporary environmental law. As stated (see the table 35 in annex)

2.1.3. Sustainable development objectives:

The main objectives based on (UNDP, 2015):

- ✓ Create harmonious relationships between the building and its surroundings.
- ✓ Natural resource sustainability, also known as job, community, and industry sustainability.
- ✓ Conserve natural resources by improving their efficiency and lowering pollution.
- ✓ Increase users' comfort, well-being, and quality of life.
- ✓ Reduce the nuisance.
- ✓ Reduce water and energy use.
- ✓ Maintain control over external environmental impacts

2.2. Bioclimatic Architecture:

2.2.1. Definition:

- ***Architecture***: The art of designing, creating, and constructing buildings and outdoor spaces in accordance with aesthetic criteria as well as certain social, technical, economic, and environmental guidelines.
- ***Bioclimatic***:
- ✓ *Bio*: The term "bio" refers to life and biology, as well as nature in general.
- ✓ *Climatic*: refers to the climatic conditions of a location.

Bioclimatic architecture can thus be understood as architecture that is naturally adapted to the surrounding climate, The term “bioclimatic” relates to bioclimatology, a branch of ecology. Its goal is integrating the building with the local ambient conditions (climatic and visual) of the geographical, sociocultural, and even economic environment, and creating a climate of well-being in spaces with pleasant temperatures. It decreases the need for heating in the winter and keeps the temperature comfortable in the summer, with little or no use of air conditioning and an energy-efficiency envelope that maximizes passive heat gain while restricting heat loss when mechanical measures are required. More precisely, it investigates the interaction between living things and climate (Armand Dutreix, 2010).

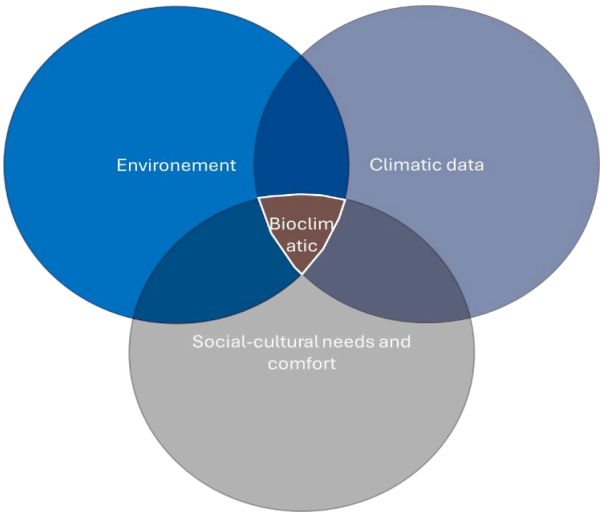


Diagram 4:the relationship between the 3 bioclimatic components

Source: authors

2.2.2. Principles of bioclimatic architecture:

The bioclimatic method is founded on the premise that a building's orientation and design allow it to draw the most energy from natural sources, particularly the climate and local topography:

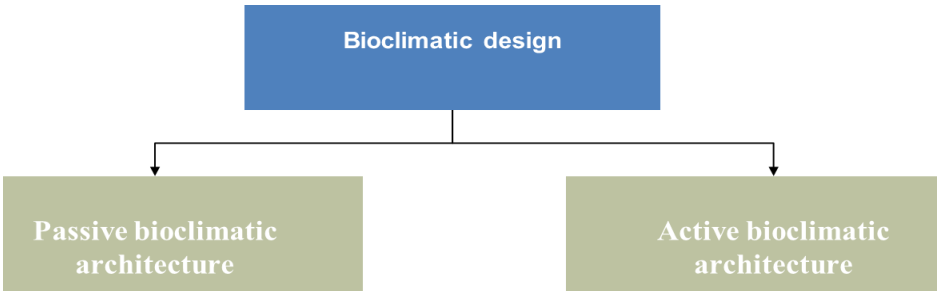


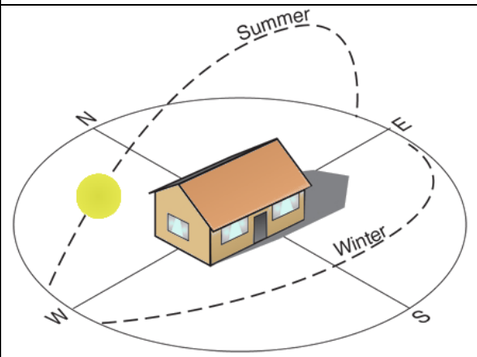
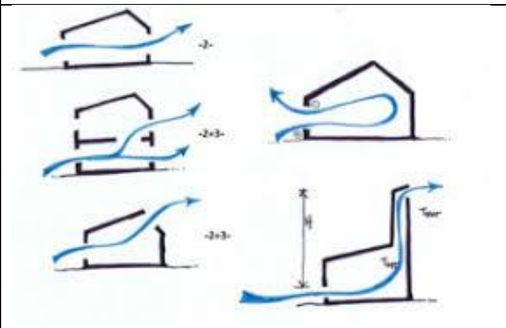
Diagram 5:Bioclimatic design strategies

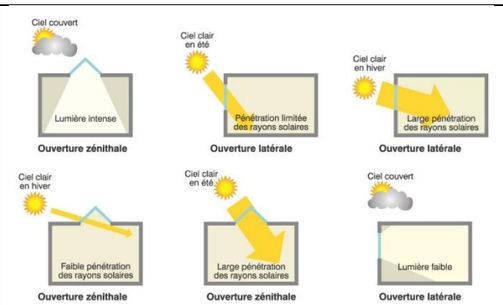
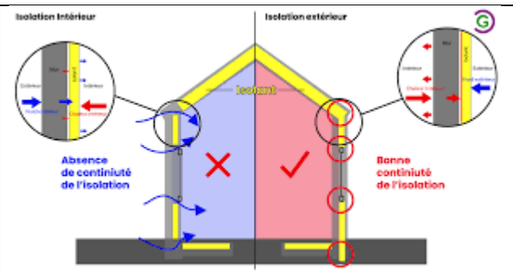
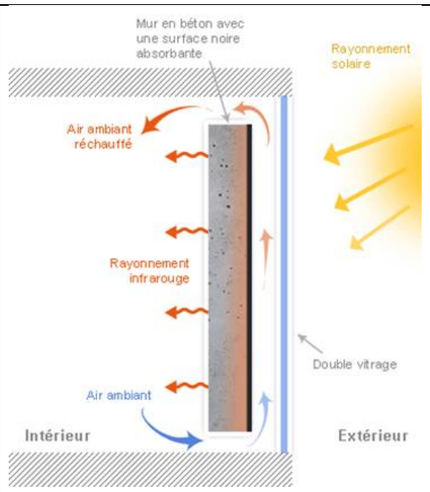
Source : authors

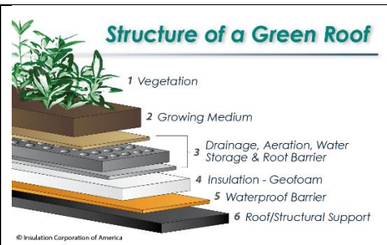
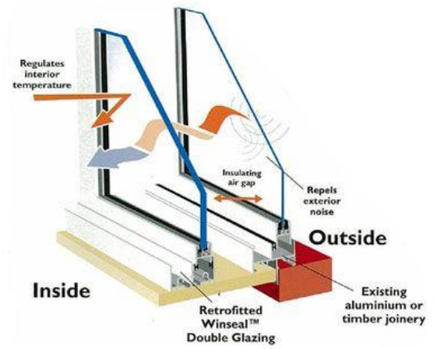
- *Passive bioclimatic architecture:*

Table 2: different type of passive bioclimatic design strategies

Source: Kaoula Dalel courses

strategy	content	illustation
Siting and orientation	Good orienting demands a thorough understanding of solar geometry. It provides solar gain in the winter while also providing mid-season sun protection. It is often assumed that any elongated design along the east-west axis provides the best thermal performance. Cover natural light requirements for visual comfort, maximize sun rays for heating in winter, prevent overheating in summer, and protect against chilly winter winds.	 *Figure 12:Siting and orientation* *Source: google image*
Orientation of openings and exposure of facades	North exposure: In temperate areas, we limit the number of openings on the north-facing facade since it is highly advantageous in mid-season, when the sun's rays are required for heating. However, in hot climates, it is very interesting. East and West Exposure: For these orientations, the sun is low. Its rays point closer to the horizon. The exposure of apertures to these two hazards makes them harder to safeguard. The western exposure is the most disadvantageous, as the afternoon is the warmest part of the day.	 *Figure 13:Orientation of openings and exposure of facades* *Source: google image*
Shape and compactness	The bioclimatic building will be basic and minimal in design. Means simple and compact in shape The more the volume is divided up, the higher the energy consumption, whereas a compact volume limits heat loss and lowers energy requirements.	
Natural ventilation	The goal of ventilation is to maintain the healthy quality of indoor air while also preventing structural damage. It removes humidity caused by inhabitants and their activities, as well as gasses, volatile particles, and other pollutants that might otherwise remain stagnant.	 *Figure 14:Natural ventilation* *Source: google image*

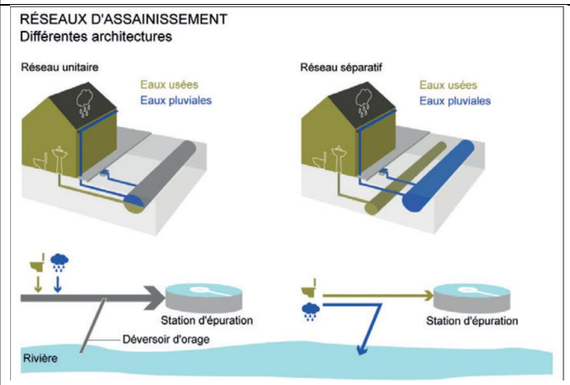
Natural lighting	Natural light, commonly known as daylight, refers to sunlight that is either direct or indirect. Its richness stems from the continuous variation in intensity, direction, and hue throughout the day and seasons.	 *Figure 15:different ways of natural lighting* *Source: google image*
Thermal insulation of the building envelope	Isolation may have the goal of preventing rewarming during the summer, as heat moves from a warm to a cold environment by conduction, radiation, and convection. The goal of thermal isolation is to reduce heat exchange between the interior and the exterior.	 *Figure 16:Thermal insulation of the building envelope* *Source: google image*
Natural and local materials	An eco-material, also known as "ecological material" or "healthy material," is a building material that meets both technical and socio-environmental criteria throughout its life cycle (production to disposal).	
Thermal inertia	The concept of thermal inertia is most commonly used in the building industry, specifically in the design of opaque exterior walls whose interior and, more importantly, exterior temperatures vary frequently, are subject to the thermal impact of solar radiation, and whose constituent materials contribute to the interior temperature stability. Controlling the thermal inertia of elements or materials aids in the optimization of manufacturing processes in industry and everyday life.	 *Figure 17:Thermal inertia mechanism* *Source: google image*

Green walls and roofs	A green roof is a green space installed on a roof, terrace, or slab, whether or not it is open to the public. Green walls provide a variety of environmental and aesthetic benefits while also insuring the façade's endurance.	 *Figure 18:detail of green walls and roofs* *Source: google image*
Glazing and windows	Glazing is a piece of glass that is framed within a window frame. In the construction business, the term "glazing" is frequently used instead of "pane" because it is the entire structure that must be positioned, examined, and constructed, given its critical relevance and numerous roles within structures. Double glazing is a wall made up of two panes of glass separated by an immovable layer of air, known as "air space." A variation, reinforced insulation glazing, is made even more efficient by applying an insulating treatment to one (or more) of the inner faces of the double glazing.	 *Figure 19:double Glazing* *Source: google image*

- *Active bioclimatic architecture:*

Table 3:different active bioclimatic design strategies

Source: Kaoula Dalel courses

strategy	Content	illustration
Energy management	Renewable energy replenish themselves naturally at such a quick rate that they are deemed inexhaustible on a human time frame.	 *Figure 20:Energy management of renewable energies* *Source: google image*
Rainwater management	Rainwater harvesting is a technology that collects and stores rainwater for later use. To achieve this goal, a specific installation is necessary, with varying levels of complexity depending on the ultimate usage. The reasons for this are typically economic or environmental; however, in some cases, such facilities are required to compensate for insufficient, malfunctioning, or non-existent running water supply. Reclaimed rainwater can vary in quality and may not be suited for certain applications, such as vegetable growing.	 *Figure 21:Rainwater management mechanism* *Source: google image*
Waste management	It includes all sorts of waste, whether solid, liquid, or gaseous, each with its own field or section. The methods of managing waste varies depending on whether one is in a developed or developing country, in order to reduce their effects on human health, the environment.	 *Figure 22:Waste management* *Source: google image*

2.3. Recommendations for energy-efficient design in Algeria:

Algeria is a vast country, with over four-fifths of its surface area covered by desert. This gives rise to a wide range of geographical and climatic diversity, from coast to desert. According to the APRUE[5], Algeria's climate classification distinguishes four main zones:

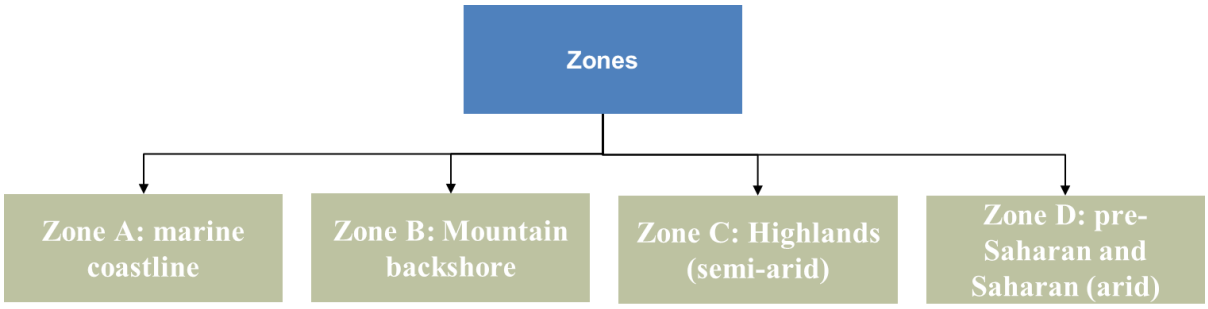


Diagram 6:Algeria's climate classification

Source: authors

The design of buildings must be adapted to different climatic zones in order to guarantee comfort and reduce energy consumption. To this end, the APRUE has established basic criteria for passive bioclimatic design to be taken into account for each site.(see table36 in annex)

III. Mobility and transport:

3.1. Transport:

5.1.1 definition of transport:

The term of 'transport' derived from the Latin word transportare, refers to the process of moving individuals or items from one location to another utilizing specific equipment. (Yousandj,2017)

5.1.2 types of transport:

See (table04) below:

Table 4: Definition of transport's types and illustration

Types of transport	definition	Illustration

[5] APRUE (Agence pour la promotion de la rationalisation de l'utilisation de l'énergie) : Created in 1985 by presidential decree and under the supervision of the Ministry of Energy and Mines, the APRUE is responsible for informing, communicating with and training public and private players in the energy sector. In particular, it aims to establish partnerships to drive cross-functional action programmes.

Road transport	Road transportation provides a high level of flexibility and enables direct delivery, although it can be susceptible to the negative effects of traffic congestion and emissions. It uses: Cars, trucks, buses, bicycles, motorcycles. **(Prior,2024)**	 *Figure 23: road* https://www.istockphoto.com/photo/aerial-view-of-traffic-and-overpasses-in-spring-gm947872874-258799462
Rail transport	Rail transportation is an effective method for transporting large quantities across extensive distances, like trains and subways (**inboundlogistics.com, 2023)**	 *Figure 24: rail* https://www.istockphoto.com/photo/swiss-train-in-the-alps-mountains-in-switzerland-around-ospizio-bernina-gm908264570-250218063
Air transport	Air transportation offers rapid and efficient long-distance travel, albeit at a higher cost, it includes airplanes and airships. **(Stainton, 2024)**	 *Figure 25:airplane* https://unsplash.com/fr/photos/avion-de-ligne-a-laeroport-pendant-la-journee-w0aj0YwUkGU

Water transport	Water transportation is highly suitable for the efficient movement of substantial cargo across waterways and oceans, it uses ships, boats, ferries, and canoes. (**inboundlogistics.com, 2023)**	 *Figure 26:Boat* https://unsplash.com/fr/photos/bateau-de-croisiere-blanc-sur-la-mer-ufnZHqodKy8

3.2. Mobility and sustainable mobility:

3.2.1. Definition of mobility:

Mobility refers to the spatial movement of people and goods. In the case of people, a distinction is made between utilitarian mobility and leisure mobility. Mobility for practical purposes involves moving around to carry out various activities in different locations. These activities correspond to the essential functions of human life, such as housing, work, education, shopping, and leisure. Therefore, transportation and mobility are considered as means to achieve practical goals. Leisure travel, on the other hand, is primarily for recreational purposes (Youmatter, 2017).

So, mobility is a fundamental necessity and a representation of democracy, liberty, and a thriving economy. It empowers individuals to independently select their work, education, and recreation engagements. Nonetheless, an excessive volume of vehicles may result in heightened traffic, potentially restricting the freedom of others. (Youmatter ,2017)

3.2.2. Definition of sustainable mobility:

According to the OECD[6], sustainable mobility is "*mobility that does not endanger public health and ecosystems, respects transport needs while being compatible with the use of renewable resources at a rate below that required for their regeneration and the use of non-renewable resources at a rate below that required for the development of alternative renewable resources*" (Céline BRANDELEER and Laura BUFFET, 2009).

[6] The Organization for Economic Cooperation and Development (OECD) The Organization for Economic Co-operation and Development (OECD) is a unique forum where the governments of 37 democracies with market-based economies collaborate to develop policy standards to promote sustainable economic growth.

There for Sustainable mobility is a concept that aims to transform transportation from an ecological point of view, focusing on reducing fuel consumption and emissions to ensure the ecosystem can regenerate. It involves a mix of measures to balance resource consumption and the ecosystem's regenerative capacity. The goal is to make transportation more environmentally friendly, socially just, affordable, economical, efficient, and safe about the free exercise of mobility but to minimize its negative consequences (Nest, 2024).

3.3. Intermodality and multimodality:

3.3.1. Single-mode transport:

Single-mode transport refers to journeys made using a single mode throughout the entire journey. This means using a specific mode to carry out transport operations, be it a private or public vehicle (e.g. bus, metro, car, bicycle, etc.).

Diagram 7:explanatory diagram of single mode transport

Source: authors

3.3.2. Intermodal transport:

Intermodality is the successive use of several modes of transport during the same trip. This may involve intermodality between several public transport modes used in succession during the same trip (city bus, then metro, then train, for example). (Aurélie Souchon.2009) According to ARENE , intermodality aims to reduce the use of private cars in favor of less polluting transport (public transport, bicycles, etc.) (ARENE, 2002).

Also, Thomas DUVAL from CERTU (The Center for Studies on Networks, Transport, Urban Planning) confirm: "to propose a competitive door-to-door service level, by articulating and coordinating the different transport offers"(Clara H, 2014)**.** *Means that intermodality is the use of at least two modes of transport to make a trip from a point of origin to a point of destination, with the coordination of the used modes of transport.*

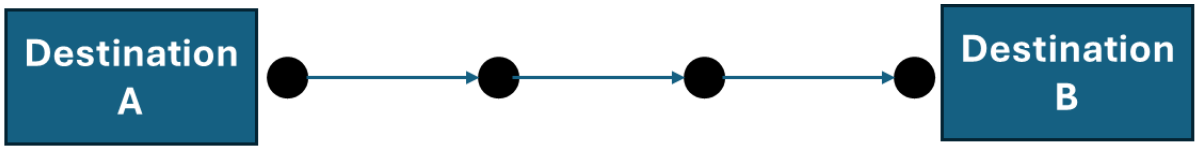


Diagram 8:explanatory diagram of intermodality

Source: authors

3.3.3. Multimodal transport:

Multimodality is the possibility of using several modes of transport alternately on the same link. It is also called alternative intermodality. It is based on the notion of choice, and the multimodal customer's choice of mode will vary according to the day, time or reason for travel. They seek to optimize the use of the range of transport options available by playing on the intrinsic performance advantages of each mode. (Aurélie Souchon.2009)

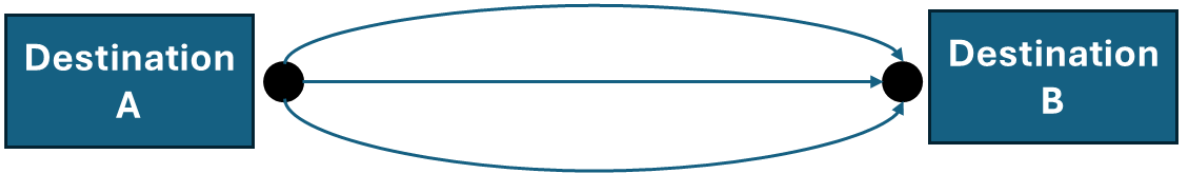


Diagram 9:explanatory diagram of Multimodality

Source: authors

We can say that, multimodality and intermodality are closely related concepts that refer to the combination of several modes of transport within a trip or journey. Multimodality implies the presence of several different modes of transport between two locations, while intermodality concerns the successive use of several modes of transport during the same journey.

4.3.4 The negative and positives sides of multimodality and intermodality:

Table 5: the negative and positive sides of multimodality and intermodality

	Advantages	disadvantages
Intermodality	- lower costs, - faster deliveries, - passenger safety, - improved sustainability and minimized product handling. (source: https://www.calculcee.fr/article/transport-intermodal/) - Fast travel by using the fastest mode - an environmental solution by reducing fuel consumption and greenhouse gas emissions	- Reliability: depends on more than one transit mode, there is a good chance that the chain will break down at some point.

	(source: https://www.transports64.fr/transport-intermodal/)	
Multimodality	-Route optimization: reduce journey times and offer more flexible solutions -Reduced CO2 emissions: use of soft modes and improve air quality. - Cost-effective solution: reduce overall trip costs - Ease of use (Source: https://www.zeway.com/lexique-multimodal)	- Complexity: it involves the coordination of several different modes of transport. - Costs: it can be expensive due to the need to coordinate several different modes of transport. (source: https://www.transportexpress.fr/fr/actualites/transport-multimodal) - Potential delays: any journey involving several modes of transport, a potential delays when transferring between different modes of transport (Source: https://salon-avenir-logistique.com/les-avantages-du-transport-multimodal/)

IV. Station/ Exchange hub/ Transit hub:

4.1 Station:

4.1.1. Definition of the transportation station:

A station is a public service infrastructure located off-road that accommodates collective transport lines, either as a terminus or a transit point. According to Larousse: "*a building and facilities where passengers embark and disembark, and goods are loaded and unloaded*."

According to (Rolf Steinberg, 1966) : "*a railway operating location comprising at least one set of points; where passenger and freight trains can depart, arrive, park, or turn around*."

In simpler terms, a station is a facility designed to accommodate passenger transfer activity between transit modes and other travel modes. It typically includes boarding/alighting platforms, bus bays, passenger shelters, benches, and other related passenger equipment.

4.1.2. The station in the city:

Since the early days of railway development, the station has played a key role in shaping cities. The station and the city rely on each other to progress. Today, stations are not just

buildings in cities, they are vital hubs connecting cities locally and internationally. They serve as meeting points for travelers, sparking various activities like travel, commerce, and economic growth. By linking different areas, stations help bridge the gap between city centers and outskirts, becoming important landmarks in the process.(Rjeb, 2021)

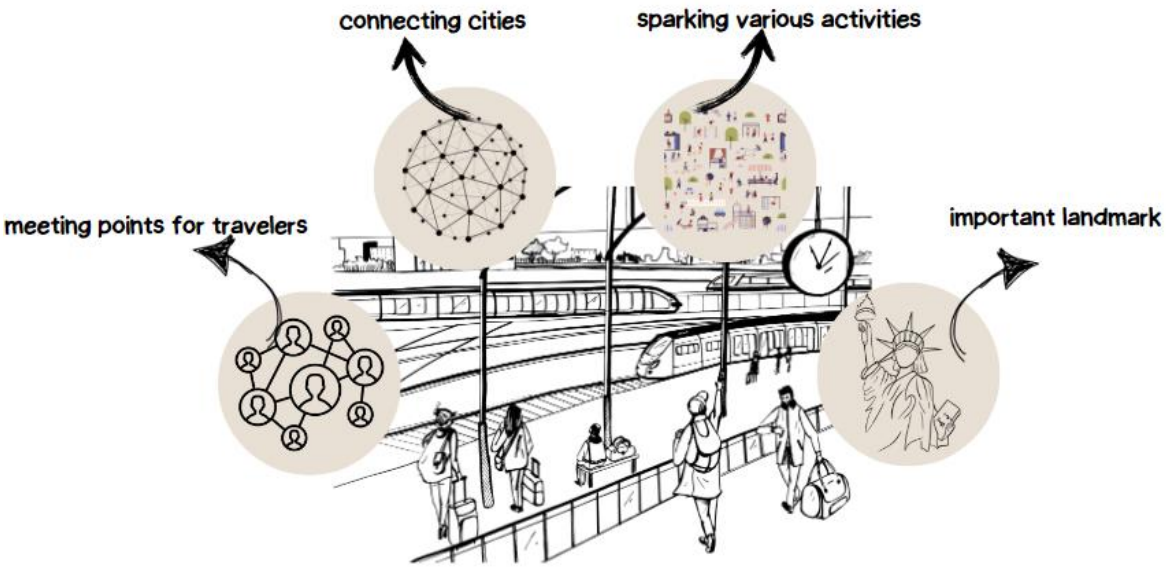


Diagram 10:station in the city

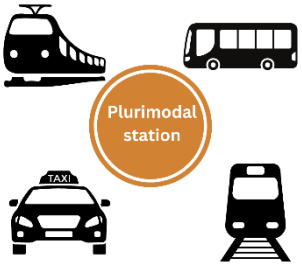
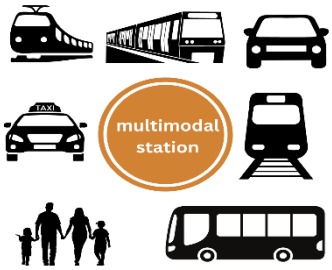
Source : authors

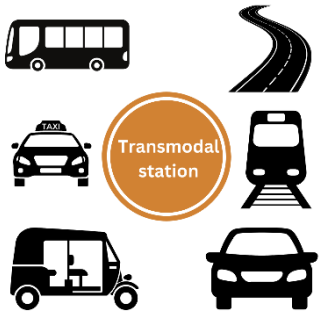
4.1.3 Types of transport station:

See table below:

Table 6:different types of transport station

type	Definition	Illustration
Train station	The appearance of the railway expanded the possibility of traveling, A train station is a place where trains stop to pick up and drop off passengers. **(Gerhardt, et Krüger,1998)**	Personnes proches de la gare photo – Image gratuite de Gris sur  Unsplash

Bus stations	This type of station was invented to bring closer the distances and long journeys provided by the train following a railway which connects specific stations, so the user is obliged to move from point A to point B passing through these stations imposed by this trajectory. **(Vialis, 2012)**	Stationnement d'autobus orange et blanc photo – Image gratuite de Bus sur Unsplash 
Plurimodal station	plurimodal station serves as a central transportation hub that combines various modes of transportation, including buses, trains, trams, and other public transit systems, to offer smooth transitions between different transportation options, enhancing the overall travel experience for passengers. **(Combalbert, 2015)**	
Multimodal station	This station provides multiple mode of transports for the same distination. **(Nasri, 2021)**	
Intermodal station	The station facilitates the combination of different transportation methods promoting accessibility and connectivity between various modes. Passengers have multiple options to move from one location to another. **(Nasri, 2021)**	

Transmodal station	The concept of a transmodal station involves the integration of various transportation modes, such as rail, road, mass rapid transit, bus rapid transit, auto-rickshaws, taxis, and private vehicles, within a single terminal infrastructure. Its objective is to enable seamless transfers between these modes, with a reduced reliance on automobiles. By encouraging the use of public transportation, this type of station aims to alleviate traffic congestion and reduce vehicular pollution. **(http://nhlm.in/ims.html,2021)**	
Exchange hub	An exchange hub serves as an urban space that aims to connect various modes of transportation and encourage the practice of intermodality through a comprehensive urban travel plan. It represents the modern concept of a station, facilitates connectivity between different parts of the city by integrating urban, peri-urban, and inter-urban transport.In order to encourage car owners to adopt a different approach, parking lots were introduced. These parking facilities play a significant role as exchange hubs, motivating motorists to park their vehicles and opt for public transportation and other eco-friendly modes of travel to continue their journeys or access the city. This initiative not only contributes to a greener environment but	

	also reinforces the concept of sustainable mobility. **(Nasri, 2021)**	

4.2 Multimodal exchange hub:

4.2.1 Definition of multimodal exchange hub:

A multimodal station refers to a transport hub that integrates several modes of transport, such as buses, trains, and bicycles, to offer seamless connectivity to passengers.

The concept of "exchange hub" is now part of the vocabulary of mobility actors. Used to refer to a building and a space, it's a concept that relates to various realities, functions, and practices. **(Pinheiro Rizerio Carmo, 2020)**

These stations are designed to offer seamless connectivity and convenience to passengers, allowing them to move easily from one mode of transport to another. They often feature modern architectural designs and infrastructure to enhance the user experience and improve the efficiency of intermodal transfers.

Understanding travelers' preferences for new modes of access/egress, such as shared bikes and autonomous vehicles, is also essential to the design of future small and medium-sized multimodal hubs. **(Ham et *al*., 2022)**

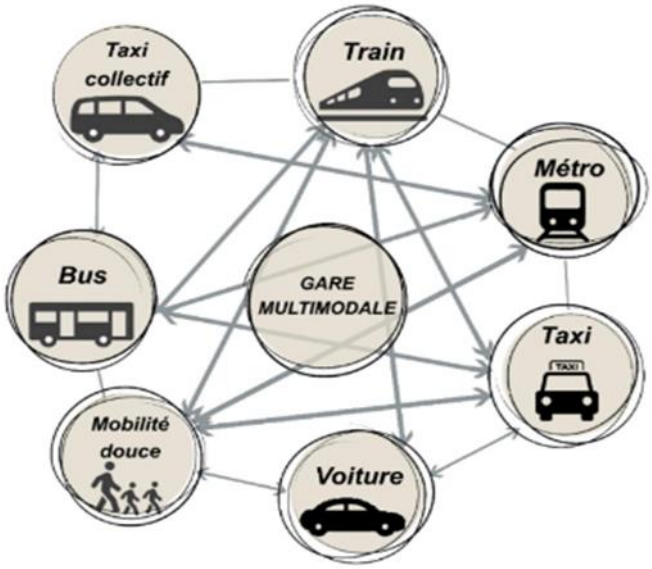


Figure 27:mobility concept diagram:

Source: Ham et al., 2022

The concept of the multimodal station has attracted attention in recent years, with an emphasis on improving the legibility and accessibility of these spaces. Factors such as

signage, the physical characteristics of the space, and the individual characteristics of travelers can influence the wayfinding experience within these hubs. Understanding these factors can lead to the development of more effective design approaches for contemporary transport hubs. **(Ham et *al.*, 2022)**

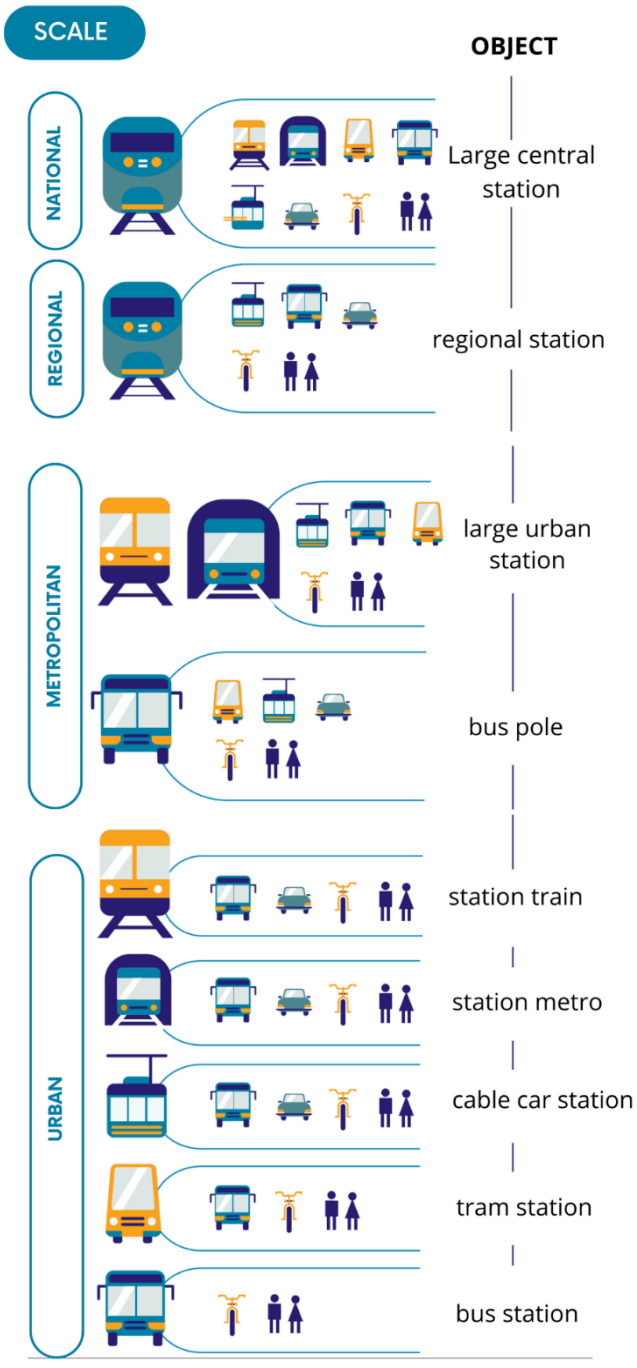


Figure 28:Typology of multimodal exchange hubs

Source: https://www.mobiliseyourcity.net/sites/default/files/2020-09/poles-echanges-multimodaux-guide-bonnes-pratiques.pdf

4.2.2 Classification of multimodal stations:

Multimodal stations can be classified into two different functions. Firstly, according to the document Rules and standards relating to the classification, construction, and organization of infrastructure for receiving and handling passengers by road, this classification is based on the surface.

Table 7: classification of multimodal stations

Source: (Aérogare, 2019)

Type	Total land area	built surface area	developed floor area	number of docks	air regulation and storage of vehicles	size of sanitary facilities number of travelers	annual vehicle movement capacity	yearly capacity of the number of traveller's
A	≥ 3	≥ 1 500	≥ 2 000	≥ 20	≥ 40	≥ 80	≥100 000	≥1 000 000
B	≥1; <3	<1 500	<2 500	<20	<40	<80	<100 000	<1 000 000
C	<1	<1 000-500	<1500-750	<10-5	<20-10	<40-35	<30 000	<700 000

The classification according to the number of users is shown below:

Table 8:classification of multimodal stations

Source: (Aérogare, 2019)

Types of multimodal station	population served in thousands of inhabitants	Reception capacity to platforms number	attendance in thousands of travelers/ day

Small station	From 10 to 50 thous/inh	5 to 10 platforms 1 to 2 reserves	2 to 4 thous / travelers / day
Medium station	From 50 to 100 thous/inh	10 to 15 platforms 2 to 4 reserves	15 to 25 thous / travelers / day
Big station	From 100 to 500 thous/ inh	15 to 20 platform 3 to 5 reserves	50 to 70 thous / travelers / day
Very big station	Plus 500 thous/ inh	More than 20 platform More than 5 reserves	More than 70

4.2.3 The functions associated with multimodal exchange hubs :

The literature associates the multimodal exchange hub with a triple functionality: transport, urban, services.

- ✓ The transport function aims to deliver a good and save journeys for the passengers, with having a good coordination and connection of the transport system.
- ✓ The urban function aims to limit cuts, improve the readability and integration of the exchange hub into its urban environment.
- ✓ The purpose of the services function is to make spaces more functional and pleasant, useful to users and residents of the neighborhood. (Leticia Pinheiro Rizerio Carmo, 2024).

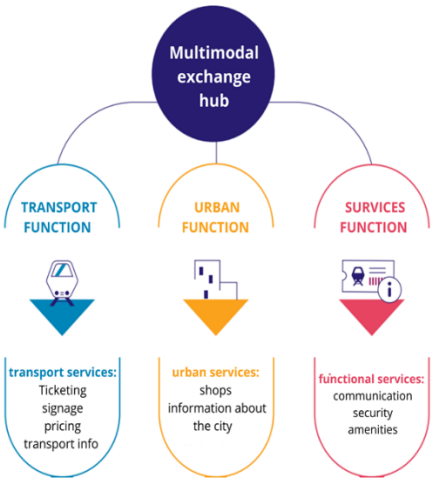


Figure 29:the functions associated with multimodal exchange hubs

Source: https://www.mobiliseyourcity.net/sites/default/files/2020-09/poles-echanges-multimodaux-guide-bonnes-pratiques.pdf . translated by authors

4.2.4 Main spaces comprising the multimodal station

a. Interior spaces

Table 9:interior space

Source : (www.gir-maralpin.org2006)

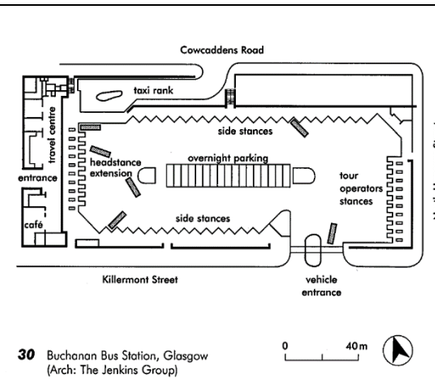
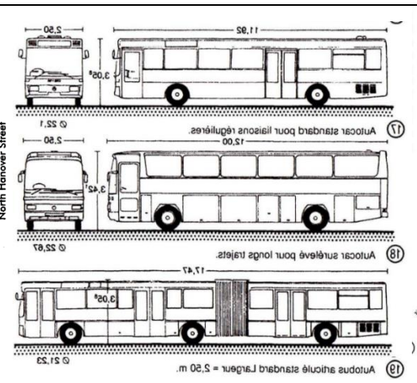
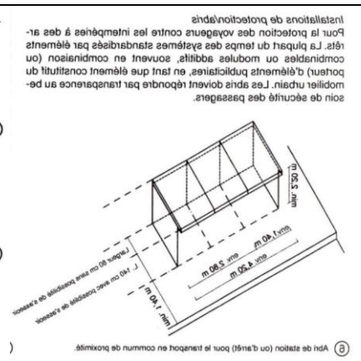
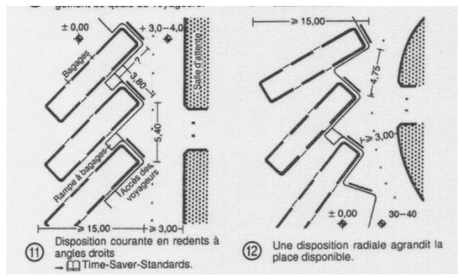
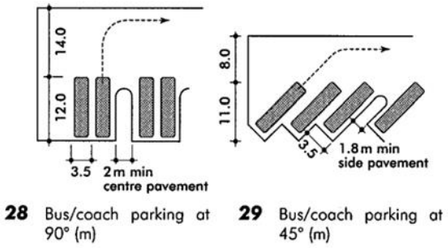
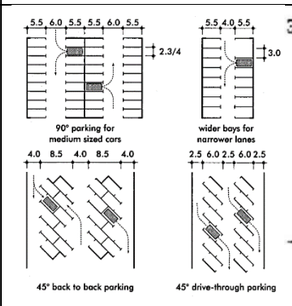
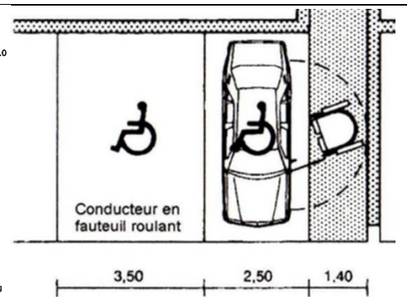
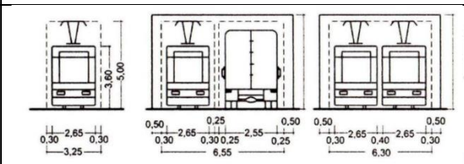
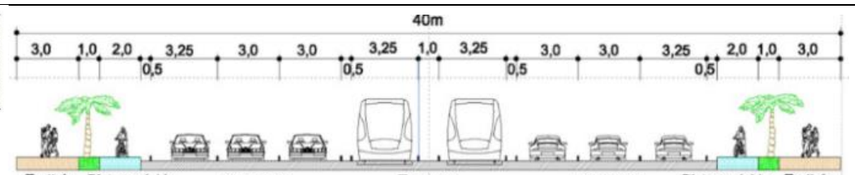
Passenger traffic	which welcomes travelers from the entrance to the passenger building to the platforms. Traffic travelers comprise the hall (exchange room), galleries, underground passages, or walkways. These are spaces of circulation, transit, and waiting that aim to ensure fluidity of circulation, facilitate the orientation and information of customers including people with reduced mobility, and highlight the architecture of the building.
Traveler services	which bring together different families of services for the comfort and well-being of the traveler and accompanying persons. They generally consist of a reception, ticket sales, waiting, luggage storage, lost and found items, toilet relays, and lounges dedicated to carriers depending on the flow and typology of customers (for example: frequent traveler lounges for TGV).
Businesses	The shops are made up of all the commercial concessions present at the station. They are adapted to travelers and their typology. They promote the overall development of the station and make it possible to complete the range of services made available to travelers (press, takeaway, etc.). These spaces are organized in passenger circulation spaces, more generally along traffic flows.
Station management services	These services are necessary for the daily operation of the station: customer information and support, train circulation, maintenance of equipment (escalators, elevators, information systems, etc.), safety and security of people and property, and building maintenance. They are generally made up of the Stopovers, Ticket Sales, security, and maintenance services. Other services may also be present at the station.

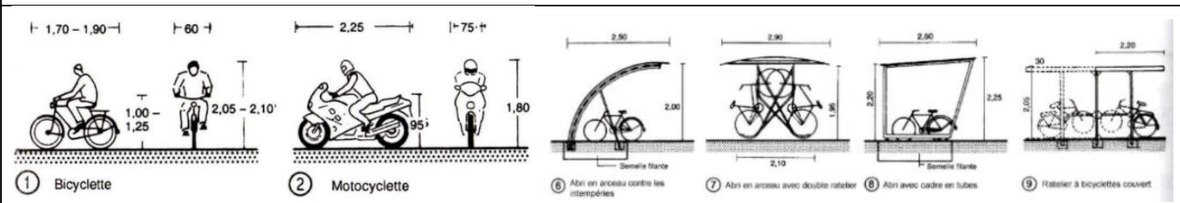
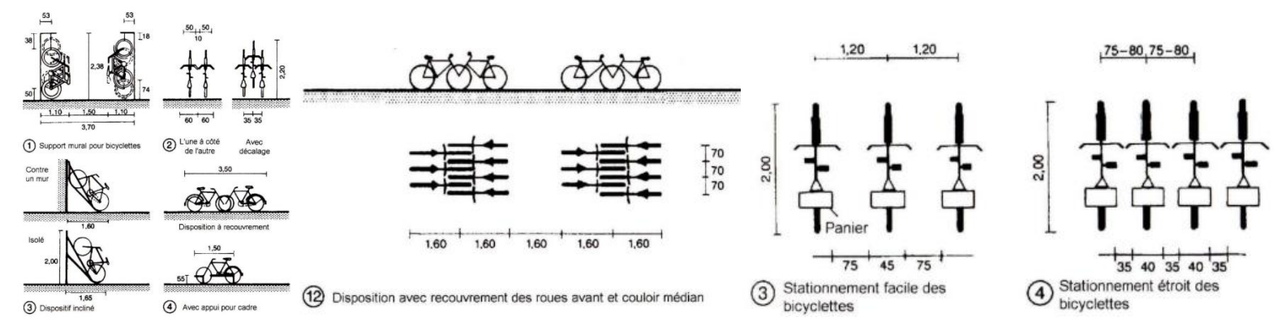
The distributed technical rooms	which are the hard cores of the building (heating, cooling, ventilation, hot water, and water cold, electricity: strong currents, weak currents, etc.).

b. outdoor spaces:

Table 10:outdoor spaces

Source: (Neufert, 2013) and (Quentin Pickard ,2002)

Platforms	**Normes**	**Illustration**
Bus	Design requirements with the growth of long-distance coach travel, stations are required to operate in a similar "manner to those for railways. At main stations a good standard of accommodation should be provided, comprising information, reservations and ticket offices, passenger waiting areas, left luggage, toilets, cafes, and kiosks, together with staff offices and restrooms. Subject to individual company arrangements, some provisions may be required for bus coach maintenance, refuelling, and cleaning.	 **30** Buchanan Bus Station, Glasgow (Arch: The Jenkins Group)    ⑪ Disposition courante en redents à angles droits → Time-Saver-Standards. ⑫ Une disposition radiale agrandit la place disponible.  **28** Bus/coach parking at 90° (m) **29** Bus/coach parking at 45° (m)
Cars/ Taxis		 
Tram and Train	METROPOLITANS Differentiation of systems: the tram travels only by sight and participates in road traffic; the urban railway runs on railway tracks following the layout of the streets.	 ⑦ Encombrement du tramway en site urbain 

	Car width: 2.3 to 2.65 m (there are still widths of 2.20 m, to be avoided when designing a new installation). Distance from the rail axes: at least 2.60 m or 2.95 m, better 3.10 m to compensate for the radius of gyration. Distance from the vehicle body to the sidewalk for separate track bodies 0.5 m, exceptionally 0.30 m. Radius of the track: if possible less than 180 m, at least 25 m in junctions and turns. Longitudinal slope: maximum 25%%, exceptionally 40%. Stops Platform width at least 3.50 m. For the installation of waiting rooms between two lanes: at least 5.50 m. Safety space 0.85 m wide from the vehicle boundary line, on the door side.	
Bicycles		 

5.3 project examples analysis:

For the examples analysis (See table37 in annex)

V. Comfort and thermal comfort:

5.1. Definition of comfort:

Comfort is "*a pleasant state of well-being, ease and physical, physiological and psychological harmony between a person and the environment*" (Jean Marc, 2021), there are different types of comfort which are: Physical comfort; Mental comfort; Visual comfort; Acoustic comfort; Olfactory comfort and Thermal comfort.

5.2. Definition of thermal comfort:

Thermal comfort refers to the sensation or state in which the occupants of a building experience a balance or regularity between the two extremes (high/low) of internal temperature. (Bouzidi & al, 2020).

It is a subjective evaluation of the perception of the thermal atmosphere and reflects its feeling of neutrality in relation to a given thermal environment. (Emetere, 2022).

Ensuring the thermal comfort of the occupants of a building or space is one of the main objectives of designers of HVAC (heating, ventilation and air conditioning) systems.

5.2.1 factors influencing thermal comfort:

When it comes to optimizing the thermal comfort, these factors need to be taken into account:

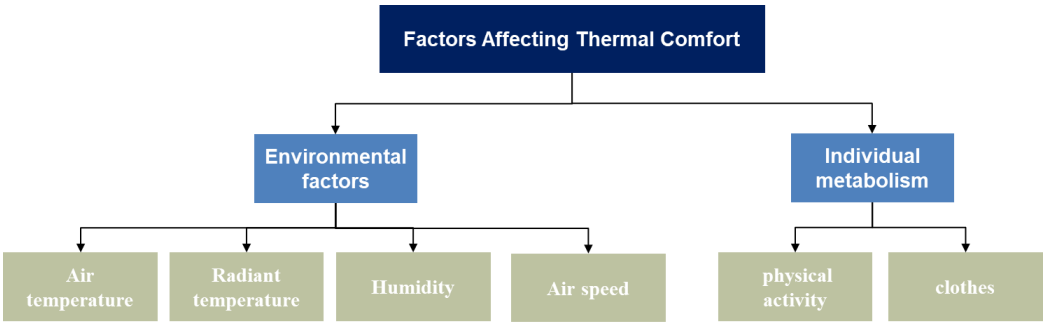


Diagram 11: the main factors affecting thermal comfort

Sources: authors

What are these factors?:

See the (table10) below to know the definition of each factor:

Table 11:table of definition of the different factors affecting thermal comfort

Source: (wattsense.com)

factors	definition
Air temperature	Air temperature is an intensive variable that expresses the sensation of heat or cold.
Radiant temperature	The air temperature in a space must be between 19°C and 21°C in winter and between 22°C and 24°C in summer.
Humidity	An ideal humidity level is between 40 and 60%.
Air speed	Must avoid winds
Individual metabolism	vary according to physical activity and the level of heat produced by the human body.

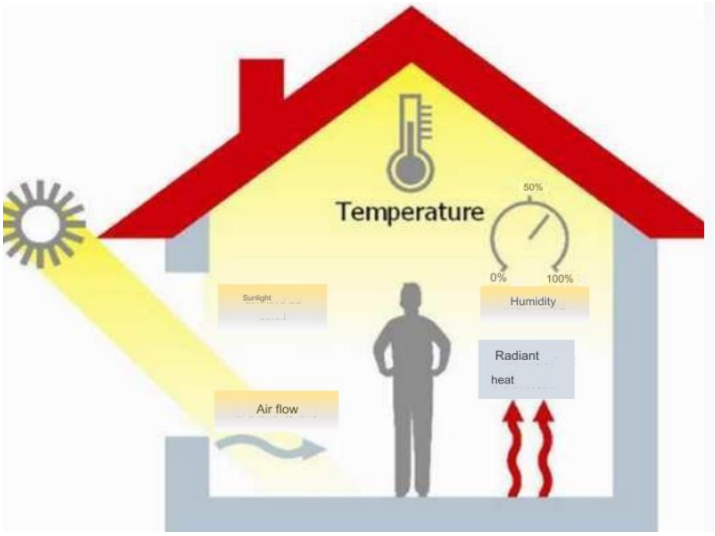


Figure 30:Illustration of environmental factors affecting thermal comfort

Source: Master thesis of Meddahi Mohamed Younes and Masker Ilyas 2023, translated by authors

5.3. Thermal (heat) insulation:

5.3.1 Definition of thermal insulation:

Thermal insulation involves reducing heat transfer between different objects or spaces. This involves using materials with low thermal conductivity, such as fiberglass, cellulose or foam, to minimize heat loss or gain through walls (interior and exterior), roofs and floors (Yüksel, 2016).

The principle of thermal insulation is based on replacing a short heat flow path with low thermal resistance with a durable, high thermal resistance (Mashkoor & al, 2020).

The aim is to maintain a comfortable indoor temperature and improve energy efficiency.

5.3.2. The different insulation techniques:

- **Insulation from the inside:** (applicable to walls, roofs, attics and floors); the insulating panels are laid directly on the inside of the areas to be insulated. The advantage of this method is that it's easy to install and takes less time, but it does reduce the surface area of the rooms.
- **External insulation:** (applicable to walls, roofs and attics); the insulation is applied directly to the outside of the building. This method offers high thermal performance and eliminates thermal bridges. However, it is one of the most expensive solutions.
- **Wall thickness insulation (integrated insulation):** this method incorporates the insulation directly into the walls. It has the advantage of optimizing construction time, reducing thermal bridges and making installation easier.

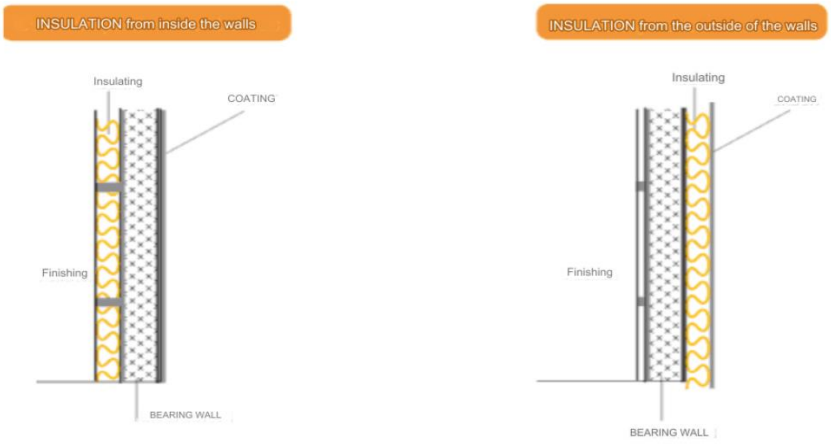


Figure 31:Demonstration of interior and exterior insulation techniques

Source: Master thesis of Meddahi Mohamed Younes and Masker Ilyas 2023, translated by authors

5.3.3. Types of thermal insulation:

There are more than 40 different types of thermal insulation materials from different parts of the world. These materials fall into two broad categories: organic insulation (carbon-based) and inorganic insulation (without carbon-hydrogen bonds, mineral). Each category can be subdivided into natural and synthetic insulants, depending on the sourcing and processing of the raw materials (Latif & al, 2019).

See table 12 :

Table 12:different types of thermal insulation

Source: (Latif & al, 2019).

Inorganic (mineral)		Organic (carbon-based)	
Synthetic	Natural	Synthetic	Natural
Aerogel 	Expanded Clay 	Expanded polystyrene 	Cellulosic Fibre 
Calcium silicate foam 	Expanded Mica 	Extruded Polystyrene 	Cotton Fibre 
Calcium Cellular Glass 	Expanded Perlite 	Melamine Foam 	Linen Fibre 

Foamed Glass	Expanded Vermiculite 	Phenolic Foam	Hemp fibre 
Glass wool 	Clay Bricks Insulating 	Polyester Fibres 	Hemp-lime (organic and inorganic) 
Gypsum foam	Pumice Stone 	Polyethylene Foam	Cork Insulation Board 

5.4. Natural ventilation:

Ventilation in a building plays a crucial role in ensuring hygiene, comfort and the preservation of the structure. Poor ventilation results in the confinement of the living space, deteriorating the quality of the indoor environment. Ventilation influences: (KHELIFI, 2022)

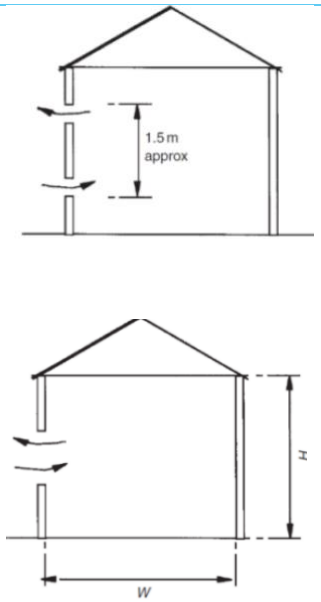
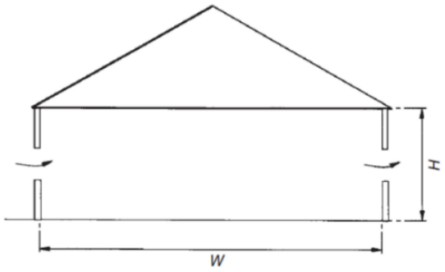
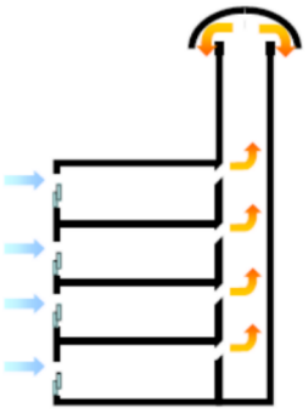
- ✓ Humidity problems.
- ✓ Thermal comfort.
- ✓ Air quality, and therefore the health of occupants.
- ✓ Heat loss, and therefore energy consumption: ventilation affects energy demand by almost 30% (Boukarta, 2020).

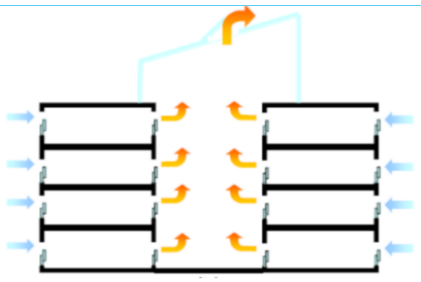
5.4.1. Type of natural ventilation:

Types of natural ventilation based on (Guide Bio-Tech, 2012):

Table 13:Table: different types of ways used for the natural ventilation

Source: (Guide Bio-Tech, 2012):

type	content	illustration
Single ventilation/single opening:	This configuration is not very effective due to the limited depth of the room, which must be less than or equal to twice the ceiling height. To ensure effective ventilation throughout the area, a maximum depth of 6 meters is recommended.	
Single/dual aperture ventilation:	The depth of the room should not exceed 2.5 times the ceiling height, with a recommended distance of approximately 1.5 times the height between the air inlet and the extraction.	
Chimney ventilation	To optimize solar gain, we recommend positioning the chimney on the sunniest side of the building, while the air intake should be on the shady side. This enhances the cooling effect in summer. It is also	

	recommended that the length of the ventilated area should not exceed five times the ceiling height.	
Atrium ventilation	The atrium offers the advantage of a building volume that can be naturally ventilated, doubling that of a chimney placed on one side only. Air enters through two sides of the building, while extraction takes place in the center.	
Double-skin façade ventilation	The choice of design is relevant when it aims to meet various constraints such as a high percentage of glazing, the absence of external shading devices, or the need to protect façade materials.	

VII. Chapter conclusion:

Urban growth is a worldwide phenomenon, marked by the horizontal expansion of cities, increasing the distance between the centre and the periphery. The car, which initially encouraged this sprawl, no longer meets today's requirements. Sustainable development is therefore becoming the main objective of all urban projects. Multimodality appears to be the only solution for reconciling urban growth and sustainability. With the development of transport, stations have become centres of urban intensity and tension, integrated interchange complexes. They are no longer simply architectural concepts, but sophisticated sets of connections.

Applying the principles of sustainable development to urban projects means addressing a range of interrelated issues. Understanding the specific characteristics of a city helps to explain the choices made for new urban projects. Intermodality, which manages the connection between different modes of transport, is crucial to the smooth running of an urban or regional network. It is not limited to the creation of stations or interchanges, but also relies on comprehensive passenger information and analysis of available transport frequencies. Intermodality also includes transforming passengers' waiting time into useful time, thanks to a range of services at interchanges. With urban expansion, journeys are becoming longer and more frequent, often depending on ease of movement and parking.

through the case study of examples we emerge 3 fundamental elements that we integrate into the design of our project:

- **location:** the periphery favors the development of these places facilitates interconnection between the different areas, strengthens the external relationship with the city.
- **functional design:** incoming and outgoing passenger flows play a significant role in the composition of the space.
- **the formal organization:** the station consists mainly of 3 elements wich are: the hall, the platforms (quais) and the passenger building
- the structure is an important element in this kind of projects

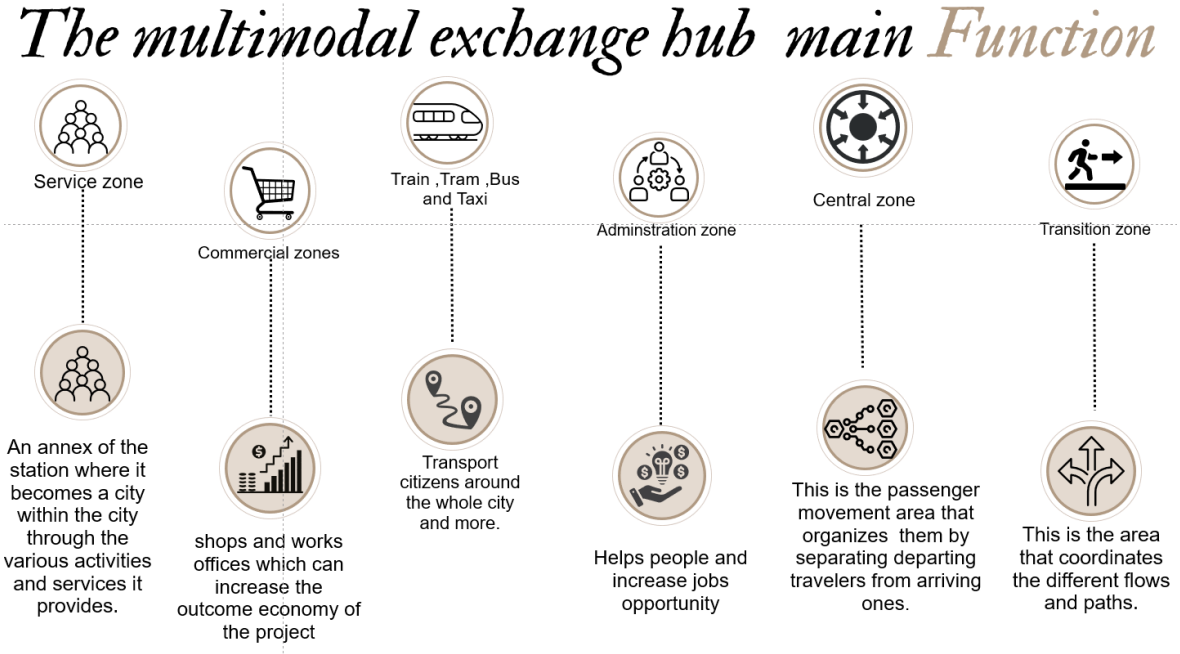


Diagram 12:functions of multimodal exchange hub.

Source: author.

CHAPTER 03: CASE OF STUDY “NEW TOWN OF BOUINEN”

Introduction:

Algeria is one of the former colonized countries, with a spatial framework designed to meet the requirements of metropolitan areas, heavily concentrated along the coastal zones. New towns were created to accommodate these needs:

- ✓ The creation of new towns also aims to correct imbalances between territories and between different, diversified regions.
- ✓ Reduce the burden of large cities in terms of housing, infrastructure and facilities, leading to population movements.

To achieve this, new towns must be designed to have a high potential for attracting new population groups. In this context, the new town of Bouinan has been considered as part of the 1st ring of new towns in Algeria, it's where our project is going to be located.

For that the site in question is located in the new town of Bouinen, more precisely in POS U02, an area characterized by residences integrating various facilities. The aim of this phase is to increase our knowledge of the site, which will later enable us to define our intervention plan for the installation of our equipment, integrating it harmoniously into the site.

I. A new city for a new life:

1.1. "Ville des roses" Blida wrida :

Blida, a city in northern Algeria, in the geographical area of the central tell. Blida or El-Boulaida is rich in history, culture and charm. The northern outskirts of the wilaya, located 50 km south of Algiers, are becoming increasingly similar to the inner suburbs of the wilaya of Algiers, as are the communes of Meftah, Larbaa, Bougara, Bouinen... It covers an area of 1 478,62 km2. The city of Blida lies at the summit of the northern slopes of the Tellian Atlas, extending to the southern edge of the Mitidja plain at an altitude of 260 meters. It is surrounded to the south by the Chréa mountains. (National Agency for Land Intermediation and Regulation)

The city's privileged location at the center of all regions, whether local, regional or national, serves as a hub for the eastern, western, central and southern regions.

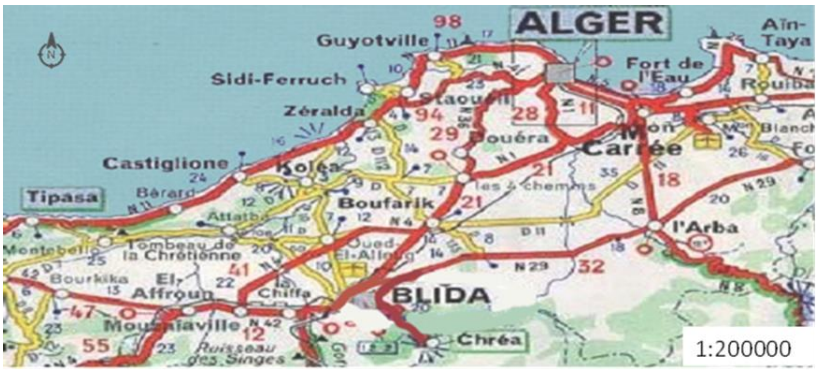
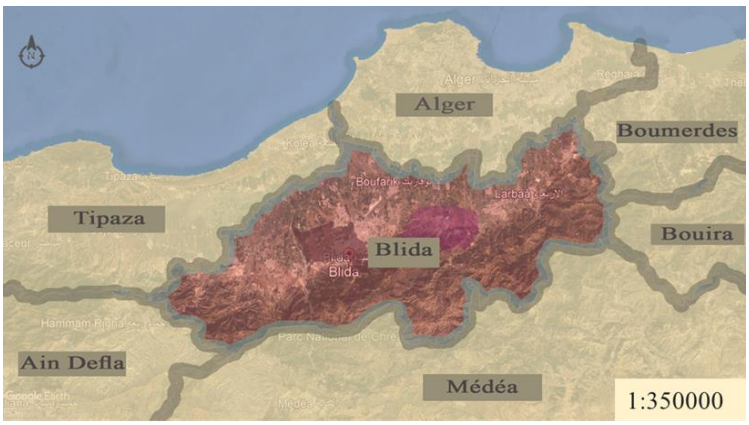


Figure 32: Situation in the Wilaya of Blida

Source: Blida's archieves

1.1.1 Geographical and administrative boundaries of ville des roses:

The Wilaya of Blida is bordered by the Wilaya of Boumerdes and Bouira to the east, the Wilaya of Medea to the south, the Wilaya of Ain Defra and Tipaza to the west and the Wilaya of Algiers to the north. It is connected to major communication networks, with the capital Algiers, and all the Metidja towns neighboring the Wilaya, offering multiple opportunities (trade, transport, communication, etc.). (National Agency for Land Intermediation and Regulation)

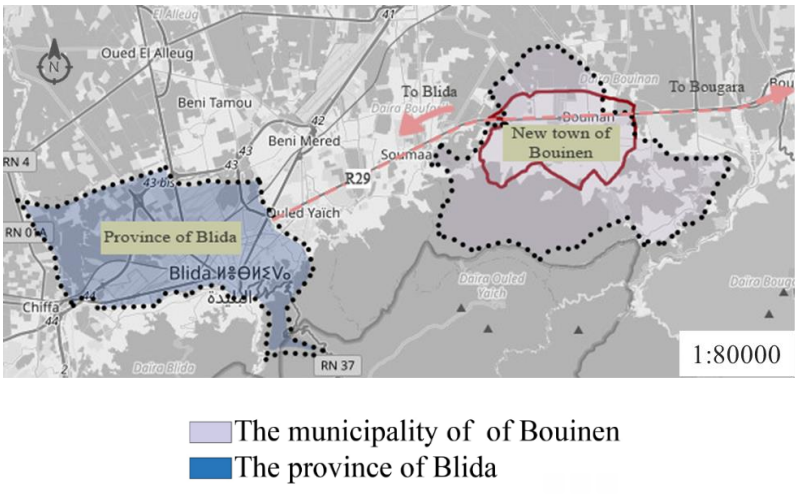


Card 1:boundaries of the Wilaya of Blida

Source : authors

1.2 Bouinane, an ecological & modern city:

Bouinan is one of the municipalities in the wilaya of Blida, at the foot of the Atlas Blidéen mountains, on the edge of the Metidja plain, between the 02 towns of Soumaa and Bougara, 25 km east of Blida and 35 km southwest of Algiers. This location is intended to accommodate the urban functions currently concentrated in Algiers.(PDAU Bouinene phase 03)



Card 2:the link between Blida and Bouinen

Source: authors

The new town of Bouinen is part of the Bouinen commune, according to the national land-use plan (SNAT 2030):

- ✓ *1ere couronne:* Improving the urban environment, easing congestion in the capital and curbing uncontrolled development. (Mr. Director General of the Public Establishment ,2015)

Figure 33:the 3 crowns of Algeria's new cities

Source: Bouinen presentation report revision 02 (adapted)

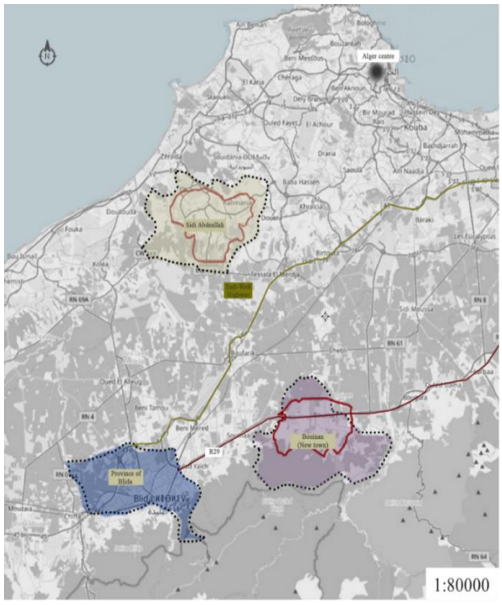
- *Why a new town?:*

✓ Contribute to regional development and the reorganization of the regional urban framework.

✓ Reduce the pressure of housing demand and curb urban development in the Algiers metropolitan area.

✓ Creation of cities based on green technologies.

Its proximity to major cities such as Sidi Abdellah, Blida, and the capital, as well as its proximity to major regional facilities, gives it a great advantage in terms of development with neighboring towns.



Card 3:links between Blida , Bouinan, Sidi Abdallah and Algiers

source: authors

1.2.1. Bouinane, a city with an accessible network:

The town of Bouinan is served by the RN 29, which links the two administrative and economic hubs of Blida and Algiers.

Establishing a network of links between the new town and the main centers located outside the site taking into account the various projects involved, in particular the access roads to the new town.

Category	Starting point	Point final	Length
1	RN29	2nd Ring Road Algiers	Extension of 12.3km
2	New town (west)	Intersection of the East-West highway ramp	New road and 11.7km extension
3	New town (west)	Connection point with the CW114	New road and 10.9km extension
4	New town (north)	3rd Ring Road Algiers	Extension of 12.1km
5	New town (west)	New town (east)	New 9.9km road
Future access route	New town (north)	3rd Ring Road Algiers	Extension of the existing track: 2.0km

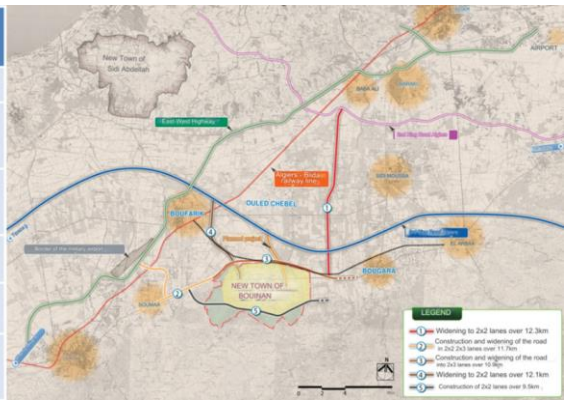
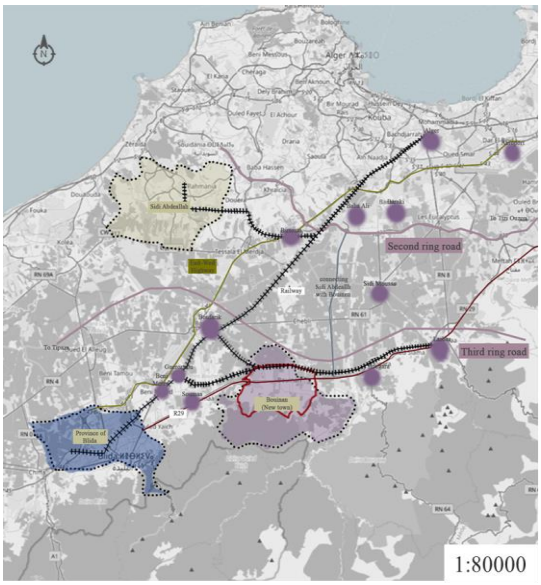


Figure 34:Bouinen's road network

Source: final report of Bouinen, translated by authors

- ✓ Facilitate access to the town of Bouinan by linking it to the main arteries of the urban network, notably the second and third ring roads and the East-West freeway.
- ✓ The existing north-south rail link connects the capital with the south of the country via the town of Blida.
- ✓ Two new links are planned, running from Beni Mered and Boufarik respectively, to Algiers airport via Bouinan.
- ✓ A new line linking Bouinan via Sidi Abdellah and Birtouta is under study.

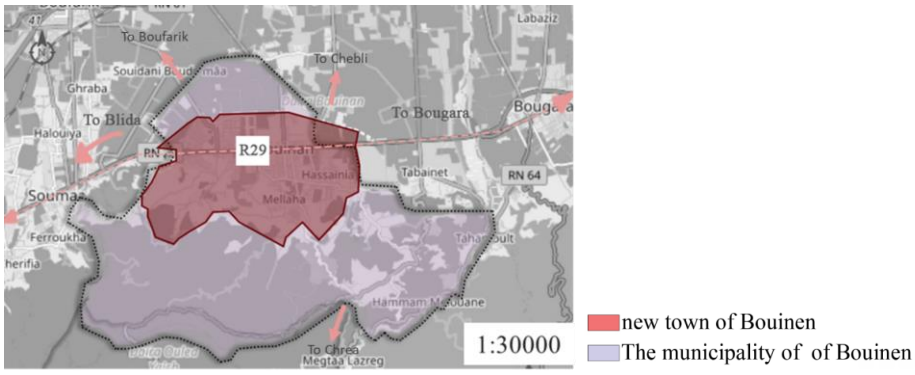


Card 4:Metropolitan road network to Bouinan

Source: authors

1.2.2. The geographical and administrative limits of the green city:

The Bouinan commune is bordered by Bougara and Hammam Melouene to the east, Soumaa to the west, Chebli and Boufalik to the north and Cherea to the south.

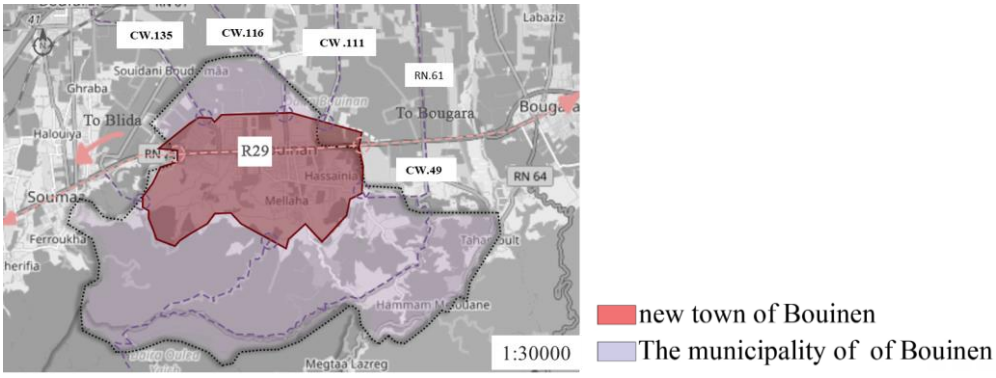


Card 5:boundaries of the Bouinen commune

Source: authors

1.2.3. Bouinane, an accessible city:

Other roads link the town to neighboring communes: CW 135 to BOUFARIK, CW 49 to CHREA to the south, CW 111 to CHEBLI and CW116 to Massouma.



Card 6:Road network to Bouinan

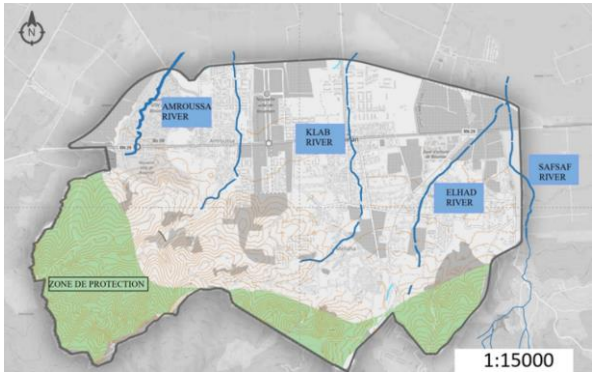
Source: authors

1.2.4. Rivers, forests and topography: a natural sanctuary:

The new city site, located between the Mitidja plain and the Atlas Mountains, is predominantly flat with gentle slopes, with 89% of its surface area flat.

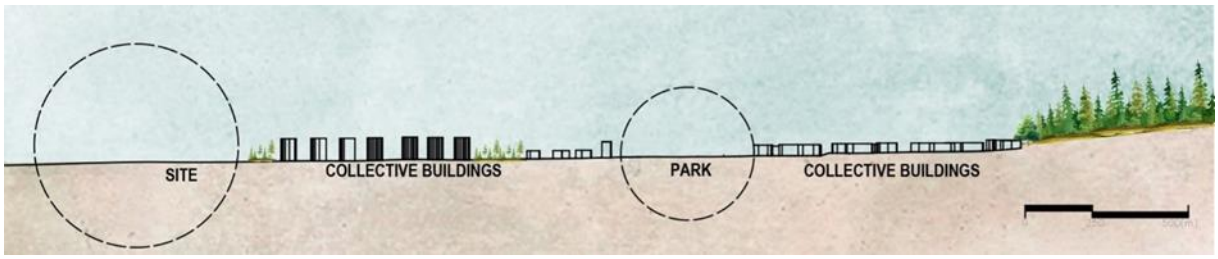
Watercourses originate in the Atlas Mountains to the south of the site and flow towards the Mitidja plain to the north. Six rivers cross the site of the new town of Bouinan: Oued Amroussa, Oued Klab, Oued Bouzid, Oued El Had, Oued Cherif and Oued Safsaf. All these wadis are dry almost all year round, with the exception of the winter rainy season. These waterways are polluted by wastewater discharges.

The site's rich flora and fauna is adjacent to the Atlas Mountains and relatively well-preserved woodlands. (Mr. Director General of the Public Establishment, 2010)



Card 7:maps of the new town's natural features

Source: authors



Card 8:City section

Source: authors

1.2.5. Green growth: the vision of a city of parks and scattered gardens:

- ✓ The project calls for the creation of a green and blue network through the preservation of wooded areas in the south of the city,
- ✓ The creation of a green belt and the maximum preservation and rehabilitation of existing waterways,
- ✓ The installation of a central park and the creation of a continuous green and aquatic network. (Mr. Director General of the Public Establishment,2015)

Card 9:maps of future green spaces

Source: authors

1.3 Bouinane, a city of green technology:

1.3.1. From a city of sports and leisure to an ecological city:

The new town of Bouinan was conceived with the specific characteristics of a sports and leisure town when the National Territorial Development Plan was drawn up, but after several consultations, it has become an ecological and modern town. Despite its own charms, this city and the new town of Sidi Abdallah form a ring that offers every guarantee of harmonious development and decongestion of the capital of Algiers. (Mr. Director General of the Public Establishment,2015)

The Ville Nouvelle de Bouinan was created by executive decree N°04-96 of 11 Safar 1425 corresponding to 01 April 2004, in accordance with several laws and decrees. Also following the guidelines initiated by the Schéma National d'Aménagement du Territoire SNAT 2030.

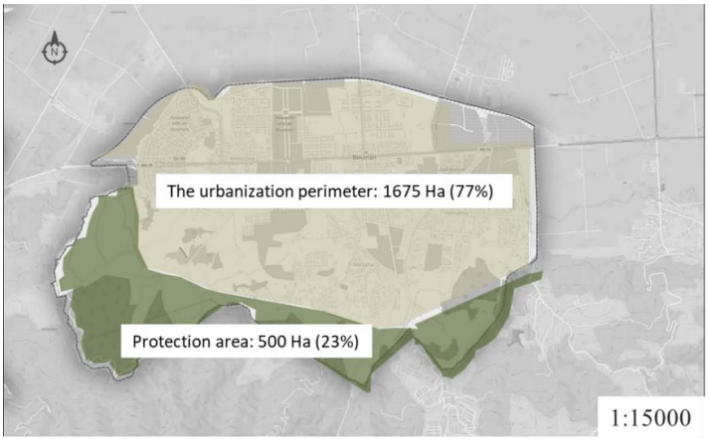
According to the final report, the project was launched in 2009 and was originally scheduled for completion in 2020. However, due to political considerations, many projects have not yet been finalized or even started. (Mr. Director General of the Public Establishment,2015)

Figure 35:a whole view of the new town of Bouinen as was suggested

Source: final report of Bouinen

1.3.2 Bouinane, a new city of youth:

It has a population of 150,000 and a surface area of 2,175 ha, of which 1,675 ha is urbanizable. Mr. Director General of the Public Establishment,2015)



Card 10: perimeter of new town of Bouinen

Source: authors

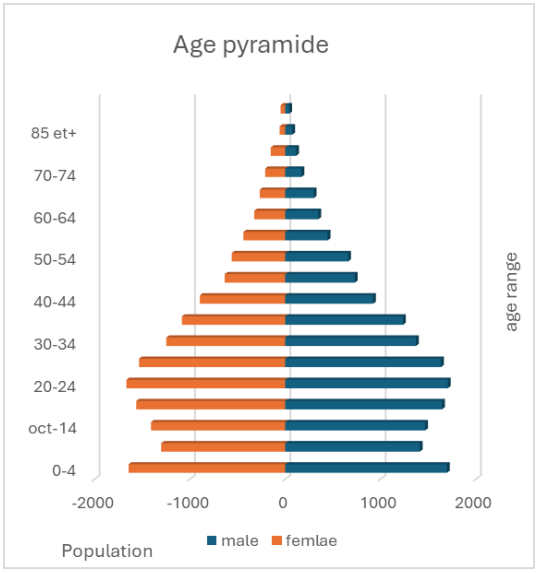


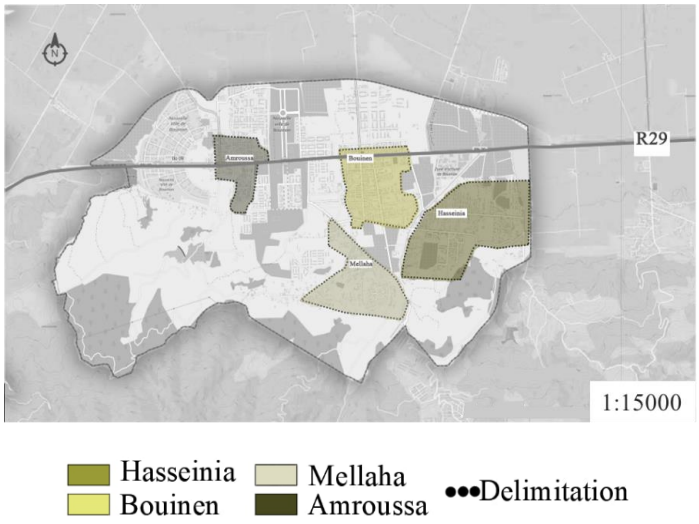
Figure 36:age pyramide of Bouinen in 2011

Source: PDAU of Bouinen

The commune's population is therefore estimated at 33,264 in 2011, as the figure shows that the main range age is the youth generation. For that the town is known for being the city of youth.

1.3.3. The old Bouinan:

This perimeter includes four (04) existing towns: Amroussa, Bouinan, Hasseinia and Mellaha.



Card 11:existent cities in Bouinen

Source: authors

1.3.4. Principles of the layout plan:

The main principles of the layout plan organization based on (Mr. Director General of the Public Establishment,2015):

- ✓ Preserve the 4 existing urban fabrics
- ✓ Preserve existing industrial activities and facilities
- ✓ Review the route of the railway line linking Algiers to the new town of Bouinan
- ✓ Consider the road access project to the new town of Bouinan

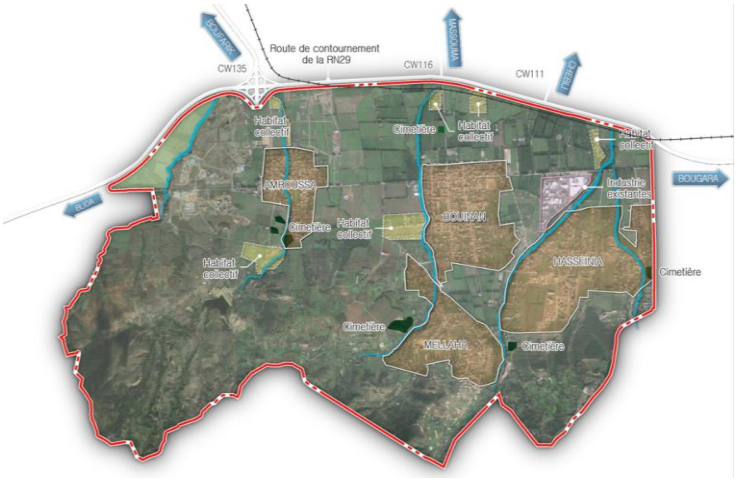


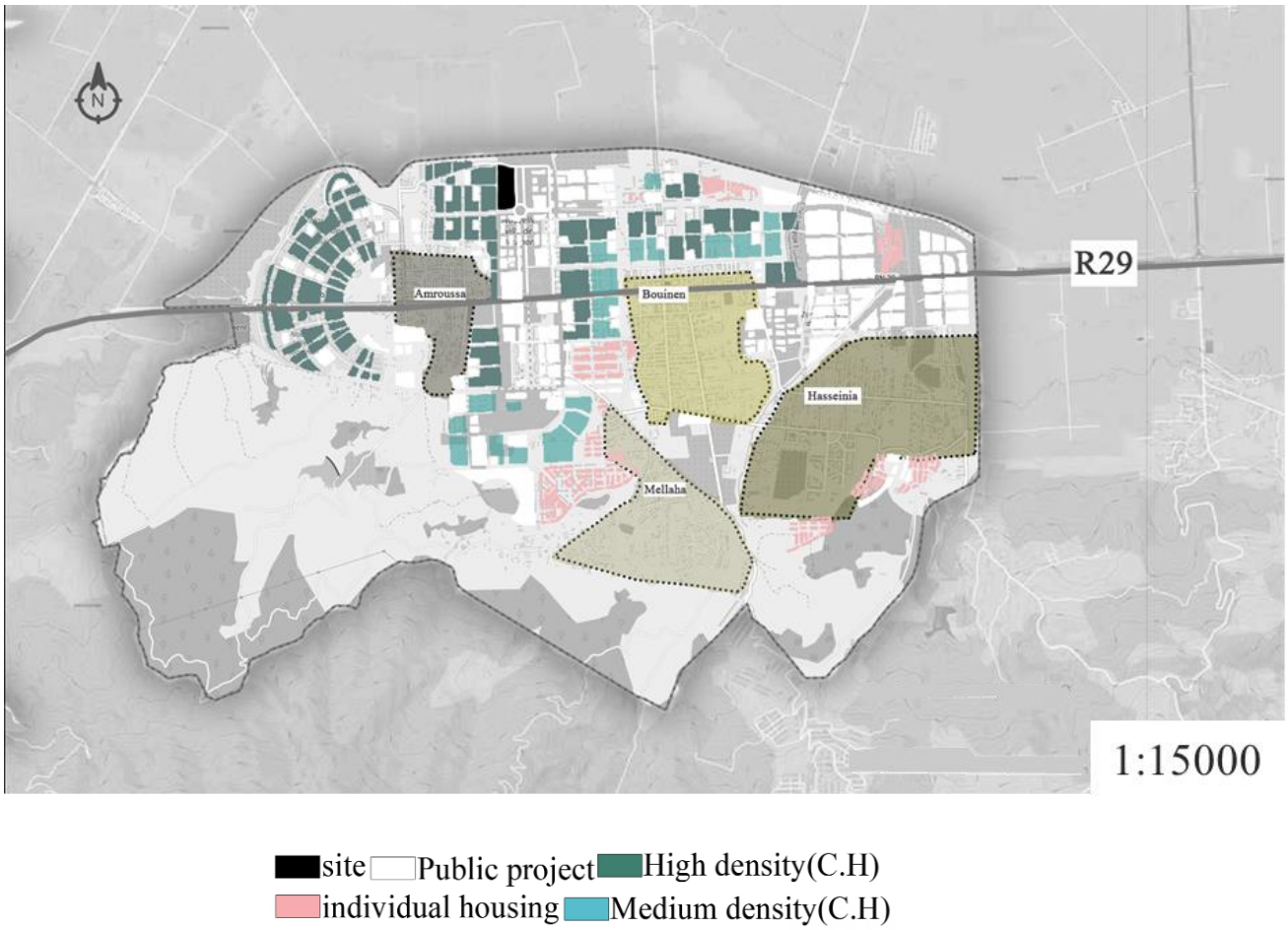
Figure 37: main used elements to elaborate the layout plan

Source: final report of Bouinen

1.3.5. The layout plan:

- *Spatial organization:*

- ✓ Take account of the city's topography and maintain the coexistence between urban space and nature.
- ✓ Promote balanced urban development by coordinating urban functions.
- ✓ Complementary structure of the new city to redefine the relationship between the two ILOTs of the new city and create a new city of excellence at international level.
- ✓ Development of the main functions and facilities around the main axis comprising the administrative district, the theme park, the Olympic complex and the high-tech industrial zone.
- ✓ Organization of the urban space in favor of future expansion and development. (Mr. Director General of the Public Establishment,2015):



Card 12:layout plan of the new town of Bouinene

Source: authors

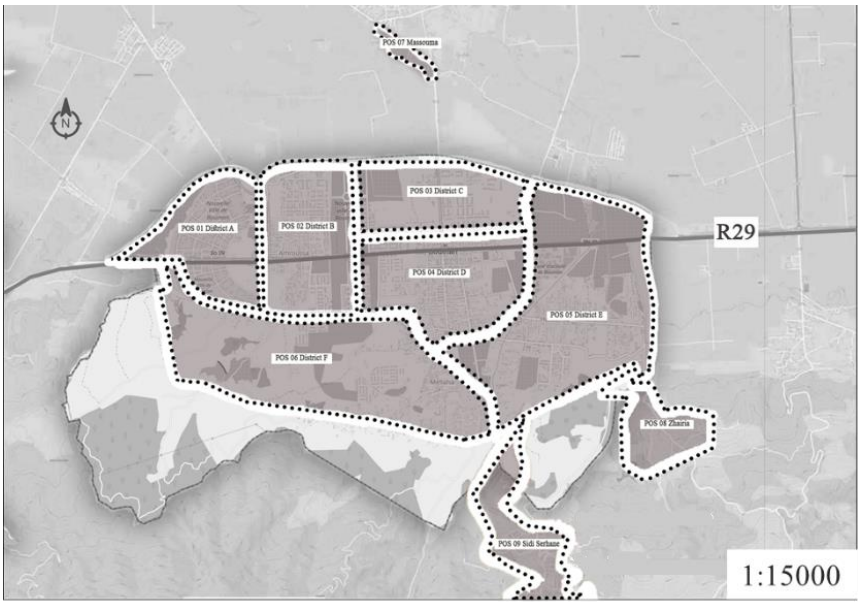
- *Land use (occupation des sols):*

✓ Develop a land-use plan allowing the introduction of various functions such as government, high-tech industry, sports and leisure, commerce, etc., to ensure the vitality of the new city.

✓ Located in an advanced industrial zone on the eastern side of ILOT in anticipation of future urban expansion.

✓ Introduction of multifunctional facilities and design of appropriate infrastructure for efficient land use. (Mr. Director General of the Public Establishment,2015):

The city is structured into 7 districts:



Card 13:different districts of the new town of Bouinen

Source: authors

- *What Bouinen's hid in store?*

A new town must have all the facilities it needs to function properly. The city must accommodate a variety of facilities such as:

Government facilities, Health, Recovery, Housing, etc.

Large-scale housing programs require the planning and construction of efficient infrastructure networks: roads, water supply, sewerage, gas, electricity, telecommunications. (see (table40) in annex)

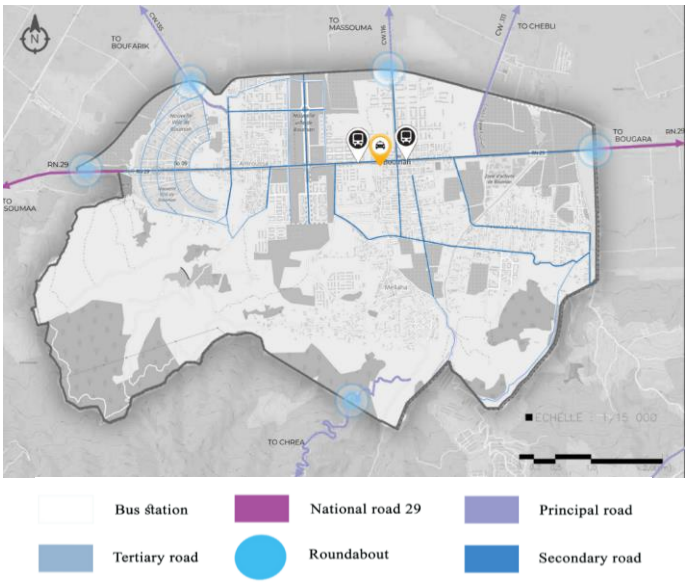
Therefore a multimodal station is proposed in the POS N°02 Quartier B.

1.3.6 Accessing the inaccessible: a city with limited bus stations and multiple access points:

The city of Bouinan boasts several access points:

- ✓ CW 136, which connects to and from Boufarik
- ✓ CW 116 leading to Massouma
- ✓ CW 111 to Chebli
- ✓ NR 29 to Bougara
- ✓ Lastly, NR 29 to Somaa

Despite this array of access points, bus stations are scarce in the city.



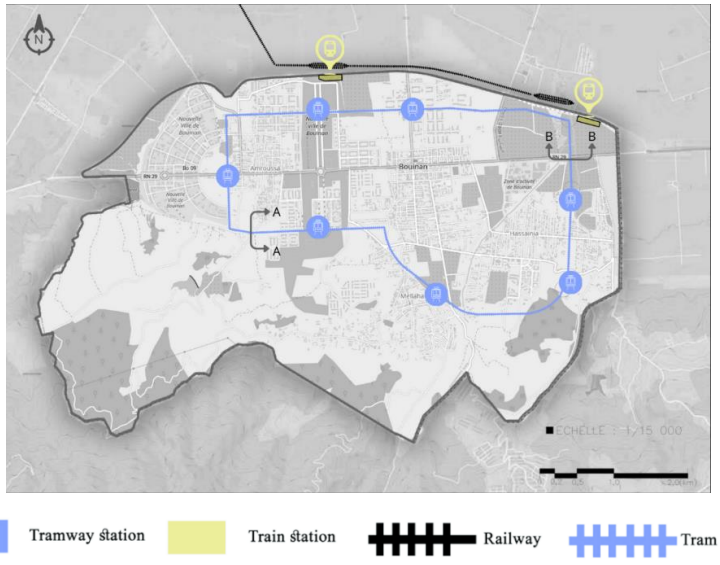
Card 14:map that indicates the access points and bus stations.

Source :author

1.3..7 On track for the future: the city's new tramway system:

Introduction to new ecological public transport system, organizing tramway line based on user needs and requirements, demonstrating design considering current and future demand and project costs.

The establishment of a common transport coordination center at the planned site for the construction of the new Bouinan railway line.



Card 15:the proposal plan of the tram line.

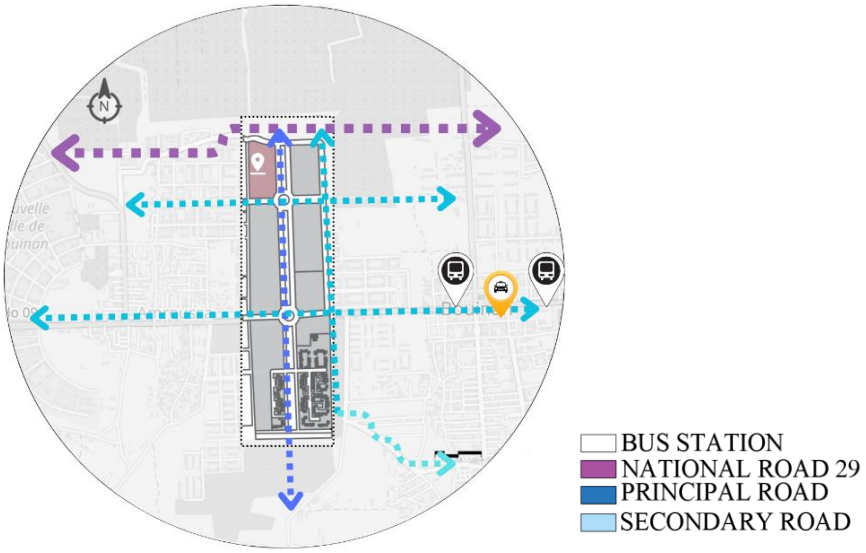
Source : author.

1.3.8. Site analysis:

Our intervention area is location in the center of the city, it is considered the main axe of functions

- *Accessing Opportunity: Maximizing Accessibility in a Multimodal Station Site:*

The intervention area is sournded by : the national road 29 , Principal road taht continues all the way of the central part of the city, and 3 secondary roads , one of them held the most important commercial zone in the city .

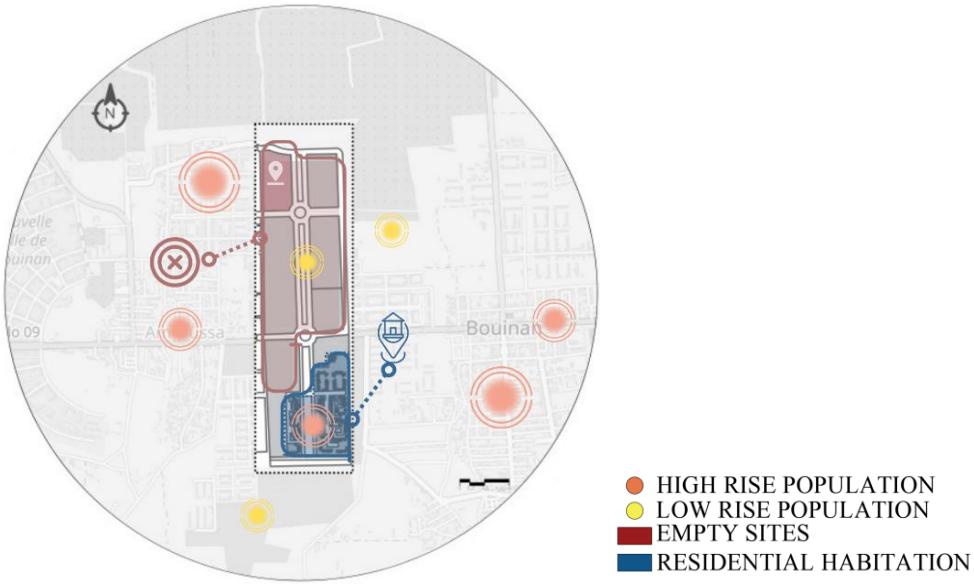


Card 16:intervention area access points and roads.

Source :author.

- *High-Rise Wasteland: The Potential of an important functional axe to an Empty Sites in a High-Residential Function:*

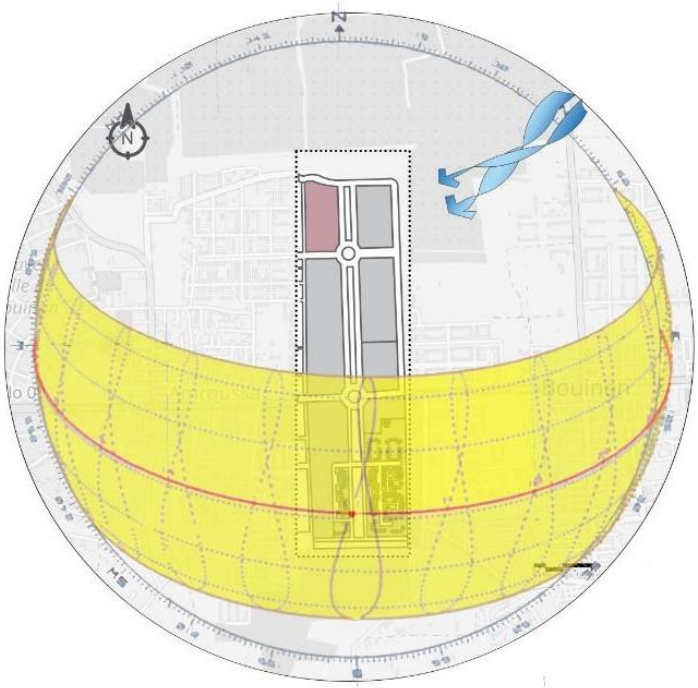
This axe, according to the city program, is the structural axe of the city, it's like the colonne bone of the city, it contains all the important functions that a city should have, yet in reality, it is full of empty sites with unbalanced low / high rise population.



Card 17: the main functions surrounding our intervention area

Source :authors.

- *Sun path and wind direction:*



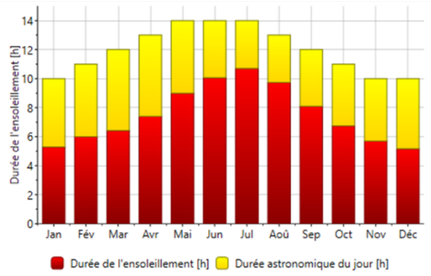
Card 18:sun track and wind direction

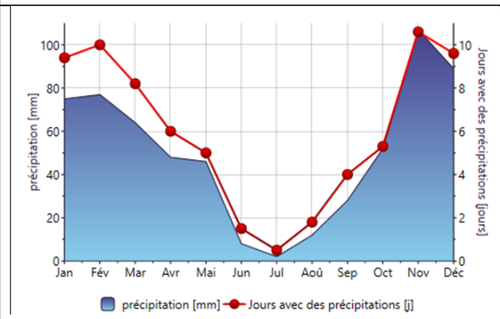
Source : authors.

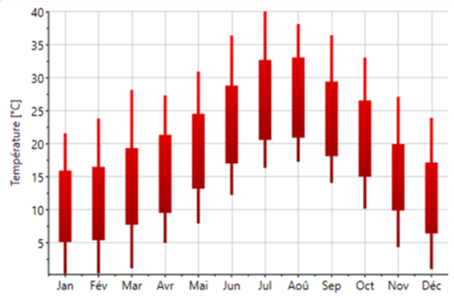
III. What summer and winter have in store for Bouinen:

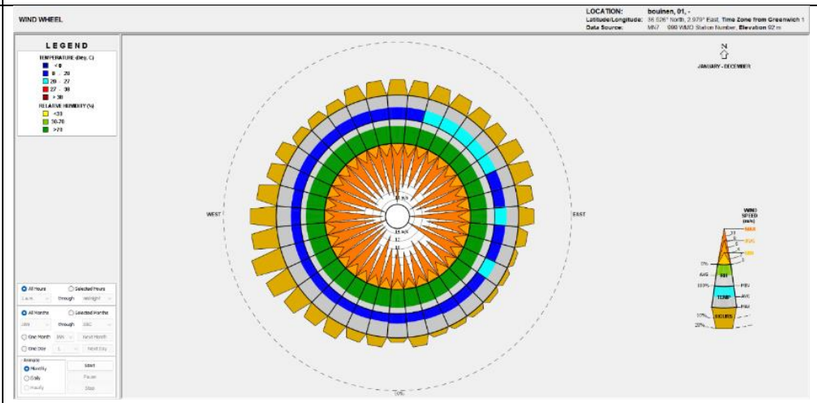
3.1 Climate analysis:

Table 14: summary of climate analysis

<table>
<tr><td colspan="4">Climate analysis</td></tr>
<tr><td>Sunshine duration</td><td>Rainfall</td><td>Monthly temperature</td><td>Winds</td></tr>
<tr><td> 

graph 1:Sunshine duration at Bouinen
(Source: Meteonorm 8)</td><td> 

graph 2:Precipitation at Bouinen
(Source: Meteonorm 8)</td><td> 

graph 3:Monthly temperature at Bouinen
(Source: Meteonorm 8)</td><td> 

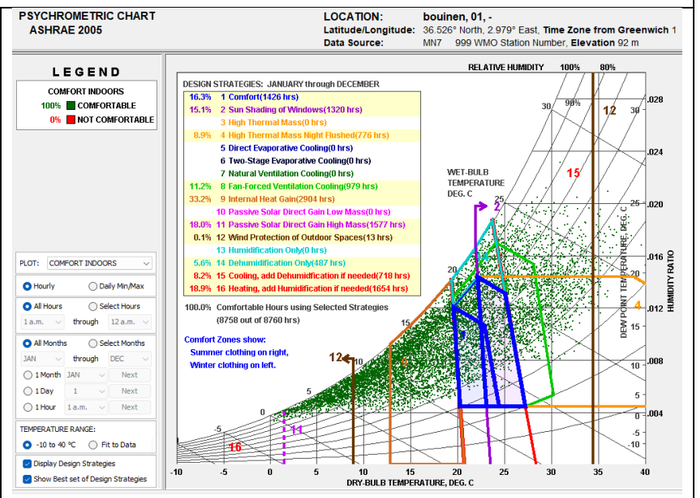
graph 4:Wind rose for the town of Bouinen
(Source :Climate Consultant 6.0)</td></tr>
<tr><td>Bouinen enjoys plenty of sunshine. In summer, sunshine is at its longest, lasting up to 10 hours a day, while in winter it doesn't exceed 6 hours.</td><td>Rainfall is around nine months a year. Rainfall peaks in November with 110mm, while the minimum is recorded in July with just 5mm.</td><td>Temperatures range from a high of 40°C in July and a minimum of 0°C in January and February.</td><td>The prevailing winds are from the west and north-east and north-easterly, with a maximum speed of 16m/s, and a minimum speed of of 8m/s.
The relative humidity in the region varies between 30% and 70%.</td></tr>
<tr><td colspan="4">Synthesis/Overview</td></tr>
<tr><td colspan="4">The climatic analysis allows us to conclude that the town of Bouinen is located in a subhumid bioclimatic zone with a Mediterranean climate. Mediterranean climate. This climate is characterised by wet, cold winters and hot, dry summers.</td></tr>
</table>

CHAPTER 03: CASE STUDY OF THE NEW TOWN OF BOUINEN

3.2 Energy analysis:

Table 15: summary of bioclimatic analysis

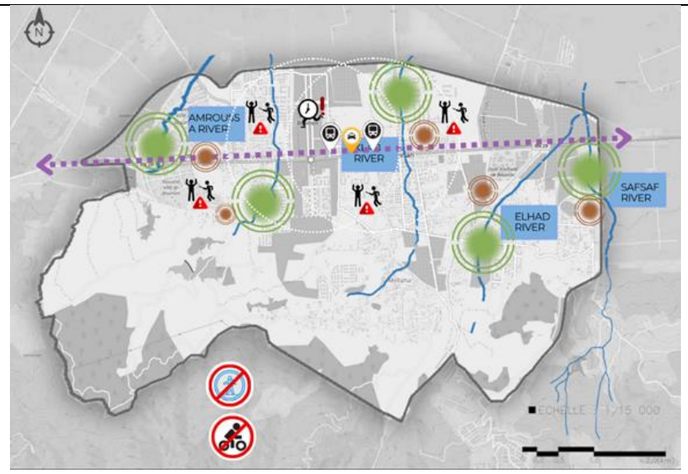
<table>
<tr><td colspan="3">Bioclimatic analysis using the GIVONI diagram</td></tr>
<tr><td>Winter (graph in annex)</td><td>spring (graph in annex)</td><td>Yearly/annual</td></tr>
<tr><td>During the 3 winter months (December, January, February), passive techniques passive techniques provide only 49.1% comfort. To achieve 100% comfort, it is necessary to use 50.9% active solutions, in particular a heating system that provides 1100 hours of heating.</td><td>During the 3 spring months (March, April, May), passive techniques provide 84.6% comfort. To achieve 100% comfort, it is necessary to use 15.4% active solutions, in particular a heating system that provides 343 hours of heating (15.5%) and an air conditioning system (0.2%) that provides 4 hours.</td><td>If we look at the annual requirements in terms of percentages and hours of comfort, we see that passive techniques provide only 72.9% of comfort.
(100%), it is necessary to use active techniques (27.1%).
The air-conditioning system accounts for 8.2% and provides operating time of 718 hours.
The heating system accounts for 18.9% and operates for 1657 hours.</td></tr>
<tr><td>Summer (graph in annex)</td><td>Autumn (graph in annex)</td><td colspan="2">Synthesis/Overview</td></tr>
<tr><td>During the 3 summer months (June, July, August), passive techniques offer 74% comfort, while active techniques offer 26% comfort, thanks in particular to an air conditioning system that provides 575 hours of comfort.</td><td>During the 3 autumn months (September, October, November), passive techniques offered 83.9% comfort, while active techniques offered 16.1% comfort, including an air conditioning system (6.4%) which provided 139 hours, and a heating system (9.7%) which provided 211 hours.</td><td colspan="2">In general, thermal comfort can be provided by passive techniques throughout the year, with the exception of winter, when active techniques are required. with the exception of winter, when it is necessary to use active techniques. The main strategies to ensure comfort in winter are as follows:
- Direct gain passive solar, large mass (16.9%)
- Internal heat gain. (32.9%)
- sun shading of windows(0.2%)
Active strategies :
- Heating. (50.9%)</td></tr>
</table>

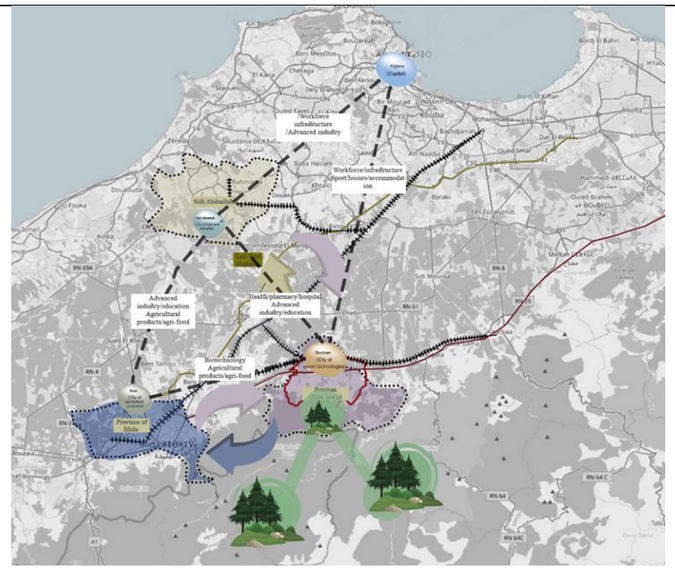
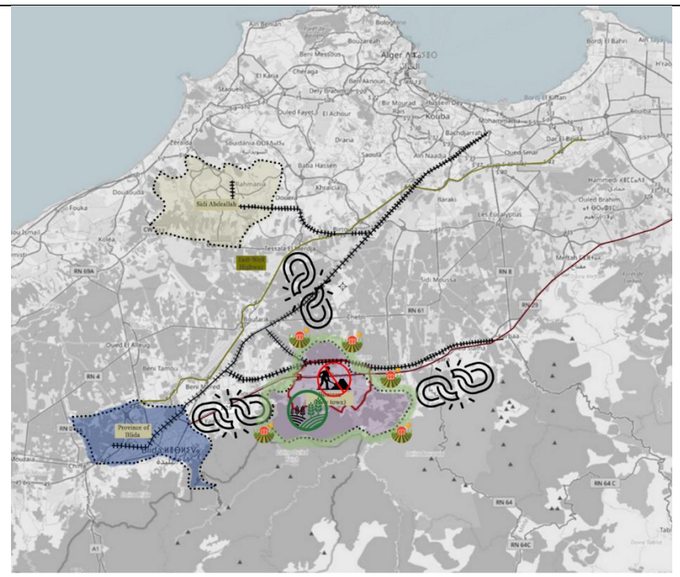


graph 5:anual Givoni diagram of the new town of Bouinen

IV. AFOM:

Table 16:AFOM

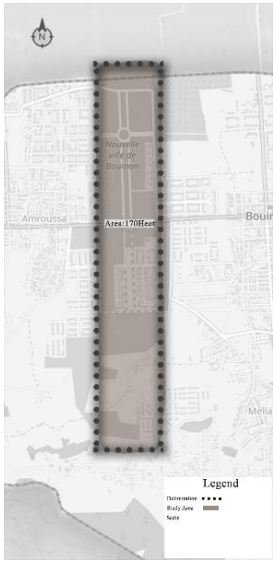
ATOUTS (advantages)	FAIBLESSES (weaknesses)
-Land availability -Social dynamism and daily internal mobility -Reduce the population of Algiers in terms of demographics -High population density, especially the young population, has led to increased profitability. -Creation of new jobs (reduction of unemployment) -Profitability comes from the abundance of nature, particularly the plant richness of the forest. -Decongestion of national road 29 which leads to soumaa and ouled yaich	-Poor quality of public spaces -Insecurity -Lack of multimodality and intermodality -Various pollution -Insufficient housing stock -Insufficient employment stock -The rivers are both polluted and dried up. -The lack of pedestrian paths and gentle mobility leads to air and noise pollution. -Additionally, there is a lack of bus stops and public transportation options. -Delay in the execution time and completion of the rest of the main public projects.
 *Card 19: attouts* *Source : authors*	 *Card 20:FAIBLESSES (weaknesses)* *Source : authors*
OPPORTUNITES (opportunities)	MENACE (threats)
-Proximity to Algiers, Blida and Sidiabdellah -Multifunctional future city	-Pressure of urbanization on agricultural land in Mitidja -Seismic risk -Pressure of urbanization on agricultural land in Mitidja

-Meet the demand of visitors from other regions through the construction of leisure and sports facilities and attractions. -enjoy ecological and natural features like the Atlas and Chréa National Park -Enjoy the Sidi Abdellah Bouinan joint in Algiers -Optimization of inter-wilaya transport -Construction of a multimodal station -Optimize relations between Blida sidi Abdallah and Algiers in terms of specialization of cities and complementarity of functions and complementarity of functions with the main neighboring cities.	-Seismic risk -lack of harmony and balance between the existing fabrics and the new city -Anarchic development of neighboring areas -Occupation of agricultural land
 *Card 21:OPPORTUNITES (opportunities)* *Source : authors*	 *Card 22:MENACE (threats)* *Source : authors*

V. Urban intervention:

5.1 Back to our study area:

our study area and the structuring axis of the city's structuring equipment, it has an area of 170 hectares.

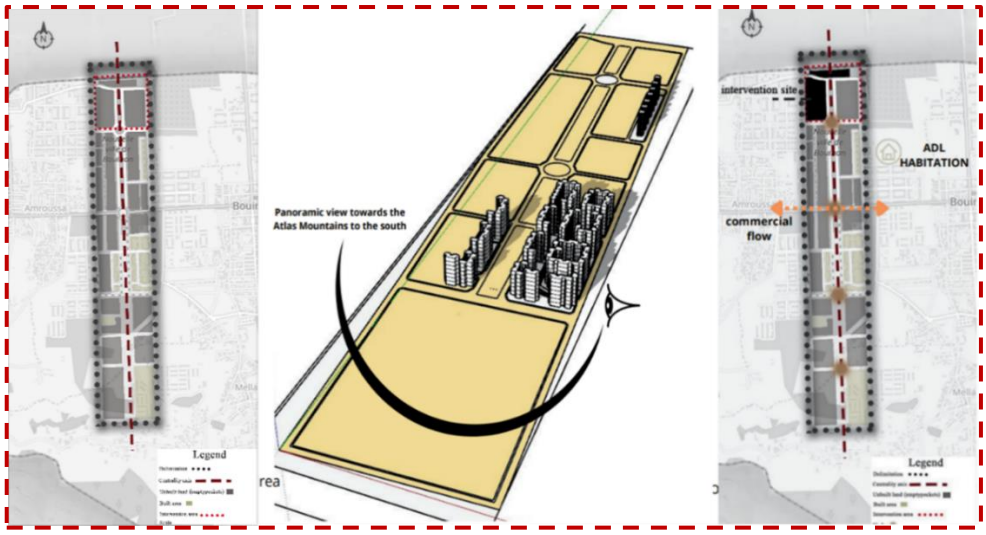


Card 23:study area

Source: authors

5.2 Only residential buildings are present along the main axis:

In the existing state of affairs in the city, there are only residential buildings along the main axis.



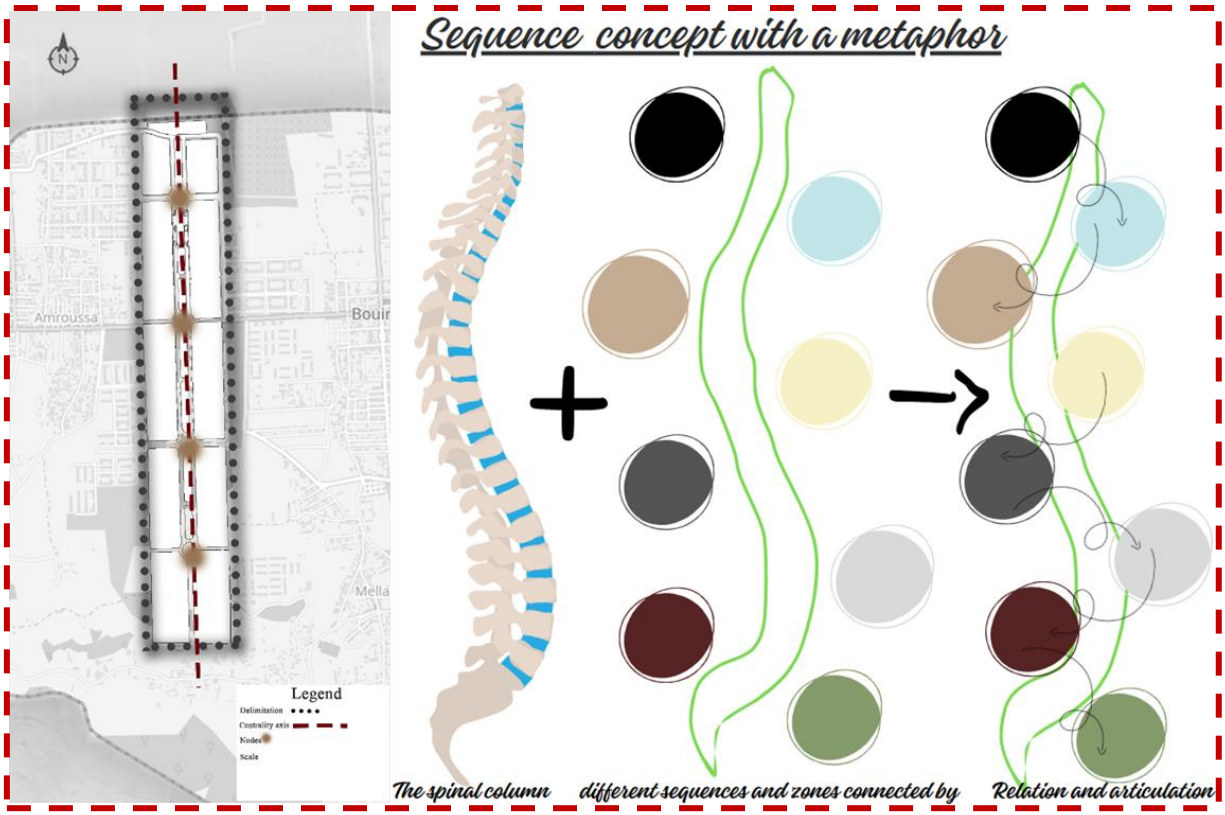
Card 24:the existing state of the study area

Source: authors

5.3 time to make an action:

Our main action in this area is the **Urban requalification** of the main axis boulevard (the structuring axis of the new city)

According to the urban analysis, we noticed that the structuring axis of the structuring equipment of the city reminds us of the spine. for this our main concept is inspired by the spine and its sequences which are articulated with each other with the integration of several concepts. see card 25:

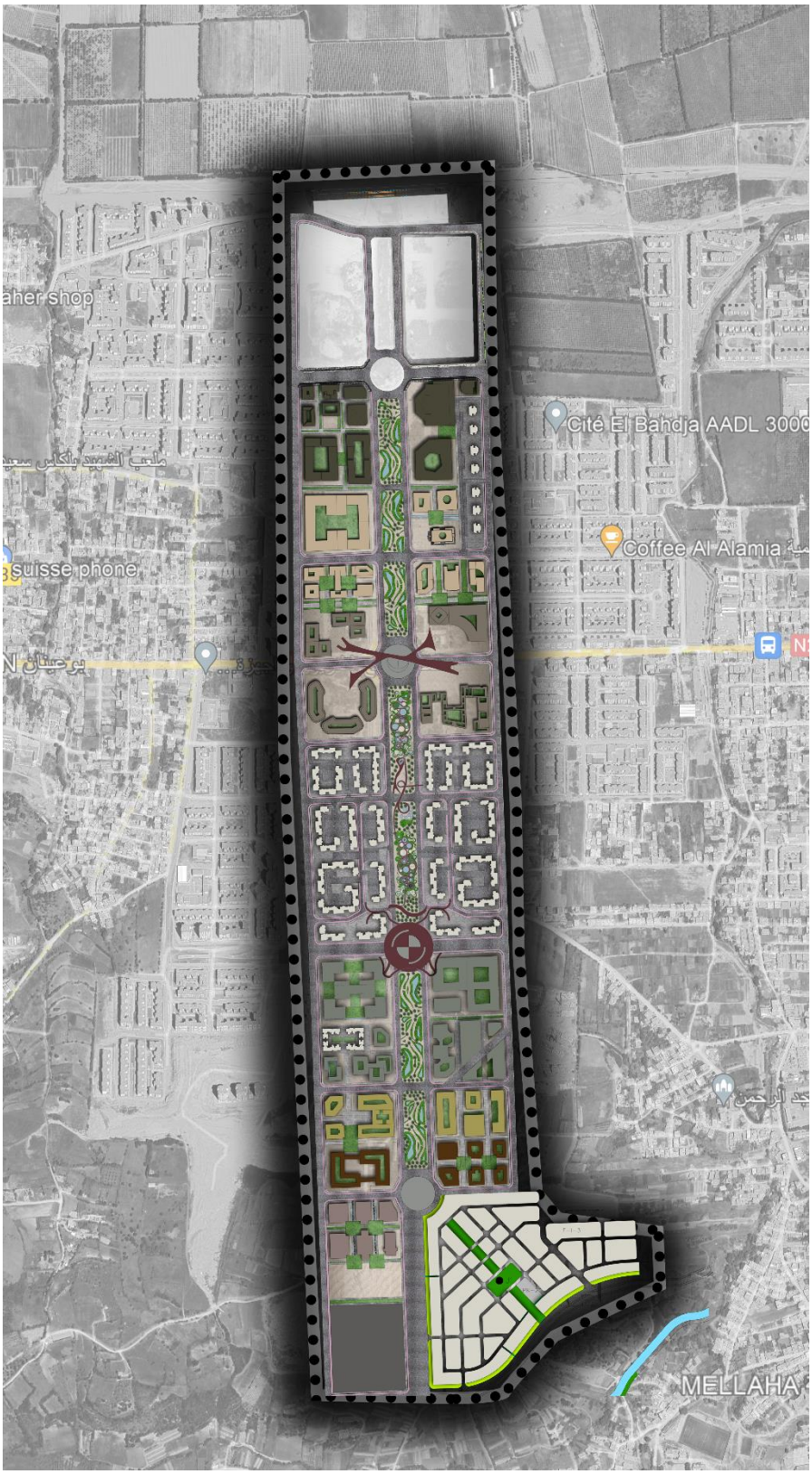


Card 25: main action to realize in the study area

Source: authors

According to the Urban Development and Planning Plan (PDAU), this land should host the following activities: administrative, educational, business and finance, healthcare, cultural, and residential and sports.

Steps to the action (see the mini report for more details)



Card 26: the final layout plan of the study area

Source: authors

VI. Getting to the point:

6.1 project presentation:

The project we're planning is a multimodal interchange, with a train station, 02 bus stations (01:taxi/cabs, and 02: buses) and a tramway station, connected by a pedestrian bridge and a commercial tunnel in the basement.

We've incorporated a multimodal interchange, as required by the Pdau de Nouvelle ville de Bouinene, a decision also motivated by the needs of local residents and to eliminate traffic congestion.

The project is based on sustainable development concepts. We want to develop the concept of sustainable mobility and especially the concept of walkability, by including cycle paths, footbridges, ramps and pedestrian walkways.

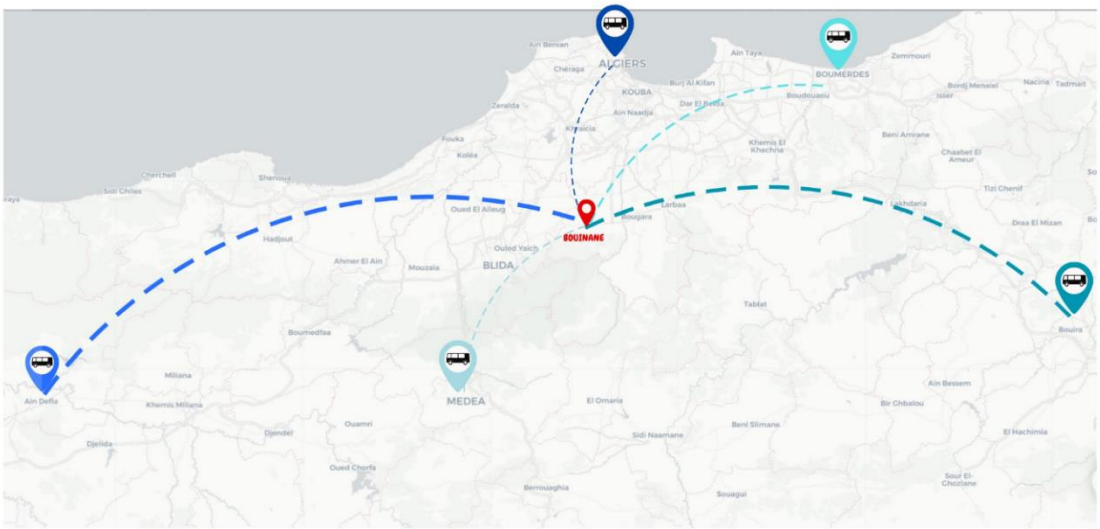
To minimize and limit the negative impact on the environment and encourage people to use different means of public transport.

For more details see the mini report

6.2 different destinations from our project :

6.2.1 regional scale:

On the regional scale , our objective is to link the blida with these regions: Algiers, Boumerdes, Tipaza Medea and ain defla.

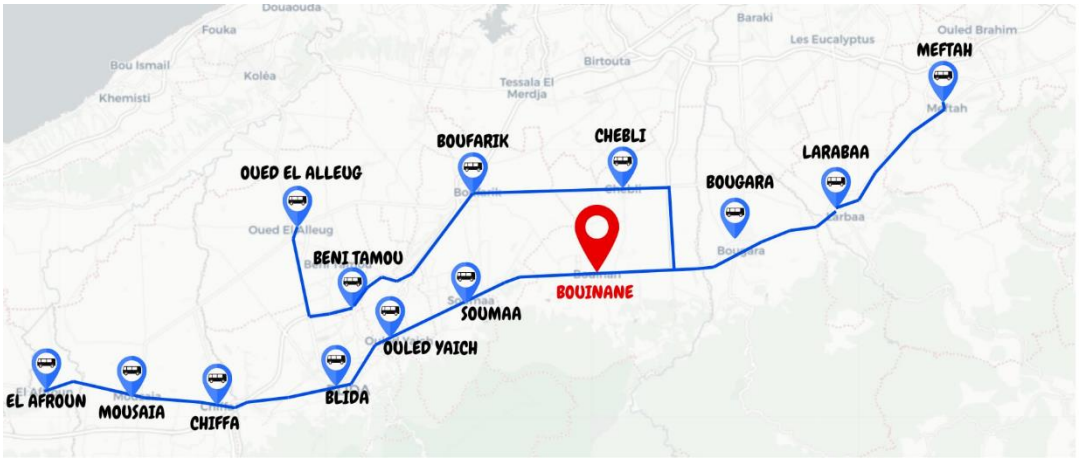


Card 27:different destinations on regional scale

Source: authors

6.2.2 state scale:

On this scale our goal is to connect bouinen with the different parts of the state of Blida such as Meftah , Blida, El-affroun and Oued El-alleug.



Card 28:different destionations on state's scale

Source: authors

6.2.3 town's scale:

On the towns scale our goal is to create the link between the different districts of the new town of Bouinen.

Card 29: revealing the main destination in the new town of Bouinen

Source: authors

6.3 steps of spatial organization of the business sequence diagram:

For more details see the mini report

6.4 the site plan result:

Card 30: the final site plan

Source: authors

CHAPTER 04: SIMULATION

I. Introduction:

In order to design a multimodal hub with low energy consumption and, above all, achieve optimum thermal comfort, it is necessary to test and verify the strategies and techniques we have applied in this project, as well as project, as well as identifying the main factor influencing energy consumption in the energy consumption in the Bouinen region.To achieve this objective, we plan to carry out a simulation using DesignBuilder software, on the railway station hall. We will base our climatic data on that extracted from the website meteonorm 08, which provides up-to-date climate information for cities cities around the world.

II. Definition of simulation :

Simulation in architecture refers to the use of computer-based models to test and evaluate the performance of building designs under real-world conditions. This process involves creating a digital representation of the building and then simulating various factors such as climate, occupancy, and energy consumption to predict how the building will behave in different scenarios. The goal of building simulation is to optimize the design for sustainability, energy efficiency, and occupant comfort while reducing costs and time in the design process (Thet Hni, 2023).

Benefits: Building simulation offers several benefits, including (Dassault systems):

1-Sustainability: By optimizing energy consumption and reducing greenhouse gas emissions, building simulation helps achieve sustainable design goals.

2-Energy Efficiency: Simulation helps predict energy demand and choose more efficient design options.

3-Occupant Comfort: By analyzing factors like temperature, lighting, and ventilation, simulation ensures that buildings are comfortable and safe for occupants.

4-Cost Savings: Simulation reduces the need for physical prototypes and minimizes the risk of costly design changes during construction.

III. simulation software :

Before starting the simulation process we will have a look on the different type of existing softwares and the most used .

Table 17:different type of software used worldwide

Source: https://www.mamunicipaliteefficace.ca/

Software	
ProSimPlus Energy	dedicated to optimising the energy efficiency of industrial processes. Includes unit operations specific to energy management (heat pumps, ORC, boilers, etc.). Includes energy diagnostics and process exergy analysis tools.
EE4 and CanQuest	assess the energy performance of buildings. EE4 is mainly used for LEED certification, CanQuest assesses performance against the CMNEB 1997 and CNEB 2011 standards.
SIMEB	used to obtain financial assistance under the EnerCible program. Enables energy performance to be assessed in relation to the ASHRAE 90.1-2007 standard.
EnergyPlus	Provides a comprehensive platform for assessing the energy performance of different types of buildings. Can be used to demonstrate compliance with energy performance standards such as ASHRAE 90.1 and NECB
Design builder	Dynamic simulation software with a graphical interface offering many features not available simultaneously in existing software. Includes an energy simulation based on the EnergyPlus engine, enabling energy consumption to be calculated and the building to be viewed inside and out. Offers parametric analysis tools for optimising and studying building variants
Open studio	Graphical energy modelling tool with functions for viewing and editing schedules, editing building and material loads, and modules for simulating HVAC systems and domestic hot water. Includes a plug-in for SketchUp and uses the EnergyPlus engine for simulations
Ecotect	includes tools for viewing and editing schedules, editing construction and material loads, and modules for simulating HVAC systems and domestic hot water.

IV. Design builder :

Design Builder is dynamic simulation software with a feature-rich graphical interface. It provides energy simulation using the EnergyPlus engine, CFD simulation integrated and coupled with thermal simulation, and daylight analysis. In addition, it offers optimisation, sensitivity and uncertainty analysis functions, which we will be exploring. (batisim)

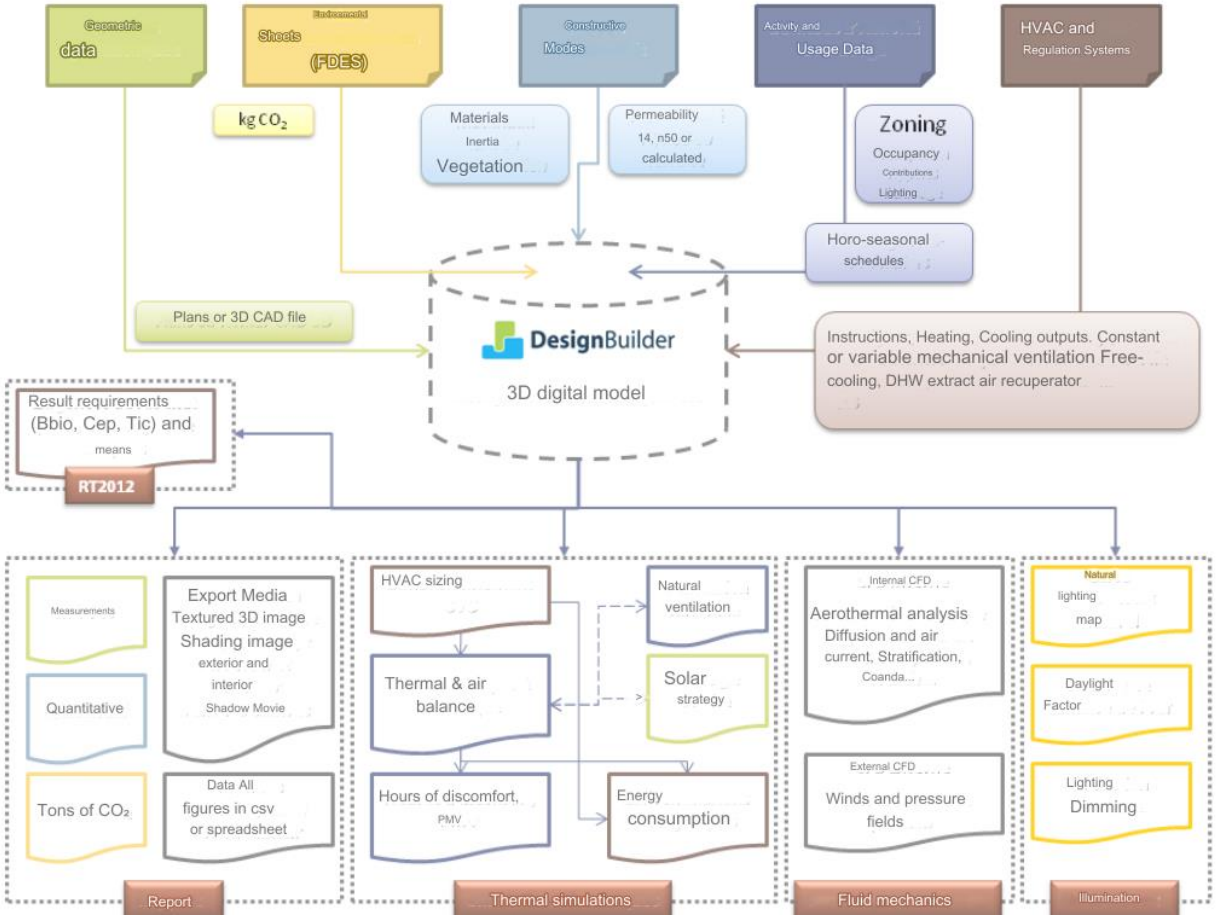


Figure 38:a summary of the use of design builder

Source: https://batisim.net/designbuilder.html translated by authors

V. space simulation study :

The simulation was conducted for the main hall in the railway station project, emphasizing its significance within the overall project. The space consists of a single level with a double height of 9m. The space is oriented to the south, facing the main entrance of the building.

This space is defined within the software as [hall]. According to the software, it should maintain a temperature range between a minimum of 12°C and a maximum of 20°C during the winter period to ensure comfort, and between 24°C and 28°C maximum during the summer period.

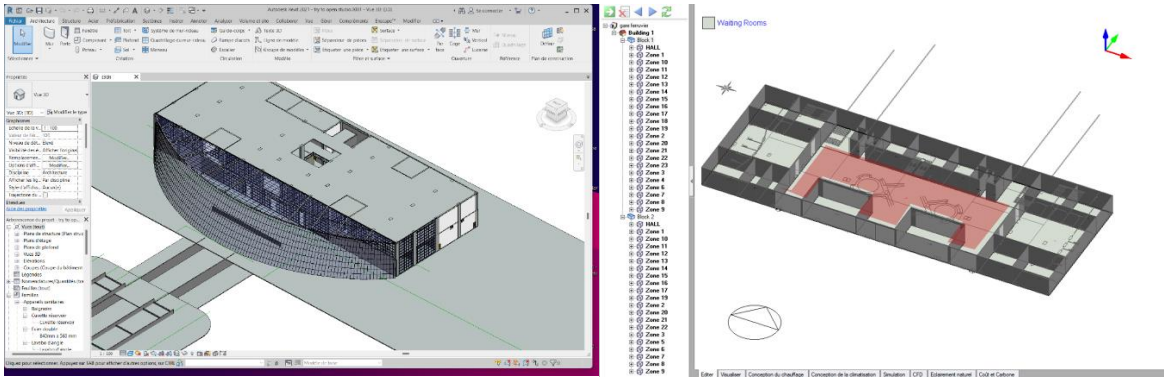


Figure 39: used building in simulation

Source: authors

VI. simulation work methodology:

Starting with the current state of the building , our work methodology is as follows:

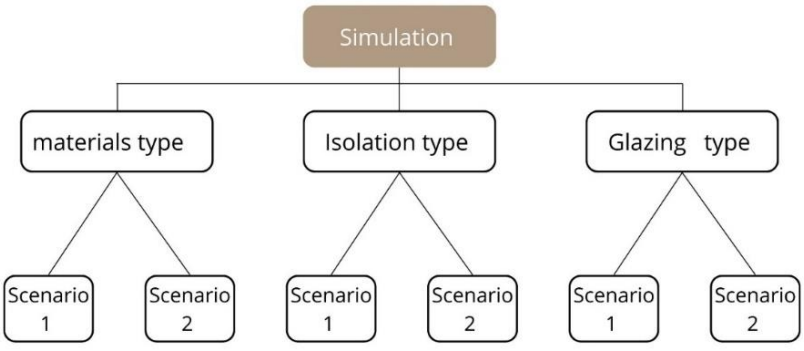


Diagram 13:work methodology.

Source : authors.

VII. simulation of different scenarios and result:

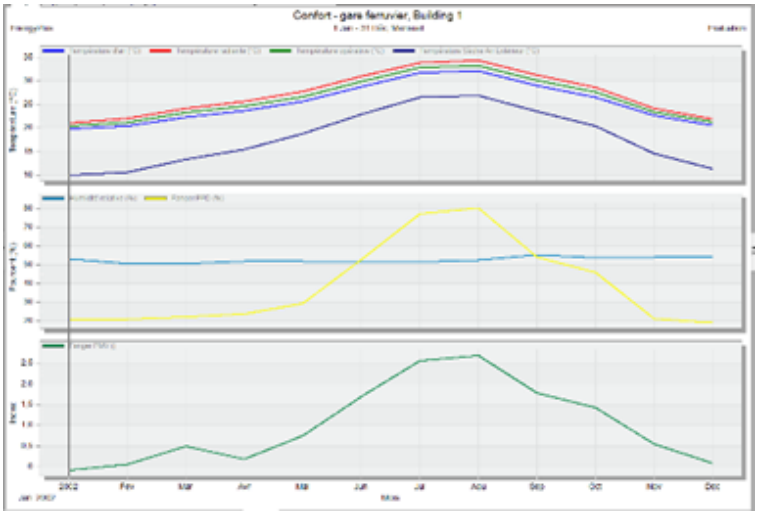
7.1 Simulation of the normal state :

In this simulation, the conventional wall is used, with the following protocol:

Table 18:protocol of the normal state scenario

Element	Composition	thickness (cm)
External walls	Hollow brick	15
	air gap	5
	Hollow brick	10
Internal partitions	Hollow brick	15
Low floor on land	Compression slab	10
Glazing	Single glazing	0,6

The result:



graph 6: result of the normal state

Table 19:result of the normal state scenario

Months	January	February	March	April	May	June	July	August	September	October	November	December
Air temperature (C)	19.77	20.42	22.34	23.72	25.67	28.82	31.81	32.15	29.06	26.55	22.66	20.59
Radiant temperature (C)	21.11	22.00	24.13	25.67	27.73	31.05	33.90	34.36	31.33	28.66	24.18	21.92
Operational temperature (C)	20.44	21.21	23.23	24.70	26.70	29.94	32.85	33.25	30.20	27.60	23.42	21.25
Outside temperature (C)	9.99	10.55	13.33	15.46	18.83	22.87	26.59	26.92	23.53	20.41	14.56	11.38
Humidity %	53.07	50.69	50.58	51.88	52.10	51.73	51.65	52.48	55.40	53.74	54.29	54.03

caption : Comfort zone | Overheated zone | Undertemperature zone

Result analysis:

From the above results, we can see 2 periods:

- The comfort period: which occurs in the following 6 months: January, February, March, April, November, December. The operating temperature varies between 20.44°C and 24.70°C.

- The overheating period: which occurs in the following 6 months: May, June, July, August, September, October. In which the temperature varies between 26.70°C and 33.25°C.

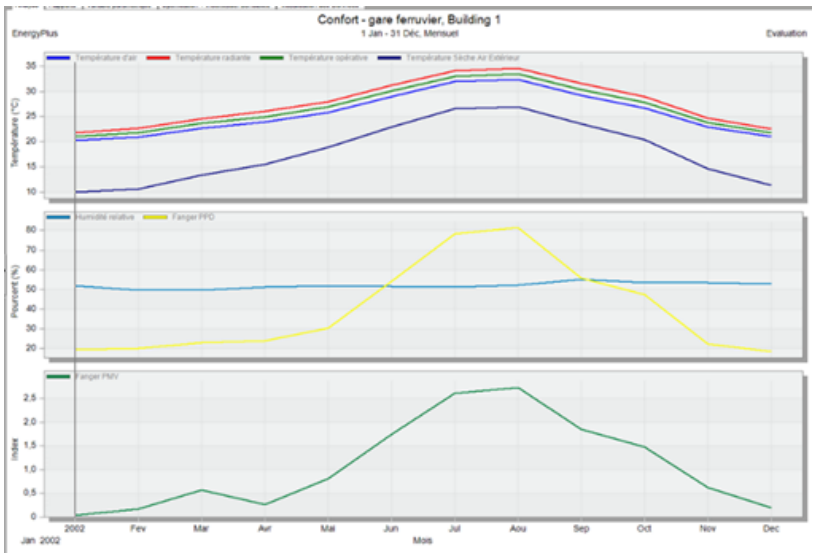
7.2 Simulation by changing the type of insulation :

7.2.1 Scenario 1: Use of rock wool:

Table 20:protocol of changing the type of insulation (01 scenario)

Element	Composition	Thickness (cm)
External walls	Hollow brick	15
	rock wool	5
	Hollow brick	10
Internal partitions	Hollow brick	15
Low floor on land	Compression slab	10
glazing	Single glazing	0,6

The result:



graph 7:changing the type of insulation (01 scenario)

Table 21:result of changing the type of insulation (01 scenario)

Month	January	february	March	April	May	June	July	August	september	october	november	december
Air temperature (C)	20.26	20.86	22.65	23.93	25.82	28.95	31.93	32.28	29.21	26.70	22.95	21.03
Radiant temperature (C)	21.77	22.61	24.60	26.02	27.99	31.26	34.09	34.57	31.56	28.91	24.63	22.53
Operational temperature (C)	21.01	21.74	23.62	24.97	26.90	30.10	33.01	33.43	30.38	27.81	23.79	21.78
Outside temperature (C)	9.99	10.55	13.33	15.46	18.83	22.87	26.59	26.92	23.53	20.41	14.56	11.38
Humidity %	51.79	49.48	49.65	51.25	52.66	51.39	51.30	52.09	54.99	53.27	53.29	52.80

caption : Comfort zone | Overheated zone | Undertemperature zone

Result analysis:

From the above results, we can see 2 periods:

- The comfort period: which occurs in the following 6 months: January, February, March, April, November, December. The operating temperature varies between 21.01°C and 24.97°C.

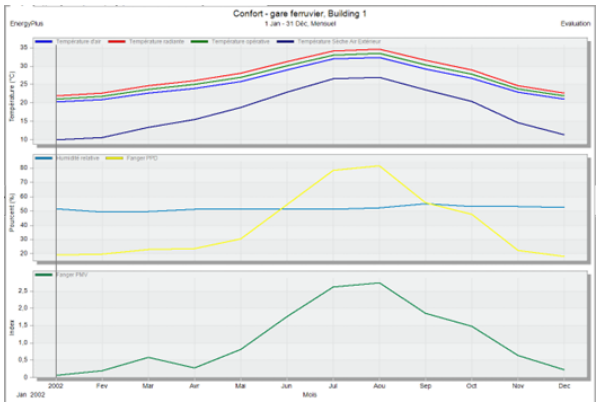
- The overheating period: which occurs in the following 6 months: May, June, July, August, September, October. In these months, the temperature varies between 26.90°C and 33.43°C.

7.2.2 Scenario 2: Use of XPS extruded polystyrene:

Table 22:protocol of changing the type of insulation (02scenario)

Elément	Composition	Thickness (cm)
External walls	Hollow brick	15
	XPS extruded polystyrene	5
	Hollow brick	10
Internal partitions	Hollow brick	15
Low floor on land	Compression slab	10
glazing	Single glazing	0,6

The results:



graph 8:changing the type of insulation (02scenario)

Table 23:result of changing the type of insulation (02scenario)

Months	January	february	March	April	May	June	July	August	september	october	november	december
Air temperature (C)	20.33	20.94	22.69	23.95	25.84	28.97	31.95	32.30	29.23	26.72	22.98	21.09
Radiant temperature (C)	21.87	22.71	24.67	26.07	28.03	31.29	34.12	34.60	31.59	28.95	24.69	22.62
Operational Temperature (C)	21.10	21.82	23.68	25.01	26.93	30.13	33.03	33.45	30.41	27.84	23.84	21.86
Outside Temperature (C)	9.99	10.55	13.33	15.46	18.83	22.87	26.59	26.92	23.53	20.41	14.56	11.38
Humidity %	51.57	49.30	49.49	51.13	51.58	51.34	51.24	52.04	54.93	53.19	53.16	52.58

caption :	Comfort zone	Overheated zone	Undertemperature zone

Result analysis:

From the above results, we can see 2 periods:

- The comfort period: which occurs in the following 6 months: January, February, March, April, November, December. The operating temperature varies between 21.10°C and 25.01°C.

- The overheating period: which occurs in the following 6 months: May, June, July, August, September, October. In these months, the temperature varies between 26.93°C and 33.45°C

Synthesis:

First of all, we note that the two types of insulation did not make much difference to the building's operating temperature. However, polystyrene has proved to be better than rock wool, increasing the operating temperature in winter and reducing it in summer.

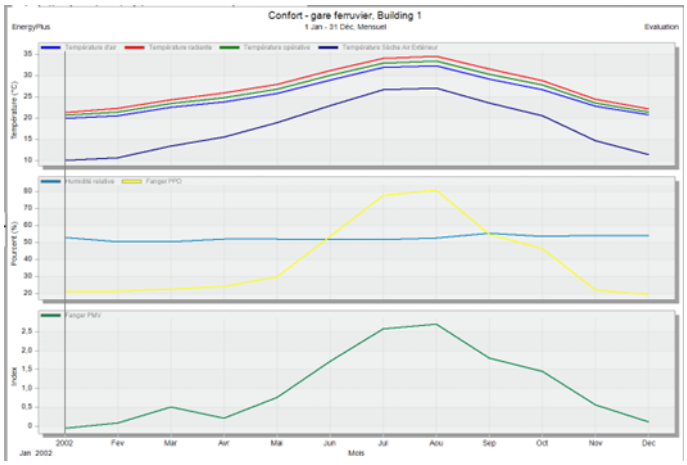
7.3 Simulation by changing the type of glazing:

7.3.1 Scenario 1: Use of double glazing:

Table 24:protocol of changing the type of glazing (01scenario)

Element	Composition	Thickness (cm)
External walls	Hollow brick	15
	air gap	5
	Hollow brick	10
Internal partitions	Hollow brick	15
Low floor on land	Compression slab	10
glazing	glazing	0,3
	Argon Gas	1,3
	glazing	0,3

The results:



graph 9: changing the type of glazing (01scenario)

Table 25: result of changing the type of glazing(01scenario)

Month	January	february	march	april	may	June	july	august	september	october	november	december
Air temperature (C)	19.86	20.50	22.41	23.77	25.71	28.85	31.84	32.19	29.10	26.59	22.72	20.67
Radiant temperature (C)	21.27	22.16	24.26	25.78	27.82	31.13	33.98	34.44	31.42	28.76	24.31	21.07
Operational Temperature (C)	20.56	21.33	23.33	24.78	26.76	29.99	32.91	33.31	30.26	27.68	23.51	21.37
Outside Temperature (C)	9.99	10.55	13.33	15.46	18.83	22.87	26.59	26.92	23.53	20.41	14.56	11.38
Humidity %	52.78	50.39	50.38	51.75	51.97	51.63	51.54	52.37	55.28	53.58	54.01	53.77

caption :	Comfort zone	Overheated zone	Undertemperature zone

Result analysis:

From the above results, we can see 2 periods:

- The comfort period: which occurs in the following 6 months: January, February, March, April, November, December. The operating temperature varies between 20.56°C and 24.78°C.

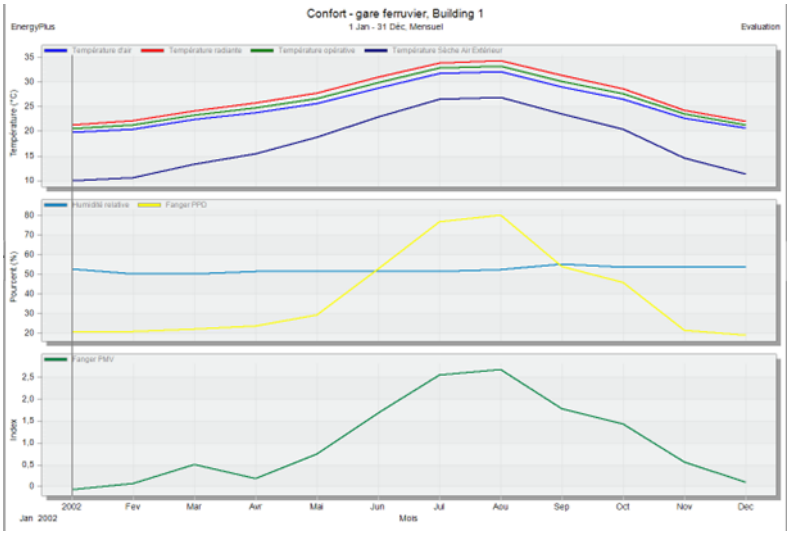
- The overheating period: which occurs in the following 6 months: May, June, July, August, September, October. In these months, the temperature varies between 26.76°C and 33.31°C.

7.3.2 Scenario 2: Use of triple glazing:

Table 26: protocol of changing the type of glazing (02 scenario)

Elément	Composition	Thickness (cm)
External walls	Hollow brick	15
	air gap	5
	Hollow brick	10
Internal partitions	Hollow brick	15
Low floor on land	Compression slab	10
glazing	glazing	0,3
	Argon gas	1,3
	glazing	0,3
	argon gas	1,3
	glazing	0,3

The results:



graph 10:changing the type of glazing (02 scenario)

Table 27: result of changing the type of glazing (02 scenario)

month	January	February	March	april	May	June	July	august	september	october	november	december
Air temperature (C)	19.84	20.48	22.38	23.74	25.66	28.80	31.78	32.12	29.05	26.55	22.69	20.65
Radiant temperature (C)	21.25	22.12	24.22	25.73	27.75	31.05	33.89	34.35	31.35	28.70	24.28	22.05
Operational Temperature (C)	20.55	21.30	23.30	24.73	26.70	29.92	32.83	33.24	30.20	27.62	23.49	21.35
Outside Temperature (C)	9.99	10.55	13.33	15.46	18.83	22.87	26.59	26.92	23.53	20.41	14.56	11.38
Humidity %	52.85	50.49	50.51	51.79	52.10	51.77	51.71	52.54	55.42	53.72	54.12	53.87

caption :	Comfort zone	Overheated zone	Undertemperature zone

Result analysis:

From the above results, we can see 2 periods:

- The comfort period: which occurs in the following 6 months: January, February, March, April, November, December. The operating temperature varies between 20.55°C and 24.73°C.

- The overheating period: which occurs in the following 6 months: May, June, July, August, September, October. In these months, the temperature varies between 26.7°C and 33.24°C.

Summary : We note that the use of double glazing and triple glazing has made an almost invisible difference to the operating temperature of the building, the difference can be estimated at (0.1°C). The type of glazing therefore has no impact on thermal comfort in the area studied.

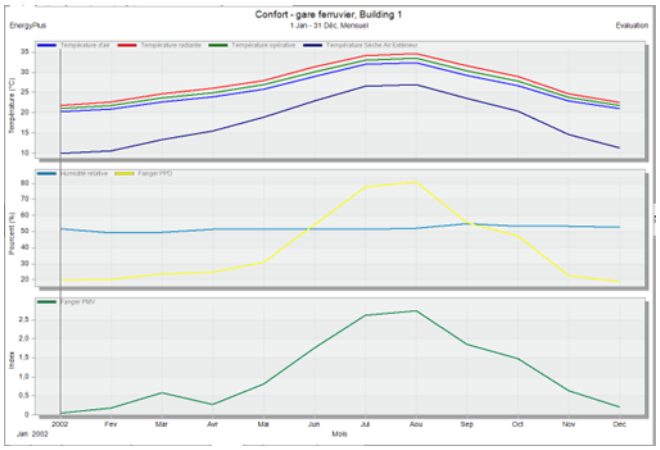
7.4 Simulation by changing the type of material :

7.4.1 Scenario 1: Using a single wall made of aerated concrete:

Table 28: protocol of changing the type of material (01 scenario)

Elément	Composition	E (cm)
External walls	Bloc of aerated concrete	30
Internal partitions	Hollow brick	15
Low floor on land	Compression slab	10
glazing	Single glaze	0,6

The results:



graph 11:changing the type of material (01 scenario)

Table 29: results of changing the type of material (01 scenario)

Month	January	february	March	April	May	June	July	august	september	october	november	december
Air temperature (C)	20.29	20.88	22.65	23.92	25.83	28.97	31.95	32.29	29.22	26.70	22.94	21.05
Radiant temperature (C)	21.83	22.66	24.64	26.04	28.01	31.30	34.12	34.59	31.57	28.92	24.65	22.59
Operational Temperature (C)	21.06	21.77	23.65	24.98	26.92	30.13	33.04	33.44	30.39	27.81	23.80	21.82
Outside Temperature (C)	9.99	10.55	13.33	15.46	18.83	22.87	26.59	26.92	23.53	20.41	14.56	11.38
Humidity %	51.75	49.36	49.63	51.34	51.69	51.38	51.30	52.10	55.01	53.31	53.27	52.66

caption :	Comfort zone	Overheated zone	Undertemperature zone

Result analysis:

From the above results, we can see 2 periods:

- The comfort period: which occurs in the following 6 months: January, February, March, April, November, December. The operating temperature varies between 21.06°C and 24.98°C.

- The overheating period: which occurs in the following 6 months: May, June, July, August, September, October. In these months, the temperature varies between 26.92°C and 33.44°C.

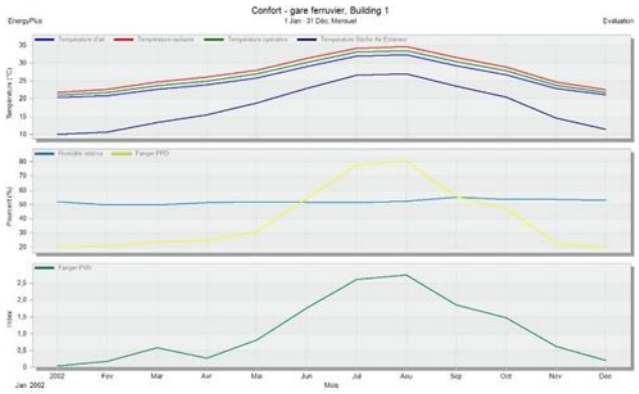
7.4.2 Scenario 2: Using a single masonry wall:

Table 30: protocol of changing the type of material (02 scenario)

Elément	Composition	E (cm)
External walls	a stone single masonry wall	30
Internal partitions	Hollow brick	15

Low floor on land	Compression slab	10
glazing	Single glazing	0,6

The results:



graph 12:changing the type of material (02 scenario)

Table 31:result of changing the type of material (02 scenario)

Month	January	february	March	April	May	June	July	August	september	october	november	december
Air temperature (C)	20.23	20.82	22.62	23.90	25.81	28.95	31.93	32.28	29.20	26.68	22.91	21.00
Radiant temperature (C)	21.75	22.58	24.58	25.99	27.98	31.27	34.10	34.56	31.54	28.89	24.60	22.51
Operational Temperature (C)	20.99	21.70	23.60	24.94	26.86	30.11	33.01	33.42	30.37	27.79	23.75	21.76
Outside Temperature (C)	9.99	10.55	13.33	15.46	18.83	22.87	26.59	26.92	23.53	20.41	14.56	11.38
Humidity %	51.88	49.51	49.73	51.38	51.74	51.42	51.34	52.15	55.06	53.36	53.38	52.80

caption :	Comfort zone	Overheated zone	Undertemperature zone

Result analysis:

From the above results, we can see 2 periods:

- The comfort period: which occurs in the following 6 months: January, February, March, April, November, December. The operating temperature varies between 20.99°C and 24.94°C.

- The overheating period: which occurs in the following 6 months: May, June, July, August, September, October. In which, the temperature varies between 26.86°C and 33.42°C.

Summary: We note that the use of the cellular concrete and masonry single wall has brought about changes in the operating temperature, which increases in winter and decreases in

summer in relation to the outside temperature. However, the impact remains minimal and can be estimated at a maximum of 0.5°C.

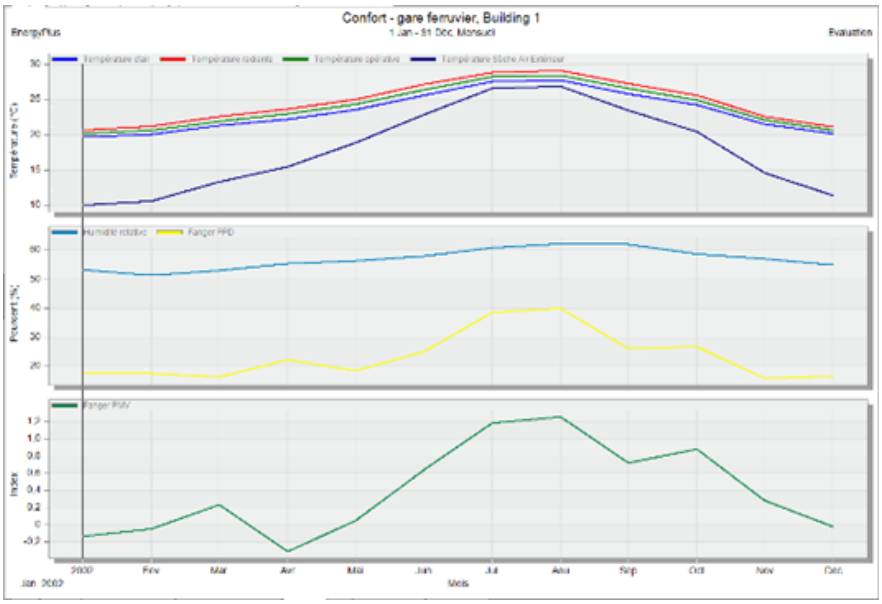
7.5 Simulation of the optimal scenario using active strategies:

Table 32: protocol of the optimal scenario using active strategies

Elément	Composition	thickness(cm)	Conductivity (W/m-K)	Specific heat (J/Kg-K)	Density (Kg/m^3)
External walls	Single wall brick	30	0,08	840	600
Internal partitions	Plaster panel	2,5	0,25	1000	900
	air gap	5	0,3	1000	1000
	Plaster panel	2,5			
Low floor on land	Compression slab	10	1,7	900	2400
External floor	Mineral foam	10	0,035	900	200
	Compression slab	10	1,7	900	2400
	Steel tray	5	50	500	7850
	Steel joist	20	50	500	7850
glazing	glazing	0,6	0,024	840	2500
	Argon gas				
	glazing				

Plus the use of active strategies (air conditioning, heating, mechanical ventilation, DHW).

The results:



graph 13:the optimal scenario using active strategies

Table 33: results of the optimal scenario using active strategies

Month	January	february	March	April	May	June	July	August	september	october	november	december
Air temperature (C)	19.62	20.04	21.28	22.22	23.57	25.62	27.60	27.80	25.8s5	24.26	21.56	20.17
Radiant temperature (C)	20.63	21.23	22.64	23.69	25.08	27.19	28.89	29.14	27.34	25.67	22.59	21.14
Operational Temperature (C)	20.12	20.64	21.96	22.96	24.33	26.40	28.24	28.47	26.59	24.97	22.07	20.65
Outside Temperature (C)	9.99	10.55	13.33	15.46	18.83	22.87	26.59	26.92	23.53	20.41	14.56	11.38
Humidity %	53.17	51.35	52.98	55.37	56.41	58.04	60.81	62.18	62.03	58.66	56.95	54.81

caption : Comfort zone | Overheated zone | Undertemperature zone

Result analysis:

From the above results, we can see 2 periods:

- The comfort period: which occurs in the following 8 months: January, February, March, April, May, October, November, December. The operating temperature varies between 20.12°C and 24.97°C.

- The overheating period: which occurs in the following 4 months: May, June, July, August, September, October. In which, the temperature varies between 26.40°C and 28.47°C.

Summary: In this case, by increasing insulation and using active strategies, we noticed better results. The comfort zone is expanded to 8 months per year. So this scenario is the best

CONCLUSION

CONCLUSION

At the end of this work, we obtained answers to the questions we had asked ourselves at the start of our research. We found that our cities are facing numerous urban challenges, leading to a significant identity crisis. These challenges include rapid and uncontrolled urbanization in Algeria, leading to various imbalances in the organization of towns and villages due to a lack of planning strategies and poor coordination of urban development. This has led to problems such as excessive consumption of space and energy, air pollution, congestion, wasted time, noise and toxic gas emissions.

To meet these challenges, a transport plan for the wilaya of Blida, and in particular for the new town of Bouinan, is crucial to regulate transport activities and meet the needs of the public. The research aims to implement sustainable, energy-efficient transport solutions in Bouinan, thereby improving its economic, social and environmental position.

Our main objective was to integrate this concept while reducing the building's energy consumption, in order to minimize its impact on the environment and guarantee the comfort and well-being of occupants, by applying the principles of bioclimatic architecture. After carrying out an urban analysis of the study area, we identified existing problems in the neighborhood and proposed intervention strategies that guided us in the siting process.

Following the initial problem set out in our dissertation, we formulated three hypotheses that were confirmed by our work. The design of a multimodal hub in Bouinan will not only meet the needs of annual visitors, but could also become the image of the city. It will encourage people to minimize car use and save time and money. The project is also based on the concept of sustainable development (green buildings). In addition, the addition of the commercial interchange to the project will attract visitors to Bouinan, emphasizing comfort and well-being through its architecture. We have confirmed that reducing the energy consumption of our project can be achieved mainly through passive rather than active strategies, by inserting photovoltaic panels in the bus and cab shelters and in the carports.

In the same context, we carried out thematic research in the state-of-the-art chapter, studied examples and carried out field visits, which enabled us to accumulate valuable knowledge about the project's design. Based on the results of our simulations, we can conclude that the energy demand in Bouinan depends mainly on the heating temperature, rather than on the external building envelope. At the end of this chapter, we were able to abstract the key elements for the design of sustainable urban transport projects, namely:

1. **Location**: Outlying areas promote development and improve connections with the city.

2. **Functional Design**: Passenger flow influences the layout of the space.

3. **Formal Organization**: Stations typically include a concourse, platforms and a passenger building, with a substantial structure.

Overall, the research identified practical and theoretical solutions, offering multiple recommendations to answer the research question. The chosen solutions are applicable to the case study and provide answers to the research problem.

Integrating thermal insulation and a combination of passive and active strategies into building design will improve the thermal comfort experience of users in Bouinan, which was proven in the final simulation chapter where we concluded that: aerated concrete was the perfect material, polystyrene was the best insulator and double glazing is the most suitable for thermal comfort.

Numerous questions are emerging as our work progresses, opening up new research perspectives on energy management and the development of sustainable mobility and walking, as well as new transport concepts in our country.

BIBLIOGRAPHY

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Books and articles:

Anis, R. (2024). *Réienterpretation de la gare multimodal de l'ariana*. Retrieved from https://issuu.com/anis.rjeb/docs/m_moire_5eme_annee_final

Atelier de généalogie, g. (n.d.). Retrieved from https://geneavaunage.e-monsite.com/pages/chroniques-vaunageoles/l-homme-et-ses-deplacements.html#

Azzag, E. (2011). *projet urbain , guide méthodologique.*

Bouinen, l. p. (2010). *La mission B de la finalisation du plan d'aménagement de la ville nouvelle de Bouinen.*

Bouinen, L. p. (2015). *Finalisation du plan d'Aménagement de la Ville Nouvelle de Bouinan révision 02.*

Bouinen, l. p. (n.d.). *Rapport de la mission D .*

Bouzidi, Y. E. (2020). Evaluation of thermal comfort in French healthcare buildings. In The 15th Conference on Sustainable Development of Energy, Water and Environment Systems (SDEWES),.

Charles, L. (2008). Definition et mesure de la mobilité durable à l'aide d'indicateurs statiques et dynamiques.

CNES. (1998). *Rapport sur la ville algérienne, le devenir urbain du pay.*

design builder . (n.d.). Retrieved from https://www.batisim.net/

Dutreix, A. (2010). *Bio climatisme et performances énergétique des batiments.* Eyrolles.

Emetere, M. E. (2022). Numerical Methods in Environmental Data Analysis. Elsevier.

Ernst, N. (2013). *les éléments des projets de construction* .

foncière, A. n. (n.d.). Retrieved from https://www.aniref.dz/DocumentsPDF/monographies/MONOGRAPHIE%20WILAYA%20BLIDA.pdf

Fouchier, V. (1999). *la politique des villes nouvelles(1965-2000).*

H, C. (2014). Retrieved from https://pro.mobicoop.fr/lintermodalite-cle-mobilite-durable/

Hni, T. (2023). Retrieved from https://www.novatr.com/blog/types-of-building-simulations

IATSS. (2011). Promoting intermodal freight transport through the development of dry ports in Asia: An environmental perspective. 16-23.

III, U. H. (2015). DOCUMENT DE TRAVAIL SUR LE TRANSPORT ET LA MOBILITÉ. *conference des nations unies sur le logement et le développement durable.* newyork.

Jacquemond, L.-P. (2017). Gro Harlem Brundtland ou l'invention du « développement durable ». pp. 254-265.

BIBLIOGRAPHY

Jaroš, D. Š. (2019). Free fare policy as a tool for sustainable development . *Human Geographies – Journal of Studies and Research in Human Geography*.

Khelifi. (2022). Evaluation du confort dans le bâtiment et diagnostic énergétique.

Marc Pallemaerts, A. G. (2007). l'émergence du développement durable dans le discours de l'union européenne. pp. 5-45.

Mashkoor, I. A. (2020). Preparation of Sustainable Thermal Insulators from Waste Materials. In IOP Conference Series: Materials Science and Engineering.

ministère de transport, e. d. (2013). *lancement de l'étude de faisabilité d'une ligne de tramway à Blida.*

Ministère des transports, w. d. (2021). *fiche des secteurs de transport.*

Nourelhouda, B. (2023). méthodologie de recherche .

Organization, U. (2002). *Report of the World Summit on Sustainable Development Johannesburg, South Africa.*

Pickard, Q. (2002). *The architect's handbook.*

(2015). *Rapport finale de Bouinen* .

Robert, J. M. (2021). Ergonomie : 150 notions clés.

(n.d.). *SNAT 2008.*

SNAT 2030. (n.d.).

SNCF. (2008). *etude complémentaires suite au débat public.*

Sofiane, B. (2020). Performance environnementale et innovations technologiques dans le bâtiment.

Souchon, A. (2009). De l'intermodalité à la multimodalité : enjeux, limites et perspectives, illustré par un projet d'expérimentation d'une tarification multimodale entre Martigues et Marseille . *Dumas*.

systemes, D. (n.d.). Retrieved from https://www.3ds.com/fileadmin/Industries/Architecture-Engineering-Construction/Pdf/Whitepapers/simulation-architecture-construction-aec-wp.pdf

UNDB. (2015). *What are the Sustainable Development Goals?* Retrieved from UNDB: https://www.undp.org/sustainable-development-goals

Yüksel, N. (2016). The review of some commonly used methods and techniques to measure the thermal conductivity of insulation materials. In Insulation materials in context of sustainability. IntechOpen.

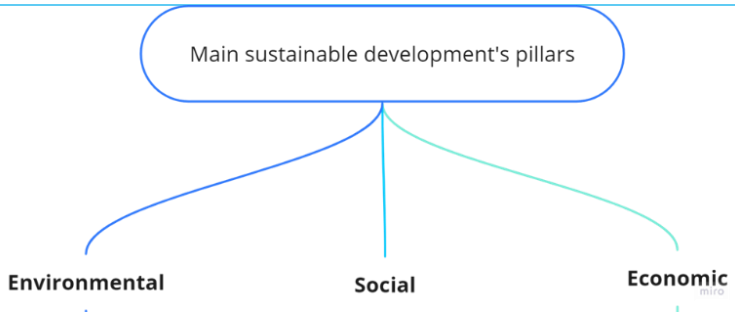
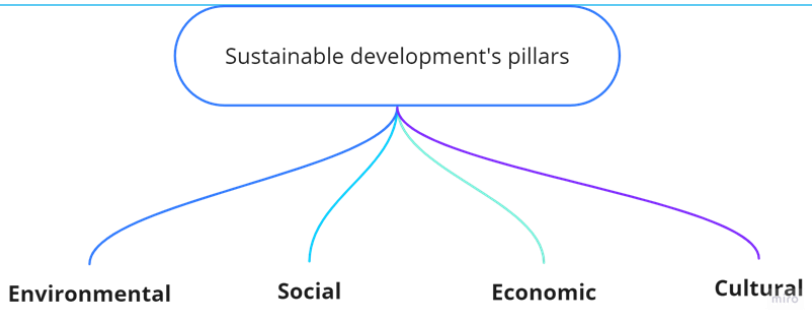
Z, B. Y. (n.d.).). Evaluation of thermal comfort in French healthcare buildings. In The 15th Conference on Sustainable Development of Energy, Water and Environment Systems (SDEWES),.

Zéroual, C. M. (2006). Transport durable et développement économique.

ANNEX

ANNEX

Table 34: different pillars of sustainable development

Description	Diagram
- **economic efficiency** (efficiency being understood as the ability to produce maximum results with minimum resources, effort or expense) - **environmental efficiency** (efficiency being understood as the dynamic capacity to perform without exceeding the tolerance threshold) - **social equity** (equity meaning impartiality, fairness of distribution.	 **Diagram : basic pillars of the sustainable development** **Source: authors**
Cultural pillar is for plurality of local solutions that respect cultural continuity	 **Diagram : sustainable development pilars based on Maillefert, Petit and Rousseau** **Source: authors**

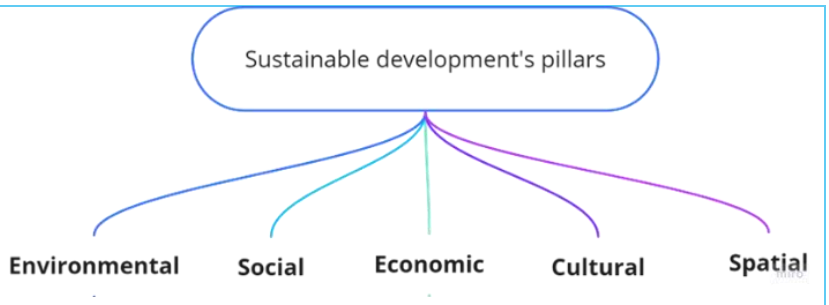
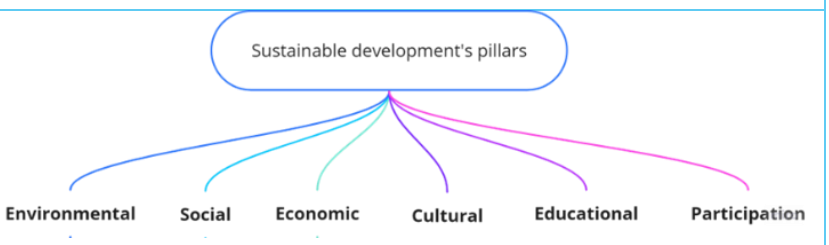
-social (alternative growth, reduced inequality), -economic (better distribution and management of resources), -ecological (minimizing damage to natural systems), -cultural (plurality of local solutions that respect cultural continuity) -spatial (urban-rural balance, land-use planning, urban development),	 **Diagram : sustainable development pilars based on ewa azzag** **Source: authors**
-educational is for -participation is for	 **diagram: sustainable development pilars based on Charlot-Valdieu and Outrequin (2011)**

Table 35: the principles of sustainable developement

principles	**content**

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The principles of prevention at source and precaution	Preventive actions must be implemented to avoid environmental degradation and pollution.
The polluter-pays principle	Those responsible for environmental degradation must make reparations.
The principle of participation	It is not only a matter of responding to contestation or consulting a more or less broad representation, but also of organising true citizen engagement in decision-making.
The principle of rationality	It is not simply a matter of ensuring a fair distribution of the benefits and drawbacks of accomplishments, but also of considering all of the societal implications of actions.
The principle of integration	At the absolute least, this requires including environmental protection into the development process.
The principle of solidarity	This entails encouraging a type of development that respects the rate of renewal of the resource in the event of a renewable resource and includes a replacement timetable in the case of a non-renewable resource.
The principle of freedom for future generations	The principle is not to lock things in, but to allow for future flexibility.

Table 36: algeria's climate classification

Zone A: coastal marine climate:

Recommandations	

ANNEX

Heat loss must be minimised by	- Well-organised spaces. - Compact buildings. - Good wall and roof insulation. - Smaller windows to the west, east and north, while still providing sufficient light. - Windows with a low heat loss coefficient, at least on the west, north and east façades. West, North and East. - Insulating night protection for windows. - Controlled ventilation
Solar solar gain be maximised by	- A main façade facing south. - South-facing south-facing to capture solar gain and preheat fresh air. - Storage of solar gain thermal thermal cladding. - A space to be be determined between buildings to avoid shading. It try in this case to provide services.
Reducing heat input average heat	- Solar protection for windows, walls and roofs. - Good thermal inertia combined with night-time ventilation. - Good ventilation of greenhouses, conservatories and attics. - Landscaping of outdoor green spaces to reduce the outside outside temperature. - A reduction in outdoor reverberation (green spaces). - Reflective for walls and exterior materials.

Zone B: Climate coastal hinterland mountain:

Recommandations:

In this case, the design should be the same as for the coastal climate climate, except that you must :

- Reduce the built area (compactness) and minimise the shape.
- Increased insulation of the building envelope.
- Greater thermal mass in walls and floors.
- Reducing the surface area of glazed walls and openings on the south side.
- Good orientation of the building, to heat more in winter.

Zone C et D: Arid and semi-arid climates:

Recommandations:

For these climate zones, the concepts are the same. However, it is recommended:

- Orientation of the building.

- Shading to reduce the air-conditioning load, using horizontal and vertical solar protection.

- High thermal inertia materials.

- Fewer openings.

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Examples analysis:

Table 37: examples analysis

Project	**Choice motivation**	**Project Fact Sheet**	**Inspiration for our project**
Kénitra Station	The project is situated in a Mediterranean climate in North Africa. Additionally, we believe it is an excellent demonstration of a project that maintains its distinct identity, evident in the facades and overall 3D design. Furthermore, its innovative structural elements, use of local materials, and « moucharabieh » in the facade contribute to its uniqueness and integration within its urban context.	**Client:** ONCF **Address:** Kenitra, Maroc **Project manager:** Silvio d'Ascia Architecture Omar Kobbité Architects (Morocco) **Programme:** TGV station and transport hub **Surface area:**13,500 m² **Works schedule:** 2016 – 2019 **(www.lightzoomlumiere.fr)**	**The "intelligent" outer skin used in the project in order** to ensure climate comfort and energy efficiency by using : sunshade, photovoltaic roof panels, natural ventilation grilles for thermal draft, and extraction grilles for the VMC in enclosed spaces,
Strasbourg Station (www.visitstrasbourg.fr)	We have selected this station because of its significant impact on the city of Strasbourg ,Its consistent functionality and commitment to staying updated over the years have made it an excellent case study to learn from.	**Country:** France **-Operator:** SNCF **- Platforms:** 6 **- Altitude:** 143 m **-Opened:** 1883 **- Architect:** Johann Eduard Jacobsthal **Connections:**Tramway BRT, Train	The functionality of the station is notable, especially the innovative approach of integrating the tram underground as it enters the multimodal station. The design elements, such as the striking canopy that serves as a welcoming entryway to the train station, and the well-thought hierarchical progression from the exterior to the semi-interior spaces, culminating in the main interior of the station, further enhance the overall experience for commuters.

Table 38: example of Kenitra station

	Kénitra Station (Milani, 2017)
Concept	The Kénitra station is an expression of the "Royal" project aimed at uniting the Mediterranean and the Atlantic through Rabat. Designed as a showcase reflecting the renewed identity of traditional Moroccan architecture, the station embodies modernity and technological progress symbolized by the arrival of the TGV Al Boraq. It is positioned as a nerve center of the city, offering not only rail services but also serving as a transit hub connecting different districts of Kénitra, linking the historic city in the north to the new city in the south. The station was thought of as a screen that is capable to be translated in its urban fabric, a renovated identity of traditional marocain architecture, due to its reinterpretation of moucharabieh

ANNEX

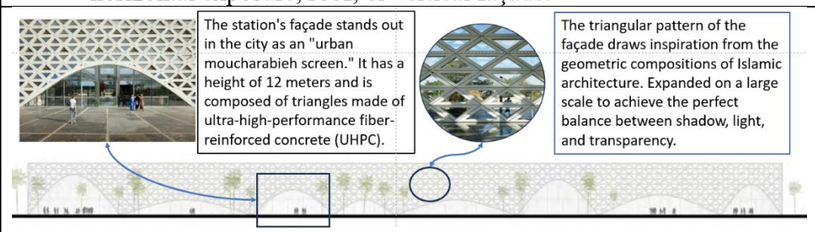
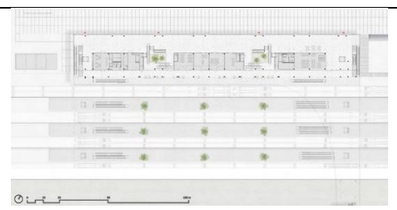
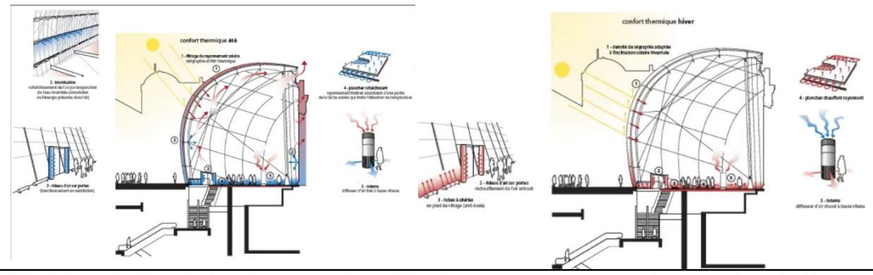
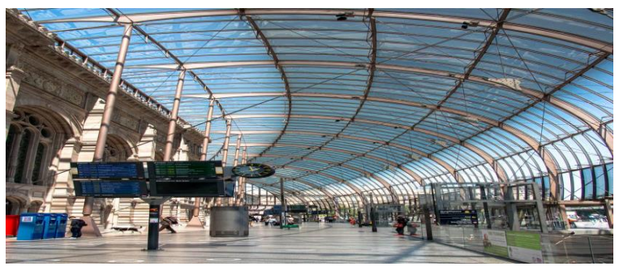
Environment and technology	The station incorporates a series of passive systems to ensure optimal climate comfort in circulation areas and the hall naturally and without mechanical equipment, innovating while continuing the Moroccan tradition, including: • **Moucharabiehs**: Ultra-high-performance concrete panels provide solar filtering and create an intelligent outer skin. • **Photovoltaic Panels**: Glass-glass panels on the roof offer shading and convert solar energy into electricity. • **Ventilation Grilles**: Glass and aluminum slat grilles on the north façade and roof enable thermal exchange and natural draft. • **Natural Ventilation**: Facilitated by an open south façade, leveraging the temperature difference between the façades. • **Rainwater Harvesting**: An innovative siphonic system collects rainwater from the roof. • **The "intelligent" outer skin** is capable of performing various functions to ensure climate comfort and energy efficiency for the future Kenitra TGV station: sunshade, photovoltaic roof panels, natural ventilation grilles for thermal draft, extraction grilles for the VMC in enclosed spaces, and solar-control transparent glazing with different characteristics depending on horizontal exposure, roof, or vertical façade.
Façade concept	
Structural system	A triangulated and glazed structure with photovoltaic elements, the lace-like architecture filters the light during the day. 
Plans	 

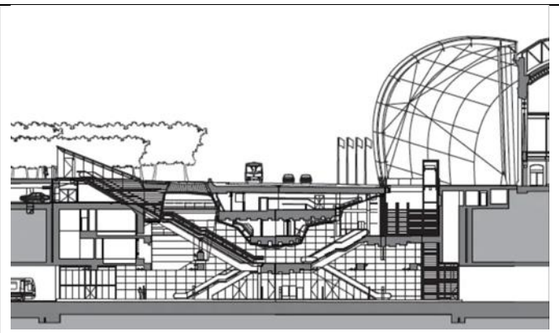
Table 39:example of strasbourg station

	Strasbourg Station
Concept	the Strasbourg Central Station is a historic train station in Strasbourg, It was built between 1878 and 1883 by architect Johann Eduard Jacobsthal in the neo-Renaissance style. The station underwent further renovations in 1980 and 2006-2007. In 2007, a 150-meter-long glass canopy designed by architect Jean-Marie Duthilleul was added in front of the historic façade, doubling the station's floor space to accommodate the arrival of high-speed TGV trains. **(AMC Architecture, 2008)**

ANNEX

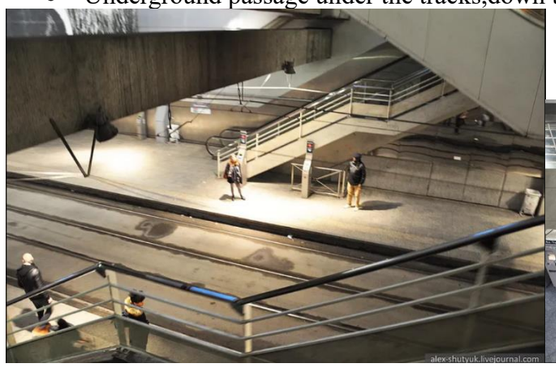
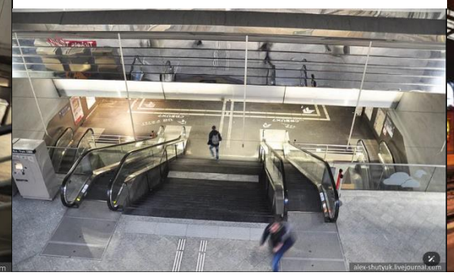
<table>
<tr><td><u>Environment and technology</u></td><td>On glass panels, the total area of which is 2,000 square meters. a special coating is applied to protect against the sun's rays, the density of which is highest at the top, where the light intensity is maximum. The lower panels, through which the sun's rays only slide, are already more transparent.
Much attention was also paid to the internal microclimate and ventilation — ventilation pylons are installed inside the hall, which on hot days draw in heated air from above and release cooled air from below. The floor itself is also cooled, in which chilled water circulates through a system of pipes.
In winter, everything works the other way around pylons and the floor works to heat the room. (Shutyuk, 2020)
  </td></tr>
<tr><td><u>Façade concept</u></td><td>The historic façade has been enclosed in glass to create a translucent glass hall, preserving the perception of the monumental structure while enhancing the brightness and functionality of the station. This extension also includes a 1.2-hectare garden on the forecourt, renovated to provide a contemporary green space. (LE Figaro ,2007) ,(Archi-Wiki.com).
 
https://upload.wikimedia.org/wikipedia/commons/f/f8/New_and_old_fa%C3%A7ade_of_Strasbourg_Railway_Station.jpg
https://c8.alamy.com/compfr/mpdef6/l-interieur-du-toit-de-verre-facade-de-la-gare-strasbourg-france-mpdef6.jpg
 
https://pokaa.fr/2021/07/20/a-partir-de-septembre-la-gare-de-strasbourg-changera-de-visage/.</td></tr>
<tr><td><u>Structural system</u></td><td>The structural system of Strasbourg station is made up of several key elements but what was interesting was:
The Station extension: A cut-stone extension was added in 2007 to improve the functionality and accessibility of the station. This extension includes a glass bubble of a similar size to the historic facade, measuring 150 meters long, which makes it possible to bring together access and circulation, including for the underground tram, in a new building and to reorganize services.</td></tr>
</table>

ANNEX

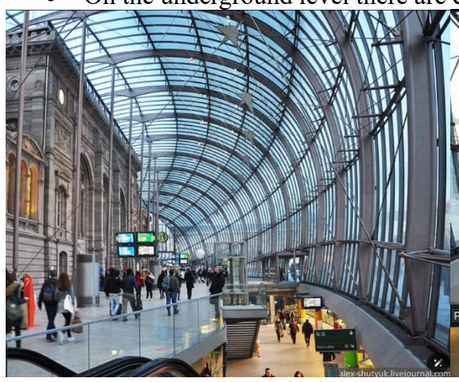


Function and interior ambiance

- Everything is quite modest on the platforms.
- There are two tram routes under the station connecting the city center with the districts on the other side of the railway.
- Underground passage under the tracks,down to the tram stop. (**Shutyuk, 2020).**


- On the underground level there are commercial premises.

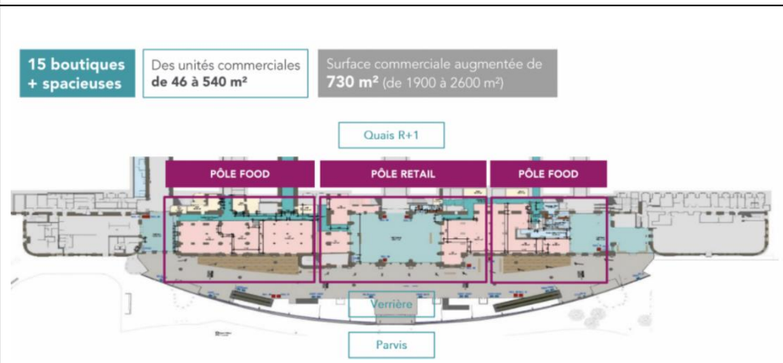


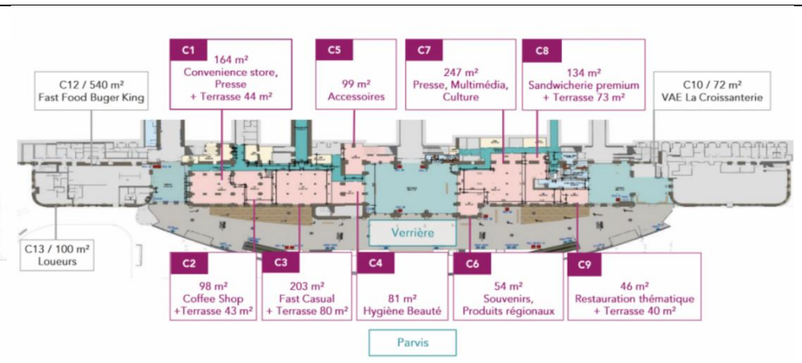

- Badak Spontaneous bicycle parking between the station and the entrance to the underground.

ANNEX

- Do you want Wi-Fi? Spin the pedals

PLANS/ programme





https://pokaa.fr/2021/07/20/a-partir-de-septembre-la-gare-de-strasbourg-changera-de-visage/.

ANNEX

https://cdn-s-www.dna.fr/images/5BCF7A51-0940-44ED-A873-BCB214DE52A9/NW_raw/le-projet-d-implantation-de-la-deuxieme-gare-infographie-dna-ebra-services-1695301356.jpg.

ANNEX

Table 40: Different districts of the new town of Bouinen

POS	Program
POS N°1 : Quartier A	• High-density housing • Equipements collectifs
POS N°2 : Quartier B	•2 Vocational Training and Apprenticeship Centers (CFPA) - Assemble Populaire Communale (APC) headquarters - Multimodal station • International finance and business center - 250-bed hotel
POS N°3 : Quartier C	- High density housing - Medium-density housing - Mixed-use building - Grand Mosque - Vocational Training and Apprenticeship Center (CFPA) - 250-bed hotel
POS N°4 : Quartier D	- High and medium density housing - Individual housing - Mixed-use building - Daïra headquarters - 2 hotels (2 x 150) beds - Exhibition hall

	- Central park - Weekly market
POS N°5 : Quartier E	- Medium-density housing - Single-family housing - Logistics and distribution center - High-tech industries - Amusement park
POS N°6 : Quartier F	- Medium-density housing - Single-family housing - Multimedia center - R&D center - Fire station - Integrated cultural center - 240-bed hospital - Golf course - National Institute for Vocational Training (INSEP)
POS N°7 : Massouma	• individual housing • Equipements de base
POS N°8 : Zhairia	- Collective, semi-collective and individual housing • Equipements
POS N°9 : Sidi Serhane	• collectif housing (AADL) 7144 Logts; • Equipements d'accompagnement.

	equipements to be offered are : - 03 Crèche or kindergarten. - City station (bus, cab).

I. DEFINITION DES INFRASTRUCTURES D'ACCUEIL ET DE TRAITEMENT DE VOYAGEURS PAR ROUTE.

- **Infrastructures d'accueil et de traitement de voyageurs par route :** Superstructure à l'intérieur de laquelle transissent des voyageurs. Conformément aux dispositions de l'article 2 du décret exécutif n°04-417 du 20 décembre 2004, elles sont de quatre (04) types : les gares routières ; les stations urbaines ; les zones d'arrêts équipées et les haltes routières ;
- **Gare routière:** Infrastructure de service public, implantée le long des axes de circulations ou à des points nodaux, accueillant des lignes de transport collectif routier en terminus où en transit et permet l'interconnexion avec les différents modes de déplacements. Elle est composée d'une manière générale :
  - D'un bâtiment voyageur : qui abrite un hall d'accueil et différents services aux voyageurs et aux transporteurs et permet souvent des activités commerciales ;
  - D'une infrastructure : composée d'aires de circulation et d'arrêts dédiées prioritairement au mode de transport collectif routier de voyageurs et aux rabattements vers les autres modes de transport (ferré, aéroportuaire, maritime).

  Les gares routières sont réparties en trois types:
  - Les gares routières de types « A » sont d'intérêt national. Elles peuvent abriter des dessertes locales et/ou régionales ;
  - Les gares routières de type « B » sont d'intérêt régional. Elles peuvent abriter des dessertes nationales et/ou locales ;
  - Les gares routières de type « C » sont d'intérêt local. Elles peuvent abriter des dessertes nationales et/ou régionales.
- **Gare multimodale:** Infrastructure qui implique l'utilisation de plusieurs modes de transport au cours d'une même destination ;
- **Pôle d'échange :** Espace qui regroupe un grand nombre de modes de transport dans le but de faciliter à l'usager une chaine de transport parfaite ;
- **Station urbaine :** Infrastructure assurant le déplacement des usagers sur le périmètre urbain et composé d'espaces bâtis, de quais couverts, d'aires de circulation et de régulation des véhicules de transport urbain et d'équipement nécessaires à l'exploitation ;
- **Zone d'Arrêt équipée :** Infrastructure implantée au niveau des petites agglomérations et ayant un trafic routier faible. Elle est composée d'espaces bâtis avec commodités nécessaires aux voyageurs, des quais couverts et d'une aire de régulation des véhicules de transport ;
- **Halte routière :** Infrastructure implantée au niveau des localités périphériques, avec un volume de trafic modéré et situées sur des axes de passage des lignes de transport inter-wilayas. Elle est constituée d'un bâtiment voyageur, des quais en ligne permettant des séjours brefs de véhicules de transport routier de personnes ;

- **Autres termes techniques :**
  - **Poste à quais** : Emplacement dédié à l'arrêt d'un bus ou un car ;
  - **Quais :** Espace de la gare regroupant un ou plusieurs postes à quai ainsi qu'un cheminement d'accès à ce(s) poste(s) à quai ;
  - **Dépose-minute :** Emplacement de parking réservé uniquement pour un court arrêt et pas pour un stationnement, utilisé pour déposer un passager ;
  - **Intermodalité** : Principe d'articulation de l'offre de transport visant à coordonner plusieurs moyens de transport et faciliter les correspondances au cours d'un même déplacement ;
  - **Aire d'attente ou de régulation :** Espace ou les véhicules peuvent stationner pour une courte durée, non utilisée pour la montée/descente des voyageurs. Elle se situe à l'intérieur de la gare, ne nécessite pas de quais et se compose de places de stationnement ;
  - **Aire de stockage :** Réponds aux besoins de stationnement de longue durée des autocars qui ne sont pas en service commercial ;
  - **Signalétique** : Composée d'information horizontale (marquage au sol) ou verticale (panneaux) identifiant un lieu. Il faut distinguer :
    - Signalétique de la gare routière : Eléments dédiés au fonctionnement de la gare routière (kiosque d'information, guichets de vente, salle d'embarquement, etc.) ;
    - Signalétiques des services divers : Différents services offerts dans le hall voyageurs (services marchands, sanitaires, salle de prière...) ;
    - Signalétique multimodale : Système donnant des informations sur les autres réseaux de transport collectif ;
    - Signalétique hors site : Jalonnement aux abords immédiats de la gare.
  - **Qualification de gestion des gares routières :** Possession d'une décision de qualification de gestion d'une (01) ou infrastructures d'accueil et de traitement de voyageurs par route, délivrée par le Directeur des Transports de Wilaya territorialement compétant.

II- REGLES ET NORMES DE CLASSIFICATION DES INFRASTRUCTURES D'ACCUEIL ET DE TRAITEMENT DE VOYAGEURS PAR ROUTE

La classification, des infrastructures d'accueil et de traitement de voyageurs par route, est établie en fonction de sa taille en termes de trafics supportés et de fréquentation, à laquelle sont associés les éléments ci-après :

- Surfaces de terrains d'assiettes et de bâtiment;
- Dimension des locaux d'exploitation ;
- Dimension des sanitaires publics ;
- Capacité d'accueil en nombre de quais.
- Vocation nationale, régionale ou locale ;
- Importance des agglomérations concernées, de leur développement futur et des flux générés et prévisionnels ;
- Services et de voyageurs au départ, à destination et en transit.

ANNEXE 2: CONDITIONS A PRENDRE EN COMPTE LORS DE LA REALISATION DES INFRASTRUCTURES D'ACCUEIL ET DE TRAITEMENT DE VOYAGEURS PAR ROUTE

2.1- POUR LES GARES ROUTIERES, GARES MULTIMODALES ET POLES D'ECHANGES

- Lier le choix du type d'ouvrage aux contraintes foncières et économiques. Il correspond à une recherche de la distance minimale entre l'accès des autres modes de transports et ceux de la gare routière. Chaque configuration d'équipement suit des recommandations qui lui sont propres ;
- Optimiser l'organisation spatiale afin que le matériel roulant puisse, sans contrainte, déposer les usagers et les prendre en charge. La circulation est facilitée par un bon fonctionnement des voies, sans toutefois diluer les pistes pour limiter les distances à parcourir à pied par les usagers ;
- Prévoir impérativement un accès facile depuis l'extérieur, pour permettre de trouver aisément son quai et être dimensionnée pour la sécurité et le confort des usagers et des véhicules ;
- Offrir un maximum de sécurité pour les personnes se trouvant à l'intérieur de l'infrastructure ;
- Prévoir une succession logique des fonctions, au fur et à mesure de l'acheminement de l'usager : entrée, panneau d'information générale, billetterie ;
- Simplifier et éviter les parcours inutiles des usagers ;
- Offrir à l'usager les conditions de sécurité et de confort ;
- Prévoir au niveau de l'infrastructure une entrée et sortie séparée pour les véhicules de transports de voyageurs ainsi que pour les voyageurs en sus, une issue de secours ;
- Adopter un sens de rotation (sens d'aiguilles d'une montre) afin d'éviter tout conflit avec les entrées – sortie des piétons ;
- Dissocier les quais de départ et d'arrivée des quais de passage (transit) ;
- Prévoir pour les villes où le transit est important, un nombre suffisant de quais de passage. Ceux-ci doivent être séparés des quais arrivée-départ et de la circulation mécanique (accès des véhicules aux quais) et de la circulation piétonne (accès des voyageurs, circulation des services) ;
- Séparer les parkings d'attente des véhicules de transport de voyageurs, et les parkings des services taxis;
- Prévoir pour l'ensemble des lieux d'attente, de prise en charge des voyageurs et passages de reliant les modes de transport des couverts vis-à-vis des conditions climatiques ;
- Implanter les prestations commerciales non liées directement aux voyageurs aux étages supérieurs du bâtiment voyageurs ;
- Faire obéir les infrastructures aux normes et règlements de sécurité régissant les établissements accueillant du public.

ANNEX

3.6- Normes requises pour les voiries

EQUIPEMENT	DIMENSION	
A)- Voirie interne au site infrastructures d'accueil et de traitement de voyageurs		
Voirie autocars/ autobus	Voie sens unique	4 m de large
	Voie double sens	7 m de large
	Rayon de giration (bus standard de 12 m)	5,30 m : rayon intérieur
		13 m : rayon extérieur
Voirie voitures particulières	Voie sens unique	3,5 m
	Voie double sens	5 m
Portail d'accès- sortie autocars/ autobus	Largeur (accès)	6 à 8 m
	Largeur (sortie)	6 à 8 m
Portail d'accès- sortie véhicules légers	Largeur (accès)	4,5 à 6 m
	Largeur (sortie)	4,5 à 6 m
Trottoirs piétons	Largeur : 2 m au minimum	
Loge de gardien avec sanitaires	12 à 14 m^2	
Traversée piétonne	2 m de large (à doubler au niveau des accès principaux)	
Plateau traversant	Entre 10 (12m si TC) et 30 m de large	
Distance entre dispositifs de ralentissement	Entre 50 et 100 m	
Ralentisseur trapézoïdal	Entre 2,5 et 4 m de large	
Coussin berlinois	Entre 1,75 et 1,9 large x entre 3 et 4 m long	
B)- Espace autocar-autobus		
Quai départ/arrivée	Quais en ligne	15 m longs x 2,5 m larges
	Autres types de quais	12 m longs x 3,20 m larges
Aire d'attente (ou de régulation)	12 m longs x 3 m larges	
Quai voyageur	2,50 m large minimum entre 2 autocars	
Sas d'accès (couloir piéton séparent les salles d'embarquement des quais de départ)	5 m de large au minimum	
C)- Station tramway (pour gares routières ou stations urbaines organisées en pôles d'échanges)		
Plate-forme (double voie)	6,85m longs	
Quai central	45 m longs x 4 m larges	
Quais latéraux	45 m 45 longe x 3 m larges	
Espace voiture particulières taxis		
Aire de prise en charge taxi (organisation en pousse-pousse)	5,60 m longs x 2 m larges	

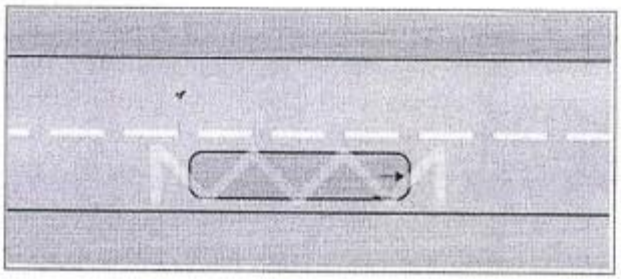
30

ANNEXE 5: CARACTERISTIQUES TECHNIQUE DES AMENAGEMENTS DES POINTS D'ARRÊT

Nous pouvons définir cinq (5) types de points d'arrêt :

A)- EN LIGNE : Cette disposition facilite l'accostage du bus ou du car sans « balayage » du trottoir par la caisse du véhicule et sa réinsertion dans la circulation générale; elle ne modifie pas l'emprise du trottoir. Elle permet un excellent parallélisme au quai et donc, une bonne accessibilité des personnes à mobilité réduite.

Elle offre une bonne covisibilité entre usagers et chauffeur. Elle contribue à la modération de la circulation et « affiche » la priorité donnée aux transports en commun sur la circulation générale. S'il est prolongé, l'arrêt sur chaussée peut perturber l'écoulement de la circulation et susciter des manœuvres de dépassement, parfois à risques. L'aire d'attente est proche de la circulation générale. Il convient de veiller à ce que le bus ou l'autocar à l'arrêt ne puisse pas surprendre les automobilistes (visibilité).



B)- EN SAILLIE : Cette configuration urbaine permet :

- ✓ Un parallélisme au quai parfait sans risque de balayage par la caisse facilite la prise en compte-personne à mobilité réduite ;
- ✓ La réinsertion du véhicule dans la circulation est aisée ;
- ✓ L'avancée de trottoir offre une grande aire d'attente pour les usagers d'un autobus ou d'un autocar, permet facilement l'implantation d'un abri tout en gérant le stationnement très naturellement et peut s'accompagner d'une traversée piétonne plus sécurisée ;
- ✓ La covisibilité entre usagers est excellente ;
- ✓ La contribution à la modération de la circulation et « affiche » la priorité donnée aux transports en commun sur la circulation générale ;

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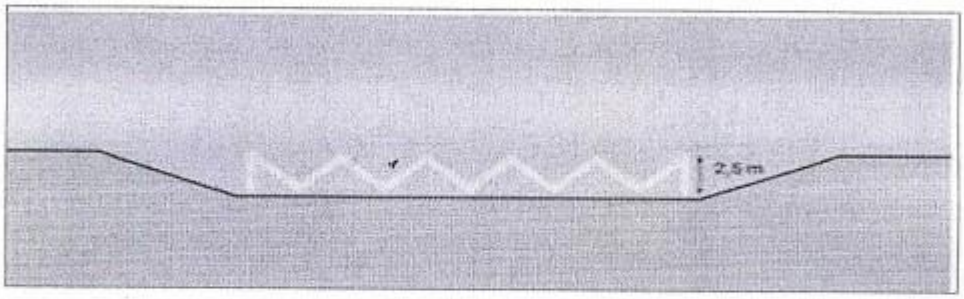
C)- En encoche (Profondeur 2,50 M A 3,00 M) : Cette disposition suburbaine ne perturbe pas la circulation automobile, surtout en cas d'arrêt prolongé du véhicule; elle permet d'éloigner l'aire d'attente de la circulation.

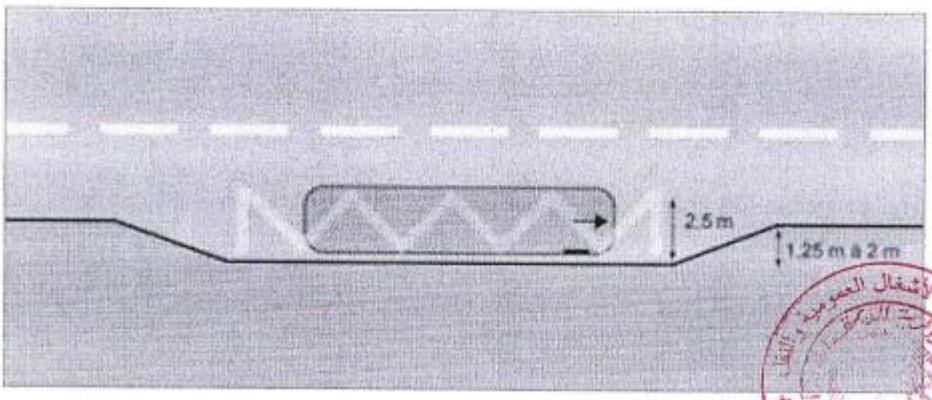
Elle rend plus difficile la réinsertion du véhicule dans la circulation générale et est consommatrice d'emprise (trottoir). L'obtention d'un bon parallélisme au quai et d'un non-balayage du quai par le véhicule rend nécessaire une grande longueur de quai et de longs biseaux ; les caractéristiques géométriques sont dépendantes de l'importance de la voie. En présence d'une forte demande de stationnement, ce type d'arrêt s'insère difficilement.

Une configuration en retrait de la voie peut être envisagée en créant une zone tampon entre la voie et l'encoche, ceci afin d'améliorer par exemple la visibilité pour un automobiliste d'une voie sécante à proximité



D)- En demi-encoche (profondeur 1,25 m à 1,50 m) : Cette configuration suburbaine est moins consommatrice d'emprise que l'arrêt en encoche permet un accostage plus facilité du quai et une réinsertion plus aisée dans la circulation générale, elle ne perturbe que modérément l'écoulement de la circulation.

Elle incite toutefois fortement les automobilistes au dépassement du véhicule à l'arrêt et nécessite donc de porter une grande attention aux traversées à proximité.



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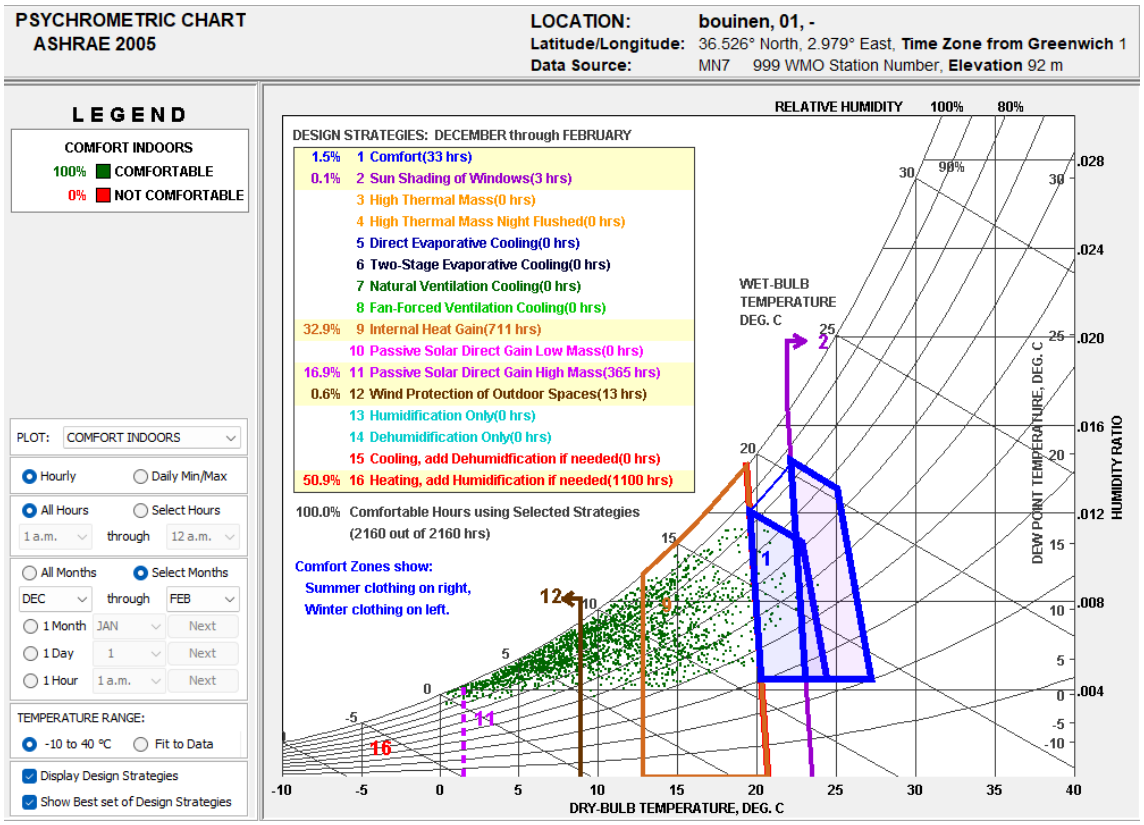
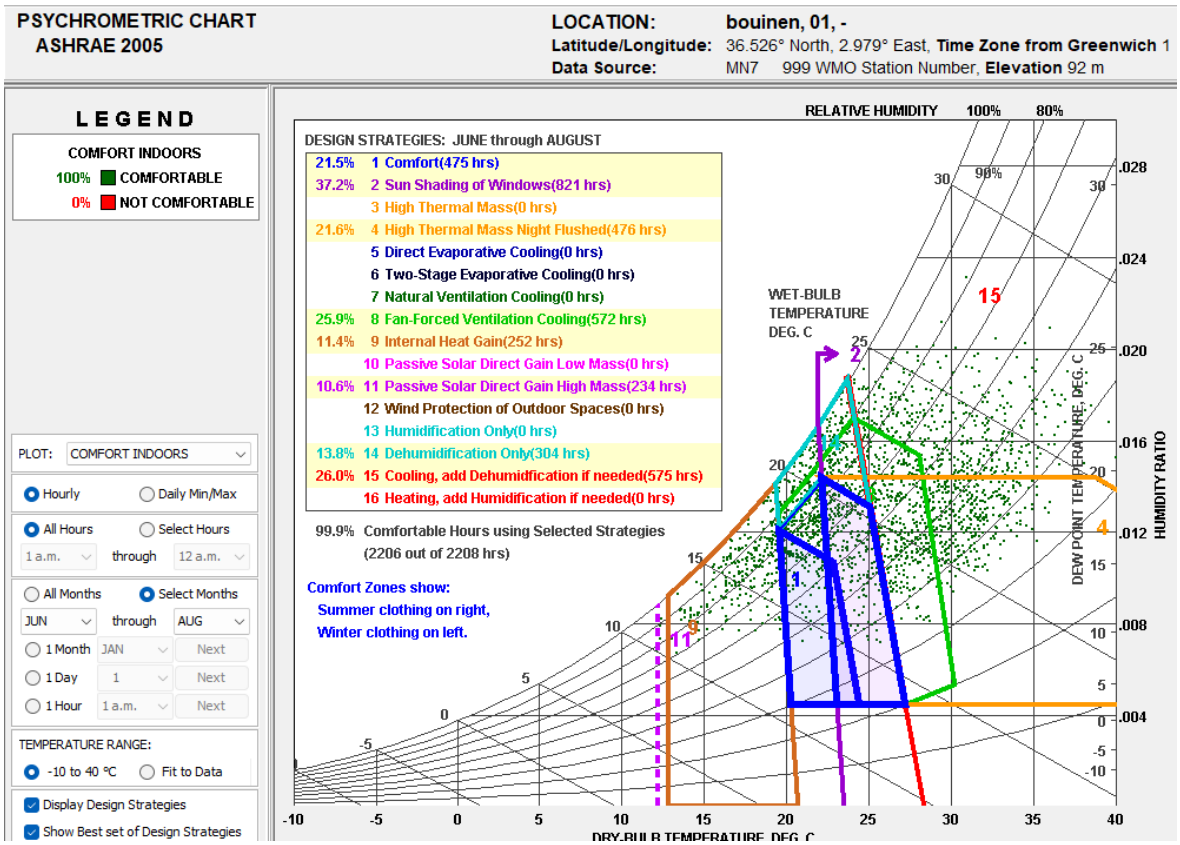
ANNEX

Winter :

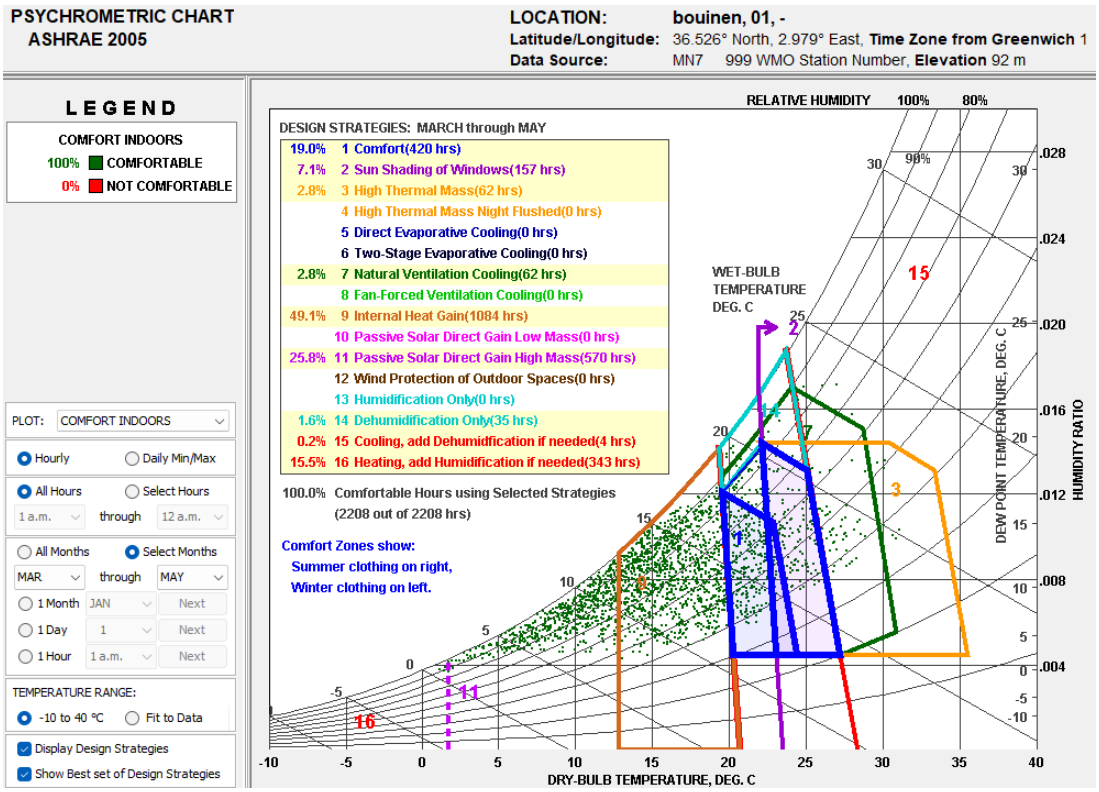


Summer :

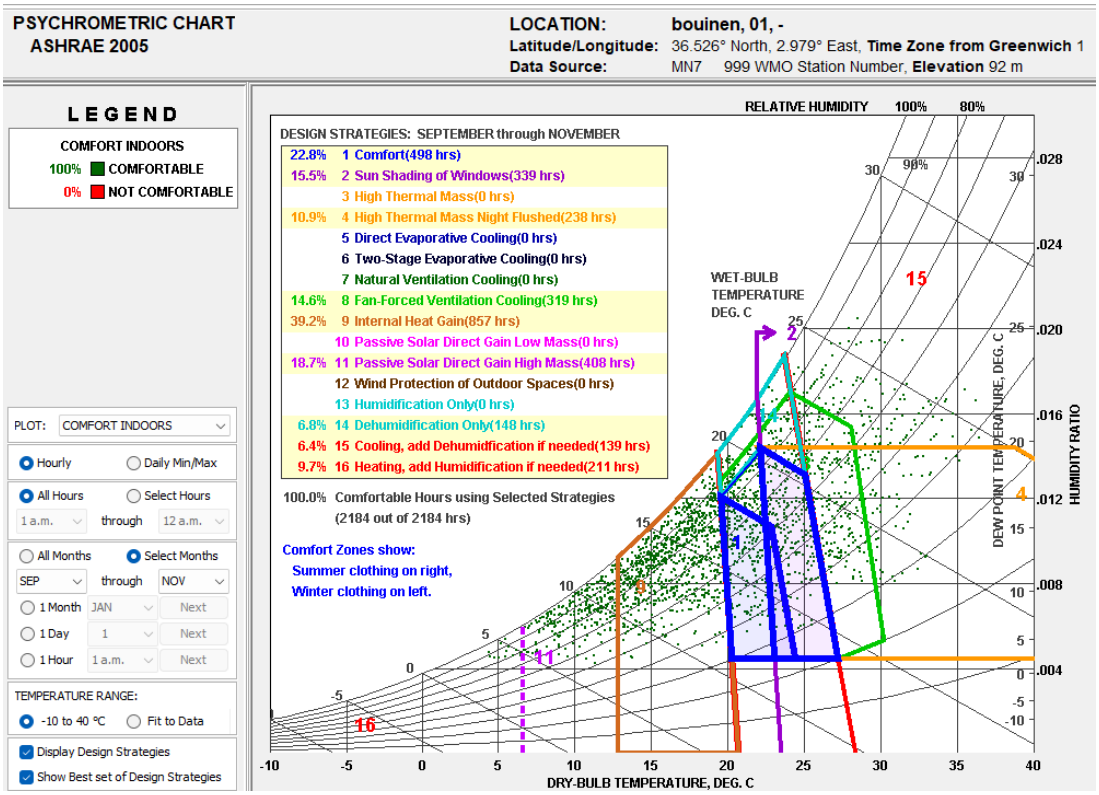


ANNEX

Spring :

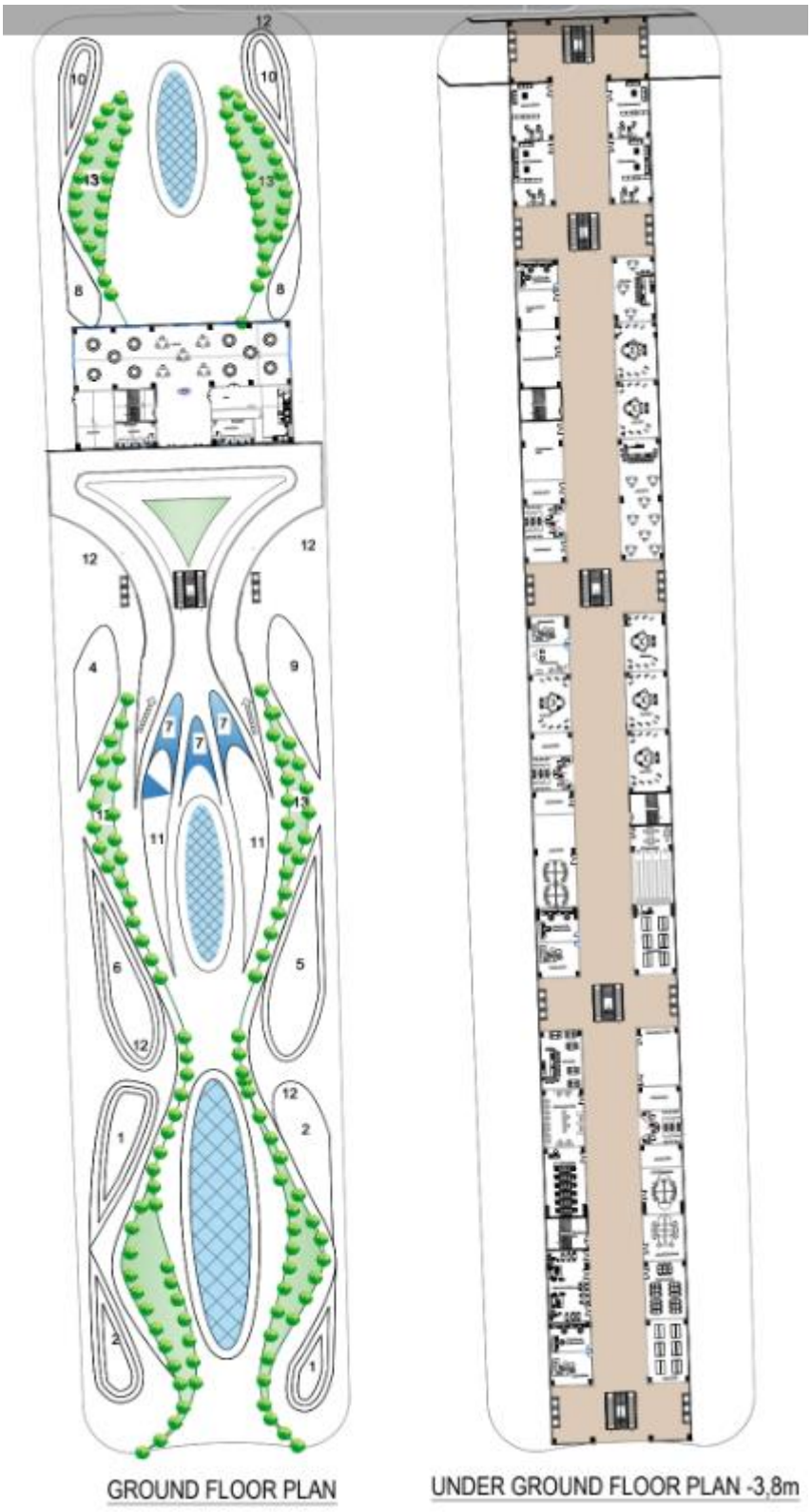


Autumn :



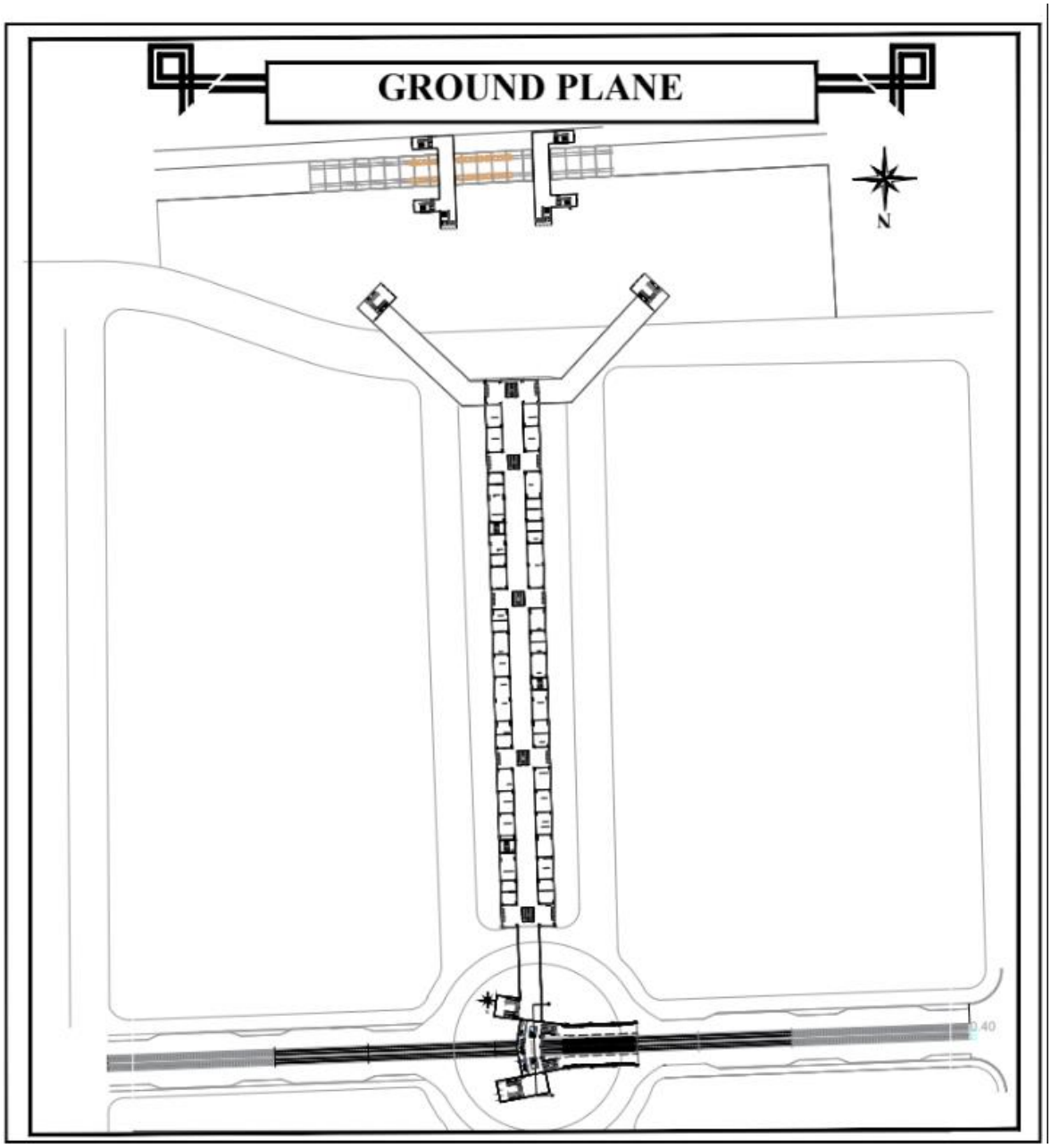
ANNEX

The esplanade:



The commercial underground tunnel plan :

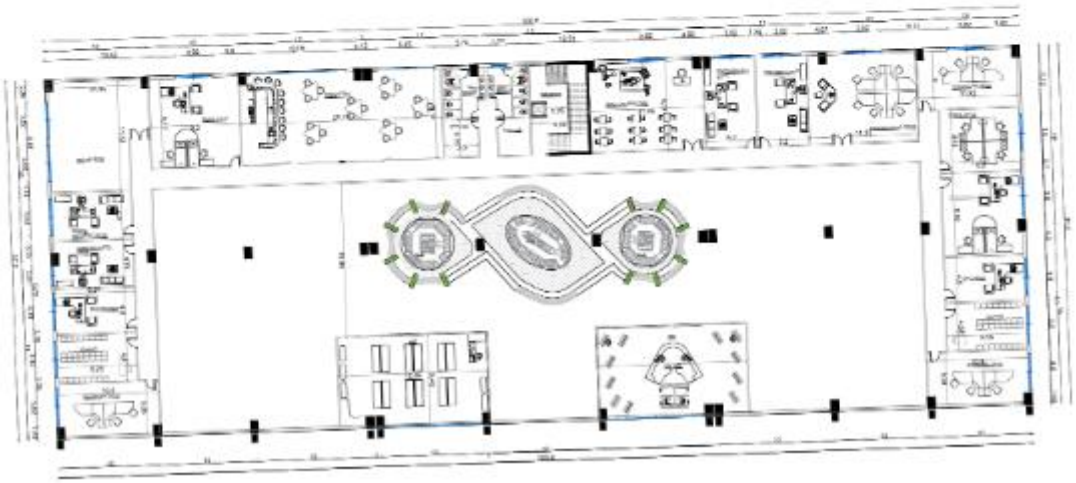
ANNEX



The train station :

ANNEX

GROUND FLOOR PLAN

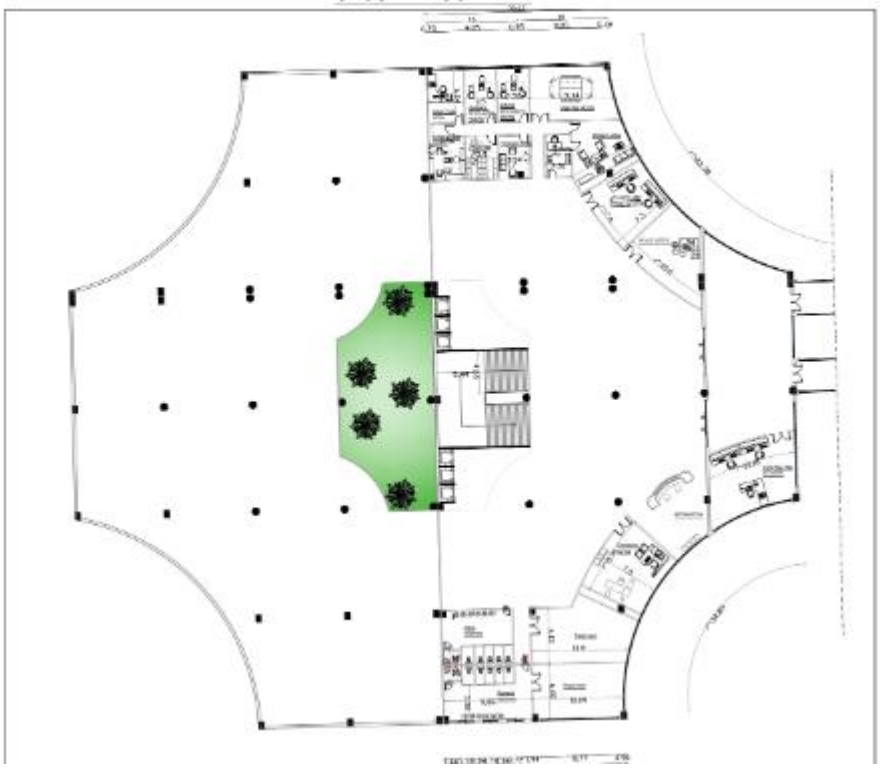


FIRST FLOOR PLAN

ANNEX

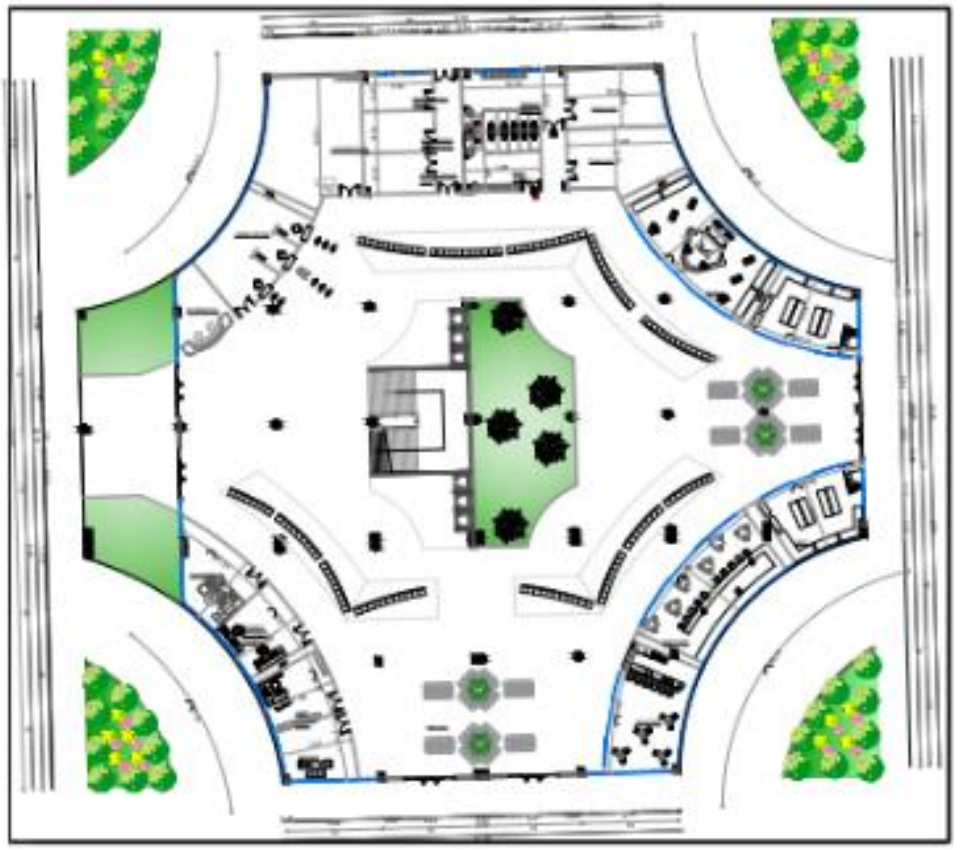
The taxi station :

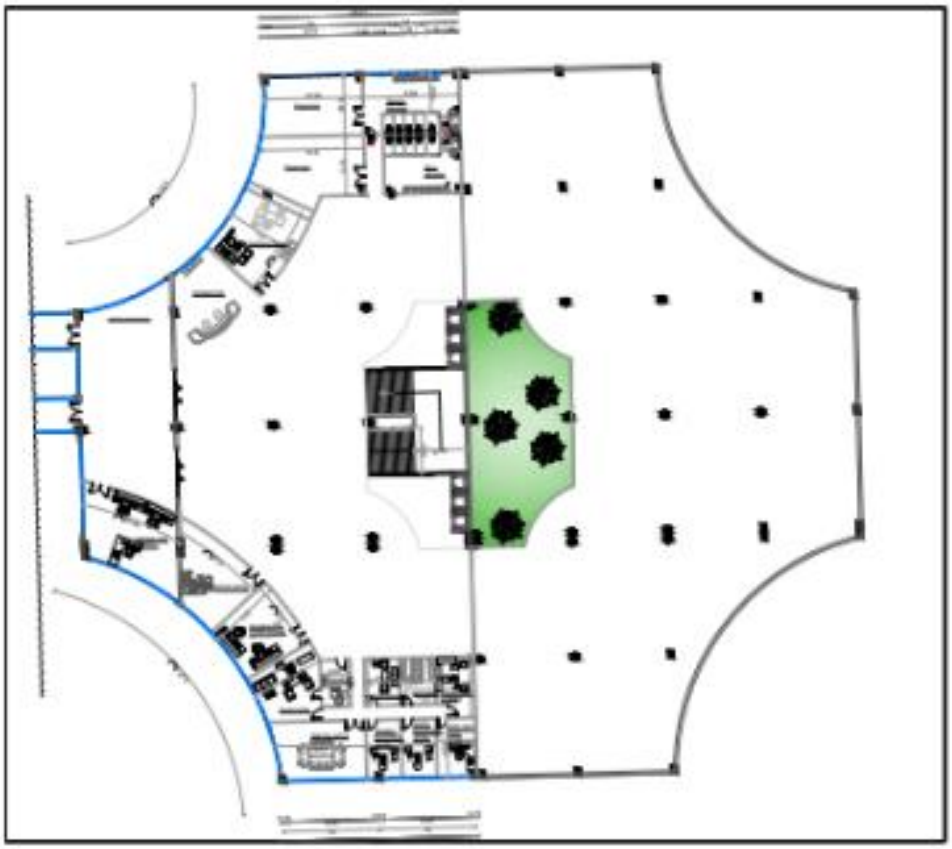
GROUND FLOOR PLAN



ANNEX

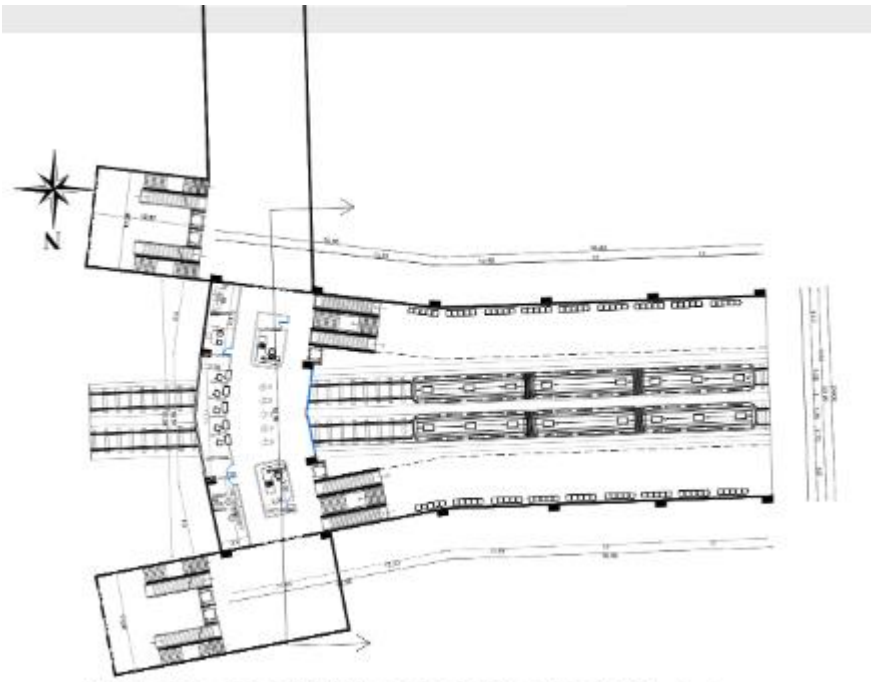
The bus station :



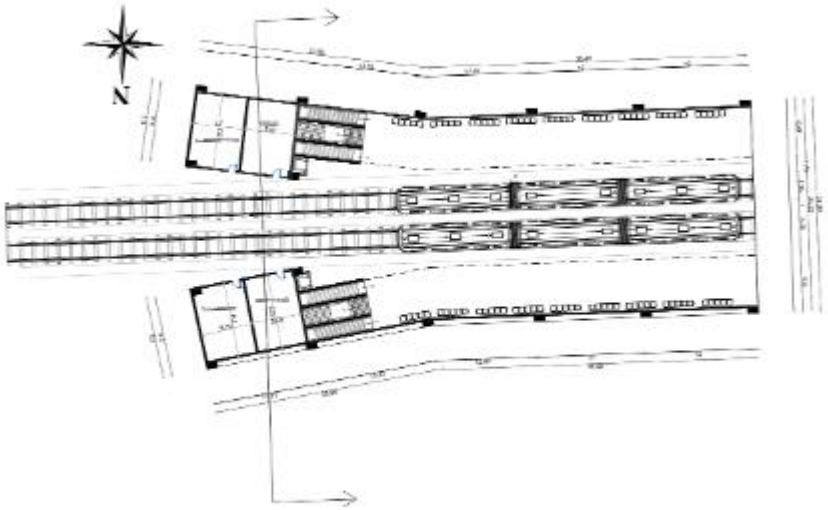


ANNEX

The tramway station :



UNDER GROUND FLOOR PLAN -3,8m



UNDER GROUND FLOOR PLAN -10m

3d views :

ANNEX