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## Master Thesis

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## Field : Architecture, Urbain and environment

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# Developing of modelling tool for improving and enhancing acoustic feature in architecture façade through artificial intelligence A project: municipal library

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By

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# *Gratitude and appreciation*

In the name of Allah, the most gracious, the most merciful. “my lord, enable me to be grateful for your favor which you have bestowed upon me and upon my parents and to do righteousness of which you approve and make righteous for me my offspring. Indeed, I am of the Muslims” (surah AI-Ahqaf:15)

Praise be to Allah, by whose grace good deeds are completed. I offer my prayers and peace upon the last of the prophets and messengers, our prophet Muhammed, and upon his family and companions.

I extend my deepest gratitude and appreciation to my esteemed supervisors who greatly guided and supported me throughout my research journey:

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# *Dedication*

To the one who has encouraged me throughout my life, the most supportive man in my life, my dear father, Djaber.

To the one who is my greatest source of strength and my refuge, my loving and generous mother, Assia.

To those who have always been by my side, offering their support and kindess, my dear siblings (Houdayfa, Mohamed, Hadjer, Abir,Taha and  Nawel)

And to my little angles (Younes, Loudjain, chahed, Maysem and Joud)

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To my close friends who have shared with me the ups and down, making every moment unforgettable, ( Ibtisseme, Amira, Hadil, Safa, Abir, Roumaissa, Noura, Hanine, Aridj, Manel, Chahine)

To everyone who has contributed, even in the smallest way, to my educational path.

To all these wonderful people, I dedicate this work to you, and I pray that Allah accepts it sincerely.

Meriem Ounis

## Summary

This work delves into the complexities of urban noise pollution and its impact on building facades, emphasizing the critical importance of acoustic considerations in architectural design. The study begins by examining the intricate dynamics of sound propagation in outdoor environments, focusing on how geographical landscape relief, atmospheric absorption, and meteorological conditions influence sound behaviour. This foundational knowledge is crucial for addressing the attenuation of sound over distances and its interaction with environmental elements.

The research identifies the significant effects of urban noise on the structural integrity and aesthetic quality of building facades, highlighting how noise pollution accelerates the wear and tear of facades, impacting the longevity and visual appeal of urban architecture. Utilizing the advanced acoustic modelling tool “Acous”, the study initially assesses noise levels impacting building facades, revealing that they significantly exceed recommended standards, this initial assessment underscores the urgent need for effective noise mitigation strategies in urban environments. Based on Acous's recommendations, various noise mitigation measures are implemented, including the use of specific materials and design modifications.

The study emphasizes the necessity of integrating acoustic considerations into the architectural design process from the outset, advocating for a multidisciplinary approach that combines environmental science, architecture, public health, and urban planning to create acoustically balanced urban spaces. A detailed analysis of the city of Biskra's climatic conditions and urban context is conducted to inform the design choices, including a bioclimatic analysis and a field study, aiming to align the design strategies with the specific climatic and morphological characteristics of the region.

The study concludes with the presentation of a proposed program for a library project, incorporating the findings and strategies developed throughout the research. This proposal highlights the practical application of the theoretical and analytical insights gained, aiming to enhance acoustic comfort and overall urban well-being. In summary, this work provides a comprehensive framework for addressing urban noise pollution through innovative facade design and strategic noise mitigation. By integrating advanced acoustic modelling and a holistic design approach, it offers valuable insights and practical solutions for creating sustainable and comfortable urban environments.

Key-words: Urban noise pollution, Building facades, Acoustic considerations, Architectural design, Sound propagation, Environmental elements, Structural integrity, Aesthetic quality, Acoustic modelling tool (Acous), Noise mitigation, Public health, Urban planning, Sustainable urban environments.

الملخص

هذا العمل يتعمق في تعقيدات تلوث الضوضاء الحضرية وتأثيرها على واجهات المباني، مشددًا على الأهمية البالغة للاعتبارات الصوتية في التصميم المعماري. تبدأ الدراسة بفحص ديناميات انتشار الصوت في البيئات الخارجية، مركزةً على كيفية تأثير تضاريس المناظر الطبيعية وامتصاص الغلاف الجوي والظروف الجوية على سلوك الصوت. هذا المعرفة الأساسية ضرورية لمعالجة تلاشي الصوت على مسافات طويلة وتفاعله مع العناصر البيئية.

تحدد الدراسة التأثيرات الكبيرة للضوضاء الحضرية على السلامة الهيكلية والجودة الجمالية لواجهات المباني، مسلطةً الضوء على كيفية تسريع تلوث الضوضاء لتآكل الواجهات، مما يؤثر على طول عمر وجاذبية الهندسة المعمارية الحضرية. باستخدام أداة النمذجة الصوتية المتقدمة ""Acous، تقوم الدراسة بتقييم مبدئي لمستويات الضوضاء التي تؤثر على واجهات المباني، كاشفةً أنها تتجاوز المعايير الموصي بها بشكل كبير. هذا التقييم الأولي يبرز الحاجة الملحة إلى استراتيجيات فعالة للتخفيف من الضوضاء في البيئات الحضرية. بناءً على توصيات Acous، تم تنفيذ العديد من تدابير التخفيف من الضوضاء، بما في ذلك استخدام مواد محددة وتعديلات في التصميم.

تؤكد الدراسة على ضرورة دمج الاعتبارات الصوتية في عملية التصميم المعماري من البداية، داعيةً إلى نهج متعدد التخصصات يجمع بين علوم البيئة والهندسة المعمارية والصحة العامة والتخطيط الحضري لإنشاء مساحات حضرية متوازنة صوتيًا. تم إجراء تحليل مفصل للظروف المناخية والسياق الحضري لمدينة بسكرة لتوجيه اختيارات التصميم، بما في ذلك تحليل بيو مناخي ودراسة ميدانية، بهدف توافق استراتيجيات التصميم مع الخصائص المناخية والمورفولوجيا المحددة للمنطقة.

تختتم الدراسة بعرض برنامج مقترح لمشروع مكتبة، يجمع بين النتائج والاستراتيجيات التي تم تطويرها طوال البحث. يبرز هذا الاقتراح التطبيق العملي للرؤى النظرية والتحليلية المكتسبة، بهدف تعزيز الراحة الصوتية والرفاهية الحضرية الشاملة. باختصار، يوفر هذا العمل إطارًا شاملاً لمعالجة تلوث الضوضاء الحضرية من خلال تصميم واجهات مبتكر وتخفيف استراتيجي للضوضاء. من خلال دمج النمذجة الصوتية المتقدمة ونهج تصميم شامل، يقدم العمل رؤى قيمة وحلولًا عملية لإنشاء بيئات حضرية مستدامة ومريحة.

**الكلمات المفتاحية:** تلوث الضوضاء الحضرية، واجهات المباني، الاعتبارات الصوتية، التصميم المعماري، انتشار الصوت، العناصر البيئية، السلامة الهيكلية، الجودة الجمالية، أداة النمذجة الصوتية (Acous)، تخفيف الضوضاء، الصحة العامة، التخطيط الحضري.

# Table of contents

# Table of contents

**List of tables**

# Introductory Chapter

# Introductory Chapter

## I- General Introduction

In the nuanced exploration of urban living, the harmony of acoustic landscapes and the pursuit of acoustic comfort stand as foundational pillars. The interplay of sound within our environments, particularly concerning urban acoustics and architectural acoustics, has garnered increasing attention as we recognize the profound impact it has on our well-being. As we delve into the complexities of noise dynamics, the infiltration of urban noise into building facades emerges as a significant challenge, prompting a revaluation of design and construction practices. This imperative arises not only to mitigate the effects of noise pollution but also to create acoustically balanced environments that contribute to a broader sense of urban well-being (Magrini & Lisot, 2016; Renterghem & Botteldooren, 2012; Eltarabily et al., 2016, p12).

Within this symphony of urban sounds, the concept of a serene facade becomes a crucial component in fostering acoustic comfort for residents navigating through elevated noise levels. This strategic approach empowers inhabitants to selectively retreat from excessive noise based on their activities or designate specific spaces within dwellings for specialized purposes, creating pockets of tranquillity amidst the urban cacophony (Fuhong & Li, 2020, p25). Complementary strategies, ranging from integrating green spaces to deploying porous asphalt and implementing building refurbishments, have been proposed to not only mitigate noise pollution but also enhance acoustic comfort around building facades (Renterghem et al., 2015, p5). However, the impact of urban noise on building facades is a critical aspect that warrants attention. The constant barrage of noise can not only compromise the structural integrity of facades but also influence the overall aesthetic and functional aspects of urban architecture. Noise-induced vibrations and reverberations on building surfaces may lead to accelerated wear and tear, impacting the longevity of structures. Moreover, the visual and auditory aspects of facades, which contribute significantly to the character of urban spaces, can be disrupted by the relentless intrusion of noise.

The recognition of the urban acoustic environment, particularly noise pollution, as an outgrowth of rapid urban development necessitates comprehensive strategies to navigate this intricate soundscape while prioritizing the well-being and comfort of urban dwellers.

Despite these pressing challenges, the disregard for urban acoustics as a critical environmental and public health concern raises significant alarm due to its far-reaching impact on human well-being. The deleterious effects of noise pollution, spanning annoyance, stress, and disruptions in daily activities, underscore the urgent need for

intervention and mitigation (Magrini & Lisot, 2016, p20). Furthermore, the reverberations of noise pollution on the workforce, particularly in diverse industrial settings, intensify the call for comprehensive strategies to harmonize the complex dynamics of urban acoustics (Renterghem & Botteldooren, 2012,p13).

In conclusion, the symphony of urban acoustics and architectural acoustics, with a focus on acoustic comfort, demands immediate attention and the deployment of nuanced mitigation strategies. This interdisciplinary challenge spans environmental science, architecture, public health, and urban planning, urging collaborative efforts to decipher and address the multifaceted challenges embedded in urban noise pollution while championing the quest for acoustic well-being in our cities. As we strive to navigate the intricate soundscape of urban life, the resilience and integrity of building facades stand as crucial elements in preserving both the physical and aesthetic fabric of our evolving urban environments.

## II- Problematic

In the intricate tapestry of architectural design, the pursuit of comfort emerges as a foundational pillar, encompassing thermal, visual, and acoustic dimensions. Despite this holistic approach, a noteworthy imbalance exists, particularly in the domain of acoustic considerations. The prevalent trend among architects and engineers to prioritize thermal and visual comfort often results in a disregard for the acoustic realm, a facet acknowledged for its inherent complexity. This oversight becomes pronounced when confronting the escalating challenges posed by noise pollution in urban and architectural spaces. Originating from diverse sources such as transportation, human activities, and the surrounding environment, these acoustic disturbances significantly impact building facades. Drawing inspiration from recent findings, noise pollution stands out as a pressing concern for public health and well-being. Paradoxically, the acoustic performance of facades, especially in outdoor spaces, is routinely neglected, despite their pivotal role in shaping the urban soundscape. The effects of facades on the urban acoustic environment encompass a range of dynamics, including sound-reflecting, sound-absorbing, and sound-producing effects. The façade, acting as both a mediator and amplifier of environmental noise, influences not only sound pressure levels and reverberation time but also people's perception of the acoustic environment. Examining real-world scenarios, a report by the European Environment Agency indicates a worrisome trend. Despite efforts to control environmental noise, an increase in the number of individuals exposed to high noise levels is evident. This reinforces the urgency of addressing acoustic challenges, with researchers

directing significant attention to the role of building facades. The facade, as a key player in the transmission and reflection of environmental noise, demands a more comprehensive integration of acoustic considerations in design practices. Accurately predicting and addressing noise issues early in a project's design phase remains a key challenge. To enable effective acoustic solutions, comprehensive expertise must complement predictive models early in the design process. Reliance on simulations without a nuanced understanding of acoustics can lead to ineffective noise control and discomfort once a project is built. By prioritizing accurate modelling alongside expert guidance, noise issues can be proactively addressed to create comfortable spaces aligned with project goals. Transitioning from the macrocosm of urban acoustics, to the microcosm of architectural spaces, with a specific emphasis on facades. The architectural facade, a crucial interface between the exterior and interior realms, becomes a canvas upon which external noise insidiously leaves its mark. However, a critical observation reveals a prevalent oversight of acoustic exigencies in the design of architectural facades, unravelling a gap in the holistic approach to architectural comfort. This lacuna not only diminishes the efficacy of architectural design but also amplifies the need for innovative strategies that seamlessly integrate acoustic considerations into the very fabric of facade design.

- What strategic initiatives and actionable steps can be taken to rectify the prevalent oversight of acoustic considerations in architectural facades, ensuring a more balanced and holistic approach to architectural comfort that effectively mitigates the challenges posed by noise pollution in urban environments?
- What are the specific sources and characteristics of acoustic disturbances in urban environments, and how do these disturbances impact the acoustic performance of building facades?
- How can innovative design strategies be developed to seamlessly integrate acoustic considerations into the architectural facade, addressing the current gap in the holistic approach to architectural comfort?

## III- Hypothesis

The questions posed in this study prompted the formulation of hypotheses, seeking innovative solutions for integrating acoustic considerations into architectural design. The aim is to achieve a comprehensive approach to architectural comfort, effectively addressing the challenges posed by noise pollution in urban settings.

- If urban planners and architects prioritize the integration of acoustic considerations early in the design phase, including consideration of façade shapes and materials, a

more balanced and holistic approach to architectural comfort will be achieved, effectively mitigating the challenges posed by noise pollution in urban environments.

## IV- Objectives

The objective of our study is to address the oversight of acoustic considerations in building facades within the context of urban acoustics and architectural design. Our goals encompass a comprehensive understanding of the sources and characteristics of acoustic disturbances in urban environments. We aim to explore the impact of noise on building facades and develop innovative design strategies to achieve architectural comfort. The study pursues the following specific objectives :

- Explore the nuanced interplay of sound in urban environments, emphasizing its impact on well-being.
- Investigate the challenge of urban noise infiltration into building facades and its implications for design and construction.
- Highlight the importance of creating acoustically balanced environments for broader urban well-being.
- Examine the effects of noise pollution on building facades and its impact on the urban soundscape.
- Address the oversight of acoustic exigencies in architectural facade design, emphasizing the need for holistic approaches.

## V- Research Methodology

In this research, we conducted a comprehensive literature review by consulting books, documents, reports, theses, and websites to deepen our understanding of the study theme and address the posed problem. This approach aimed to grasp the various concepts, notions, and techniques related to the acoustic considerations in architectural facades within the context of urban acoustics and design.

The research will be organized into four main chapters:

**Introductory Chapter:** This chapter will provide a general introduction, including the problem statement, the hypothesis and the research objectives.

**Theoretical Chapter:** This section will be divided into two parts. The first part will focus on factors influencing sound propagation in the outdoor environment, spanning from the source to the receiver. The second part of this chapter will determine the exposure to environmental noise through strategic noise mapping of noise sources.

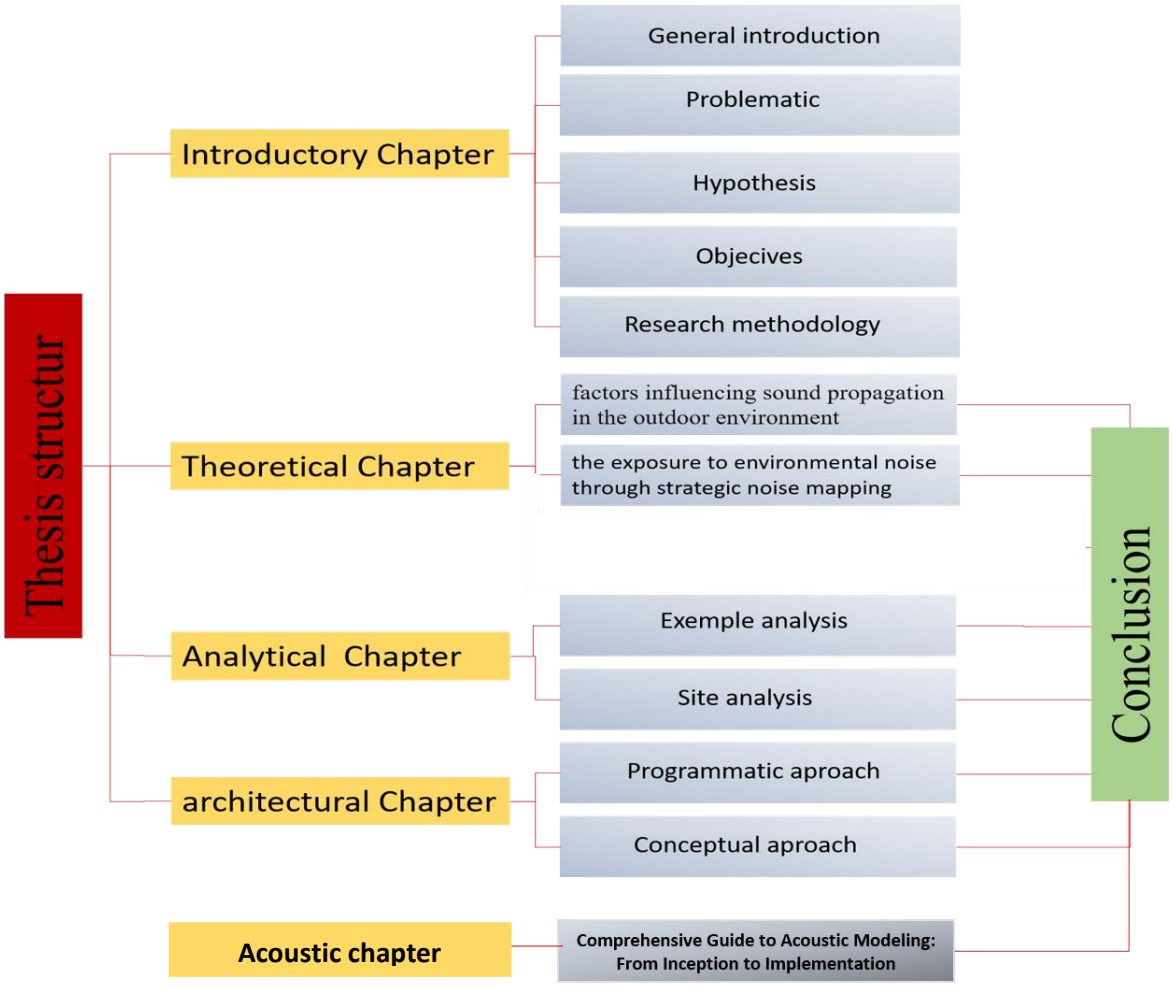
**Analytical Chapter:** This section will involve the analysis of examples to understand various parameters of projects, including formal, functional, constructive, structural

aspects, and others. Additionally, we will analyse the site and its climatic parameters using specialized software for climate analysis that aids in the design process.

**Architectural Chapter:** This chapter will be dedicated to the proposed project, detailing the project program, the methodology through which the project took shape, various graphical representations, and the functioning of the project.

**Acoustic chapter:** this chapter will be dedicated to the application "Acous", a comprehensive guide to acoustic modelling from inception to implementation.

## Thesis structure



# Theoretical Chapter

# First part : sound noise propagation

## I- Introduction

With the problematic of propagation of sound in outdoors are already address the several world authors, e.g., (Harris, C., p. 40) (Ingard, U, p. 25). Also on the basis of their knowledge and scientific outputs, it is clear that sound propagation outdoors is affected by several main factors such as geographical landscape relief, atmospheric sound absorption, weather conditions and the occurrence of various obstacles. Regarding the meteorological conditions, they need to divide and describe their effect individually. Among the most significant meteorological conditions that affect sound propagation in the external environment are: air temperature, air speed and direction, atmospheric pressure and relative humidity as well as the turbulent effect [9]. The sound that propagate in the atmosphere is attenuate depending on the distance. The attenuation due to distance varies for different kinds of sound sources. Most of the sounds with which they come into contact, are point and line sources. For point and line sources it is true that sound pressure level is reduced by 6 dB for every doubling of distance from it. The purpose of this chapter is to identify, all factors that effect and attenuate sound propagation in outdoors environment.

## I-1 Atmospheric Absorption of Sound

The attenuation of sound in the atmosphere is influenced by various factors, with atmospheric absorption being dependent on four key variables. These include the frequency of the sound, ranging from 50 Hz to 10 KHz, the temperature of the air within the span of -20 °C to +50 °C, relative humidity varying from 10% to 100%, and the pressure of the air at 101.325 KPa [4]. In addition to these variables, the propagation of sound is significantly affected by specific types of atmospheric conditions:

- Under downward-refraction propagation conditions, characterized by a positive vertical gradient of effective sound celerity from the source to the receiver, sound waves exhibit distinct behaviour.
- Homogeneous atmospheric conditions, characterized by a null vertical gradient of effective sound celerity over the entire area of propagation, play a crucial role in the overall sound propagation process. These atmospheric conditions contribute to the complex interplay of factors influencing the attenuation and propagation of sound in the environment.

It's important to note that there are two mechanisms by which acoustic energy is absorbed by the atmosphere—molecular relaxation and viscosity effects. Molecular relaxation is the more dominant mechanism, particularly influencing high frequencies more than low frequencies. The amount of absorption depends on the temperature and humidity of the atmosphere, as illustrated by figures showing the variation of absorption with temperature and relative humidity.

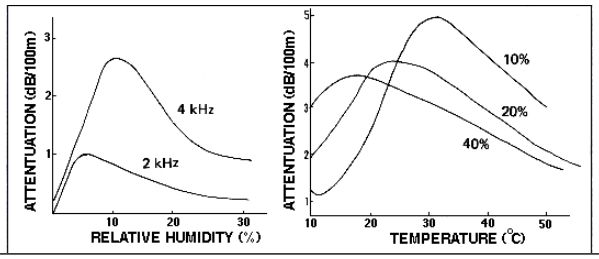



Figure 1: (left) Frequency dependence of attenuation as a function of relative humidity- (right) Attenuation as a function of temperature for various percentages of relative humidity. Source [2]

## I-1-1 effect of temperature of the air

Temperature gradients play a crucial role in shaping the propagation of sound waves within the atmosphere. As a common atmospheric occurrence, a negative temperature gradient often characterizes sunny afternoons when intense solar radiation leads to elevated surface temperatures and significant heat transfer from the ground to the surrounding air. This condition, known as a super-adiabatic or positive lapse, causes sound waves to bend upward in all directions, forming a circular shadow zone. Conversely, during nights, a positive temperature gradient is prevalent due to rapid surface cooling as heat is absorbed by the ground. Referred to as an inversion or negative lapse, this condition results in the downward bending of sound waves.

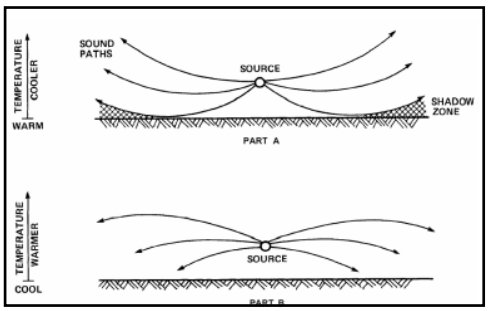



Figure 2: Effects of temperature gradients on sound propagation. (Top): In the case of positive lapse. (Bottom) : in the case of negative lapse. Source : [8]

The influence of temperature on sound propagation extends beyond these occurrences. Temperature influences air density, subsequently affecting the speed of sound. In a gas, like air, higher temperatures lead to higher sound speeds. This variation in temperature and density causes sound waves to refract, altering their trajectory. The phenomenon of sound refraction is comparable to the refraction of light. Furthermore, under temperature inversion conditions, where temperatures increase with altitude, sound waves may refract downward, allowing them to be heard over more extensive distances, particularly in winter and during sundown. These interactions showcase the intricate relationship between temperature and the behaviour of sound waves in the atmosphere.

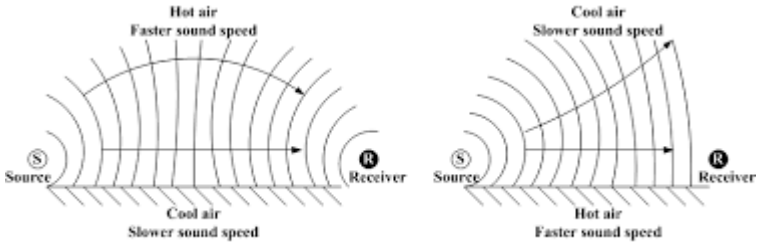



Figure 3: Refraction of sound waves by two layers of air at different temperatures as a result of the change of speed of the sound. Source : [3]

Relative humidity also has influence on sound waves, particularly in the case of high-frequency sound propagation (> 1000 Hz) [9]. Optimal sound propagation occurs in high humidity conditions, while lower humidity levels can negatively impact the efficiency of sound transmission in certain conditions. Moisture is constantly being absorbed into the air from the sea, lakes, rivers, and moist ground by the process of evaporation. There is a limit to the amount of water vapour that a given mass or 'parcel' of air can contain, and the amount actually present at any given time is expressed as a percentage of that limit. This percentage is known as the relative humidity of the air. For example, if the water vapour content is half the amount of vapour the mass of air can hold, then the relative humidity is 50%. The effect of temperature on relative humidity is critical. If air is warmed, the relative humidity will decrease as the parcel of air becomes capable of holding a greater amount of water vapour. Conversely, if the temperature drops, the air will be unable to hold as much water vapour, and so the existing vapour, which remains the same, will represent a greater proportion of the maximum limit.

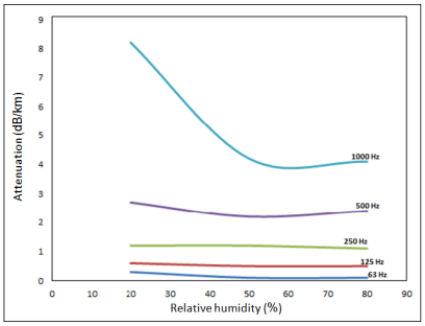



Figure 4 : Dependence of the sound attenuation [dB/km] on the relative humidity at different frequencies. Source : [9]

## I-2 meteorological conditions (weather conditions)

Meteorological conditions exert a profound influence on the propagation of sound, encompassing a range of factors that collectively shape the acoustic environment. Elements such as temperature gradients, wind speeds, wind directions, cloud cover, snow, and precipitation play crucial roles in determining how sound travels through the atmosphere. Among these variables, wind stands out as the most significant contributor to sound propagation dynamics (Kephalopoulos, S., Paviotti, M., Anfosso-Lédée, F, 2012, p. 25). The speed and direction of the wind profoundly affect the movement of sound waves, influencing their trajectory, dispersion, and overall efficiency of transmission. Wind speed, in particular, can introduce rapid variations in the soundscape, impacting the distance and direction over

which sound travels. Understanding the complex interplay of meteorological conditions is vital for accurately predicting noise levels in diverse settings. While temperature, precipitation, and other factors certainly contribute to the overall acoustic environment, recognizing the paramount importance of wind allows for a more comprehensive consideration of the factors that shape sound propagation in varying weather conditions

## I-2-1 effect of the wind

Wind plays a crucial role in sound propagation, particularly over extended distances. While wind alone has minimal effects on sound levels at short distances up to 50m [10], its impact becomes more pronounced over longer distances, especially over open ground. Vertical wind velocity gradients, influenced by factors like friction and solar radiation, contribute to bending sound waves. Wind speed profiles, varying with the time of day, weather conditions, and surface characteristics, lead to fluctuations in sound transmission. In practical scenarios, wind speeds are higher above the ground, causing wind speed gradients that "bend" sound waves over large distances. The wind's variability at different heights results in distinct downwind and upwind effects.

### a- Downwind Effects:

During downwind situations, sound waves are bent towards the Earth's surface, enhancing audibility over larger distances. The combined velocity increase with height results in sound waves refracting towards the ground, mitigating some of the attenuating effects of terrain, vegetation, or barriers that would typically intercept the sound path. Downwind measurements are normally preferred by acoustical consultants as the variability is smaller and the result is viewed as conservative and “worst case”.

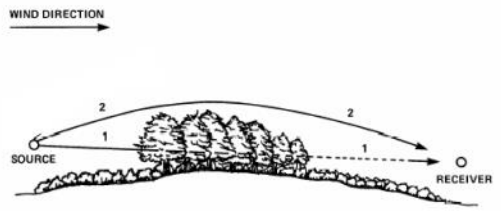



Figure 5: illustrates the principle of downwind sound propagation .source: [13]

### b- Upwind Effects

On the contrary, upwind conditions refract sound waves away from the Earth's surface, creating shadow zones. The combined velocity decrease with height leads to areas where sound waves are deflected, resulting in reduced sound levels. Persistent upwind conditions can cast a shadow zone, causing sound level reductions of up to about 20dB. This phenomenon occurs at distances greater than approximately 1000 feet (300m) for wind speeds above 10 to 15 mph (16 to 24 km/hr).

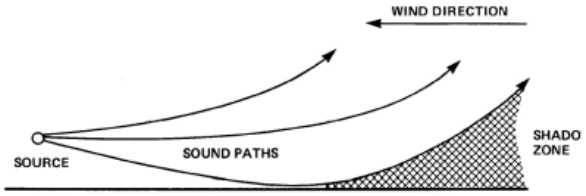



Figure 6 : illustrates the principle of up-wind sound propagation. Source: [10]

Understanding the influence of wind conditions on sound propagation is essential for assessing sound level variations over different distances. The impact of wind becomes more pronounced at greater distances from the sound source. At 1000m, downwind scenarios show reductions of up to 5dB (potentially influenced by distance effects), side wind conditions result in reductions of up to —11dB, and the most substantial reduction occurs in upwind measurements, reaching up to —20dB (Nijs, L., & Wapenaar, C.P.A, 1990, p. 50). Consideration of wind direction and distance is crucial for evaluating potential sound level variations in a given environment see figure.

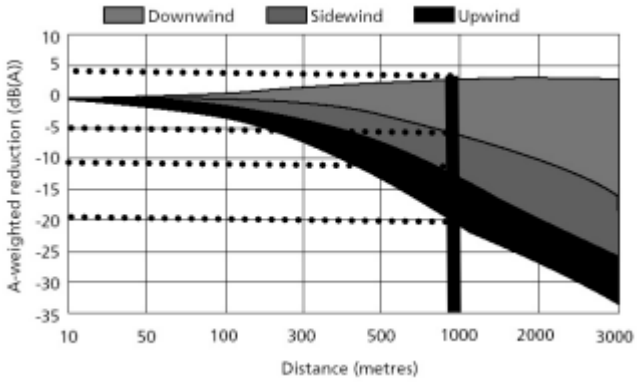



Figure 7 : Potential sound level reductions in terms of dBA relative to a down wind, side wind or upwind situation versus distance traveled from the sound source: [11]

## I-3 geographical landscape relief

The impact of geographical landscape relief on sound propagation is a multifaceted consideration that significantly influences how sound waves travel through the environment. This influence can be broadly categorized into two main components: geometrical divergence and ground effect (Kephalopoulos, S., Paviotti, M., Anfosso-Lédée, F, . "Noise Assessment Methods in Europe (CNOSSOS-EU)." , 2012, p. 24). Geometrical divergence refers to the spreading of sound waves as they move away from the source, influenced by the three-dimensional nature of the terrain. Ground effect, on the other hand, is concerned with how the physical characteristics of the ground, such as its composition and topography, interact with sound waves, either enhancing or impeding their transmission. This dual perspective, encompassing both geometrical divergence and ground effect, offers a comprehensive understanding of how the geographical landscape relief shapes the propagation of sound in diverse outdoor environments.

## I-3-1 geometrical divergence

Geometrical divergence refers to the spreading of sound waves as they move away from the source due to the three-dimensional nature of the terrain. It is a phenomenon that has a significant impact on sound propagation and is influenced by the geometric characteristics of the environment. Two main types of geometrical divergence are spherical divergence and cylindrical divergence.

### a- Spherical divergence

Spherical divergence occurs in three-dimensional spaces and is typical of sound waves radiating from a point source. As sound waves propagate outward, they spread spherically in all directions, resulting in a decrease in sound intensity proportional to the square of the distance from the source. For example, in the case of spherical spreading from a point source, the sound level is reduced by 6 dB for each doubling of distance from the source. See figure

### b- Cylindrical divergence

Cylindrical divergence, on the other hand, occurs when sound waves propagate along a cylindrical shape. This is observed in situations where sound is radiated along an elongated source or travels within a confined space. Sound waves spread outward in a cylindrical pattern, and the decrease in intensity with distance follows an inverse relationship between sound intensity and distance. Unlike spherical divergence, cylindrical divergence results in a slower rate of intensity decrease. See figure

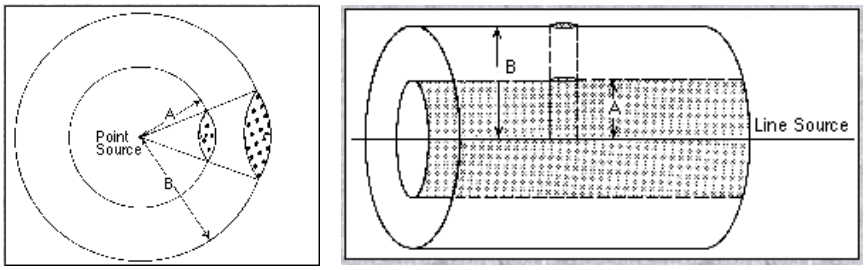



Figure 8 : (left) Attenuation from a point source where the intensity decreases according to the square of the distance from the source (note increasing cone area) - (right) and from a line source where the intensity decreases directly according to the distance from the source. Radii A and B indicate a doubling of distance.source: [7]

The effect of geometrical divergence on sound propagation leads to a natural attenuation of sound as it travels away from the source. In open spaces, such as fields or flat terrains, spherical divergence is more prominent, and sound waves spread uniformly in all directions. In confined spaces or areas with elongated sound sources, cylindrical divergence may be more relevant, affecting the distribution of sound.

## I-3-2 ground effect on sound propagation

The attenuation due to the ground effect is primarily a result of the interference between the reflected sound and the directly propagated sound from the source to the receiver. This phenomenon is closely tied to the acoustic absorption properties of the ground, influenced by its porosity. Generally, compact ground tends to be reflective, while

porous ground exhibits absorptive properties. The acoustical characteristics of each ground region are considered through a ground factor (G), categorizing surfaces into reflecting and absorbing categories. The attenuation depends on the surface type, with smooth, hard surfaces leading to minimal absorption and thick grass causing reductions in sound levels up to about 10 dB per 100 meters at 2000 Hz (Wiener, & Keast, p. 31), particularly at higher frequencies. Moreover, the ground effect becomes more or less significant depending on atmospheric conditions during propagation, affecting the height of the sound path above the ground and the overall attenuation of sound levels.

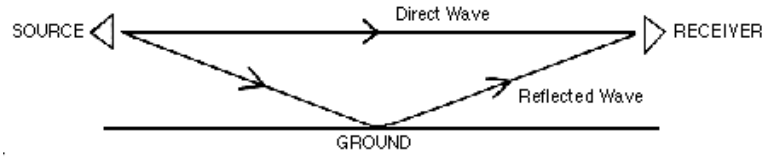



Figure 9 : illustrate ground effect on Sound propagation. Source : [12]

### a- Acoustic characterisation of ground

The acoustic absorption properties of the ground are primarily associated with its porosity. Compact ground generally exhibits reflective characteristics, while porous ground tends to be absorbent. The acoustical properties of each ground region are considered by incorporating a ground factor denoted as G (ISO 9613-2, 1996, p. 12). Three categories of reflecting surfaces are specified as follows

- Hard ground, which includes paving, water, ice, concrete and all other ground surfaces having a low porosity. Tamped ground, for example, as often occurs around industrial sites, can be considered hard. For hard ground G = 0.
- Porous ground, which includes ground covered by grass, trees or other vegetation, and all other ground surfaces suitable for the growth of vegetation, such as farming land. For porous ground G = 1.
- Mixed ground: if the surface consists of both hard and porous ground, then G takes on values ranging from 0 to 1, the value being the fraction of the region that is porous.

The acoustic absorption of a ground is represented by a dimensionless coefficient G, between 0 and 1. G is independent of the frequency. Table1 gives the G values for the ground outdoors. In general, the average of the coefficient G over a path takes values between 0 and 1. Here the mean G represents the absorbent fraction along the path.

| Description | type | (KPa.s/m2) | G value | Description | type | (KPa.s/m2) | G value |
|---|---|---|---|---|---|---|---|
| Very soft(snow or moss-like) | A | 12.5 | 1 | Soft forest floor (short, dense heather-like or thick moss | B | 31.5 | 1 |
| Uncompacted , loose ground(turf, grass, loose soil) | C | 80 | 1 | Normal uncompacted ground ( forest floor pasture field) | D | 200 | 1 |
| Compacted field and gravel ( compacted lawns, park area) | E | 500 | 0.7 | Compacted dense ground ( gravel road, car park | F | 2000 | 0.3 |
| Hard surfaces ( most normal asphalt, concrete) | G | 20 000 | 0 | Very hard and dense surfaces ( dense asphalt, concrete, water) | H | 200 000 | 0 |

Table1: G values for different types of ground. Source: [6] [8]

## I-4 obstacles and barriers

The attenuation or diffraction due to barriers in sound propagation is influenced by several factors. Solid barriers can significantly attenuate sound, with the effectiveness depending on their height. The barrier should be tall enough to obscure the 'line of sight' between the noise source and the receiver. However, barriers smaller than this may have a negative effect by eliminating the destructive interference phenomenon. Barriers are most effective for high frequencies; as low frequencies are more easily diffracted around the edges of a barrier. The maximum performance of a barrier is limited to around 40 dB due to scattering by the atmosphere [1]. The placement of a barrier is crucial for its effectiveness, with optimal results achieved when placed either very close to the source or the receiver. It's important to note that a barrier's performance can be adversely affected by temperature and wind gradients. When multiple obstacles contribute to diffraction, they are treated collectively as a single multiple diffraction.

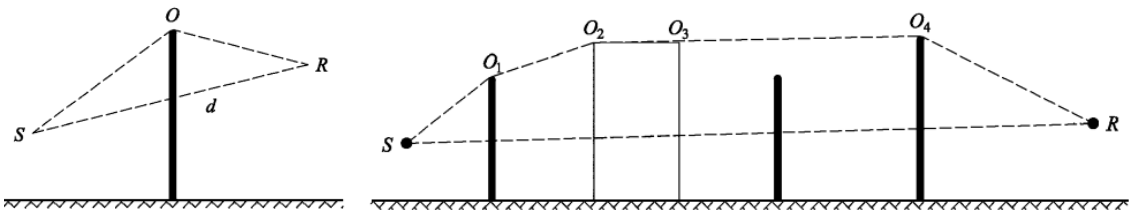



Figure 10: (Left) the path length difference in the case of single diffraction. (Right) the path length difference in the case of multiple diffraction. Source: [5]

Diffraction of low-frequency sound waves around a barrier is illustrated, showing that the barrier does not create a sound shadow in the area of the lower right-hand corner. In sound propagation situations, barriers not specifically built for acoustical purposes, such as hills and buildings, are common. Buildings in urban situations can serve as effective barriers, although they may produce different acoustical effects.

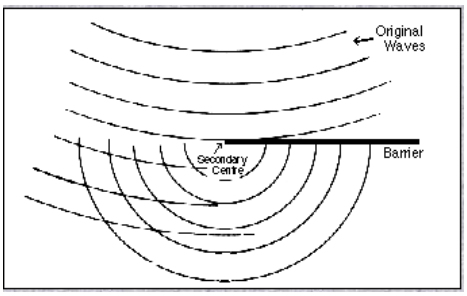



Figure 11: Diffraction of a low frequency sound wave around a barrier. Note that the barrier does not create a sound shadow in the area of the lower right-hand corner. Source: [1]

## I-4-1 the conditions of obstacle

An object shall be taken into account as a screening obstacle (often called a barrier) if it meets the following requirements:

- The surface density is at least 10 kg/m2.
- The object has a closed surface without large cracks or gaps (consequently process installations in chemical plants, for example, are ignored).
- The horizontal dimension of the object normal to the source-receiver line is larger than the acoustic wavelength A at the nominal midband frequency for the octave band of interest (ISO 9613-2, 1996, p. 15).

## I-5 reflection

When sound encounters a surface that neither absorbs nor transmits it, the result is reflection. This reflection adheres to the same law as light, wherein the angle of incidence of a sound wave equals the angle of reflection, akin to a 'mirror image.' This principle holds when the wavelength of the sound is small compared to the dimensions of the reflecting surface. Sound reflection contributes to phenomena such as diffusion, reverberation, and echo. Various surfaces exhibit different reflecting powers, quantified by absorption or reflection coefficients. Concave surfaces focus sound waves, concentrating them in specific areas, while convex shapes scatter sound, promoting effective diffusion. Symmetrical surfaces produce symmetrical reflections, exemplified in phenomena like the whispering gallery. Moreover, in outdoor settings, reflections from ceilings and vertical surfaces, such as building façades, can elevate sound pressure levels at the receiver through the consideration of image sources.

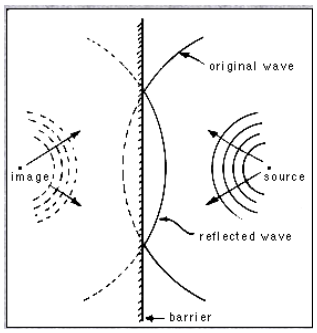



Figure 12: Reflection of a sound wave at a barrier, as if from an imaginary source at an equal distance behind the barrier. Source: [12]

## I-5-1 Attenuation through absorption

Sound reflections from vertical obstacles, such as building façades and noise barriers, are addressed through image sources. An obstacle is classified as vertical if its slope concerning the vertical is less than 15°. In cases of reflections on notably sloping obstacles, a 3D approach is employed. Obstacles with at least one dimension less than 0.5 m are typically excluded from reflection conditions (Kephalopoulos, S., Paviotti, M., Anfosso-Lédée, F., 2012, p. 94).

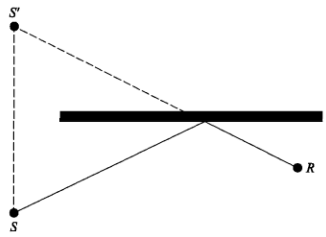



Figure13: Specular reflection on an obstacle dealt with by the image source method (S: source, S': image source, R: receiver). Source: [6]

## I-5-2 Attenuation through retro-diffraction

In the geometrical research of sound paths, during reflection on a vertical obstacle (barrier wall, building), the position of the impact of the ray in relation to the upper edge of this obstacle determines the more or less significant proportion of energy effectively reflected. This loss of acoustic energy when the ray undergoes a reflection is called attenuation through retro-diffraction.

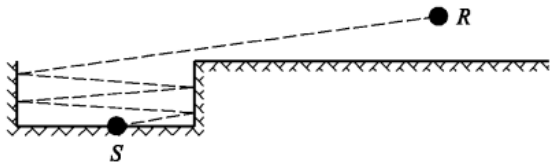



Figure 14: illustrate the attenuation through retro-diffraction phenomena. Source: [6]

# Second part : noise sources

## I. Road traffic noise source emission

### I-1 classification of vehicles

The source of road traffic noise can be attributed to the cumulative effect of noise emissions from individual vehicles composing the traffic flow. These vehicles can be categorized into four distinct classes based on their noise emission profiles:

- Category 1: Light motor vehicles.
- Category 2: Medium heavy vehicles.
- Category 3: Heavy vehicles.
- Category 4: Motorized two-wheelers.

Within the motorized two-wheeler category, further sub classification into mopeds and motorcycles is necessary due to their significantly different driving patterns and often contrasting prevalence.

| Category | Name | Description |
|---|---|---|
| 01 | Light motor vehicles | Passenger cars, delivery vans ≤ 3.5 tons, SUVs,MPVs, including trailers and caravans |
| 02 | Medium heavy vehicles | Medium heavy vehicles, delivery vans > 3.5 tons, buses, touring cars, etc. with two axles and twin tyre mounting on rear axle |
| 03 | Heavy vehicles | Heavy duty vehicles, touring cars, buses, with three or more axles |
| 04 | Powered two- wheelers | 4a mopeds, tricycles or quads ≤ 50 cc |
| | | 4b motorcycles, tricycles or quads > 50 cc |

Table2 : classification of vehicles. Source : [10]

### I-2 Number and position of equivalent sound sources

For the calculation of noise propagation and for the determination of sound power emission, it is necessary to describe the source with one or several point sources. each vehicle (category 1, 2, 3 and 4) is represented by one single point source. As depicted in Figure 15, this point source is placed 0.05 m above the road surface

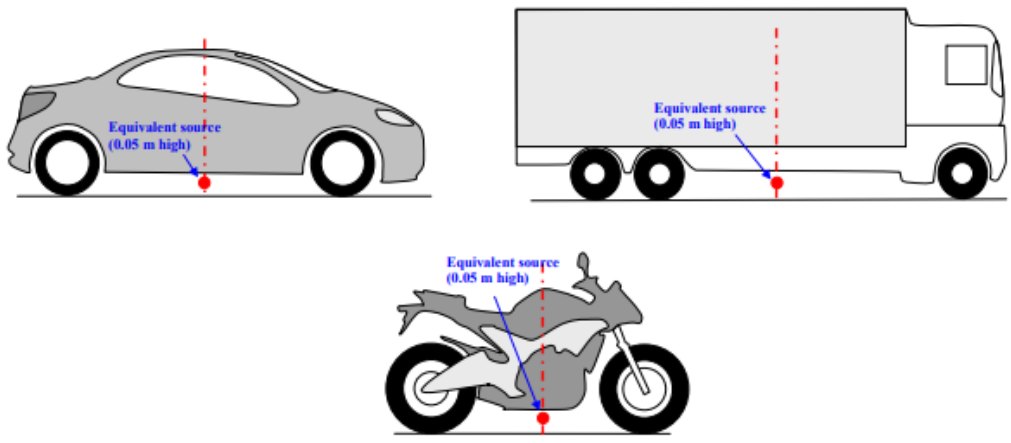



Figure 15: Number and position of equivalent sound sources. Source: [10]

Each road vehicle generates noise from two primary sources:

- **Rolling noise**: This originates from the interaction between the tires and the road surface.
- **Propulsion noise**: This stems from the vehicle's drivetrain, including the engine, exhaust system, and other components.

# II. railway traffic noise source emission

## II-1 classification of vehicles

Railway and tram noise generation involves a complex interplay of various track-vehicle system components. These components include: the rails and sleepers/slabs, the wheels, fans, compressors, and engines (if applicable), electrical equipment, exhaust systems (for diesel locomotives), superstructure of freight trains.

At high speeds, aerodynamic factors also come into play, including the bogies, pantograph, and train body. The relative contribution of each source varies depending on the speed. Therefore, excluding any source upfront is not feasible.

Furthermore, these noise sources are primarily determined by the specific features of individual train subunits rather than being uniform across the entire train. For this reason, a more accurate approach involves classifying each subunit and summing their contribution on a specific track section, rather than relying solely on overall train type classifications.

| Descriptor | Vehicle type | Number of axles per vehicle | Brake type | Wheel measure |
|---|---|---|---|---|
| Explanation of the descriptor | A letter that describes the type | The actual number of axles | A letter that describes the brake type | A letter that describes the noise reduction measure type |
| Possible descriptors | h<br>high speed vehicle (>200km/h) | 01 | c<br>cast-iron block | n<br>no measure |
| | m<br>self- propelled passenger coaches | 02 | K<br>Composite or sinter metal block | d<br>dampers |
| | P<br>Hauled passenger coaches | 03 | n<br>non-tread braked, like disc, drum, magnetic | s<br>screens |
| | C<br>City tram or light metro self- propelled and non-self-propelled coach | 04 | / | o<br>other |
| | d<br>diesel loco | / | / | / |
| | e<br>electric loco | / | / | / |
| | a<br>any generic freight vehicle | / | / | / |
| | o<br>other ( i.e. maintenance vehicles etc) | / | / | / |

Table3 : classification of vehicles. Source : [10]

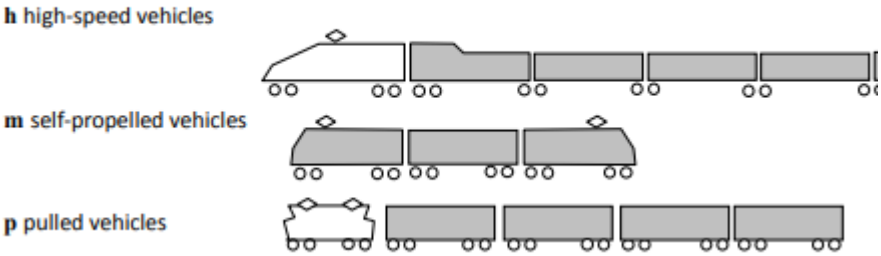



Figure 16: classification of vehicles. Source: [10]

## II-2 Number and position of equivalent sound sources

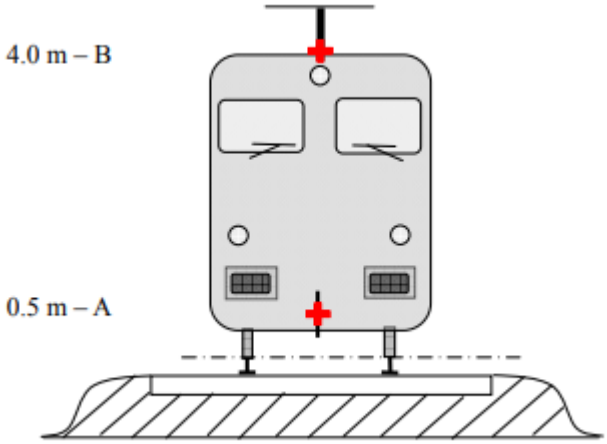



Figure 17: Number and position of equivalent sound sources. Source: [10]

Train noise is modelled using several imaginary noise sources placed at different heights along the train track. These sources represent various physical mechanisms that generate noise, such as:

- **Rolling noise (0.5m height)**: This comes from the roughness of wheels and rails.
- **Traction noise (0.5m and 4.0m heights):** This originates from engines, transmissions, and other equipment, depending on their location (axles vs. roof).
- **Aerodynamic noise (0.5m and 4.0m heights):** This is caused by air flow around the train, including pantographs.
- **Impact noise (0.5m height):** This comes from crossings, switches, and junctions.
- **Squeal noise (0.5m height):** This is a separate category from other noises.
- **Bridge noise (0.5m height):** This noise is caused by the train traveling over bridges.

# III. Industrial noise source emission

## III-1 Classification of source types (point, line, area)

Industrial noise sources come in various sizes, from large factories to small machines. To accurately model their noise impact, different techniques are needed depending on the source's dimensions:

- **Point sources**: Suitable for small, concentrated sources like machines.
- **Line sources**: Represent noise extending over a line, like a conveyor belt.
- **Area sources**: Model noise originating from a broad area, like a large factory floor.

### III-2 Number and position of equivalent sound sources

Modelling real noise sources involves using one or more imaginary point sources. These point sources should represent the total sound power of the real source. Here's a guideline for choosing the number of point sources:

- **Small sources** (largest dimension less than half the distance to the receiver): Use a single point source.
- **Larger sources** (largest dimension more than half the distance to the receiver): Split the source into a line or area of point sources, each fulfilling the "half distance" rule.
- **Sources with large height variations** (>2m or near ground): Doubling point sources vertically may not improve accuracy significantly.

## IV. Elementary propagation paths

In general, four types of paths can be considered

### IV-1 Type 1

These are ‘direct’ paths from the source to the receiver, which are straight paths in plane view and which may nevertheless include diffractions on the horizontal edges of obstacles. These are the easiest scenarios to deal with

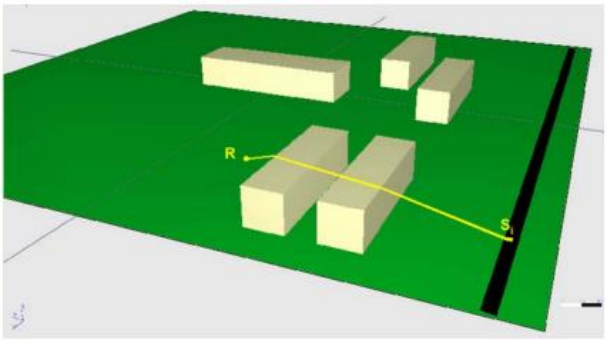



Figure 18: type path 01. Source: [10]

### IV-2 Type 2

These are paths reflected on vertical or slightly sloping (< 15°) obstacles, which may also include diffractions on the horizontal edges of obstacles

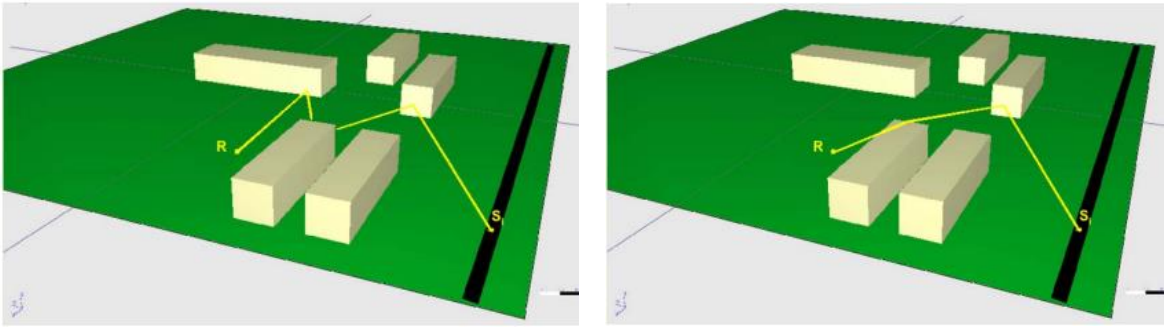



Figure 19: type path 02. Source: [10]

## IV-3 Type 3

These are the paths diffracted by the lateral edges of obstacles

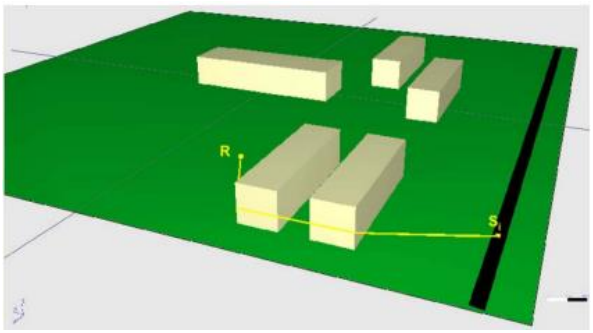



Figure 20: type path 03. Source: [10]

## IV-4 Type 4

These are mixed paths which are diffracted by the lateral edges of obstacles and reflected by vertical surfaces (< 15°).

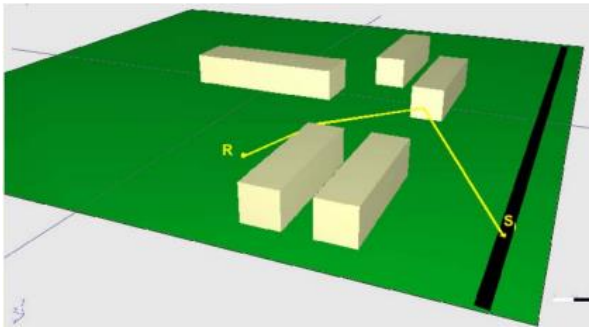



Figure 21: type path 04. Source: [10]

## Conclusion

The dynamics of sound propagation in outdoor environments and the acoustic design of building facades highlight the significant influence of geographical landscape relief, atmospheric sound absorption, and meteorological conditions on sound behavior. This understanding is crucial for addressing sound attenuation over distance and its interaction with environmental elements. The findings underscore the importance of integrating acoustic considerations into architectural design to enhance environmental comfort and mitigate noise pollution. By delving into existing theories and concepts related to facade acoustics, emphasizing the need for a multidisciplinary approach in architectural design, where acoustic considerations are integral to achieving a balanced and comfortable urban environment.

# Analytical Chapter

## I. Introduction

In this chapter, we will focus on the analytical approach to the three aspects of our work. We will analyze several literary and existing examples of libraries to better understand the functioning of these spaces. Then, we will analyze the context, specifically the data from the city of Biskra, including a climate analysis (a bioclimatic analysis) and a field analysis. The aim of this analysis is to take into consideration the specific climatic data of the region and the morphological data to better define the strategic choices in the design phase.

## II. The liste of exemples

Stuttgart city library

Free University's Philology Library

Vennesla city Library

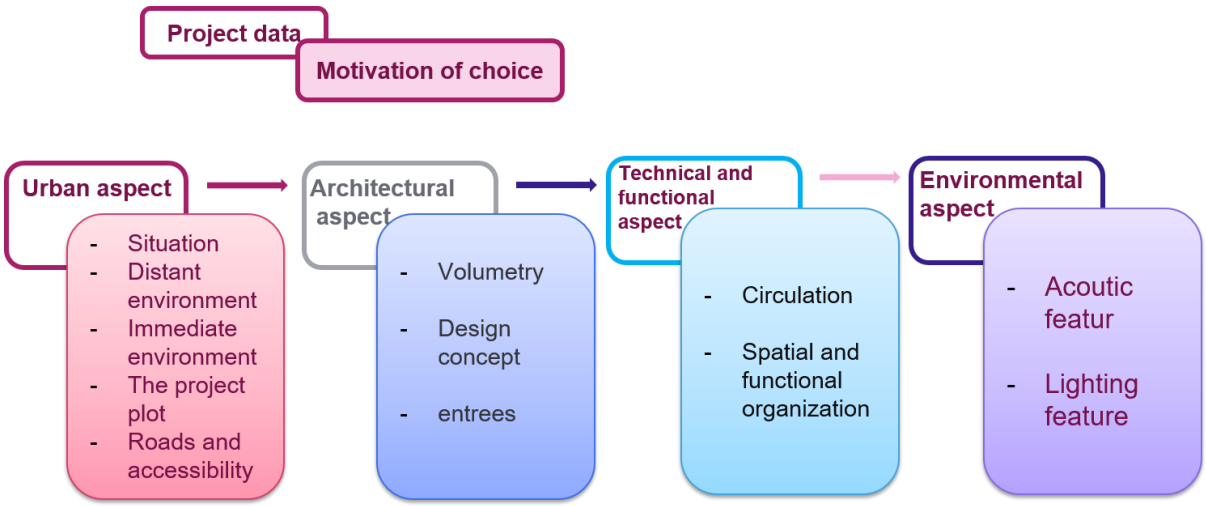
Aarhus city Library

the national library of Algeria.

the public library of Jijel

Figure 1: represent the list of the chosen projects to be analysed. Source: author.

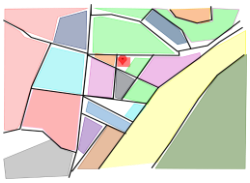
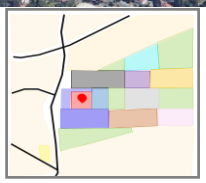
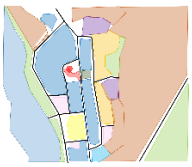
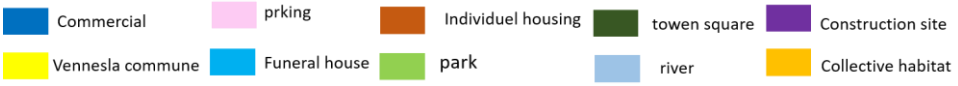
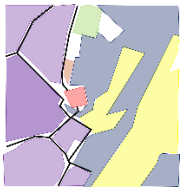
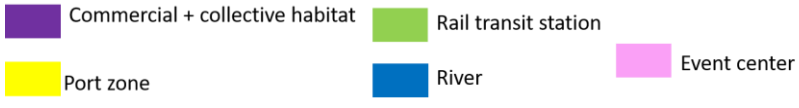
## III. The elements to be analyzed

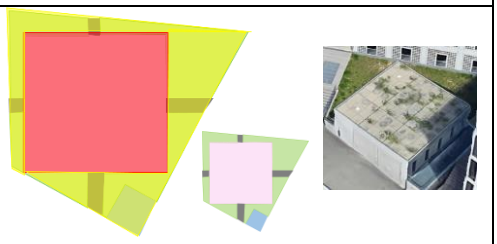
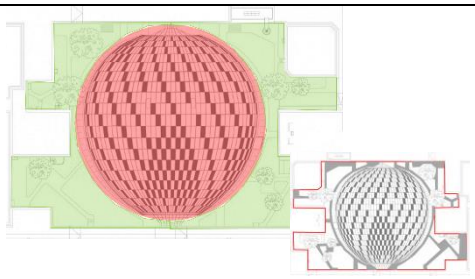
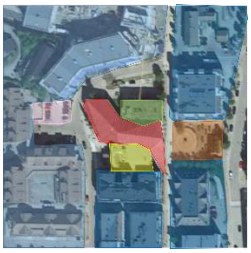
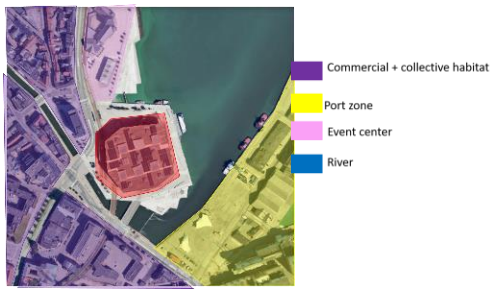
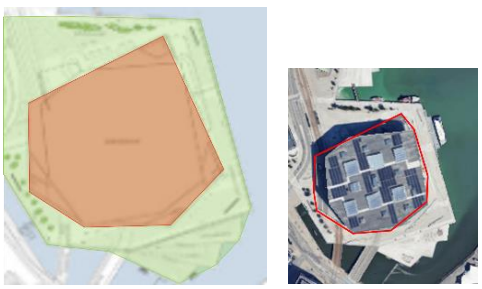


## IV. literary examples

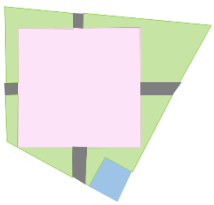
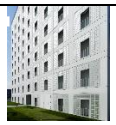
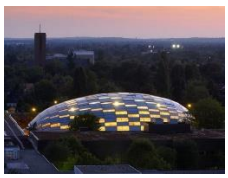
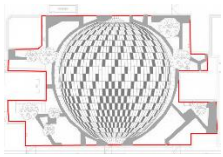
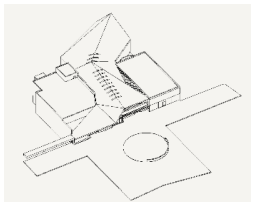
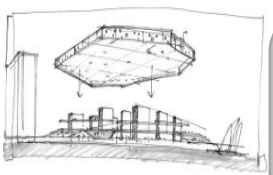
| The project | Project data | Situation | Motivation of choice |
|---|---|---|---|
|  **Stuttgart city Library** | **Category**: city library,<br>**Date of realisation:** 1999-2011<br>**Architect**: Eun Young Yi architect<br>**Area:** 3 201m2<br>**N° of storeys:** 9 storeys + roof Terrace 2 lower ground floor levels | Located in the city centre Mailänder Platz in Stuttgart, southern Germany. | The selection of Stuttgart City Library is driven by its innovative architecture, user-centric design, and integration of technology, making it an ideal subject for investigating the interplay between spatial design and acoustics. |
|  **Free University's** | **Category**: central university library,<br>**Date of realisation:** 2001-2005<br>**Architect**: NORMAN FOSTER<br>**Area:** 6.290 m2<br>**N° of storeys:** 5 storeys | The Library University of Berlin was built in the space resulting from the union of six college courtyards, in the Dahlem district of southwestern Berlin district of Steglitz-Zehlendorf, Germany. | The selection of Free University's Philology Library, serves as an ideal subject for study, exploring innovative architecture, sustainable design, and the dynamic evolution of educational spaces, encapsulating cultural impact and user-centric considerations. |
|  **Vennesla city Library** | **Category**: city library,<br>**Date of realisation:** 2009-2011<br>**Architect**: Helena Hard<br>**Area:** 1 938m2<br>**N° of storeys:** 2 storeys + mezzanine | The library located in the center of the city, vennesla, Norwav. | Vennesla Library in Norway presents a rich study opportunity, showcasing innovative timber architecture and a sustainable, community-oriented design that reflects the evolving role of modern libraries. |
|  **Aarhus city Library** | **Category**: city library,<br>**Date of realisation:** 2005-2015<br>**Architect**: Shmidt Hammer<br>**Area:** 35 600 m2<br>**N° of storeys:** 4 storeys + basement for car parking | The Dokk library is Located at the mouth of the Aarhus River beside the harbour on the east side of Aarhus, Denmark. | The selection of Dokk Library for study provides an in-depth examination of state-of-the-art library design, community innovation, and valuable insights into modern public space dynamics. |

# Analytical Chapter

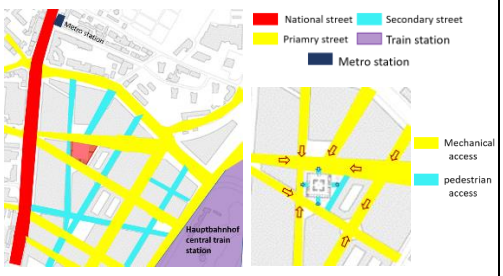
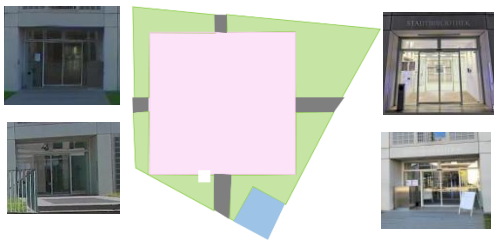
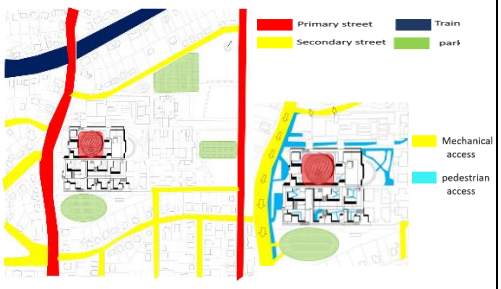
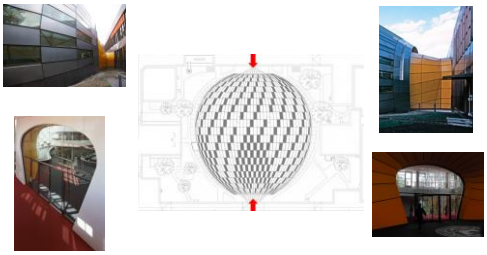
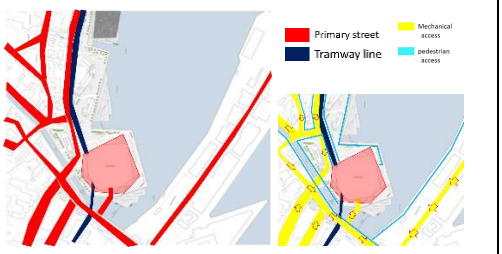
| The project | Distant environment of the project |
|---|---|
| **Stuttgart city library** **Germany** |    The project is located in a compact site and is well-integrated into the environment.  |
| **Philology Library** **Germany** |    The Philological library is nestled into a rectangular site in the center of Berlin's Free University. Its sheers size between the bordering buildings lends itself to the university by integrating the new Library into the older campus.  |
| **Vennesla city Library** **Norway** |    The library is situated in a diverse urban site, emphasizing the significance of adaptive architecture that honors the area's existing character while contributing to its evolution.  |
| **aarhus city Library** **Denmark** |    The project is located in a compact site connecting the city with the port and water. Flanked by forests to the north and south,  |

| The project | The immediate environment | The project plot |
|---|---|---|
| **Stuttgart city library**<br>**Germany** |  <br>The project is strategically located within the urban fabric. Its proximity to diverse elements contributes to creating a dynamic and interconnected urban environment |  <br>The City Library's cube occupies 60% of the plot, while the remaining unbuilt section features a level area of durable dark green lawn spanning 1,300m2. This space is complemented by an additional cube structure housing the air-conditioning plant. |
| **Philology Library**<br>**Germany** |  <br>The project is situated amidst a diverse array of academic and communal facilities, the site of this project not only benefits from a rich tapestry of resources but also fosters a dynamic, interconnected environment that promotes collaboration, convenience, and a comprehensive support system for both academic and daily needs. |  <br>The Library occupies 80% of the plot, while the remaining unbuilt section features a level area of durable dark green lawn spanning, trees and passages to reach the library and the spaces surrounded by. |
| **Vennesla city Library**<br>**Norway** |  <br>This site provides accessibility for a broad demographic, fostering community engagement and serving as a cultural and educational hub amidst a dynamic and multifaceted neighbourhood. |  <br>The city library occupies 100% of the plot |
| **aarhus city Library**<br>**Denmark** |  <br>The library is located in a dynamic and multifaceted environment, where its diversity enhances the library experience by offering a wide array of resources and opportunities for engagement. |  <br>The library occupies 80% of its plot, with the remaining unbuilt section featuring an open concrete space |

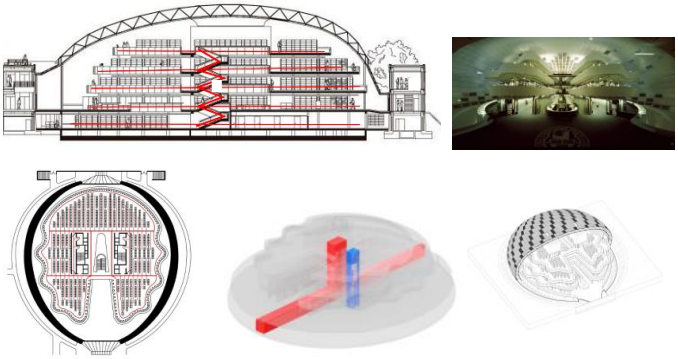
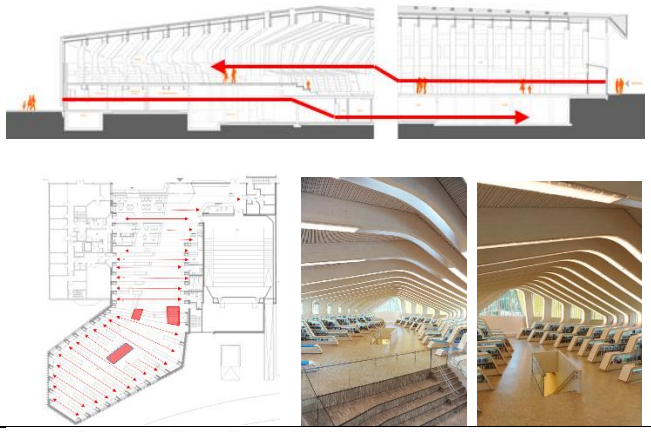
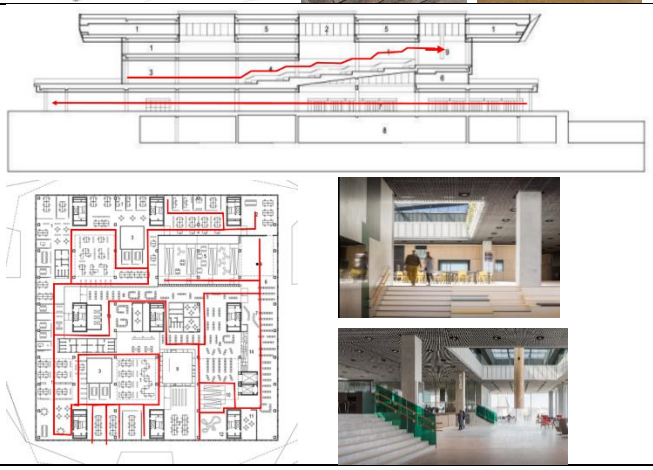
# Analytical Chapter

| The project | The volumetry | The design concept |
|---|---|---|
| **Stuttgart city library**<br>**Germany** |  <br>  <br>A striking detached square-shaped building, the library is contained within a perfect white(ish) cube positioned directly to the compass points, labeled in languages corresponding to the four faces of the globe (north/south/east/west), with dimensions measuring 44 m x 44 m x 40 m. |  <br>  <br>  <br>  <br>  <br>The library's architectural inspiration is rooted in the idea of simplicity. The cubic exterior, with its clean lines and geometric precision, reflects a contemporary aesthetic. the building is a pantheon at the heart of a concentric plan, crowned by an inverted ziggurat the building inspired by Etienne-Louis Boullée's design for the French National Library in the 18th century. |
| **Philology Library**<br>**Germany** |  <br>  <br>The volumetry of the library aligns with the goal of maximizing the floor area without encroaching on the exterior courtyard. The building envelope seamlessly merges the concepts of walls and ceilings to achieve this design integration (spherical shape).D (19*55*64) |  <br>  <br>  <br>According to the metaphor of "brain" that has earned the building its shape, the white inner skin can be identified with the brain membrane, while the space between the inner and outer skin serves as an air chamber for natural ventilation the building. |
| **Vennesla city Library**<br>**Norway** |  <br>  <br>The volumetry of the library resulted from the necessity to integrate it between two existing buildings on the town square. The irregular shape of the terrain consequently influenced the unique volumetric design of the library. |  <br>  <br>  <br>The library draws inspiration from ribs, enhancing its visual appeal while also serving as a structural element that defines the roof geometry and divides the interior space |
| **aarhus city Library**<br>**Denmark** |  <br>  <br>The library's volumetric design, conceptualized as a stack of distinct volumes – a "polygonal slice" atop, a glazed midsection, and a podium at the base – is driven by a deliberate intention to create an architecturally dynamic and visually compelling structure |  <br>  <br>The glass building is designed as an open urban space with 360-degree views of the water, harbour, forest and city. The building has no clear front or back, which is emphasised by the multi-edged top slice that creates the impression of rotation and movement. |

# Analytical Chapter

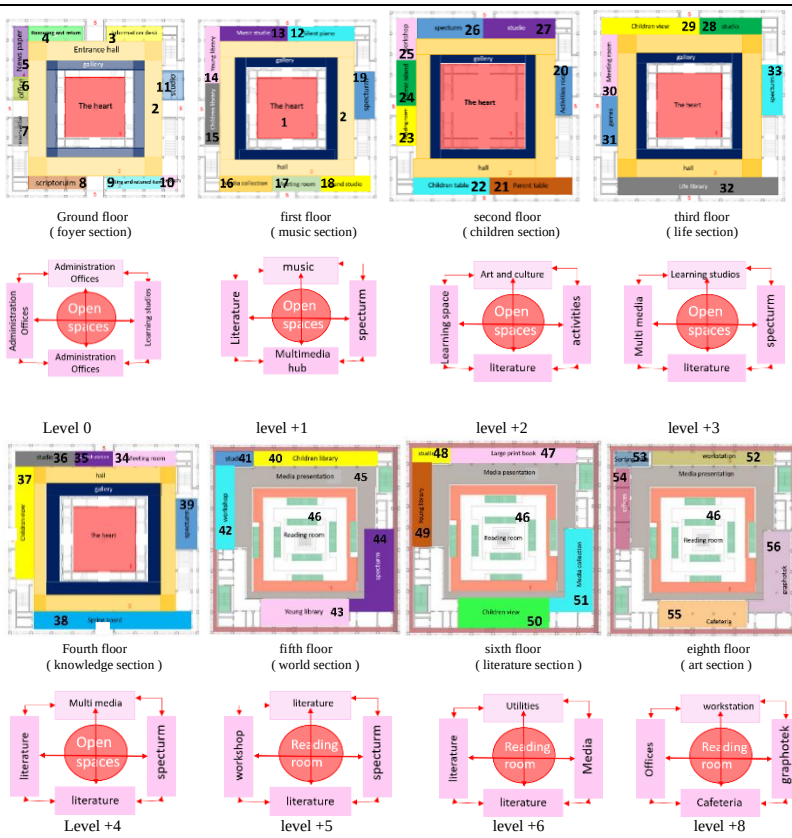
| The project | Roads and accessibility | Entrees |
|---|---|---|
| **Stuttgart city library**<br>**Germany** |  <br>The project's central location in the city provides diverse access points and transportation options for reaching it |  <br>The uniformity of all the library facades allows for four entrances on each side, facilitating easy accessibility from all directions. |
| **Philology Library**<br>**Germany** |  <br>Being located within the university, the project enjoys easy accessibility by both transportation and on foot. |  <br>The library has no exterior entry; instead, its two entrances are connected through the university's institute. |
| **Vennesla city Library**<br>**Norway** |  <br>Being centrally located in the city, the project has easy access from all directions. |  <br>The library has two entries: one on the main facade facing the town square and another in the south, facilitating easy access from both directions. |
| **aarhus city Library**<br>**Denmark** |  <br>The library is strategically and conveniently located, providing excellent connectivity for a diverse range of users, ensuring easy access and accessibility. |  <br>There are four large staircases around the perimeter, which fan outwards to entice visitors to venture up to various entrances on the elevated podium level. The intention was for the building to have no clear front and back |

# Analytical Chapter

| The project | Circulation |
|---|---|
| **Stuttgart city library**<br>**Germany** |  The project is distinguished by its magnificent spiralling circulation. Paired staircases create fluid walkways between the floors, and the interior circulation is elegantly arranged in a spiral configuration around the reading gallery areas |
| **Philology Library**<br>**Germany** |  The circulation of the library acts in layers, with the outer most containing workspaces, then stacks, then service spaces, and at the core, stairs. In between each layer is room for circulation, allowing for fluid movement throughout each floor of the library. |
| **Vennesla city Library**<br>**Norway** |  The library's circulation flows seamlessly due to its open space design. This architectural choice promotes a dynamic and interconnected environment, fostering easy movement and accessibility throughout the library for visitors. |
| **aarhus city Library**<br>**Denmark** |  The circulation of the library is a free and open circulation system, allowing visitors to move easily between different areas and engage with information seamlessly. |

| The project | Spatial and functional organization |
|---|---|

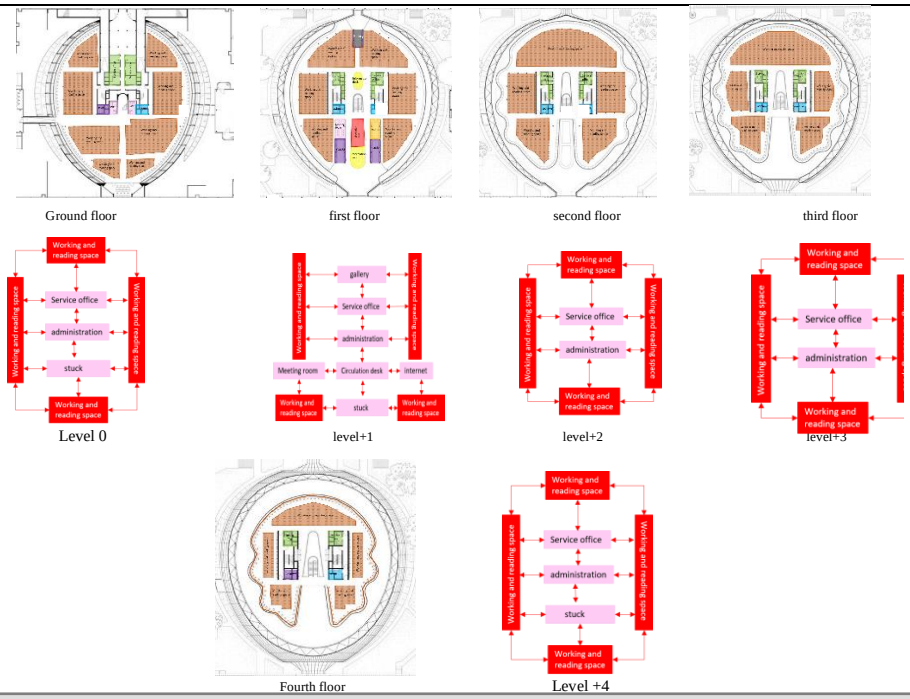
## Stuttgart city library – Germany




The library features a square-shaped plan that mirrors the cubic exterior of the building. It comprises two underground and nine above-ground floors. At the center of the building lies its spatial and meditative heart, encompassed by staircases extending from the ground floor to the third floor. The reading room occupies the upper half of the heart, spanning from the fourth to the eighth floor and encircled by a shell of books. The remaining areas of the library are organized around both the heart and the reading room across all floors.

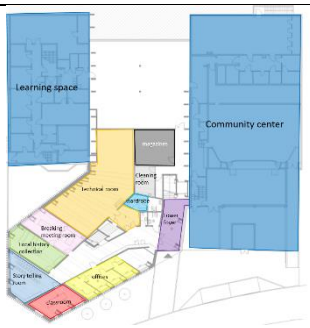
1- the heart 2- entrance hall+gallery 3- check station 4- returne 5- newspaper 6/54- office 7-inscription 8/19/26/33/39/44/- scriptoruim 9- returne item 10- research 11/27/28/36/41/48- studio 12- silent piano 13- music studio 14/43/49- young library 15/40- children library 16- media collection 17/23/30/34- meeting room 18- sound studio 20/50- activities room 21- parent table 22- children table 24- comic island 25/42- workshop 29- children view 31- games 32- life library 35- research media 37- children view 38- spring board 45- media presentation 46- reading room 47- large print bock 51- media collection 52- workstation 53- sorting area 55- cafeteria 56- graphotek

## Philology Library- Germany



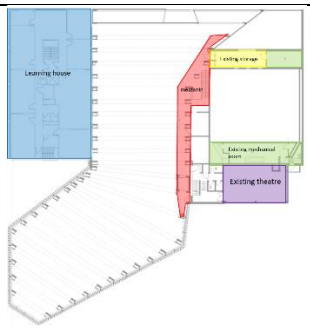

The library's brain-inspired design, featuring an inner membrane and air chamber, organizes into five levels mirroring cerebral structure. With undulating upper levels akin to cerebral lobes, it optimizes space for readers to comprehend, process, and store information in a compact, well-structured environment

## Vennesla city Library - Norway

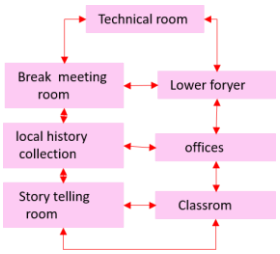



Basement floor

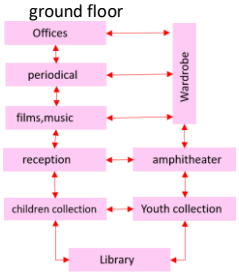

ground floor



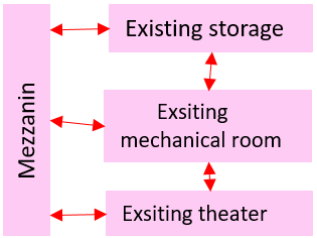

mezzanine floor




Basement level




level 0




level +0.5

The library links an existing community house and learning center, combining main public functions in a generous space with visible structural elements, furniture, and spatial interfaces, while also providing personal study zones along the perimeter.

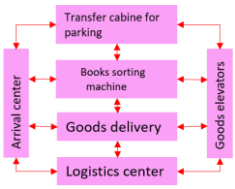
## aarhus city Library - Denmark

Ground level

first floor

second floor


third floor




Level0

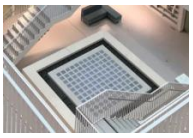
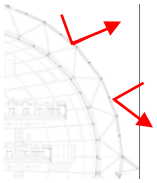
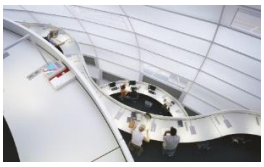
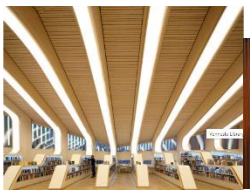
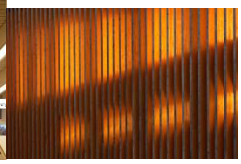
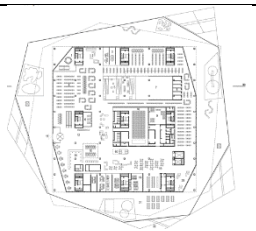
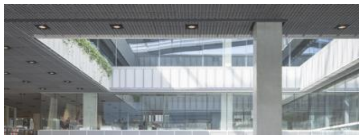

level +1


level+2


level +3

The library's organization is characterized by an open layout fostering visual connections between different functions. Two levels are internally connected by five staggered platforms dedicated to exhibitions, gaming, workshops, reading, and events. Termed a "meandering path of activity" by architects, these platforms facilitate easy access to the children's section, promoting openness for social interaction and information exchange

# Analytical Chapter

| The project | Acoustic feature | Lighting feature |
|---|---|---|
| **Stuttgart city library**<br>**Germany** |    <br>Three effective methods contribute to acoustic comfort in the library. The first involves a double façade, featuring glass bricks on the outer layer and glass blocks on the inner layer. This design isolates the educational and cultural spaces from external noise while providing a versatile space for visitors. The second method incorporates water features inside the building to absorb and minimize noise. Additionally, the third method focuses on the shape of the space, utilizing gradations and angles to both absorb and transmit sound effectively. The façade space serves as a buffer, providing library visitors and staff with the option to use it as a leisurely walkway or balcony |    <br>Natural light is maximized in the library through the recessed floor design, which opens the space to the ceiling, and the inclusion of open facades with windows on all sides of the envelope |
| **Philology Library**<br>**Germany** |   <br>The library's method for noise reduction centers around the spherical shape of the structure, which serves as an effective strategy by scattering sound waves in multiple directions, preventing their concentration, and minimizing direct reflections. Additionally, the curved surfaces act as sound diffusers, promoting an even distribution of sound throughout the space and contributing to a balanced acoustic environment |   <br>An inner membrane of the envelope, made of translucent glass fiber, filters sunlight, creating an atmosphere of concentration. Scattered window openings generate changing patterns of light and shade, offering momentary views of sunlight and glimpses of the sky |
| **Vennesla city Library**<br>**Norway** |   <br>The acoustic design of this project employs two key methods for optimal sound control. Seven prefabricated glue-laminated timber ribs, with offset construction, not only act as spatial interfaces but also integrate acoustic absorbents. This dual-purpose approach enhances both visual aesthetics and sound absorption, creating a harmonious and immersive auditory environment |   <br>Natural light floods in through glazed facades that are exposed at the front and shaded behind timber slats at the back. |
| **aarhus city Library**<br>**Denmark** |   <br>The polygonal shape of the floor in the library aids in sound reduction by introducing irregular surfaces and angles, dispersing sound waves to minimize direct reflections and create a balanced acoustic environment. Furthermore, strategic placement of sound-absorbing objects in the ceiling, such as acoustic panels or baffles, contributes to dampening noise reflections, enhancing overall acoustic control within the space. |   <br>The library prioritizes an abundance of natural light, evident in its open façades that invite sunlight from all directions. Strategically placed openings in the roof further amplify the inflow of natural light, creating a well-lit and inviting interior. |

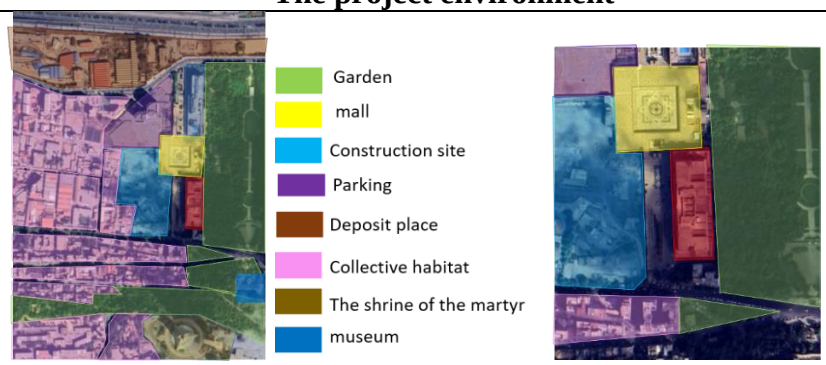
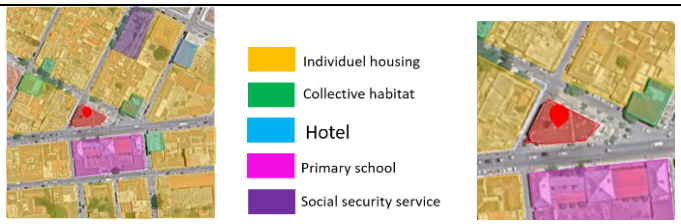
## V. Analytical synthesis of literary examples

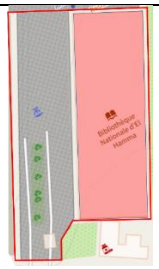
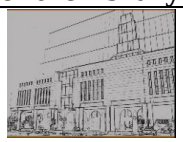
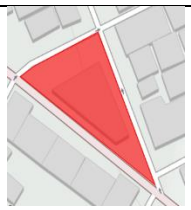
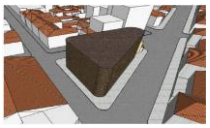
| | Synthesis |
|---|---|
| **Situation** | The libraries are strategically situated within urban landscapes, each blending into its unique surroundings—be it a city center, a university district, a central city location, or a scenic riverfront in Aarhus |
| **Distant environment** | The libraries demonstrate diverse environmental integration: one seamlessly fits into a compact site, another becomes an integral part of a university campus, one adapts to a diverse urban setting, and the last connects the city with the port and water, surrounded by forests. |
| **Immediate environment** | The libraries strategically position themselves within their urban surroundings, fostering dynamic and interconnected environments. They benefit from diverse elements, creating comprehensive support systems for academic and daily needs, promoting collaboration, accessibility, and community engagement. |
| **Plot** | The libraries vary in plot utilization, with one emphasizing green space (60% plot with a cube structure), another combining 80% occupation with dark green lawns and cubes, a third fully occupying the plot, and the fourth utilizing 80% with an emphasis on open concrete space. |
| **Volumetry** | The libraries showcase diverse volumetric approaches: one adopts a square-shaped cube with labeled faces; another integrates a spherical shape to maximize floor area and courtyard space; a third embraces irregular terrain influence for a unique design; and the fourth employs a dynamic stack of volumes for a visually compelling structure. |
| **Design concept** | Each library manifests a unique design concept: one prioritizes simplicity and geometric precision with a pantheon-like structure; another incorporates a metaphorical "brain" concept with an air chamber for natural ventilation; a third draws inspiration from ribs, integrating them structurally and aesthetically; and the fourth embraces a glass building with a multi-edged top slice, creating a sense of rotation and movement |
| **Accessibility** | Each library prioritizes accessibility: one strategically situated in the city, ensuring diverse access points; another enjoying proximity within a university, facilitating easy access by both transportation and foot; the third centrally located for easy access from all directions; and the fourth strategically and conveniently positioned to ensure excellent connectivity and accessibility for diverse users. |
| **Entrees** | The libraries exhibit diverse entrance strategies: the first, with four uniform entrances on each side, ensures accessibility from all directions; the second, featuring two entrances connected through the university's institute; the third, boasting two entries for accessibility from the town square and the south; and the fourth, designed with four large staircases around the perimeter, aiming for a building without a clear front or back. |
| **Circulation** | Circulation in the libraries varies: the first showcases a magnificent spiralling arrangement, creating fluid walkways around reading galleries; the second employs a layered approach with workspaces, stacks, service spaces, and stairs; the third ensures seamless flow through open space design, promoting dynamism; and the fourth adopts a free and open circulation system, facilitating easy movement and engagement with information. |
| **Spatial and functional organisation** | The libraries' organization displays unique approaches: the first is structured around a central heart and reading room on various floors; the second, inspired by the brain, mirrors cerebral lobes to optimize space for comprehension; the third links community spaces, consolidating main functions with personal study zones; and the fourth adopts an open layout with staggered platforms fostering easy access, social interaction, and information exchange. |

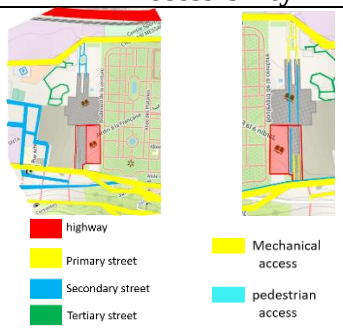
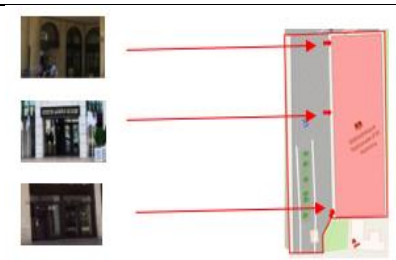
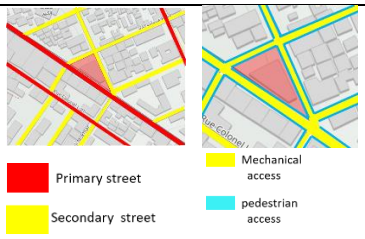
| | |
|---|---|
| **Acoustic feature** | The libraries feature innovative acoustic designs. One employs a double façade with glass blocks for insulation and adaptable space, while another utilizes water features and spatial shapes with gradations. The spherical shape of one library scatters sound waves effectively, and timber ribs in another serve as spatial interfaces and acoustic absorbents. Additionally, a library with a polygonal floor shape and strategic ceiling objects achieves a balanced acoustic environment. These varied approaches ensure optimal sound control and contribute to harmonious auditory experiences. |
| **Lighting feature** | The libraries prioritize natural light, employing various methods. Recessed floor designs and open facades with windows maximize sunlight, ensuring a well-lit interior. Translucent glass fiber in one library filters sunlight, creating a focused atmosphere, while another strategically places openings in the roof to enhance natural light. These designs contribute to inviting and well-illuminated library spaces. |

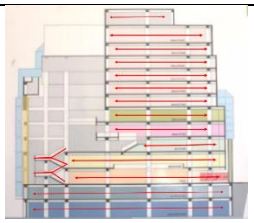
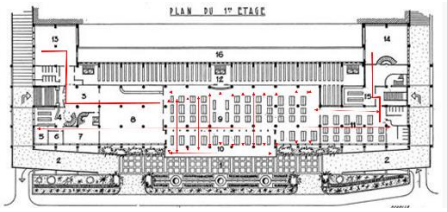
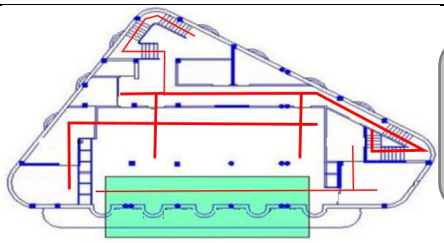
## VI. Existing example

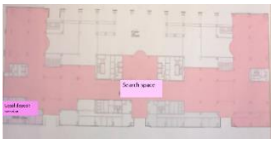
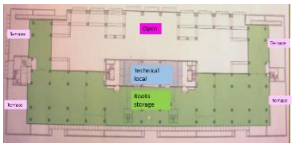
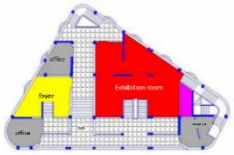
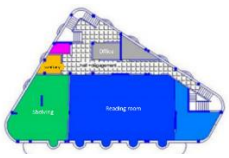
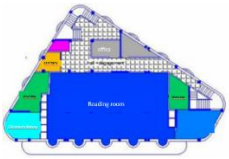
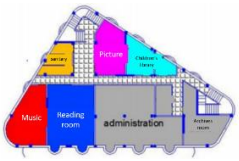
| The project | Project data | Situation | Motivation of choice |
|---|---|---|---|
|  **The national library of Algeria El Hamma** | **Category:** national library.<br>**Date of realisation:** 1986-1994.<br>**Architect:** Italian company.<br>**Area:** 67 000m2.<br>**N° of storeys:** 13 storeys, two underground and 11 storeys above ground. | The National Library of Algeria is centrally positioned in Algiers, situated on Boulevard Mohamed Belouizdad (formerly Belcourt) to the south, below Anassers hill, connecting the east to the west. It offers a panoramic view from the north, overlooking Hassiba Ben Bouali Boulevard, and is adjacent to the renowned Essay Garden. | The selection of the National Library for study provides a unique lens into the convergence of architecture, cultural preservation, and community engagement, offering an insightful case study on the pivotal role libraries play in shaping national identity and cultural development |
|  **Public Library of Jijel** | **Category:** city library.<br>**Date of realisation:** 1980-1990.<br>**Area:** 321m2.<br>**N° of storeys:** 5 storey | the library is located in the chief town of Jijel, situated on Abd El Hamid Ben Badis Avenue at the southern boundary of the old historical triangle; this is the city's prime location. | the selection of the Library of Jijel is motivated by several factors, including its exposure to various sources of external and internal noise, and its prior utilization by users. |

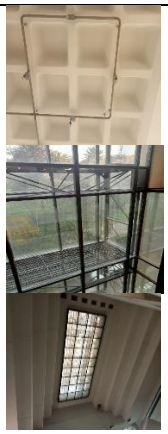
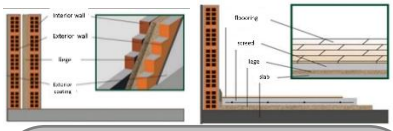
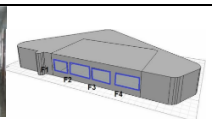
| The project | The project environment |
|---|---|
| **The national library of Algeria El Hamma** |  <br>The library, situated in a compact site surrounded by a diverse urban setting, provides accessibility, cultural richness, and a dynamic environment, making it an attractive and strategic location to engage a wide range of visitors and serve as a cultural and educational hub. |
| **Public Library of Jijel** |  <br>The library, located in a residential environment, offers a tranquil and accessible space, enhancing community engagement and serving as a cultural and educational hub for local residents. |

| The project | The project plot | The design of the library |
|---|---|---|
| The national library of Algeria El Hamma |    The City Library utilizes 50% of the plot, with the remaining unbuilt section designated as green space, providing a welcoming area for people to sit and access parking facilities. |   The national library of Algeria's architectural presence is characterized by stacked rectangular parallelepipeds, symbolizing strength and stability. The conceptual idea emphasizes massiveness to create a building adaptable to future development, showcasing a forward-looking and expansive architectural vision. |
| Public Library of Jijel |   . The library occupies 100% of the terrain. |   The building is a single compact volume, ingeniously maximizes land use and integrates seamlessly with the triangular shape, overcoming challenges of the reduced terrain. Its design, with three symmetrical and vertically emphasized facades, strategically employs awnings to break verticality and define the entrance. |

| The project | Accessibility | Entrees |
|---|---|---|
| The national library of Algeria El Hamma |   Being located in the center of Algeria gives the library an advantage as it is accessible from all directions and various modes of transportation, making it easily reachable. |  The library contains three entrances: one main entry situated in the center, one for employees in the north, and another for readers in the south. |
| . Public Library of Jijel |   Being situated next to a primary street in a residential environment gives the library easy access from various parts of the city, and making it convenient for individuals to reach it on foot. |   The library has only one entrance, strategically located on the secondary street to minimize traffic interference. |

| The project | Circulation |
|---|---|
| The national library of Algeria El Hamma |    The library, with its open circulation design, creates a welcoming environment, allowing patrons to freely explore diverse sections. This approach fosters a dynamic and inclusive experience, emphasizing accessibility and adaptability within the library's unique setting. |
| Public Library of Jijel |  The circulation within the library is restricted due to the limited space of the building. |

| The project | Spatial organization |
|---|---|
| The national library of Algeria El Hamma |  Basement 1  basement 2  ground floor  Mezzanine floor  first floor  second floor  Fourth floor The organization of the library is intricately tied to the circulation of books, which must precede and accompany the movement of people. |
| Public Library of Jijel |  Ground floor  mezzanine  first floor  Second floor  third floor The library's organization demonstrates a thoughtful distribution of functions across its levels, providing a well-defined layout for diverse activities and services. |

| The project | Acoustic feature | Light feature |
|---|---|---|
| **The national library of Algeria El Hamma** |  Utilizing recesses in the ceiling acts as effective acoustic absorbers, capturing and damping sound waves to reduce reverberation. Similarly, incorporating degradations or irregularities in the roof disrupts sound trajectories, preventing echoes and contributing to a controlled acoustic environment by promoting both absorption and diffusion of sound. The library further enhances its acoustic environment by incorporating a double-glazed facade. |   The project embraces ample natural light through strategically placed large openings across all facades. This design approach floods the interior with sunlight, creating a well-lit and inviting space that seamlessly connects with the outdoors, enhancing both visual comfort and the overall atmosphere of the project |
| **Public Library of Jijel** |  The room is equipped with acoustic treatments, featuring interior partition walls made of 15cm bricks with 5cm straw panels. The exterior walls consist of a double layer with a thickness of 32cm: an outer wall of 15cm and an inner wall of 10cm with 7cm cork insulation. The floors, constructed with 22cm resin-filled voids, include a 2cm cork insulation layer, and the ceiling is made of perforated plywood. |   The library did not prioritize lighting features, employing standard and simplistic window designs similar to conventional projects. The approach to lighting lacks distinctive or innovative elements, reflecting a more straightforward and ordinary design strategy. |

## Official programme of spaces

### a- The national library of Algeria El Hamma

| Space | Area |
|---|---|
| Reception and Information | 1,680m2 |
| Reading Rooms | 14,600m2 |
| Related Reading Room Services | 1,600m2 |
| Training and Internship | 1,000m2 |
| Administration | 900m2 |
| Restaurant | 1,100m2 |
| Technical Areas | 1,250m2 |
| General Storage and On-call Housing | 28,000m2 |
| On-call Housing | 370m2 |
| **Total** | 50 000 m2 |

**b- The public library of Jijel**

| Space | Area |
|---|---|
| Exhibition Hall | 91m2 |
| Foyer + Bureau | 52m2 |
| Discothèque | 15m2 |
| Bureau | 18.50m2 |
| Hall + Réception | 37.50m2 |
| Dépôt | 6m2 |
| Theater Room | 77.50m2 |
| Conservation Space | 13m2 |
| Offices | 78m2 |
| Reading Room (Boys) | 135m2 |
| Reading Room | 28m2 |
| Shelving | 66m2 |
| Reading Room (Primary) | 17m2 |
| Librarian's Office | 10.50m2 |
| Restrooms | 12m2 |
| Music Room | 65m2 |
| Archives Room | 24.40m2 |
| Laboratory | 24m2 |
| Administration Office | 77.50m2 |
| **Total** | 847.9m2 |

## VII. Analytical synthesis of Existing examples

| | Synthesis |
|---|---|
| **Situation** | The libraries are strategically situated within compact residential surrounding |
| **Environment** | The libraries strategically position themselves within their urban surroundings, fostering dynamic and interconnected environments. |
| **Plot** | The libraries vary in plot utilization, with one emphasizing green space (50%), and the other fully occupying the plot. |
| **Design concept** | Each library manifests a unique design concept: one prioritizes strength and stability for its importance and the other prioritizes simplicitY |
| **Accessibility** | Each library prioritizes accessibility: both of theme located in the city most dynamic area |
| **Entrees** | The libraries exhibit diverse entrance strategies: the first one with three entrance and the second with only one entrance |
| **Circulation** | Circulation in the libraries varies: the first showcases an open circulation and the second one is restricted due to the limited space of the building. |
| **Spatial and functional organisation** | The libraries' organization displays unique approaches: with one intricately tied to the circulation of books while the second library tied to the function of spaces |

| | |
|---|---|
| **Acoustic feature** | The libraries shows a varies of acoustic innovative designs. One employs recesses, degradations and double-glazed façade while the second library employs acoustic treatment in all structure |
| **Lighting feature** | The libraries shows a distinct whene it comes to light feature with one embracing natural light due to its huge space while the second library employing standard and simplistic window designs similar to conventional projects |

## VIII. Contexte analysis

## Introduction

This analysis is composed of two parts: In the first part, we will analyze the data of the city Biskra, a climatological and bioclimatic analysis that will be organized into two sections: the first is an analysis of the climate of the city of Biskra, and the second is the analysis of the chosen site. The purpose of this analysis is to take into consideration the specific climatic data of the region and the morphological data to better define the choices of strategies at the design level.

## Presentation of the city Biskra

The gateway to the desert, the capital of Zibans, Biskra, is located in the southeast of Algeria, in the eastern part of the northern Sahara. It serves as the transition between the folded Atlas Mountains in the north and the flat, desert expanses in the south.

## Geographic location

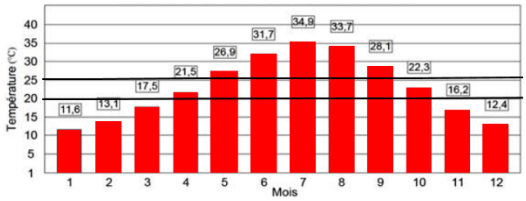
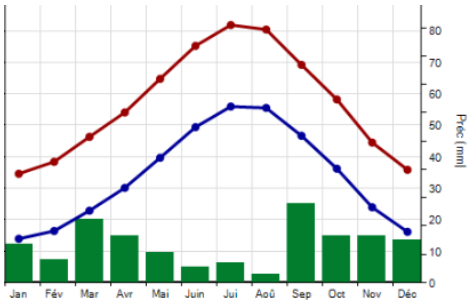
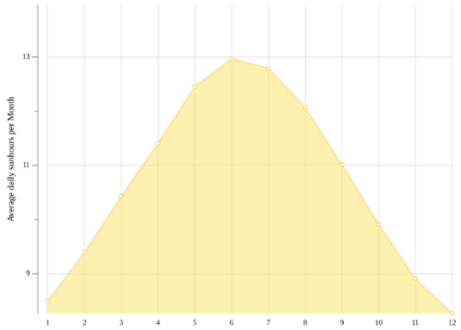
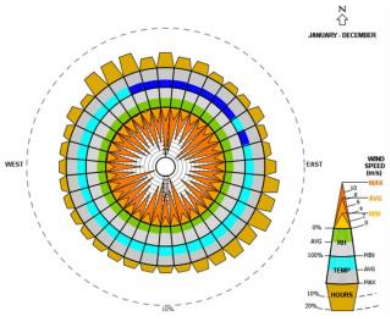
Biskra is a municipality in the northeastern Algerian Sahara. It covers an area of 22,379.95 km2,

- Geographical coordinates of Biskra, Algeria:
- Latitude: 34° 51' 1" N
- Longitude: 5° 43' 40" E


Figure 20 :(a)et(b), Situation géographique de la ville de Biskra ; (c) carte de découpage administratif, wilaya

### Climatological analysis

The city's average altitude is 88 meters above sea level. Biskra has a subtropical desert climate, characterized by mild winters (with the potential for cold nights) and very hot, dry, and sunny summers.

| | Graphs | Observation |
|---|---|---|
| Temperature |  Fig. : Average monthly temperature under shelter of the city of Biskra (Biskra Meteorological Station, 2016) | It is noted that two types of temperatures primarily characterize this city. Very high temperatures persist during a long, hot period, while low temperatures occur during a short, cold period. This significantly influences the thermal behavior of construction, particularly during the summer. |
| Precipitation |  Fig: average monthly precipitation diagramme | The total annual precipitation amounts to 155 millimeters, indicating a desertic level of precipitation. In the least rainy month (August), precipitation reaches 2 mm, while in the most rainy month (September), it increases to 25 mm. Here is the average precipitation |
| Sunhours |  Fig: average daily sunhours per month | In June, the highest number of daily sunshine hours on average is measured in Biskra. In June, there is an average of 12.8 hours of sunshine per day and a total of 396.79 hours of sunshine in the month.<br>Conversely, in January, the lowest number of daily sunshine hours on average is recorded in Biskra. In January, there is an average of 8.27 hours of sunshine per day, with a total of 256.29 hours of sunshine for the month.<br>Approximately 3900.03 hours of daylight are recorded in Biskra throughout the year. On average, there are 128.15 hours of daylight per month. |
| |  Fig: wind rose of Biskra with climat consltant | The winds are frequent during two periods of the year: relatively humid winds during the winter, and sand winds during the spring. The dominant wind directions are from the southeast and northwest |

**Bioclimatic analysis**

The bioclimatic analysis of the city of Biskra are primarily based on the examination of climatic data, utilizing Mahoney's tables and Givoni's diagram. This approach provides recommendations that assist in the design process.( see annex A).

# IX. Site analysis

## 1. site location in relation to the city

he project site is located in the western expansion area of the city of Biskra, ‘’the new urban development area’ ’It is 3.66Km away from the city center (10min by car).



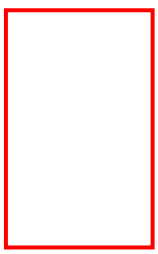
Strategically situated along major intercity roads, the project offers unparalleled accessibility, visibility, and economic potential for businesses and travellers alike

## 2. why this land

- the site is proposed for a library in land occupation plan
- For future western expansion, No.01 agreed upon in 2015.
- The site is strategically located along major intercity roads.
- The project site is situated in an administrative neighbourhood
  Close to housing, educational and university facilities.
- The project’s location within a new urban development

Opens the door to a host of opportunities and growth potential.

## 3. site morphology



The site boasts a naturally flat terrain, with a regular rectangular shape, having two halves, one of theme is flat which minimizes excavation efforts, simplifying realisation, while the other half, featuring gradients, demands strategic optimization for an overall efficient project implementation

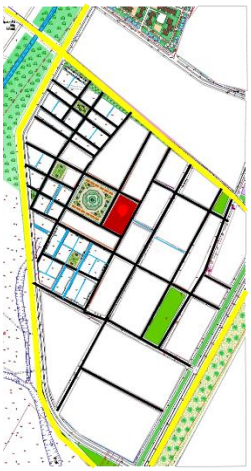
## 4. environment of the project

Urban fabric

A multi-facated urban fabric, ensuring a comprehensive and vibrant community experience.


The projects are part of the competition portfolio sourced from DUCH, including a curated list of projects and their respective architect offices named few ( Qaqi Nour al-din / Belmasoud Abbas


## 5. Roads and accessibility



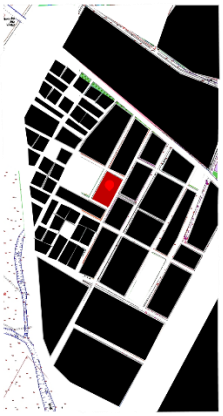


In terms of servitude, two main roads cross the selected area: the western Biskra bypass to the west and N03 to the north.

## 6. Mobility

The site is well served by public transport (bus) which make it easy to access from all the directions as we can see in the figure .

## 7. Built and unbuilt system




**Topological relationship:**

-Joining continuous frame.

-linear frames.

**Geometric relationship:**

-parallel or perpendicular axes.

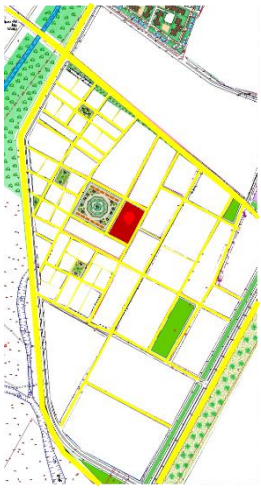
-regular figures relatively homogeneous.

**Dimensional relationship:**

-not very significant variation.

By studying the built space we notice a high density of buildings compared to non-built areas, after using the Photopea software (equivalent to Photoshop) to define the number of pixels on the PDAU map, we found 79% built and 21% of unbuilt for this study area which concludes that statistically folded spaces are the majority.

### The unbuilt



The unbuilt section, constituting 21% of the area, predominantly represents green spaces and vegetation within the study area

## 8. Green spaces

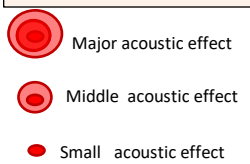
The green spaces in our study area are characterized by small pockets dedicated to the inhabitants, with only three significant green spaces, indicating a limited proportion of greenery in the overall area

## 9. Wind

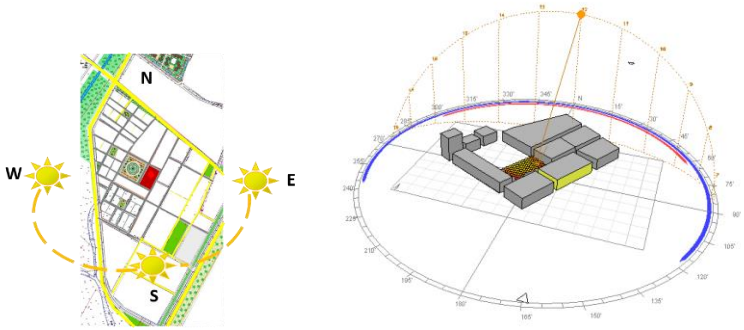
The dominant wind directions are from the southeast and northwest

## 10. Acoustic

The project is encompassed by a diverse array of noise sources emanating from all direction contributing to a multifaceted acoustic environment

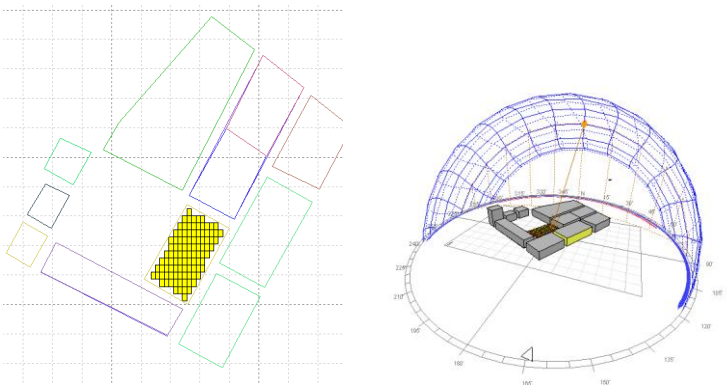


## 11.**Sun**




Sun in different period time of day in spring

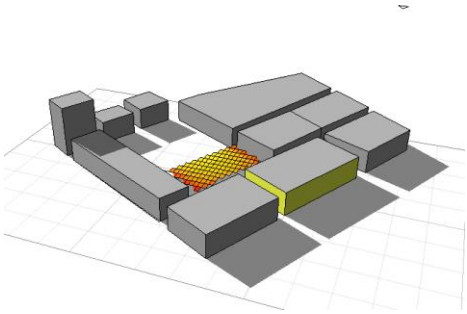
The site maximizes sunlight exposure during winter by strategically leveraging available sunlight from the south and west, while neighbouring buildings shield it from the east and north. In contrast, during summer, the project benefits from sunlight in all directions, taking advantage of the higher sun position in the sky

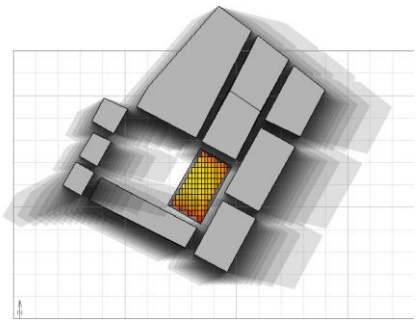


annual sun path

The site strategically engages with the sun's path in relation to the cardinal directions—north, east, west, and south—allowing for meticulous planning of sunlight exposure and shading considerations across the site

## 12.Shadow





Shadow range in all time of the day

The analysis of figures reveals that the site is sheltered from shadows cast by surrounding buildings at the periphery, while the central area remains unobstructed throughout various periods of the day

## 13.Urban facade

| Facade | Material | colors | Texture | Roof |
|---|---|---|---|---|
| Facades follow different styles,covering and colors | Concrete and bricks | white – gray – pink | smoth | horizantal |

| Facade | Material | colors | Texture | Roof |
|---|---|---|---|---|
| Facades follow different styles,covering and colors | Concrete - bricks - glass | white – yellow – brown-pink | smoth area – and rough area | horizantal |


| Facade | Material | colors | Texture | Roof |
|---|---|---|---|---|
| Facades follow different styles,covering and colors | Concrete - bricks – glass- wood | white – bleu – brown-pink | smoth | horizantal |

## 14. Network and sanitation

The figures illustrate a distinct distribution of utilities on the site, with electricity infrastructure located on the east side, gas facilities situated on the west side, and wastewater and potable water infrastructure positioned to the north. This organized allocation of utilities ensures a systematic and efficient distribution network, contributing to the overall functionality and planning of the site

## 15. The existing building in the area


Despite the area's relative isolation and limited existing constructions, the site offers a viable and easily implementable space for the project. The strategic placement of the first topography point is readily identifiable, contributing to the ease of project implementation within the surroundings

## Synthesis

To conclude the analysis of the study area, we summarize the most prominent features within our study area on a single map, accompanied by a SWOT analysis table (Strengths, Weaknesses, Opportunities, and Threats).

| Strength | Weakness |
|---|---|
| - Strategically located along major intercity roads.<br>- Situated in an administrative neighborhood.<br>- Proximity to housing, educational and university facilities.<br>- Multi-faceted urban fabric, ensuring a comprehensive community experience.<br>- Being the site proposed In the western expansion area of the city of Biskra.<br>- Well-served by public transport (bus) from all directions.<br>- Strategic engagement with the sun's path, allowing for meticulous planning of sunlight exposure and shading considerations.<br>- Distinct distribution of utilities, organized for a systematic and efficient network. | - High density of buildings compared to non-built areas.<br><br>- Limited proportion of greenery in the overall area.<br><br>- Diverse array of noise sources contributing to a multifaceted acoustic environment |

| Opportunities | Threats |
|---|---|
| - Location within a new urban development opens opportunities for growth.<br><br>- The large surface area provides potential for diverse development.<br><br>- Proximity to major intercity roads and public transport enhances accessibility | - Noise from diverse sources may pose challenges for a peaceful environment. |

# Architectural Chapter

# Architectural Chapter

## I. Introduction

Architectural programming is part of a broader and complex set of stages essential for the realization of building construction. It is a crucial element in the implementation process, often positioned at the very beginning, and in many cases, as the first step. Architectural programming's primary objective is to anticipate, ahead of project design, the essential and constitutive elements of good architecture.

## II. Programmatic approach

After analyzing various libraries, conducting extensive research on library spaces, and studying the differences in layouts among different libraries, we have successfully derived the ideal library program that encompasses all necessary spaces and more.

| Function | Space | N | S U | S T (m2) |
|---|---|---|---|---|
| **reception** | Entrance and reception area | 1 | 150 | 150 |
| **Public spaces** | Exhibition hall | 1 | 300 | 300 |
| | Foyer and waiting area | 1 | 100 | 100 |
| | Multi-purpose | 1 | 200 | 200 |
| | Cafeteria. | 1 | 50 | 50 |
| | Audio and visual room | 1 | 50 | 50 |
| | **Total** | | | 1100 |
| **Reading and study areas** | Quiet reading space | 2 | 100 | 200 |
| | Group study space | 2 | 100 | 200 |
| | Individual study carrels | 4 | 50 | 200 |
| | Newspaper and magazine area | 1 | 100 | 100 |
| | Digital media stations | 2 | 50 | 100 |
| | **Total** | | | 800 |
| **Collection** | General collection | 1 | 200 | 200 |
| | Specialized collection | 1 | 100 | 100 |
| | Children’s collection | 1 | 50 | 50 |
| | Teen collection | 1 | 50 | 50 |
| | Popular collection | 1 | 50 | 50 |
| | Periodicals section | 1 | 100 | 100 |
| | **Total** | | | 550 |
| **Technology and innovation** | Computer station | 1 | 150 | 150 |
| | Media production rooms | 2 | 50 | 100 |
| | Virtual reality station | 1 | 50 | 50 |
| | Innovation lab | 2 | 50 | 100 |
| | **Total** | | | 400 |
| **Children and teen spaces** | Children’s reading area | 1 | 100 | 100 |
| | Teen lounge | 1 | 100 | 100 |
| | Gaming area | 1 | 50 | 50 |
| | **Total** | | | 250 |

| | | | | |
|---|---|---|---|---|
| **Educational spaces** | Workshop rooms | 2 | 25 | 50 |
| | Training rooms | 2 | 25 | 50 |
| | Conference rooms | 1 | 250 | 250 |
| | **Total** | | | 300 |
| **Administration** | Administrative offices | 4 | 25 | 100 |
| | Staff break room | 1 | 30 | 30 |
| | Storage and archives | 1 | 100 | 100 |
| | **Total** | | | 230 |
| **Outdoor spaces** | Reading garden | 1 | 100 | 100 |
| | Outdoor seating areas | 1 | 100 | 100 |
| | **Total** | | | 200 |
| **Accessibility and Inclusivity** | Spaces for disabilities | 1 | 50 | 50 |
| | Multi-lingual services | 1 | 50 | 50 |
| | **Total** | | | 150 |
| **Sanitary** | Restrooms | 4 | 50 | 200 |
| **Circulation and shelving** | Efficient shelving layout | 1 | 300 | 300 |
| | Check-out and return station | 1 | 50 | 50 |
| | **Total** | | | 500 |
| **Atrium** | Open space for event | 1 | 100 | 100 |
| | Art display areas | 1 | 50 | 50 |
| | **Total** | | | 150 |
| **Security** | Security measures | 1 | 50 | 50 |
| **Culture** | Chapel | 2 | 25 | 50 |
| **Total** | | | | 5030 |

## III. Conceptual approach

**Idea :**

"Library as a wonderland", the idea behind this library is to redefine the conventional notion of a library, transcending its traditional role solely focused on reading and studying. My vision is to transform the library into a captivating world filled with wonders, enticing individuals with the excitement of endless discoveries.

**Objectives**

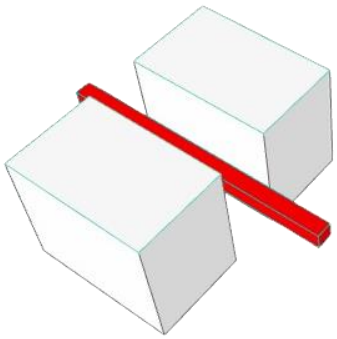
- Utilize the building's form and orientation to facilitate natural ventilation pathways, promoting cross-ventilation and passive cooling to enhance indoor air quality and reduce the need for mechanical systems.
- Plan the layout to establish distinct thermal zones within the library, optimizing areas for different comfort levels and activities, and promoting energy-efficient climate control.
- Integrate bioclimatic principles into the design, considering local climatic conditions to inform decisions on building form, orientation, and material selection for enhanced energy efficiency.

- Incorporate passive solar design features, such as maximizing south-facing glazing for winter heat gain and minimizing west-facing glazing to reduce overheating in the afternoons
- Incorporate thermal mass elements, such as exposed concrete or stone, to absorb, store, and release heat, stabilizing indoor temperatures and contributing to passive heating and cooling.
- Implement sound-absorbing materials and strategic spatial planning to ensure optimal acoustic comfort, creating quiet zones for focused activities and vibrant spaces for interactive events.

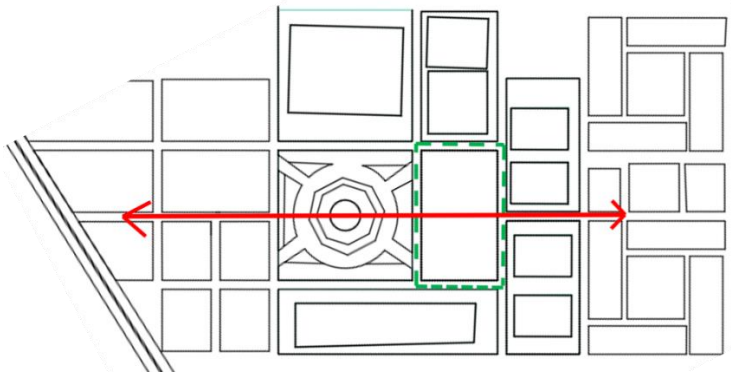
## IV. Concept design

- **First part**

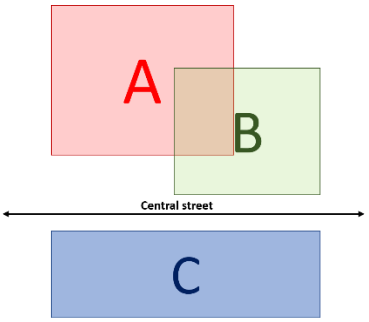
➢ **First step: "**been a part of the urban**",** recognizing the circulation challenges faced by residents in the area who currently need to navigate extensively to reach the other side.

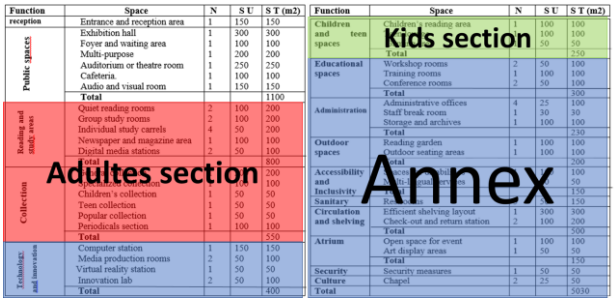


- Creating a central street
- Integrating the library with its surrounding
- Offering a welcoming path to people to walk through and interact with the space



- **Second step:** "programme", from the programme we recognize three majors' section, adults' section, kids' section and annex section



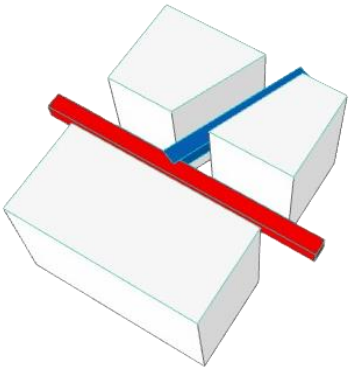



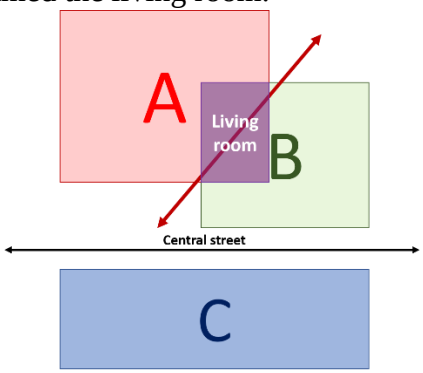

| Function | Space | N | S U | S T (m2) |
|---|---|---|---|---|
| reception | Entrance and reception area | 1 | 150 | 150 |
| Public spaces | Exhibition hall | 1 | 300 | 300 |
| | Foyer and waiting area | 1 | 100 | 100 |
| | Multi-purpose | 1 | 200 | 200 |
| | Auditorium or theatre room | 1 | 250 | 250 |
| | Cafeteria | 1 | 100 | 100 |
| | Audio and visual room | 1 | 150 | 150 |
| | Total | | | 1100 |
| Reading and study areas | Quiet reading rooms | 2 | 100 | 200 |
| | Group study rooms | 2 | 100 | 200 |
| | Individual study carrels | 4 | 50 | 200 |
| | Newspaper and magazine area | 1 | 100 | 100 |
| | Digital media stations | 2 | 50 | 100 |
| | Total | | | 800 |
| Collection | [illegible] | 2 | 100 | 200 |
| | Children's collection | 1 | 50 | 50 |
| | Teen collection | 1 | 50 | 50 |
| | Popular collection | 1 | 50 | 50 |
| | Periodicals section | 1 | 100 | 100 |
| | Total | | | 550 |
| Technology and innovation | Computer station | 1 | 150 | 150 |
| | Media production rooms | 2 | 50 | 100 |
| | Virtual reality station | 1 | 50 | 50 |
| | Innovation lab | 2 | 50 | 100 |
| | Total | | | 400 |

| Function | Space | N | S U | S T (m2) |
|---|---|---|---|---|
| Children and teen spaces | Children's reading area | 1 | 100 | 100 |
| | [illegible] | 1 | 100 | 100 |
| | [illegible] | 50 | 50 | 50 |
| | Total | | | 250 |
| Educational spaces | Workshop rooms | 2 | 50 | 100 |
| | Training rooms | 1 | 100 | 100 |
| | Conference rooms | 2 | 50 | 100 |
| | Total | | | 300 |
| Administration | Administrative offices | 4 | 25 | 100 |
| | Staff break room | 1 | 30 | 30 |
| | Storage and archives | 1 | 100 | 100 |
| | Total | | | 230 |
| Outdoor spaces | Reading garden | 1 | 100 | 100 |
| | Outdoor seating areas | 1 | 100 | 100 |
| | Total | | | 200 |
| Accessibility and Inclusivity | [illegible] | 2 | 100 | 200 |
| | [illegible] | 1 | 100 | 100 |
| Sanitary | Restrooms | 3 | 50 | 150 |
| Circulation and shelving | Efficient shelving layout | 1 | 300 | 300 |
| | Check-out and return station | 2 | 100 | 200 |
| | Total | | | 500 |
| Atrium | Open space for event | 1 | 100 | 100 |
| | Art display areas | 1 | 50 | 50 |
| | Total | | | 150 |
| Security | Security measures | 1 | 50 | 50 |
| Culture | Chapel | 2 | 25 | 50 |
| Total | | | | 5030 |

- Each section will be unique and have its own identity, tailored to different age groups, mentalities, perspectives, and other factors.
- Optimizes space usage by ensuring each area is specifically designed for its intended purpose.
- Each section hosts specialized activities and programs tailored to its audience.
- Custom design elements and layouts enhance the user experience for each demographic.

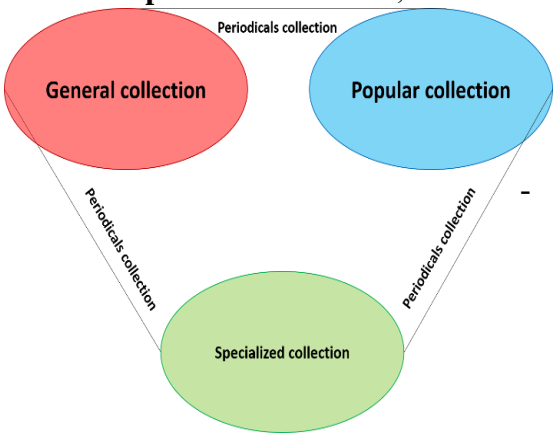
- **Third step:** "living room", At the intersection of the adults' and kids' sections in the library, a unique space emerges, aptly named the living room.






- a vibrant "HUB" serves as the heart and life of the library.
- Featuring multiple public area
- Creating visual and tactical distinction with open circulation serving the ambiance.
- Fostering a unique microclimate with the integration of mineral and vegetation elements.

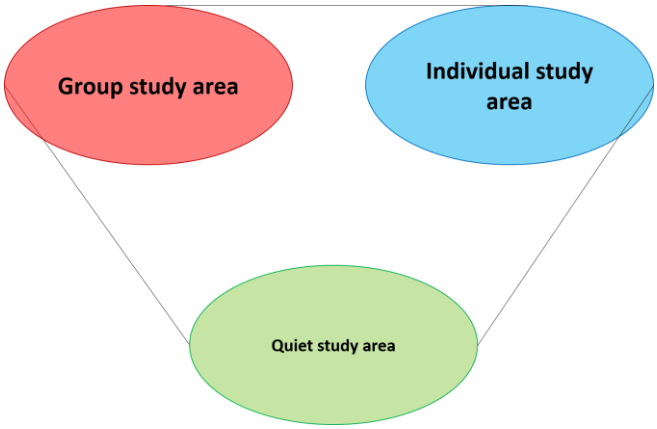
➢ **Fourth step:** "adults' section", contains collection, reading and study areas.



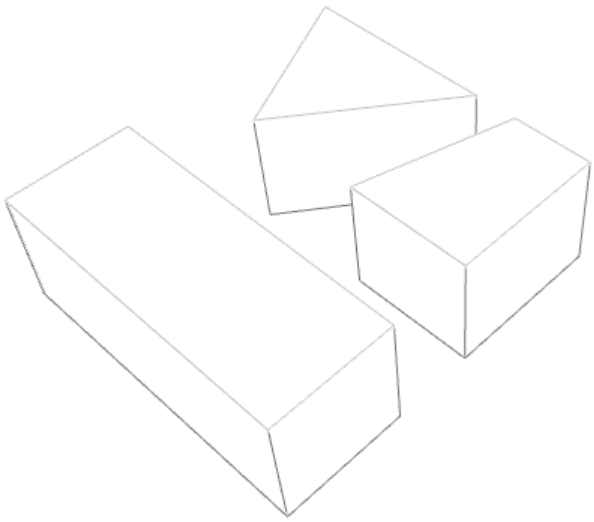

- **Collection:** according to the programme the collection contains, general collection specialized collection, popular collection and periodicals collection.

- **Reading and study area:**

From the programme, the reading and study area is divided into three sections group study area, individual study area and quiet study area.

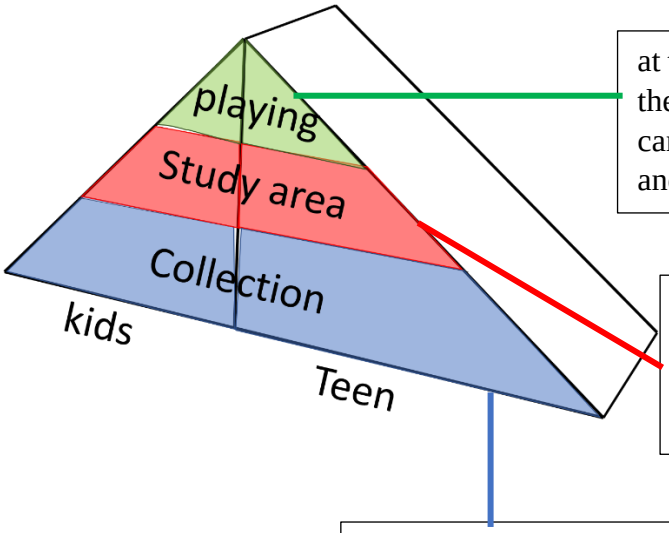



- **The shape of the adult's section**



The form of the adults' section is a direct response to the programmatic and functional needs of the space.

- **Fifth step:** "kids' section", integrates spaces for both teenagers and younger children, accommodating their needs through designated areas for collections, reading, studying, as well as playing and games. The arrangement of these diverse spaces is achieved through a hierarchical organization of functions. Inspired by the "pyramid shape".




at the top symbolizes the culmination of their learning experience, where they can apply their knowledge in a creative and interactive manner.

in the middle signifies the growth and development that occurs as children delve deeper into learning and understanding

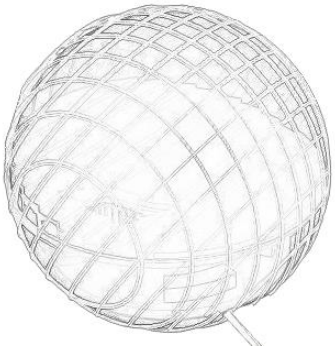
at the base represents the foundation of knowledge, where children start their exploration by discovering books and resources.

- **Sixth step:** "annex section", includes four main areas, conference space, technology and innovation spaces, educational spaces, and multipurpose spaces.

- **Conference space:** with its spherical shape inspired from the Las Vegas sphere.

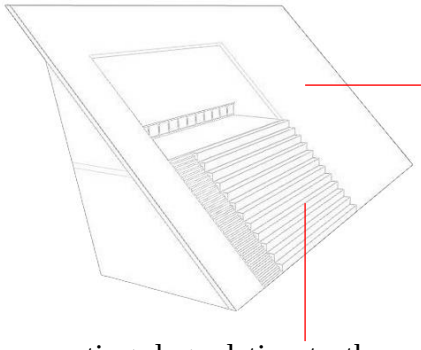
Picture: Las Vegas sphere. Source: / http: google.com.

- The sphere shape allows for cutting-edge technology to be integrated into the entire surface, creating a massive digital display.



The entire spherical façade acts as a giant screen, fitted LED screen, which can be programmed to display dynamic images and animations, transforming the building into an attraction point in Biskra, the Sphere will be illuminated day and night, with the displays adapted to fit the season and noteworthy events.

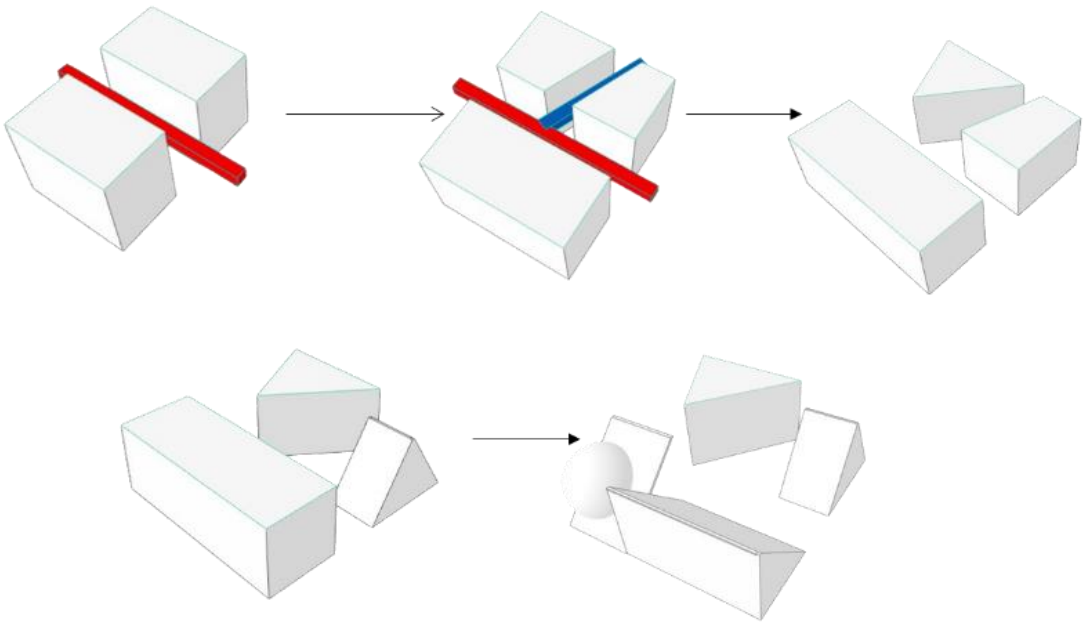
- **The shape of the annex section**



sloping roof to visually differentiate and break away the design of the library

- incorporating degradation to the roof to create a space where people can gather and linger, encourages interaction and engagement with the library

➢ **Result of the first part**

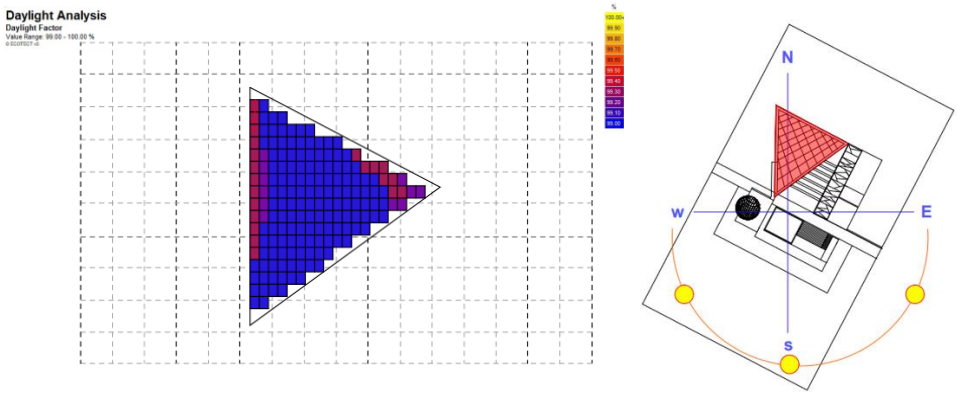


- **Second part**

➢ **Seventh step:** "light feature"

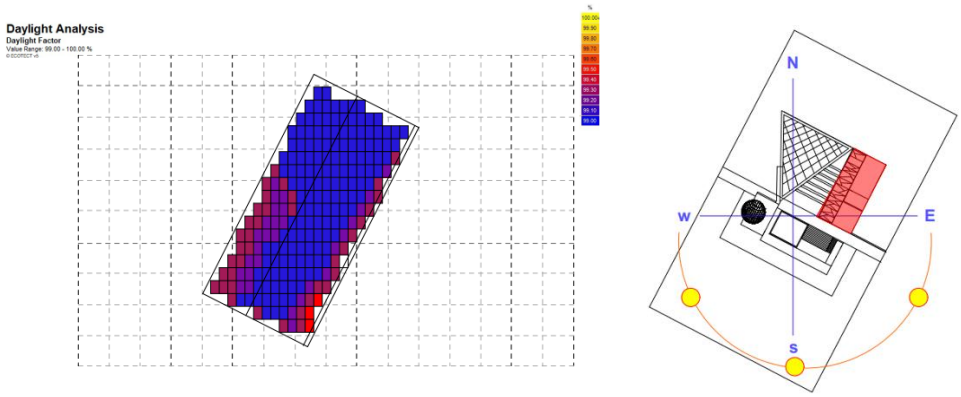
- **Adults section:** For the reading and study area, the best choice for light direction is zenith light
- Provides even and uniform lighting
- Reduces shadows and glare
- Eases eye strain during prolonged reading or studying
- Full spectrum of natural light is more comfortable for the eyes
- Helps maintain circadian rhythms
- Improves concentration and mood
- Ensures well-lit reading surfaces without discomfort
- Reduces the need for artificial lighting during daylight hours

Since the reading and study area is not fully oriented to the north. I had to adjust the height of the space to align it better with the northern orientation

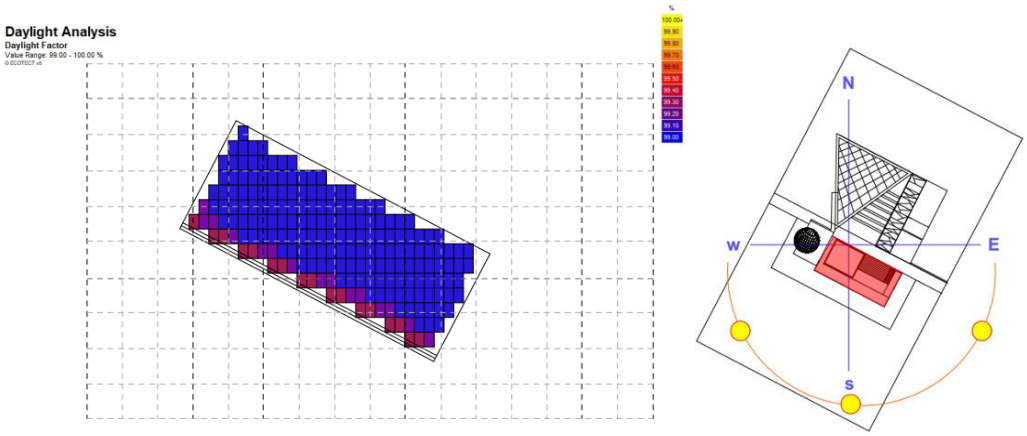



- **kids' section:** two types of lighting were used in this section, lateral light to illuminate the spaces and zenith light with colored glass for the circulation areas, with one passive solution for both of theme to reduce sun exposure which is "double curtain wall"

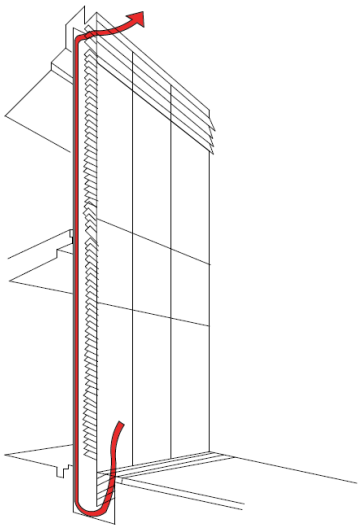
  And the use of colored glass, besides its aesthetic and ambiance benefits, is because it offers these qualities
- Absorbs and reflects a greater portion of sunlight
- Reduces glare and heat transmission
- Offers better UV protection
- Provides better overall protection from harmful UV rays
- Helps manage interior temperature and improves comfort



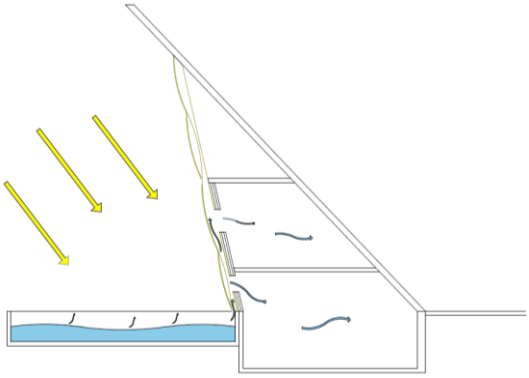

- **Annex section:** The annex section, facing south and west, presented a significant challenge due to sun exposure. To address this, two solutions were integrated into the design: a double-glazed facade and panels, along with a sloping wall design in the space to reduce sun exposure.



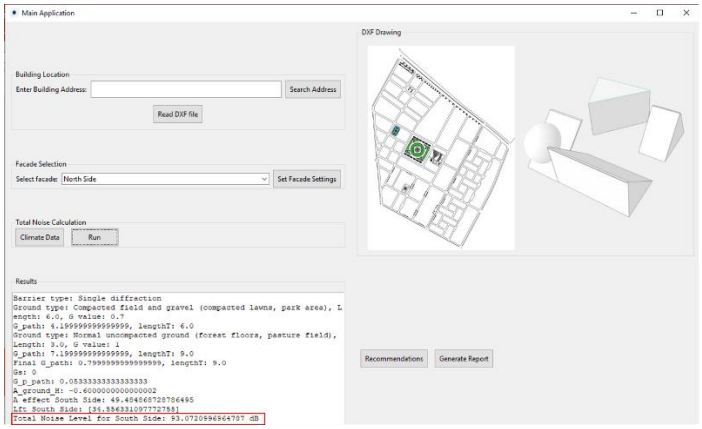

- **Eighth step:** "thermal feature", two solutions were used in the project when it comes to thermal comfort, double façade and and evaporative cooling technique.
- **Double façade:** were used in kids 'section, living room and the annex section.



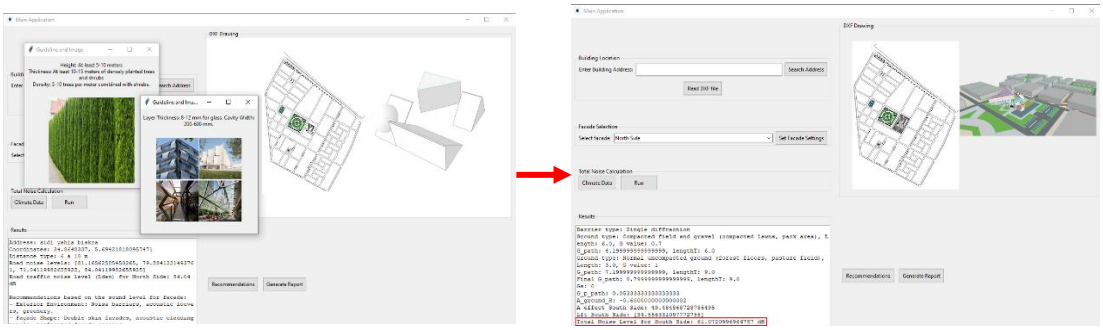
- **Evaporative cooling technique:** were used in the annex section facing the south façade.



➢ **Ninth step**: "acoustic feature", Initially, I input the project data into an acoustic modelling tool "Acous", and determined that the noise level reaching the North facade is 84 dB, and the noise level reaching the South facade is 93dB which exceeds the recommended levels specified in the DTR.




After implementing some of the recommendations proposed by the application, I re-entered the project data and conducted another simulation for the noise level. The results showed a decrease to 61 dB, for the South facade.



## Project presentation

### Location plan

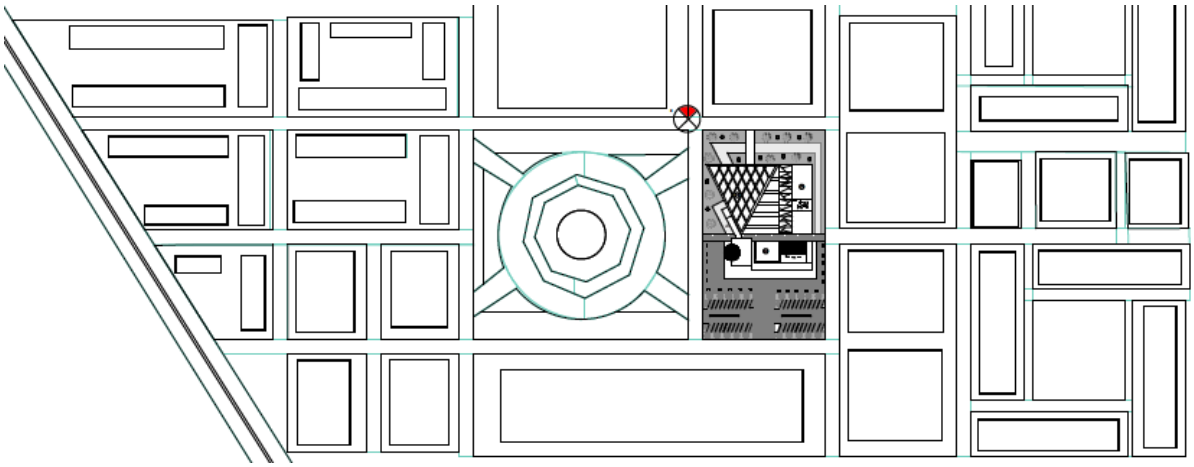


Figure 1: location plan ,scale 1/500. Source:

### Masse plan

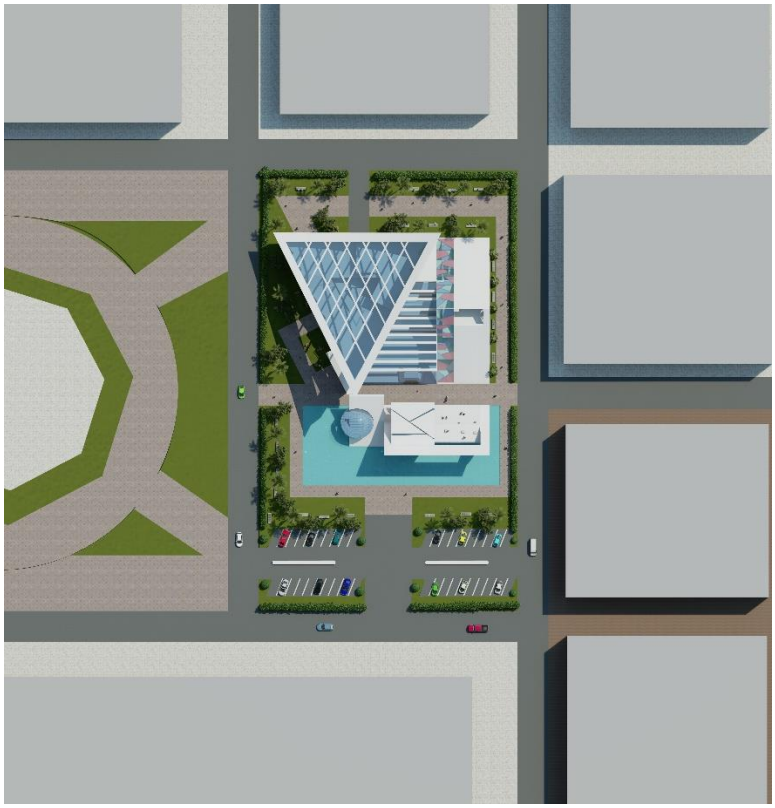
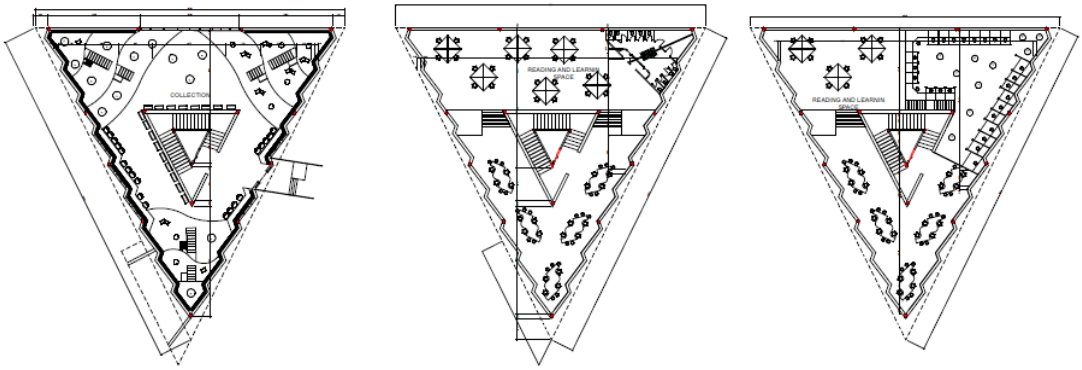


Figure 2: masse plan, scale 1/200. Source: author

## Architecture layouts

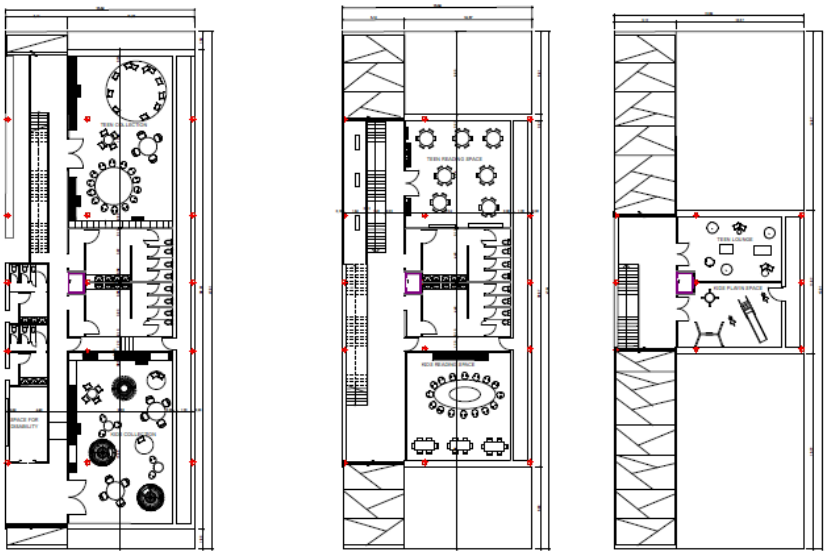
- **Adults section**



Ground floor first floor mezzanine

Figure 3: adult's section layouts, scale 1/100. Source: author

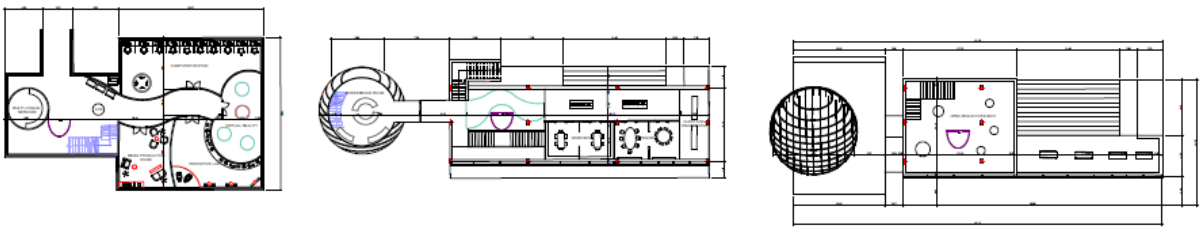
- **Kids section**



Ground floor first floor second floor

Figure 4: kids section layouts, scale 1/100. Source: author

- **Annexe section**



underground floor first floor second floor

Figure 5: annexe section layouts, scale 1/100. Source:

## assembly plan

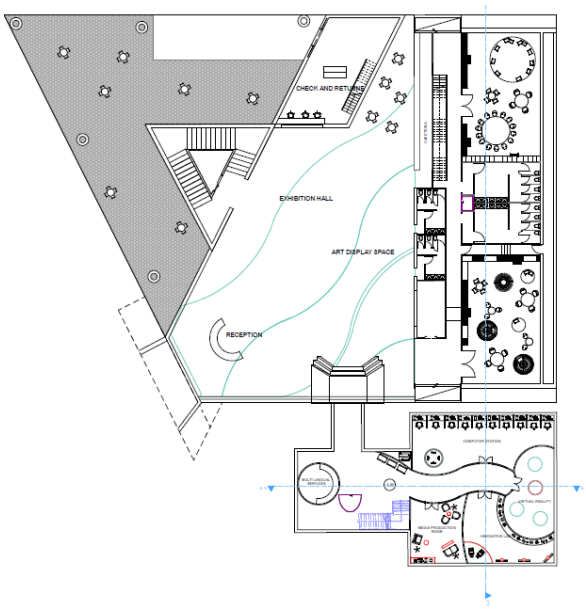
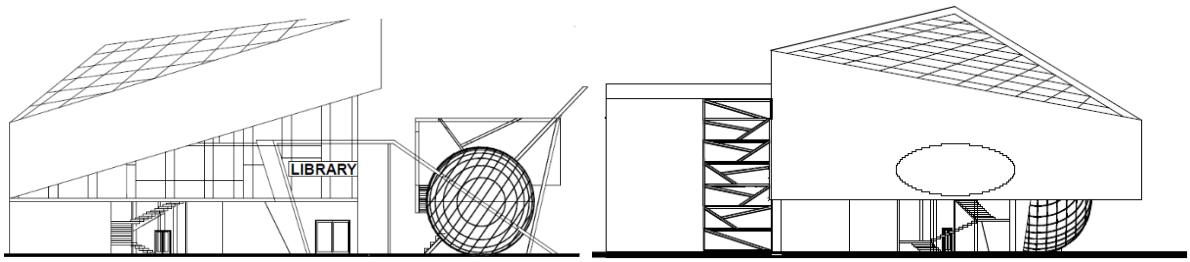
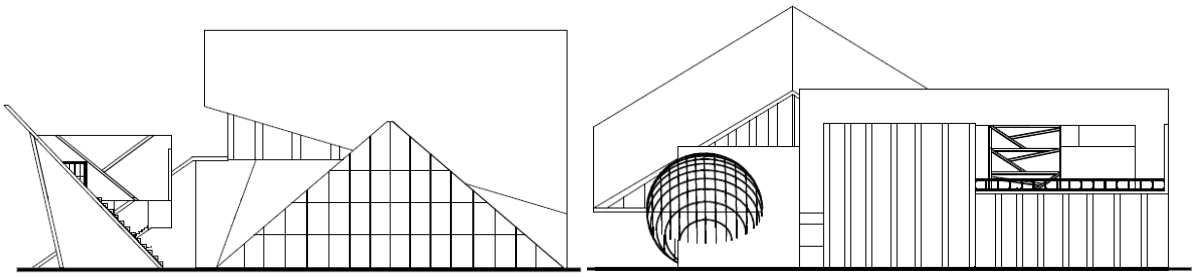



Figure 6: assembly layouts, scale 1/100. Source: author

## Elevation



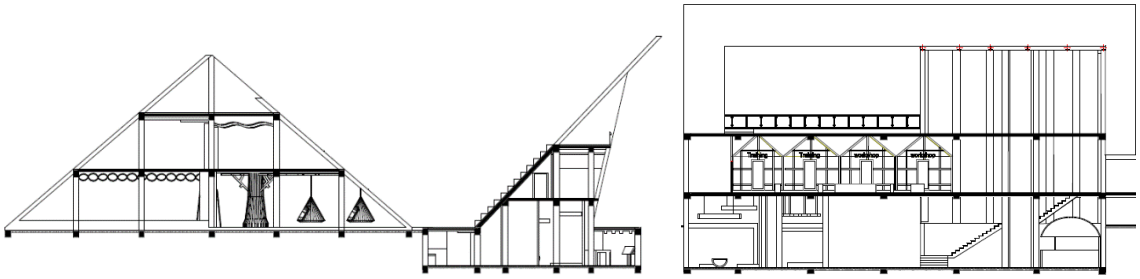

NORTH WEST NORTH EST



SOUTH EST SOUTH WEST

Figure 7: elevations of the projects, scale 1/100. Source:

## Section



Section A-A

Section B-B

Figure 7: sections of the projects, scale 1/100. Source:

## Conclusion

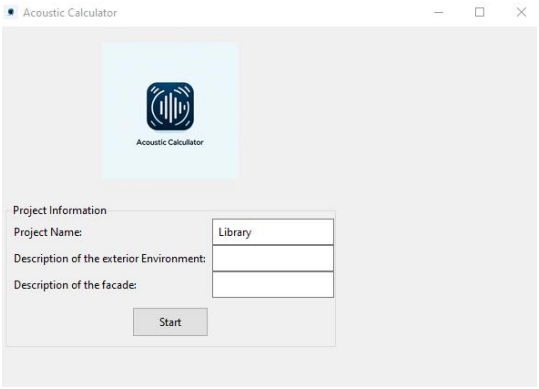
In this chapter, we presented the fruit of our work of research, and how we reflected all of our objectives in the project.

# Acoustic chapter

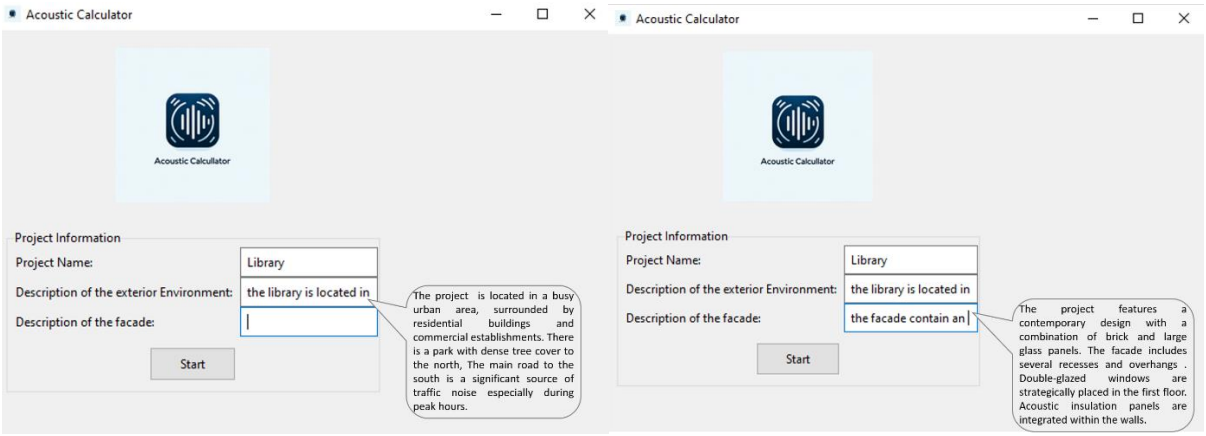
# I. Acous “acoustic solution”, acoustic calculator

## I.1Part one

- **First step**: As the initial step, you need to input the project name into the application. This is crucial because each project has distinct acoustic requirements. When the project name "library" is entered, the application's database will retrieve the relevant acoustic criteria specific to a library.

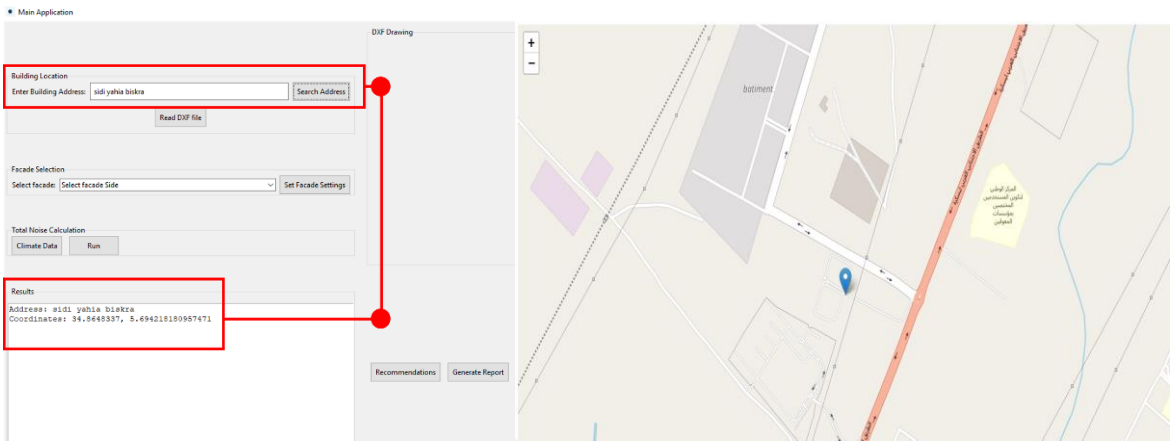



- **Second step:** “ description of the exterior environment”and “ description of the façade”, the purpose of entering this information is to provide the application with a comprehensive understanding of the contextual and structural factors that influence the acoustic characteristics of the building.

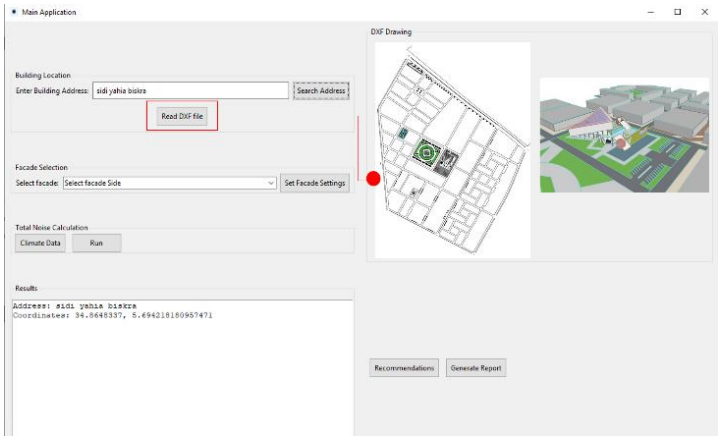



## I-2 Part two

- **First step**: “ building location”, The purpose of entering the building's location is to provide geographical context, which helps in analyzing environmental factors that affect acoustic performance. Factors such as surrounding noise sources, proximity to major roads, and the general urban or rural setting. By pinpointing the location on Google Maps, the application can incorporate these contextual elements into its analysis, ensuring that the acoustic recommendations are tailored to the specific environmental conditions of the site.

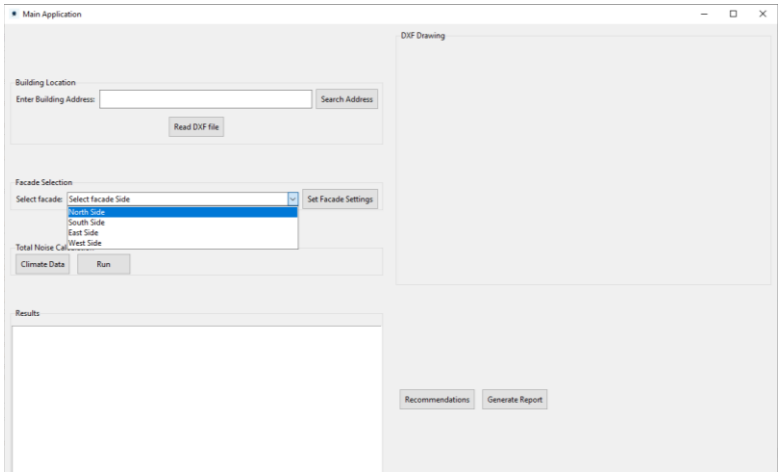



- **Second step**: " upload masse plan", for the current phase, the master plan needs to be uploaded in a DXF file for now, but in the next development of the application, it will be in 3D.



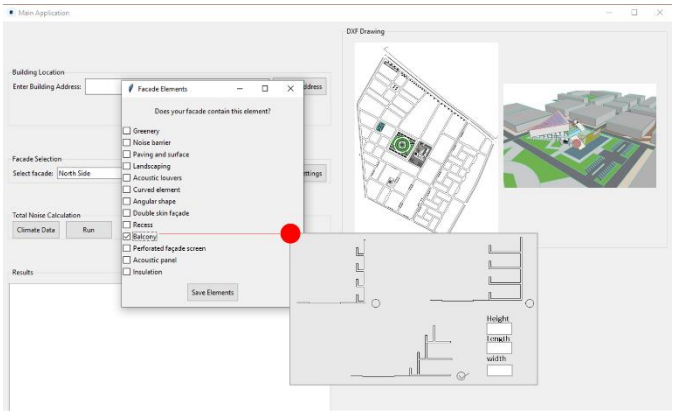

## I-3 Part three

- **First step:** " select façade", as a first step, you need to select which facade you will be calculating the sound emission level for. The selection of the facade is related to the noise source.



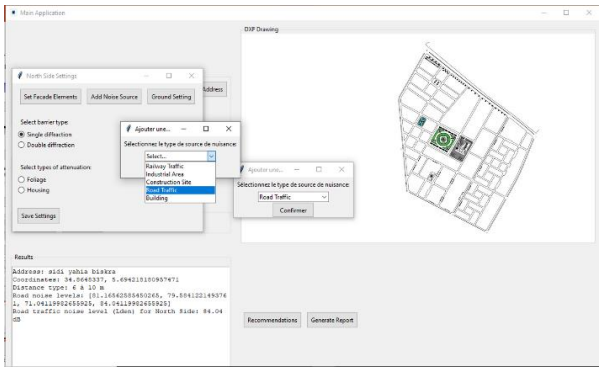
- Once you select the facade, you will need to provide additional details to ensure the calculation is accurate.

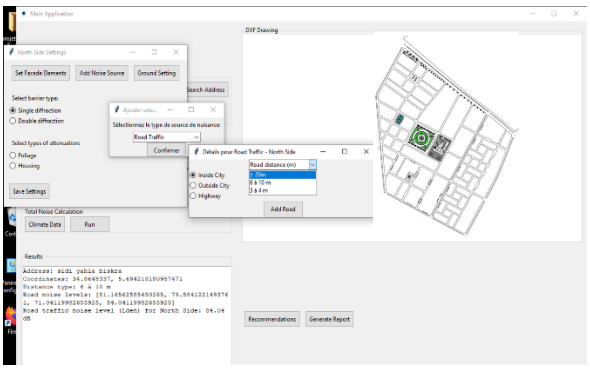
**a. Set facade elemetns**



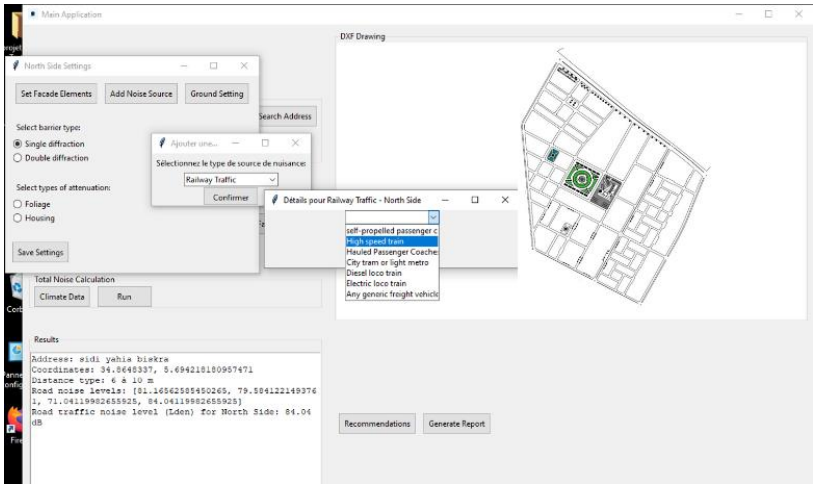
**b. Add noise source**

- **Road traffic**

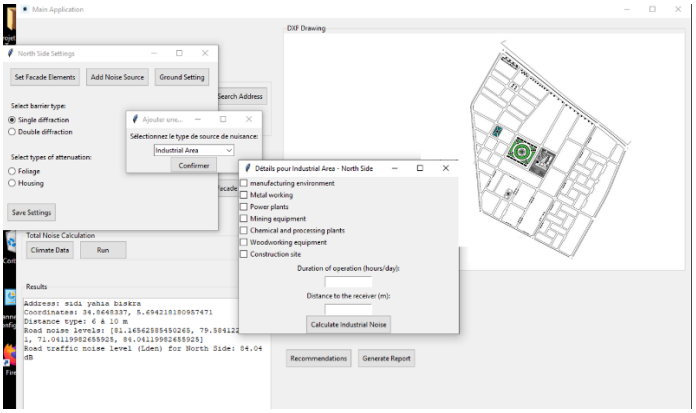




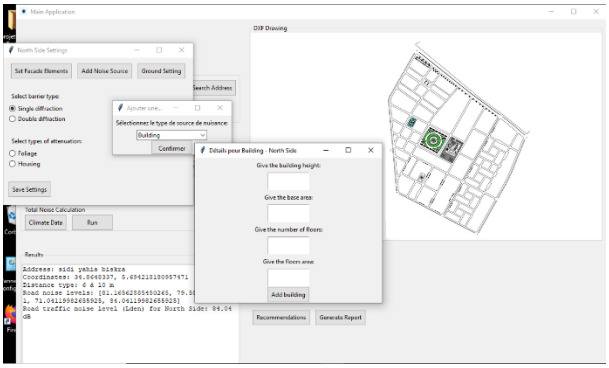
- **Railway traffic**



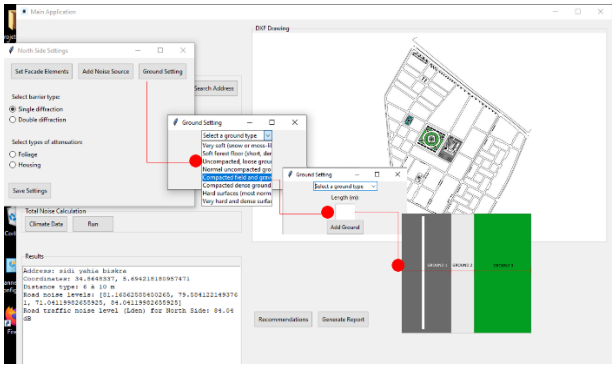
- **Industrial area**



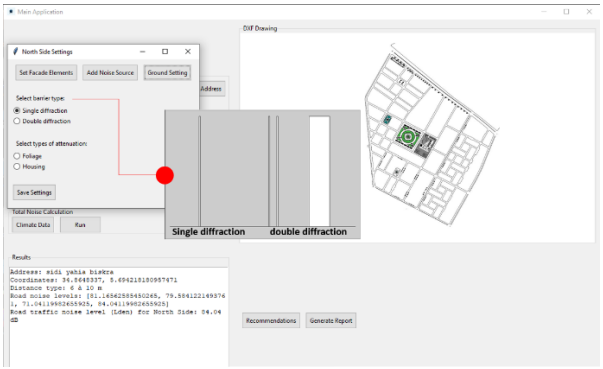
- **Building**



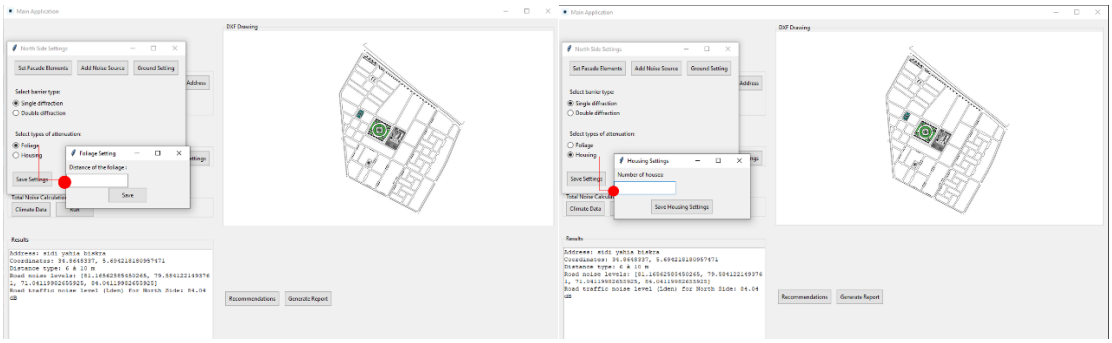
**c. Ground setting**



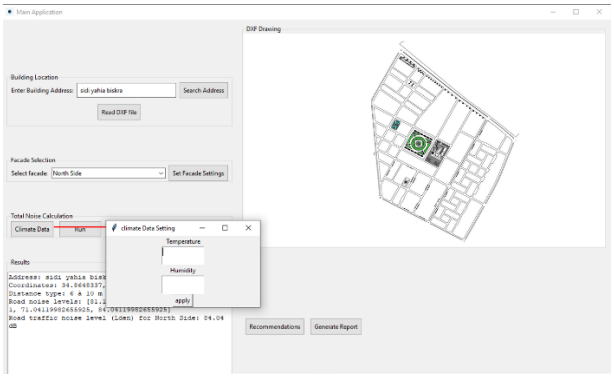
**d. Select barriere type**



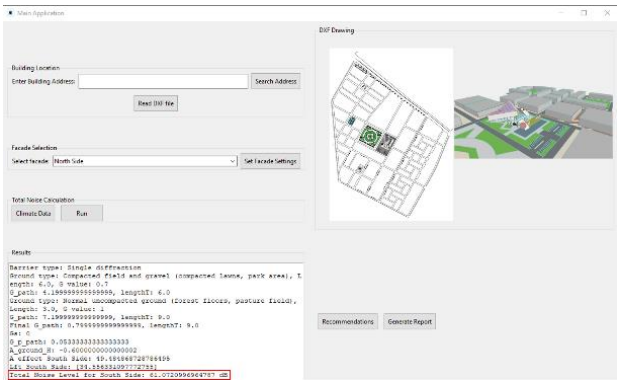
### e. Select type of the attenuation



### f. Climate data

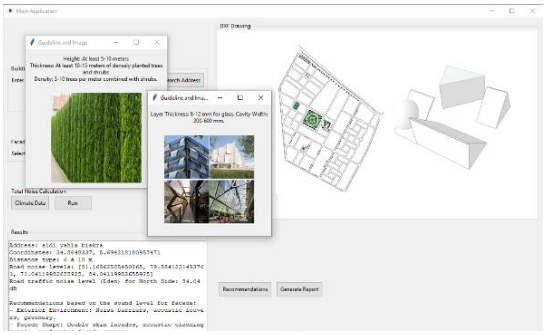


- **Second step**: "RUN calculation", After uploading all the project inputs correctly, the application will start calculating the sound emission level of your selected facade.

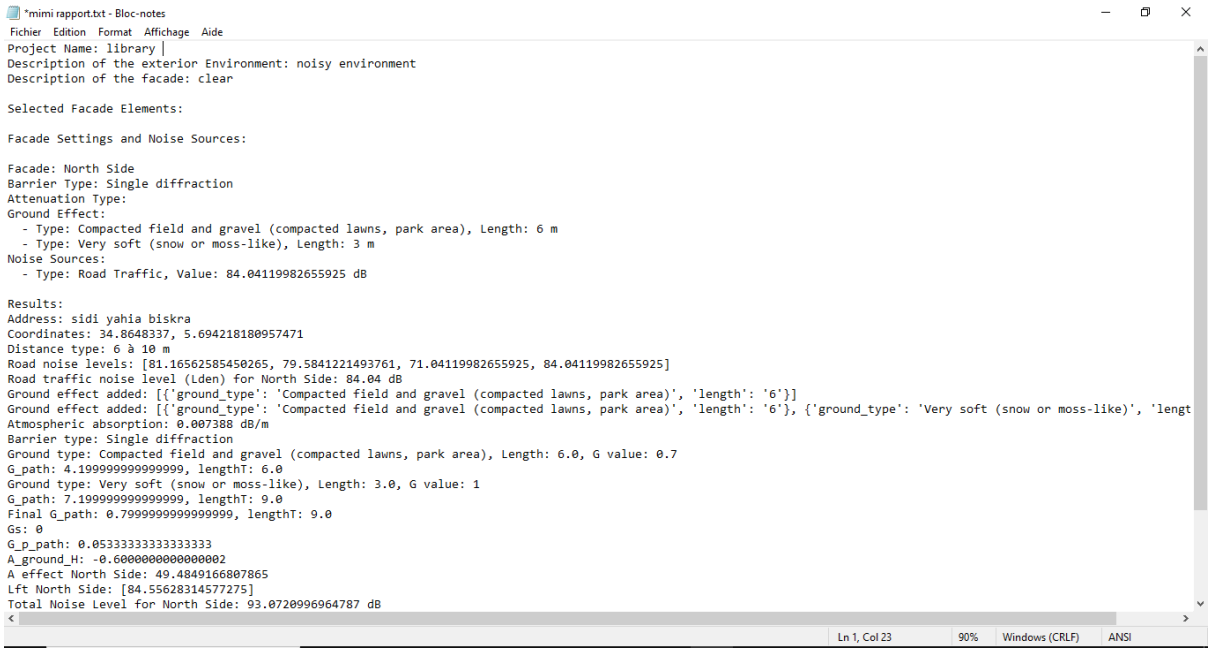


## I-4Fourth part

- **First step:** “recommendation”, After the sound emission level of your facade is calculated, the application will provide recommendations suited to your specific case.



- **Second step:** “generate report”, After everything is completed, the application will generate a report that includes all the information about your project.



*mimi rapport.txt - Bloc-notes

Fichier Edition Format Affichage Aide

```
Project Name: library
Description of the exterior Environment: noisy environment
Description of the facade: clear

Selected Facade Elements:

Facade Settings and Noise Sources:

Facade: North Side
Barrier Type: Single diffraction
Attenuation Type:
Ground Effect:
  - Type: Compacted field and gravel (compacted lawns, park area), Length: 6 m
  - Type: Very soft (snow or moss-like), Length: 3 m
Noise Sources:
  - Type: Road Traffic, Value: 84.04119982655925 dB

Results:
Address: sidi yahia biskra
Coordinates: 34.8648337, 5.694218180957471
Distance type: 6 à 10 m
Road noise levels: [81.16562585450265, 79.5841221493761, 71.04119982655925, 84.04119982655925]
Road traffic noise level (Lden) for North Side: 84.04 dB
Ground effect added: [{'ground_type': 'Compacted field and gravel (compacted lawns, park area)', 'length': '6'}]
Ground effect added: [{'ground_type': 'Compacted field and gravel (compacted lawns, park area)', 'length': '6'}, {'ground_type': 'Very soft (snow or moss-like)', 'lengt
Atmospheric absorption: 0.007388 dB/m
Barrier type: Single diffraction
Ground type: Compacted field and gravel (compacted lawns, park area), Length: 6.0, G value: 0.7
G_path: 4.199999999999999, lengthT: 6.0
Ground type: Very soft (snow or moss-like), Length: 3.0, G value: 1
G_path: 7.199999999999999, lengthT: 9.0
Final G_path: 0.7999999999999999, lengthT: 9.0
Gs: 0
G_p_path: 0.05333333333333333
A_ground_H: -0.6000000000000002
A effect North Side: 49.4849166807865
Lft North Side: [84.55628314577275]
Total Noise Level for North Side: 93.0720996964787 dB
```

Ln 1, Col 23 | 90% | Windows (CRLF) | ANSI

# Conclusion

# General conclusion

At the end of this work, a comprehensive exploration of the acoustic challenges and solutions within urban environments, particularly focusing on the impact of noise pollution on building facades, was achieved. Through an extensive literature review and practical application, the study examined the intricate interplay between urban noise and architectural acoustics, highlighting the critical need for integrated acoustic considerations in building design. The study reveals that noise pollution significantly affects the structural integrity and aesthetic quality of building facades, leading to accelerated wear and tear and decreased lifespan of structures. Additionally, noise pollution impacts the acoustic comfort of urban dwellers, causing various health and well-being issues.

In response to these challenges, the study utilized advanced acoustic modelling tools to assess the current noise levels impacting building facades. Initial findings revealed that noise levels were significantly higher than recommended standards, with facades experiencing levels up to 84 dB to mitigate this issue, various strategies recommended by the modelling tool were implemented, including the use of specific materials, facade design modifications, and other noise mitigation measures. After applying these recommended strategies, a re-evaluation of the noise levels showed a substantial reduction to 61 dB, demonstrating the effectiveness of the acoustic modelling tool and the proposed interventions.

This significant improvement underscores the value of incorporating advanced modelling tools and expert guidance in addressing urban acoustic challenges. The findings emphasize the necessity of a holistic

approach that integrates acoustic considerations into the design process from the outset. Creating acoustically balanced environments is crucial for urban well-being, and facades play a pivotal role in mediating the effects of urban noise.

The use of the acoustic modelling tool was particularly impactful in our project. It provided a detailed analysis of noise levels and offered actionable recommendations, which, when implemented, led to a significant improvement in the acoustic environment. This demonstrates that integrating advanced acoustic modelling into the design and planning phases can effectively mitigate noise pollution, enhance acoustic comfort, and contribute positively to the overall quality of urban living.

In conclusion, this work underscores the importance of addressing acoustic challenges in urban environments to improve the well-being of residents. It highlights that noise pollution is not just an environmental concern but also a significant factor affecting the structural and aesthetic aspects of urban architecture. By leveraging advanced modelling tools and adopting a comprehensive, interdisciplinary approach, it is possible to create more acoustically comfortable and sustainable urban spaces. This study serves as a foundational reference for future research and practical applications in the field of urban acoustics and architectural design.

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## Link :


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- https://silo.tips/download/stadtbibliothek-am-mailnder-platz#google_vignette
- https://gracearchmusic.blog/2019/05/30/it-all-starts-with-a-library-above-a-traditional-market/
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- https://www.archdaily.com/438400/free-university-of-berlin-foster-partners/525d642be8e44ecb170009a8-free-university-of-berlin-foster-partners-level-06-plan?next_project=no
- https://arquitecturaviva.com/works/biblioteca-y-restauracion-de-la-universidad-libre-7#
- https://www.arch2o.com/free-university-philology-library-fosterpartners/
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- https://perkinswill.com/project/dokk1-aarhus-denmark/
- https://librarybuildings.info/sites/default/files/dokk1-english.pdf

# Annexe

# Annexe –A

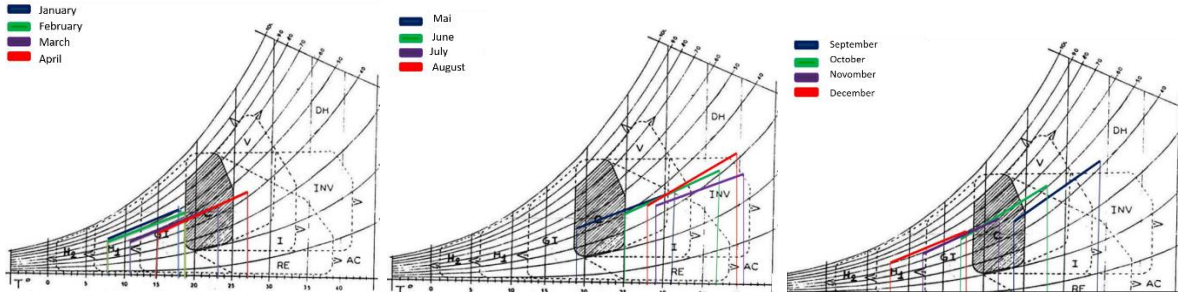
## Givoni's diagram

a- Temperature

| | J | F | M | A | M | J | J | A | S | O | N | D |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Temp.Moy.Max | 18 | 19 | 23 | 27 | 31 | 37 | 41 | 40 | 34 | 28 | 22 | 18 |
| Temp.Moy.Min | 8 | 8 | 11 | 15 | 19 | 25 | 29 | 28 | 24 | 17 | 12 | 8 |

b- Humidity

| | J | F | M | A | M | J | J | A | S | O | N | D |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Humidité Rel.Max | 61 | 56 | 51 | 47 | 44 | 40 | 35 | 38 | 47 | 55 | 57 | 60 |
| Humidité Rel.Min | 60 | 51 | 46 | 42 | 36 | 31 | 26 | 31 | 42 | 50 | 55 | 59 |




Recommendations drawn from givoni diagrams

| Month | recommandations | Month | recommandations | Month | recommandations |
|---|---|---|---|---|---|
| **january** | H1 , GI | **mai** | V , I , INV , AC | **Septembre** | V , I , INV , AC, DH |
| **february** | H1 , GI | **june** | V , I , INV , AC | **Octobre** | GI, C , V , I |
| **march** | H1 , GI , C | **july** | V , I , INV , AC | **Novembre** | H1 , GI |
| **april** | GI , C , V | **august** | V , I , INV , AC , DH | **december** | H1 , GI |

**H2**: Active solar heating

**H1**: Passive solar heating

**C**: Comfort

**V**:ventilation

**I** Strong inertia

**H**: heating

**GI**: Internal gain

**AC**: cooling

**DH**: dehumidification

**INV**: Very high inertia and night ventilation

**RE**: Ventilation cooling

## Mahoney's tables

### a- Temperature

| | J | F | M | A | M | J | J | A | S | O | N | D |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Temp.Moy.Max | 18 | 19 | 23 | 27 | 31 | 37 | 41 | 40 | 34 | 28 | 22 | 18 |
| Temp.Moy.Min | 8 | 8 | 11 | 15 | 19 | 25 | 29 | 28 | 24 | 17 | 12 | 8 |
| E.D.T | 10 | 11 | 12 | 12 | 12 | 12 | 12 | 12 | 10 | 11 | 10 | 10 |

| La+haute | TAM |
|---|---|
| 41 | 24.5 |
| 8 | 33 |
| La+basse | EAT |

### b- Humidity , rain and wind

| | J | F | M | A | M | J | J | A | S | O | N | D |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Humidité Rel.Max | 61 | 56 | 51 | 47 | 44 | 40 | 35 | 38 | 47 | 55 | 57 | 60 |
| Humidité Rel.Min | 60 | 51 | 46 | 42 | 36 | 31 | 26 | 31 | 42 | 50 | 55 | 59 |
| Humidité Rel.Moy | 60.5 | 53.5 | 48.5 | 44.5 | 40 | 35.5 | 30.5 | 34.5 | 44.5 | 52.5 | 56 | 59.5 |
| Groupe(G.H) | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 3 |
| Pluie(mm) | 15.9 | 17.5 | 24.7 | 22.6 | 5.7 | 23.6 | 00.0 | 3.7 | 10.4 | 16.3 | 44.8 | 0.3 |
| Vent Dominent | 4.5 | 4.7 | 5 | 4 | 5.2 | 4.6 | 2.9 | 2.9 | 2.9 | 3.4 | 3.8 | 3.2 |
| Vent Secondaire | | | | | | | | | | | | |

| Total annuel pluie |
|---|
| 185.5 |

| G.H | |
|---|---|
| < 30% | 1 |
| 30-50 | 2 |
| 50-70 | 3 |
| >70 | 4 |

### c- Comfort

| | J | F | M | A | M | J | J | A | S | O | N | D |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| G.H | 3 | 3 | 2 | 2 | 2 | 2 | 1 | 2 | 2 | 3 | 3 | 3 |

**-Température:**

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Moy.Mens.Max | | 18 | 19 | 23 | 27 | 31 | 37 | 41 | 40 | 34 | 28 | 22 | 18 |
| Confort diurne | Maxi | 29 | 29 | 31 | 31 | 31 | 31 | 34 | 31 | 31 | 29 | 29 | 29 |
| | Mini | 23 | 23 | 23 | 23 | 23 | 23 | 26 | 23 | 23 | 23 | 23 | 23 |
| Moy.Mens.Min | | 8 | 8 | 11 | 15 | 19 | 25 | 29 | 28 | 24 | 17 | 12 | 8 |
| Confort nocturne | Maxi | 23 | 23 | 24 | 24 | 24 | 24 | 25 | 24 | 24 | 23 | 23 | 23 |
| | Mini | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 |

**-Stress thermique:**

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Jour | f | f | / | / | / | c | c | c | c | / | f | f |
| Nuit | f | f | f | f | / | c | c | c | / | / | f | f |

### d- Indicators

| | J | F | M | A | M | J | J | A | S | O | N | D |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| H1 | | | | | | | | | X | | | |
| H2 | | | | | | | | | | | | |
| H3 | | | | x | x | | | | | X | | |
| A1 | | | x | | | | | | | | | |
| A2 | | | | | | | X | X | | | | |
| A3 | x | x | | | | x | | | | | X | X |

## Architectural recommendations for Algeria (N.Ould Hnia)

a- summer climate zones

According to the summer climatic zones which were defined by Ould Hnia, the wilaya of Biskra is located in zone E3 ( pre-Sahara tassili), this zone is characterized by a very hot and dry summer.

| Recommandations | Les principes dans la période d'été |
|---|---|
| 1.Orientation | Nord-sud ( est et ouest à proscrire). |
| 2.Espacement entre les bâtiments | Plan compact en diminuant l'exposition des murs avec l'extérieur |
| 3.Ventilation ou aération d'été | Ventilation nocturne |
| 4.Ouvertures/fenetres | Moyenne 25 à 40 % |
| 5. Murs et planchers | Murs et planchers massifs. Forte inertie thermique multi journalière (hors période surchauffe) avec couleurs claires. |
| 6.toiture | Massive. Forte inertie thermique multi journalière (hors période surchauffe) avec couleurs claires. |
| 7.Isolation thermique | Toiture isolée |
| 8.protection | Protection d'été. Occultation totale des ouvertures, ouvertures nord-sud |
| 9.Espaces extérieurs | Emplacement pour le sommeil en plein air. Cuisine à l'extérieur |
| 10. Végétation | Végétation ombrage murs et fenetres. |
| 11. Chauffage passif | / |

b- winter climate zones

According to the winter climatic zones, which were defined by Ould Hnia, the wilaya of Biskra is located in zone H3a, this zone is characterized by an altitude between 500-1000.

| Recommandations | Les principes dans la période d'hiver |
|---|---|
| 1.Orientation | Nord-sud souhaitée avec occupation Verticale des espaces. |
| 2.Espacement entre les bâtiments | Plan compact en diminuant l'exposition des murs en contact avec l'extérieur |
| 3.Ventilation ou aération d'été | / |
| 4.Ouvertures/fenetres | Sur surface totale ouvertures prévues,affecter pour captage soleil hiver surface vitrage sud égale à 0.15 par m² plancher. |
| 5. Murs et planchers | Murs et planchers massif-inertie thermique journalière>8 heures compromis à prendre avec l'été. |
| 6.toiture | Toiture massive et isolée. |
| 7.Isolation thermique | Isolation thermique par toiture. |
| 8.protection | D'hiver des vents de sable par plantation à feuilles persistantes qui poussent dans le sud . |
| 9.Espaces extérieurs | / |
| 10. Végétation | Végétation à feuilles persistantes pour vents dominants froids et surtout de sable. |
| 11. Chauffage passif | Chauffage passif par stockage murs massifs inertie déphasage 8 à 12 heures ou vitrage sud. |
| 12.Climatisation | / |

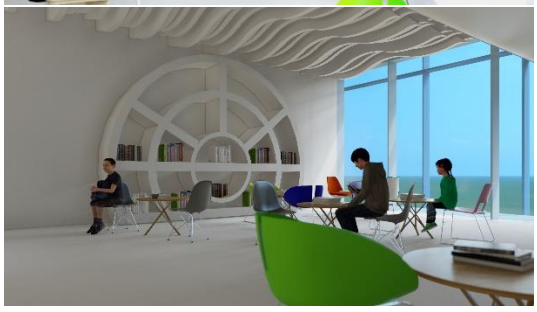
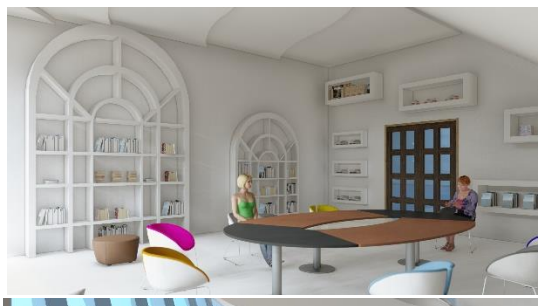
**Annexe-B**
**Project views**




















**Annex -c**

الجمهورية الجزائرية الديمقراطية الشعبية

وزارة التعليم العالي والبحث العلمي

جامعة محمد خيضر - بسكرة

حاضنة أعمال جامعة بسكرة

رقم 27/ الحاضنة /2024

# شهـــادة توطيـــن /تحضيـــن "مشروع مبتكر ضمن قرار 1275"

انا الممضي أسفله، السيد (ة): **محمد جلاب**

مسير(ة) حاضنة الأعمال: **جامعة محمد خيضر – بسكرة-**

المقر الاجتماعي / العنوان: **المجمع الإداري المقابل لكلية العلوم الاقتصادية، الطابق الثاني، جامعة بسكرة 07000**

رقم علامة الحاضنة: **2311223051**

تاريخ تسليم العلامة: **23 نوفمبر2022**

أشهد أن الطالبة الذاتية أسمها:

| الاسم و اللقب | الطور الدراسي | التخصص | الكلية |
|---|---|---|---|
| لونيس مريم | ماستر 02 | هندسة معمارية | العلوم والتكنولوجيا |

تحت إشراف الاساتذة الذاتية أسمائهم:

| الاسم و اللقب | الرتبة | التخصص | الكلية |
|---|---|---|---|
| مزردي توفيق | أستاذ محاضر أ | هندسة معمارية | العلوم والتكنولوجيا |
| دعيش حياة | أستاذ محاضر أ | هندسة معمارية | العلوم والتكنولوجيا |

تم احتضانه على مستوى حاضنة أعمال جامعة محمد خيضر - بسكرة بمشروع تحت اسم:
تطوير أداة نمذجة لتحسين وتعزيز الميزة الصوتية في الواجهة المعمارية من خلال الذكاء الاصطناعي
خلال السنة الجامعية 2024/2023 .

سلمت هذه الشهادة بطلب من المعني للإدلاء بها في حدود ما يسمح به القانون.

حرر في: بسكرة بتاريخ 2024/01/27

مدير الحاضنة

مدير حاضنة المؤسسات الناشئة

د/ محمد جـــلاب

Scanné avec CamScanner

**الجمهورية الجزائرية الديمقراطية الشعبية**

وزارة التعليم العالي والبحث العلمي جامعة محمد خيضر – بسكرة –

جامعة محمد خيضر – بسكرة

## عنوان المشروع:

تطوير اداة نمذجة لتحسين وتعزيز الميزة الصوتية في الواجهة المعمارية

من خلال الذكاء الاصطناعي

الاسم التجاري

**Acous**

**Acoustic solution**

صورة العلامة التجارية

السنة الجامعية 2024/2023

## بطاقة معلومات:

حول فريق الاشراف وفريق العمل

1-فريق الاشراف

| فريق الاشراف | |
|---|---|
| الأستاذ المشرف مزردي توفيق | هندسة معمارية |
| الأستاذة المساعد دعيش صفاء | هندسة معمارية |

2-فريق العمل

| فريق المشروع | التخصص | الكلية |
|---|---|---|
| اونيس مريم | هندسة معمارية | العلوم والتكنولوجيا |

# فهرس المحتويات

# المحور الاول: تقديم المشروع

بدات فكرة المشروع من خلال ملاحظة التاثير العميق للتلوث الضوضائي على الحياة الحضرية والتجاهل الكبير للاعتبارات الصوتية في تصميمات الهندسة المعمارية. وكذلك رؤية الدراسات والاحصائيات التي يؤدي بها التلوث الضوضائي نذكر منها:

- وفقًا لوكالة البيئة الأوروبية، يتعرض أكثر من 100 مليون شخص في أوروبا لمستويات ضارة من الضوضاء البيئية، تأتي بشكل رئيسي من حركة المرور على الطرق، السكك الحديدية، والمصادر الصناعية.
- أظهر مسح أجرته مؤسسة أبحاث البناء (BRE) أن 30% من شاغلي المباني أبلغوا عن عدم رضاهم عن مستويات الضوضاء، مما يبرز الحاجة إلى تصميم صوتي أفضل في مشاريع البناء.
- أفاد المعهد الوطني لعلوم البناء أن دمج استراتيجيات التصميم الصوتي الفعالة يمكن أن يقلل من شكاوى الضوضاء بنسبة تصل إلى 50%.
- تقدر منظمة الصحة العالمية (WHO) أن التلوث الضوضائي يسهم في فقدان 1.6 مليون سنة حياة صحية سنويًا في أوروبا الغربية بسبب تأثيراته على اضطرابات النوم، أمراض القلب والأوعية الدموية، وضعف الإدراك لدى الأطفال.
- وجدت دراسة نشرت في مجلة المنظورات الصحية البيئية أن التعرض طويل الأمد لمستويات عالية من الضوضاء يزيد من خطر الإصابة بارتفاع ضغط الدم بنسبة 15% وأمراض القلب التاجية بنسبة 20%.
- تم ربط التعرض المستمر للضوضاء بزيادة مستويات التوتر والقلق والاكتئاب. أفادت دراسة في مجلة علم النفس البيئي أن الأفراد الذين يتعرضون لمستويات عالية من الضوضاء يكونون أكثر عرضة بنسبة 25% للمعاناة من ضائقة نفسية كبيرة.
- وجدت أبحاث من الجمعية الأمريكية لعلم النفس أن التلوث الضوضائي يؤثر سلبًا على الأداء المعرفي، بما في ذلك الذاكرة، الانتباه، ومهارات حل المشكلات، خاصةً لدى الأطفال وكبار السن.
- وجدت دراسة استقصائية أجرتها جمعية الصوتيات الأمريكية أن 60% من المستجيبين في المناطق الحضرية الصاخبة شعروا بأن قدرتهم على الاستمتاع بالأماكن الخارجية والتفاعل الاجتماعي تضررت بشكل كبير بسبب الضوضاء.

- تشير الأبحاث إلى أن التلوث الضوضائي يمكن أن يؤدي إلى زيادة التآكل والتلف على واجهات المباني بسبب الاهتزازات والارتدادات الناتجة عن الضوضاء، مما يقلل من سلامتها الهيكلية وعمرها الافتراضي.

على الرغم من الأهمية البالغة للصوتيات، إلا أن عددًا قليلاً فقط من المتخصصين في مجالنا يأخذون في الاعتبار الجوانب الصوتية في مشاريع التصميم الخاصة بهم.

**مجال نشاطنا يتمثل في التطبيقات الحديثة " تطوير اداة نمذجة لتحسين وتعزيز الميزة الصوتية في الواجهة المعمارية من خلال الذكاء الاصطناعي**

## فكرة المشروع الحل المقترح

سيساعد التطبيق المهندسين المعماريين على انشاء بيئات متوازنة صوتيا، وذلك من خلال تحليل البيئة الخارجية المحيطة بواجهة المبنى، وقياس مستويات انبعاث الصوت، وتقديم توصيات مفصلة للحلول الصوتية. ستساعد هذه الحلول المهندسين المعماريين والمهندسين على دمج استراتيجيات تخفيف الضوضاء في تصميماتهم، مما يعزز الراحة الصوتية لشاغلي المبنى.

## تعريف المشروع

| العنصر | الشرح |
|---|---|
| طبيعة المشروع | تطوير أداة نمذجة لتحسين وتعزيز الميزة الصوتية في الواجهة المعمارية من خلال الذكاء الاصطناعي |
| اسم المشروع | Acous « acoustic solution » |
| مجال النشاط | تطبيقات حديثة |
| موقع المشروع | ولاية بسكرة |
| النطاق | وطني, دولي |
| الفئه المستهدفة | وزارة التعليم العالي, المهندسين المعماريين, مكاتب الدراسات, مستثمرين عقاريين, طلبة الهندسة المعمارية, أساتذة الجامعيين في مجال الهندسة المعمارية |
| عدد العمال | 07 |
| تسمية النشاط | تطوير تطبيقات في مجال الصوتيات والتلوث الضوضائي |
| مضمون النشاط | تحليل البيئة الخارجية المحيطة بواجهة المباني. |

| | |
|---|---|
| | قياس مستويات انبعاث الصوت.<br>تقديم توصيات مفصلة للحلول الصوتية.<br>اقتراح تجار وممولين. |
| الشكل القانوني للمؤسسة | شخص معنوي SARL |
| تكلفه شراء الارضية | 00 دينار جزائري |

## القيم المقترحة

- تحسين الراحة الصوتية: يعمل التطبيق على تحسين البيئة الصوتية، مما يقلل من مستويات الضوضاء والصدى لإنشاء مساحة أكثر راحة للمستخدمين.
- حلول قابلة للتخصيص: يقدم التطبيق حلولاً قابلة للتخصيص لمواجهة تحديات صوتية محددة في بيئات مختلفة، وتقديم توصيات مخصصة لكل سيناريو.
- واجهة سهلة الاستخدام: يتميز التطبيق بواجهة سهلة الاستخدام تسهل على المهندسين المعماريين والمصممين فهم التوصيات الصوتية وتنفيذها.
- حلول فعالة من حيث التكلفة: يقترح التطبيق حلولاً فعالة من حيث التكلفة لتحسين الصوتيات، مما يضمن إمكانية تحقيق التحسينات الصوتية ضمن قيود الميزانية.
- كفاءة الطاقة: يأخذ التطبيق في الاعتبار كفاءة الطاقة في توصياته، مما يضمن أن التحسينات الصوتية لا تؤثر على أداء الطاقة الإجمالي للمبنى.
- نهج التصميم المتكامل: يعزز التطبيق نهج التصميم المتكامل، مما يشجع المهندسين المعماريين على مراعاة العوامل الصوتية في وقت مبكر من عملية التصميم لتحسين الأداء العام للمبنى.
- التحليل الشامل: يوفر التطبيق تحليلاً شاملاً للبيئة الصوتية، مع الأخذ في الاعتبار عوامل مثل مستويات الضوضاء والصدى ووضوح الكلام لتقديم حلول شاملة.
- توفير الراحه النفسية والجسدية للسكان وخاصة كبار السن للأطفال.

## فريق العمل

| الطلبة | التخصص | الدورات التكوينية |
|---|---|---|
| أونيس مريم | هندسة معمارية | – شهادة في اللغة الانجليزية مستوىB2<br>– تربص ميداني على مستوى مديرية الترقية والتسيير العقاري–بسكرة. |

| | | |
|---|---|---|
| | | – تربص ميداني على مستوى مكتب دراسات.<br>– دورات تكوينية حول برامج المحاكاة 3D<br>– دورة تكوينية في مجال البرمجة و الذكاء الاصطناعي |

## اهداف المشروع

**أهداف قريبة المدى:**

- ✓ تطوير التطبيق: ابتكار تطبيق متكامل وسهل الاستخدام لتحليل وتحسين الخصائص الصوتية في البيئات الداخلية والخارجية.
- ✓ اختبار وتحسين الأداء: تقييم أداء التطبيق وضبطه لضمان جودة وفعالية النتائج.
- ✓ جذب العملاء: ترويج التطبيق وجذب عدد كبير من العملاء المحتملين للاستفادة من خدماته.
- ✓ شراكات استراتيجية مع الشركات الأخرى: إيجاد شراكات استراتيجية مع شركات البناء وتوزيع المواد لتعزيز قنوات التوزيع وزيادة حصة السوق.

**اهداف متوسطة المدى:**

- ✓ تطوير حلول تقنية مبتكرة: البحث عن تقنيات جديدة للتحكم في الضوضاء في المباني. وتطوير أنظمة ذكية لقياس الضوضاء وإدارة مستوياتها في الوقت الفعلي. ودمج مبادئ التصميم الصوتي مع تقنيات البناء الذكي.
- ✓ التأثير الاجتماعي والبيئي: تحقيق تأثير إيجابي على المجتمع والبيئة من خلال توفير بيئات صوتية أفضل.
- ✓ الابتكار المستمر: الاستمرار في البحث والتطوير لتحسين التطبيق وإضافة مزيد من الميزات الجديدة.

**أهداف بعيدة المدى:**

- ✓ تحقيق الاستدامة المالية: ضمان استمرارية المشروع من الناحية المالية عبر زيادة الإيرادات وتقليل التكاليف." توسيع قاعدة العملاء وتنويع خطط الأسعار لتحقيق أقصى استفادة مالية."
- ✓ تحقيق التميز التكنولوجي: الوصول إلى مستوى رفيع من التميز التكنولوجي والابتكار في مجال تحليل وتحسين الخصائص الصوتية." توفير تقنيات وحلول متقدمة تضع المشروع في مكانة متقدمة في سوق التكنولوجيا الصوتية".

- ✓ دعم التغييرات في السياسات:
  - o الدعوة إلى اعتماد معايير تصميم صوتي إلزامية للمباني الجديدة والتجديدات.
  - o العمل مع الحكومات والمنظمات الدولية لتطوير سياسات تهدف إلى تقليل التلوث الضوضائي.
  - o تشجيع استخدام مواد بناء صديقة للصوت في مشاريع البناء.
- ✓ تعزيز التعاون الدولي:
  - o مشاركة المعرفة والخبرات مع خبراء التصميم الصوتي في جميع أنحاء العالم.
  - o التعاون في تطوير معايير دولية للتصميم الصوتي للمباني.
  - o المساهمة في الجهود العالمية لمكافحة التلوث الضوضائي.
- ✓ التوسع العالمي: توسيع نطاق التطبيق ليصبح مرجعًا عالميًا في تحليل وتحسين الخصائص الصوتية

## جدول زمني لتحقيق الأهداف

## المحور الثاني: الجوانب الابتكارية

1- **طبيعة الابتكار**: ابتكارات تكنولوجية

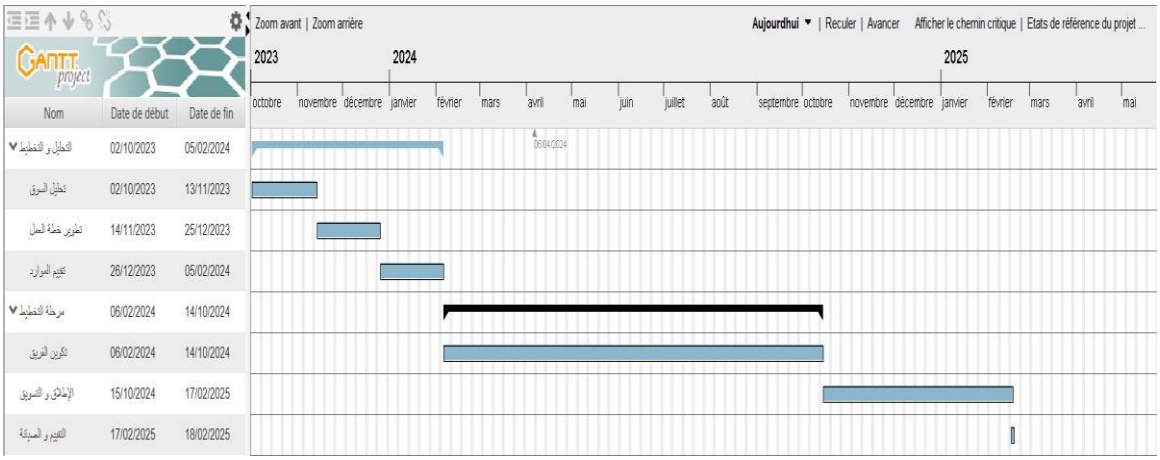
**2- مجالات ابتكارية:**

- التميز: التطبيق هو الأول من نوعه في السوق الذي يجمع بين حساب مستويات انبعاث الصوت وتقديم التوصيات والحلول الفورية.
- تحليل البيانات الذكي: استخدام تقنيات الذكاء الاصطناعي لتحليل البيانات وتحسين أداء العزل بناءً على معطيات دقيقة.
- التحليل الشامل: توفير تقارير تحليلية شاملة للمستخدمين حول أداء العزل واقتراحات للتحسين
- سهولة الاستخدام: تصميم واجهة مستخدم بسيطة وبديهية تسهل على المستخدمين التعامل مع التطبيق وتحقيق أقصى استفادة منه.
- التصميم المستدام: تقديم حلول عزل مستدامة تقلل من الأثر البيئي وتساهم في الحفاظ على الموارد الطبيعية.
- التفاعل الاجتماعي: إضافة ميزات تفاعلية تسمح للمستخدمين بمشاركة تجاربهم وآرائهم والاستفادة من تجارب الآخرين.

- حساب مستويات انبعاث الصوت: التطبيق يوفر ميزة فريدة لحساب مستويات انبعاث الصوت بدقة عالية، مما يساعد المستخدمين على فهم طبيعة الضوضاء المحيطة.
- تقديم توصيات وحلول فورية: بناءً على البيانات المحللة، يقدم التطبيق توصيات وحلول مخصصة لكل حالة لضمان تحسين العزل الصوتي بفعالية.

## المحور الثالث: التحليل الاستراتيجي للسوق

### 1- تحليل GANTT




### 2- تحليل PESTEL

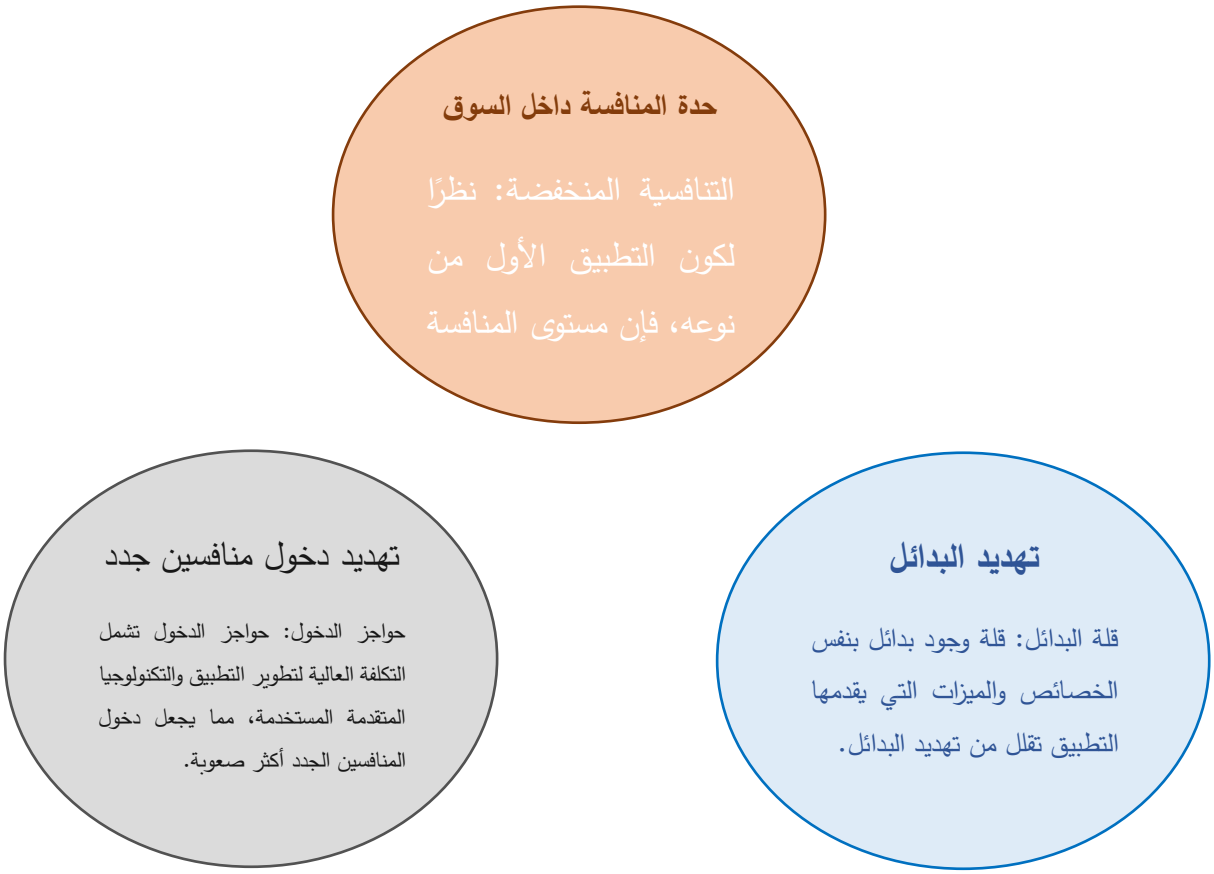
| سياسية | اقتصادية | اجتماعية | قانونية | بيئية | تكنولوجية |
|---|---|---|---|---|---|
| • التشريعات والسياسات الحكومية المتعلقة بالبناء والتطوير العقاري<br>• إمكانية الحصول على دعم حكومي أو حوافز للمشاريع التي تعزز كفاءة الطاقة وتستخدم تقنيات العزل المستدامة<br>• الاستقرار السياسي في الأسواق المستهدفة<br>• متابعة السياسات الحكومية والتشريعات التي قد تؤثر على سوق العزل الصوتي والحراري<br>• السعي للحصول على دعم حكومي أو حوافز لتعزيز وتوسيع نطاق تطبيقك<br>• التركيز على الأسواق المستقرة سياسياً لتقليل المخاطر. | • دراسة السوق وتحليل الظروف الاقتصادية لتحديد استراتيجيات التسعير المناسبة.<br>• الوضع الاقتصادي العام وقدرته على التأثير على القدرة الشرائية للشركات والأفراد<br>• إدارة التكاليف بكفاءة لتقليل النفقات وزيادة العائد على الاستثمار.<br>• تكاليف تطوير وتسويق التطبيق.<br>• البحث عن فرص استثمارية لتمويل المشاريع التوسعية.<br>• إمكانية الحصول على استثمارات لتمويل تطوير وتحسين التطبيق. | • تنفيذ حملات توعية وتثقيف لزيادة معرفة الجمهور بأهمية العزل<br>• تقديم مواد تعليمية وتوعوية حول فوائد التطبيق وميزاته.<br>• استهداف المناطق الحضرية والمكتظة بالسكان لتوسيع قاعدة العملاء.<br>• زيادة الوعي بين الناس حول أهمية العزل الصوتي والحراري في تحسين جودة الحياة.<br>• مدى معرفة الجمهور بأهمية العزل الصوتي والحراري وفعالية التطبيقات التي تدعمه<br>• زيادة النمو السكاني والتحضر يمكن أن يزيد من الطلب على حلول العزل في المباني. | • الامتثال للمعايير واللوائح المحلية والدولية المتعلقة بتقنيات العزل الصوتي والحراري<br>• متابعة التغيرات في التشريعات واللوائح لضمان الامتثال الكامل.<br>• حماية حقوق الملكية الفكرية لتطبيقك وضمان عدم انتهاكها من قبل المنافسين.<br>• تسجيل حقوق الملكية الفكرية وتأمينها لحماية تطبيقك من التقليد والانتهاك.<br>• التفاوض مع الشركاء والعملاء لضمان عقود قانونية تضمن حقوق جميع الأطراف<br>• العمل مع خبراء قانونيين لصياغة عقود واضحة ومحمية | • تطوير حلول عزل مستدامة تقلل من الأثر البيئي وتساهم في الحفاظ على الموارد الطبيعية.<br>• الحاجة إلى حلول صديقة للبيئة ومستدامة في مجال العزل الصوتي والحراري.<br>• التركيز على تطوير منتجات صديقة للبيئة وتلبي معايير الاستدامة.<br>• تأثيرات التغير المناخي وزيادة الطلب على تقنيات تحسين كفاءة الطاقة في المباني<br>• ضمان الامتثال للمعايير البيئية في جميع مراحل تطوير وتوزيع التطبيق.<br>• الالتزام باللوائح والتشريعات البيئية المتعلقة بالمواد المستخدمة في العزل. | • الاستثمار في البحث والتطوير لمواكبة التطورات التكنولوجية وتقديم حلول مبتكرة<br>• الابتكارات في مجال تقنيات العزل الصوتي والحراري يمكن أن توفر فرصاً لتحسين التطبيق<br>• ضمان أن التطبيق يمكنه العمل بكفاءة مع البنية التحتية الرقمية المتاحة.<br>• تعزيز جهود البحث والتطوير لتحسين فعالية التطبيق وإضافة ميزات جديدة<br>• توفر الإنترنت والبنية التحتية الرقمية اللازمة لدعم تشغيل وتحديث التطبيق.<br>• استثمار في البحث والتطوير لتحسين فعالية التطبيق وإضافة ميزات جديدة |

## 3- تحليل S.W.O.T

| نقاط القوة(Strengths) | نقاط الضعف(Weaknesses) |
|---|---|
| - الابتكار الحصري :أول تطبيق يجمع بين حساب مستويات انبعاث الصوت وتقديم التوصيات والحلول الفورية .<br>- التقنيات المتقدمة :استخدام الذكاء الاصطناعي والتعلم الآلي لتحليل البيانات وتقديم حلول مخصصة .<br>- واجهة المستخدم :تصميم واجهة بسيطة وبديهية تعزز تجربة المستخدم. | - الوعي السوقي :قلة الوعي بين العملاء المحتملين حول فوائد التطبيق يمكن أن يؤثر على التبني السريع. |

| الفرص(Opportunities) | التهديدات(Threats) |
|---|---|
| - السوق المتنامي :زيادة الطلب على حلول العزل الصوتي والحراري مع زيادة النمو السكاني والتحضر .<br>- الدعم الحكومي :إمكانية الحصول على دعم حكومي وحوافز للمشاريع المستدامة<br>- الشراكات الاستراتيجية :التعاون مع شركات البناء والتطوير لتعزيز التوزيع وزيادة الحصة السوقية. | - المنافسة :دخول منافسين جدد إلى السوق يمكن أن يقلل من الحصة السوقية<br>- التغيرات التشريعية :تغييرات في التشريعات واللوائح البيئية والبنائية قد تؤثر على التطبيق<br>- الوضع الاقتصادي :تقلبات الوضع الاقتصادي يمكن أن تؤثر على القدرة الشرائية للعملاء. |

## 4- تحليل PORTER




## 5-المزيج التسويقي

| المنتج/ الخدمة | خصائص ومميزات منتجاتك/خدماتك | الاحتياجات التي يلبيها |
|---|---|---|
| اداة نمذجة لتحسين وتعزيز الميزة الصوتية في الواجهة المعمارية من خلال الذكاء الاصطناعي | ○ حساب مستويات انبعاث الصوت.<br>○ تقديم توصيات وحلول فورية حسب حالة المستخدم.<br>○ استخدام الذكاء الاصطناعي لتحليل البيانات وتقديم حلول مخصصة.<br>○ واجهة مستخدم بسيطة وبديهية.<br>○ تحليل البيئة الخارجية المحيطة بواجهة المباني.<br>○ اقتراح تجار وممولين.<br>○ تحسينات مستمرة على الأداء والوظائف بناءً على ردود فعل المستخدمين.<br>○ إضافة ميزات جديدة لتعزيز القيمة المضافة للتطبيق. | ○ تحسين جودة الحياة من خلال تقليل الضوضاء.<br>○ تقديم حلول فعالة ومستدامة للعزل الصوتي والحراري.<br>○ توفير الوقت والمال من خلال توصيات مخصصة. |

## 6-السعر

**استراتيجية التسعير:** استخدام نموذج تسعير يعتمد على الاشتراك الشهري أو السنوي لتوفير وصول مستمر إلى التحديثات والدعم الفني.

تقديم فترة تجربة مجانية لجذب المستخدمين وإظهار قيمة التطبيق.

تسعير تنافسي مع مراعاة القيمة المضافة التي يقدمها التطبيق مقارنة بالبدائل التقليدية.

**تسعير مرن:**

تقديم حزم تسعير متعددة لتلبية احتياجات مختلف العملاء (مثل الأفراد، الشركات الصغيرة، الشركات الكبيرة).

## 7-الترويج

| وسيلة الترويج | التفاصيل | التكلفة |
|---|---|---|
| حملات إعلانية | حملات إعلانية عبر الإنترنت تستهدف الأسواق المستهدفة باستخدام وسائل التواصل الاجتماعي ومنصات البحث. | مجاني |
| إنشاء محتوى تعليمي | إنشاء محتوى تعليمي (مثل المدونات، والفيديوهات) لزيادة الوعي بفوائد التطبيق. | مجاني |
| العلاقات العامة | نشر المقالات في المجلات والمواقع المختصة بالبناء والتكنولوجيا لزيادة الوعي بالتطبيق.<br>المشاركة في المؤتمرات والمعارض الخاصة بالبناء والتكنولوجيا للترويج للتطبيق والتواصل مع الشركاء والعملاء المحتملين. | مجاني |
| التسويق عبر العلاقات | تقديم برامج إحالة للمستخدمين الحاليين لتشجيعهم على دعوة الآخرين لاستخدام التطبيق.<br>توفير خدمة عملاء ممتازة لدعم العملاء وحل مشاكلهم بسرعة وكفاءة. | مجاني |
| مقابلة | من خلال الذهاب للمؤسسات وعرض الخدمة | تكلفة النقل= 2000دج |

## 8-التوزيع

**الطريقة الأولى**

- نشر التطبيق على منصات التحميل الرقمية مثل App Store وGoogle Play لضمان وصول سهل إلى المستخدمين.
- إنشاء موقع ويب خاص بالتطبيق يوفر معلومات شاملة وروابط تحميل مباشرة.

**الطريقة الثانية**

- الشراكات: التعاون مع شركات البناء والتطوير العقاري لترويج التطبيق كجزء من حزمة العزل الحراري والصوتي.
- إقامة شراكات مع مقدمي الخدمات التكنولوجية لتوسيع نطاق الوصول إلى العملاء المحتملين.

طريقة الدفع: طريقة الدفع تكون على شكل

## 9- عرض القطاع السوقي

**السوق المستهدف:** اي شخص يعمل في مجال الهندسة والهندسة المعمارية ومجال البناء.

**السوق المحتمل:** مكاتب الدراسات، مستثمرين عقاريين في مجال البناء، تجار، ممولين، مؤسسات البناء والترقية العقارية.

**سوق متخصص:** أصحاب مشاريع الصحة (مستشفيات، عيادة).

**تحليل السوق**

**تحليل الزبائن**

| الزبائن |
|---|
| وزارة التعليم العالي |
| المهندسين المعماريين |
| مكاتب الدراسات |
| مستثمرين عقاريين |
| طلبة الهندسة المعمارية |
| أساتذة الجامعيين في مجال الهندسة المعمارية |
| مؤسسات البناء والترقية العقارية. |
| تجار وممولين في مجال البناء |

**تحليل المنافسين**

منافسين مباشرين

منافسين عالمين

| الاسم | الموقع | الخبرة |
|---|---|---|
| **Arup** | شركة هندسة واستشارات عالمية تقدم خدمات التصميم الصوتي للمباني من جميع الأنواع، بما في ذلك المنازل والمكاتب والمستشفيات والمدارس | 70سنة |
| **AECOM** | شركة هندسة وبناء عالمية تقدم خدمات التصميم الصوتي للمباني والمرافق العامة. | 25 سنة |
| **WSP** | شركة استشارات هندسية عالمية تقدم خدمات التصميم الصوتي للمباني والبنية التحتية. | 50 سنة |
| **Jacobs** | شركة هندسة وبناء عالمية تقدم خدمات التصميم الصوتي للمباني والمرافق الصناعية. | 50 سنة |
| **Ramboll** | شركة هندسة واستشارات عالمية تقدم خدمات التصميم الصوتي للمباني والبنية التحتية | 75 سنة |

منافسين اقليمين

| | | |
|---|---|---|
| **BuroHappold** | شركة هندسة واستشارات إقليمية (الشرق الأوسط وأفريقيا) تقدم خدمات التصميم الصوتي للمباني من جميع الأنواع | 50 سنة |
| **Atkins** | شركة هندسة واستشارات إقليمية (الشرق الأوسط) تقدم خدمات التصميم الصوتي للمباني والبنية التحتية | 80 سنة |
| **Dar Al-Handasah Shair and Young** | شركة هندسة واستشارات إقليمية (الشرق الأوسط وشمال إفريقيا) تقدم خدمات التصميم الصوتي للمباني والبنية التحتية. | 50 سنة |
| **Parsons** | شركة هندسة وبناء إقليمية (الشرق الأوسط) تقدم خدمات التصميم الصوتي للمباني والمرافق الصناعية. | 50 سنة |
| **AECOM Middle East** | فرع إقليمي لشركة AECOM العالمية يقدم خدمات التصميم الصوتي للمباني والبنية التحتية في منطقة الشرق الأوسط | 15 سنة |
| **Acoustic Design Consultants (ADC)** | شركة هندسة صوتية محلية (الجزائر) تقدم خدمات التصميم الصوتي للمباني من جميع الأنواع | 25 |
| **Acoustics & Vibration Consultants (AVC)** | شركة هندسة صوتية محلية (المغرب) تقدم خدمات التصميم الصوتي للمباني من جميع الأنواع | 20 |
| **Acoustics & Vibration Engineering Consultants (AVEC)** | شركة هندسة صوتية محلية (مصر) تقدم خدمات التصميم الصوتي للمباني من جميع الأنواع | 30 |
| **Acoustic Design Bureau (ADB)** | شركة هندسة صوتية محلية (تونس) تقدم خدمات التصميم الصوتي للمباني من جميع الأنواع. | 10 |
| **Acoustics & Vibration Consultants (AVC)** | شركة هندسة صوتية محلية (الأردن) تقدم خدمات التصميم الصوتي للمباني من جميع الأنواع | 15 |

**استراتيجيات التسويق:**

**استراتيجية الانطلاق:**

- **التسويق الرقمي:** استخدام وسائل التواصل الاجتماعي والمواقع الإلكترونية للترويج للتطبيق.
- **الشراكات والتعاونات:** البحث عن فرص التعاون مع شركات أو منظمات في مجال الهندسة المعمارية والتصميم لتعزيز التطبيق وجذب الاهتمام.
- **التسويق الإعلاني:** استخدام الإعلانات عبر الإنترنت والشبكات الاجتماعية لزيادة الوعي بالتطبيق وجذب المزيد من المستخدمين المحتملين.
- **المحتوى التعليمي:** القيام بإنشاء محتوى تعليمي يشرح كيفية استخدام التطبيق وفوائده، وانشره عبر القنوات المناسبة.
- **الترويج المباشر:** المشاركة في معارض وفعاليات صناعية لعرض التطبيق وجذب العملاء المحتملين.

**استراتيجية التوسع:**

- **تحديثات وتطويرات منتظمة:** القيام بإصدار تحديثات منتظمة لتحسين وظائف التطبيق وإضافة ميزات جديدة لجذب المزيد من المستخدمين.
- **التوسع إلى أسواق جديدة:** بمجرد تحقيق النجاح في السوق الحالية، القيام بالتوسع إلى أسواق جديدة واستهداف فئات جديدة من المستخدمين.
- **التعاون مع شركاء استراتيجيين:** البحث عن شركاء من أجل توسيع نطاق توزيع التطبيق وزيادة شهرته.
- **التفاعل مع المستخدمين:** استماع لملاحظات المستخدمين واستجاب لاحتياجاتهم لتعزيز رضاهم وبقائهم مع التطبيق.

## المحور الرابع: خطة الإنتاج والتنظيم

### مخطط الإنتاجي

**الموقع** يقع عقار المشروع في طريق سيدي عقبة–بسكرة، بجانب جامعة محمد خيضر.


**سبب اختيار الموقع** بسبب قربه لجامعة محمد خيضر، سهولة التواصل والشراكة مع قسم الهندسة المعمارية وقسم الاعلام الالي بالجامعة وسهولة تطوير المشروع

**الجانب المعماري للمشروع** تقدر مساحة المشروع ب 48م$^2$

### احتياجات المشروع

### المعدات والآلات

| اسم العتاد | الكمية | السعر | السعر الإجمالي |
|---|---|---|---|
| حاسوب | 07 | 200 000,00 | 000 400 1, 00 |
| مكاتب | 07 | 10 000, 00 | 70 000, 00 |
| كراسي | 14 | 7 000,00 | 98 000, 00 |
| خزائن | 01 | 17 000, 00 | 17 000, 00 |

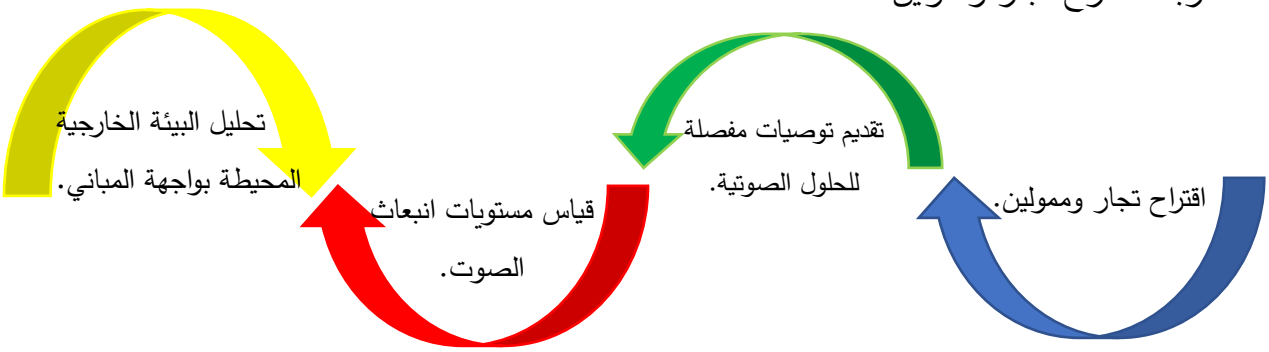
| | | | |
|---|---|---|---|
| ألة قياس الصوت sonomètres | 01 | 150 000,00 | 150 000, 00 |
| مودام انترنت | 02 | 4 000, 00 | 8 000, 00 |
| المجموع | | | 1 743 000, 00دج |

**احتياجات الطاقة والكهرباء**

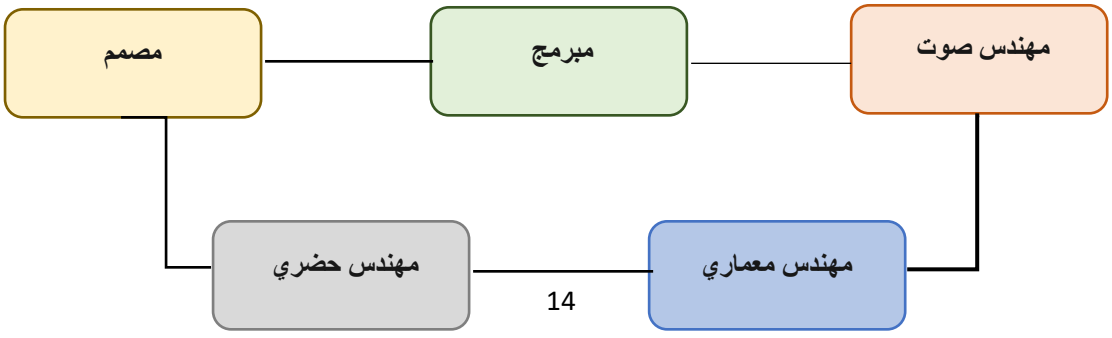
| الخدمات | احتياجات الثلاثي% الزيادة ب 1% | تكلفة السنة 1 |
|---|---|---|
| الماء | 200m³ | 10 800,00 |
| الكهرباء | | 60 000,00 |
| انترنت وهاتف | غير محدود | 30 000,00 |
| صيانة | / | 150 000,00 |
| المجموع | | 250 800,00دج |

**نظام الانتاجي: خطوات الإنتاج**

- أولا: تحليل البيئة الخارجية المحيطة بواجهة المباني.
- ثانيا: قياس مستويات انبعاث الصوت.
- ثالثا: تقديم توصيات مفصلة للحلول الصوتية.
- رابعا: اقتراح تجار وممولين.




**مخطط التنظيمي**



**احتياجات اليد العاملة والأجور**

| المنصب | العدد | التخصص | الوظيفة | الأجور |
|---|---|---|---|---|
| **مهندس صوت** | 02 | ماستر هندسة معمارية تخصص بيئة وتكنولوجيا | تحديد متطلبات التصميم الصوتي للمباني المختلفة، بما في ذلك المنازل والمكاتب والمستشفيات والمدارس.<br>البحث عن تقنيات التصميم الصوتي الأكثر فعالية وتطوير حلول مبتكرة | 70 000, 00 |
| **مبرمج** | 02 | ماستر اعلام الي | برمجة وتطوير التطبيق | 70 000,00 |
| **مصمم** | 01 | ماستر اعلام الي | تصميم التطبيق والموقع | 30 000,00 |
| **مهندس معماري** | 01 | ماستر هندسة معمارية | العمل على الحلول والتوصيات الخاصة بواجهات المباني المعمارية | 30 000,00 |
| **مهندس حضري** | 01 | ماستر تسيير تقنيات حضرية | تحليل البيئة الخارجية المحيطة بواجهة المباني.<br>اقتراح حلول في البيئة الحضرية | 20 000,00 |
| **المجموع** | | | | 220 000,00دج |

**التموين**

- **الآلات** تكون مرة واحدة فقط الا إذا احتجنا الآلات جديدة فأيضا يكون الشراء مرة واحدة فقط والدفع يكون اما عند الاستلام أو عن طريق CCP
- **تجهيزات المكتبية واللوازم** تكون مرة واحدة

**الشركاء**

| اسم الشريك | أهمية الشريك |
|---|---|
| البنوك | دور الكبير في تمويل المشروع وذهاب لتجسيده في أرض الواقع |
| الزبائن | الارتباطات والعلاقة الشخصية ودورهم في إنجاح المشروع |

## المحور الخامس الخطة المالية

### تكاليف المشروع واهتلاك الاستثمار

### تكاليف استثمارية

| الأصول | التكلفة |
|---|---|
| العقار | / |
| الآلات والمعدات | 15 580 000,00 |
| الأثاث | 17 000,00 |
| رأس المال العامل | / |
| المجموع | |

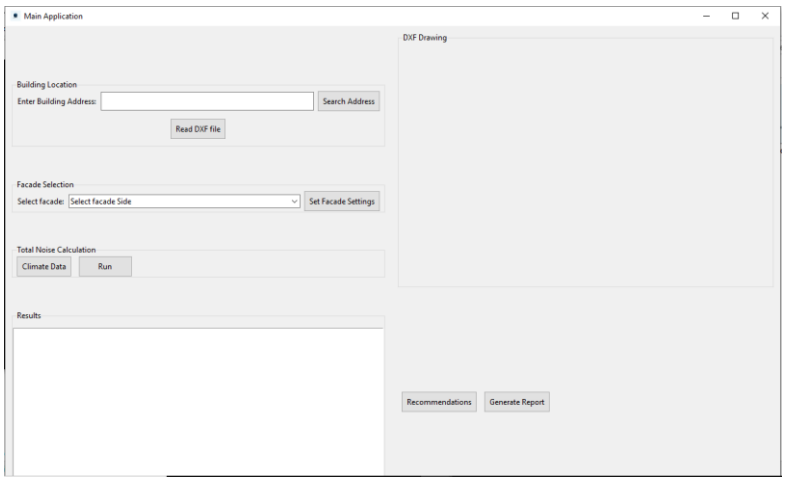
### التكاليف التشغيلية

| الأصول | التكلفة |
|---|---|
| الأجور | 2 640 000,00 |
| الهاتف والانترنت | 30 000,00 |
| الكهرباء والماء | 70 800,00 |
| المجموع | 2 740 800 دج |

### تقدير المبيعات

| / | جانفي | فيفري | مارس | أفريل | ماي | جوان | جويلية | أوت | سبتمبر | أكتوبر | نوفمبر | ديسمبر | المجموع |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2024(60%) | 14520 | 29040 | 43560 | 58080 | 72600 | 87120 | 101640 | 116160 | 130680 | 145200 | 159720 | 174240 | 1132560 |
| 2025(70%) | 16940 | 33880 | 50820 | 67760 | 84700 | 101640 | 118580 | 135520 | 152460 | 169400 | 186340 | 203280 | 1321320 |
| 2026(80%) | 19360 | 38720 | 58080 | 77440 | 96800 | 116160 | 135520 | 154880 | 174240 | 193600 | 212960 | 232320 | 1510080 |
| 2027(90%) | 21780 | 43560 | 65340 | 87120 | 108900 | 130680 | 152460 | 174240 | 196020 | 217800 | 239580 | 261360 | 1698840 |
| 2028(100%) | 24200 | 48400 | 72600 | 96800 | 121000 | 145200 | 169400 | 193600 | 217800 | 242000 | 266200 | 290400 | 1887600 |
| مجموع المبيعات ل5 سنوات | | | | | | | | | | | | | 7550400 |
| سعر المبيعات ل5 سنوات | | | | | | | | | | | | | 1170312000دج |

# المحور السادس النموذج الاولي التجريبي


| شرائح العملاء | العلاقات مع العملاء | القيم المقترحة | الأنشطة الرئيسية | الشركات الرئيسية |
|---|---|---|---|---|
| وزارة التعليم العالي<br>المهندسين المعماريين<br>مكاتب الدراسات<br>مستثمرين عقاريين<br>طلبة الهندسة المعمارية<br>طلبة الهندسة المعمارية<br>أساتذة الجامعيين في مجال الهندسة المعمارية<br>مؤسسات البناء والترقية العقارية.<br>تجار وممولين في مجال البناء | علاقة اوتوماتيكية مع العموم<br>خاصة مع المؤسسات والشركات<br>**القنوات**<br>حملات إعلانية<br>مقابلة<br>وسائل التواصل الاجتماعي<br>العلاقات العامة<br>إنشاء محتوى تعليمي | تحسين الراحة الصوتية والعزل الصوتي في المباني السكنية<br>حلول قابلة للتخصيص لمواجهة تحديات صوتية محددة في بيئات مختلفة، وتقديم توصيات مخصصة لكل سيناريو<br>واجهة سهلة الاستخدام<br>حلول فعالة من حيث التكلفة<br>كفاءة الطاقة<br>نهج التصميم المتكامل<br>التحليل الشامل<br>توفير الراحة النفسية والجسدية للسكان وخاصة كبار السن للأطفال. | تحليل البيئة الخارجية المحيطة بواجهة المباني.<br>قياس مستويات انبعاث الصوت.<br>تقديم توصيات مفصلة للحلول الصوتية.<br>اقتراح تجار وممولين.<br>**الموارد الرئيسية**<br>العمال<br>الآلات<br>عقار | تجار في مجال البناء والعزل<br>المؤسسات الناشئة والمصغرة في مجال العمارة، البناء، والعزل الصوتي |

| المصادر والإيرادات | هيكل التكاليف |
|---|---|
| الإعلانات<br>الرسوم | تكاليف ثابتة: اجار العاملين، تكاليف تهيئة المقر، تكاليف شراء الآلات والمعدات.<br>تكاليف متغيرة : تكاليف الصيانة |