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GRATITUDE AND APPRECIATION

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

"My Lord, inspire me to be grateful for Your favor which You have bestowed upon me and upon my parents and to do righteousness - that which You will approve for me and for my offspring. Indeed, I am of the Muslims." (Surat Al-Ahqaf: 15)

Praise be to God, by whose grace good deeds are accomplished. I send blessings and peace upon the Seal of the Prophets and Messengers, our Prophet Muhammad, and upon all his family and companions.

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

Aridj Meriem Yasmine SARRAI

Abstract

In response to the increasing demand for sustainable and energy-efficient architecture, this work examines how climate data can be integrated into parametric design processes to improve building performance. The study focuses on the use of computational design tools, such as Grasshopper and other generative modeling platforms, to incorporate environmental information during the early stages of architectural design.

By including climatic variables such as solar radiation, wind flow, air temperature, and humidity within parametric frameworks, the design process becomes more adaptive and data-oriented. This approach enables architects to move beyond static forms and to create designs that interact dynamically with their environment. The outcomes are architectural solutions that combine aesthetic quality, functional efficiency, and measurable improvements in energy performance, thermal comfort, and environmental adaptability.

This work builds on selected research focused on digital simulations and environmental performance assessments. In those studies, various design scenarios are examined using daylight analysis, energy modeling, and thermal evaluation tools to explore how incorporating climate data can affect spatial configuration and material selection.

Key-words : Parametric Design, Climate Data , Computational Design, Environmental Performance, Building Envelope , Building Optimization, Digital Simulation.

الملخص

استجابةً للطلب المتزايد على العمارة المستدامة والتصميم الموقر للطاقة، يتناول هذا البحث كيفية دمج بيانات المناخ في عمليات التصميم البرامتري بهدف تحسين أداء المباني. يركز هذا العمل على استخدام أدوات التصميم الحاسوبي، مثل **Grasshopper** ومنصات النمذجة التوليدية الأخرى، لإدخال المعطيات البيئية في المراحل الأولى من عملية التصميم المعماري.

من خلال إدماج المتغيرات المناخية مثل الإشعاع الشمسي، تدفق الرياح، درجة حرارة الهواء، والرطوبة داخل الأطر البرامترية، يصبح التصميم أكثر تكيفًا وارتكازًا على البيانات. يتيح هذا النهج للمعماريين تجاوز الأشكال الثابتة نحو تصاميم تتفاعل ديناميكيًا مع بيئتها. والنتيجة هي حلول معمارية تجمع بين الجماليات، الكفاءة الوظيفية، والتحسينات القابلة للقياس في أداء الطاقة، والراحة الحرارية، والقدرة على التكيف البيئي.

يرتكز هذا العمل على مجموعة من الدراسات السابقة التي تناولت المحاكاة الرقمية وتحليل الأداء البيئي. في هذه الدراسات، تم اختبار عدة سيناريوهات تصميم باستخدام أدوات تحليل الإضاءة الطبيعية، ونمذجة استهلاك الطاقة، والتقييم الحراري، لاستكشاف كيفية تأثير دمج بيانات المناخ على تنظيم الفضاء واختيار المواد.

الكلمات المفتاحية: التصميم البرامتري، بيانات المناخ، التصميم الحاسوبي، الأداء البيئي، الغلاف الخارجي للمبنى، تحسين أداء المباني، المحاكاة الرقمية.

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INTRODUCTORY CHAPTER

I. INTRODUCTORY CHAPTER

I.1 Introduction

New digital tools and recent computer technologies have allowed architectural design to provide buildings with new forms that facilitate new ways of thinking in construction. Based on the need and desire to produce novelty and innovation, computer aided design systems have become increasingly parametric, offering designs that change with the input data. Such systems give more control and capability to designers, allowing the discovery of new forms and offering a better understanding of the conceptual structure of such designs (Alazzawi & Al-Majidi, 2021a).

The urgent need to address climate change has driven the architecture, engineering, and construction (AEC) industry toward innovative approaches that integrate environmental performance with cutting-edge design methodologies. Among these, parametric design has emerged as a powerful tool, allowing architects and engineers to explore complex geometries while optimizing building performance. However, the effectiveness of parametric design is often limited by the extent to which real-world climatic conditions are incorporated into the design process.

In many practices, environmental simulation on building performance is conducted at the very last phase of design process as a means of validating the feasibility of building designs. When conducted late in the process, the environmental analysis can suggest only a limited range of improvements because most building elements have already been determined and interrelated to each other. However, considering environmental factors from the earliest phase of design can significantly enhance the timeliness of environmental analysis and the overall quality of building performance. Moreover, it can accelerate the design process by providing concrete evidence at each step of design decision-making (Lee et al., 2018a).

Optimization methods applied to building performance simulation, or simple BSO (Building Simulation Optimization), are beneficial since many variables affect building performance, such as form, layout, envelope materials, orientation, and landscape design. These variables are usually defined qualitatively and mainly considered in the conceptual design phase. Consequently, designers lack sufficient information to make effective and appropriate decisions that lead to high-performance buildings, and the subject has been the focus of many investigations. Furthermore, although optimizing the energy-efficient building design is encouraging, many applications demand skills that most architects are unfamiliar with, and a smooth connection with standard and parametric modeling programs is still missing (R. M. Sakiyama et al., 2021a).

In conclusion, By leveraging computational tools, simulation software, and environmental analysis, we seeks to establish a framework that enables architects to make data-driven design decisions. we highlight the potential of computational design to drive climate-responsive architecture, offering a new paradigm where form follows not just function, but environmental intelligence. demonstrating that climate-adaptive parametric design can lead to both aesthetic and functional advancements in contemporary architecture. involves developing parametric models that adapt to specific climatic inputs, optimizing building shape, façade configurations, and material selection for improved energy efficiency, daylight performance, and occupant comfort.

I.2 Problematic

Current design practices often rely on post-design performance evaluation, where environmental analysis is conducted after the form has been generated, leading to suboptimal solutions that require modifications. This approach contrasts with a truly integrated workflow, where climate considerations influence the generation of form from the outset. Moreover, complex geometries pose additional challenges in terms of solar exposure, natural ventilation, thermal performance, and material efficiency, making it crucial to establish methodologies that balance aesthetic freedom with environmental responsibility.

The increasing complexity of architectural forms, driven by parametric design, presents both opportunities and challenges in optimizing building performance. While parametric tools enable the creation of intricate and adaptive geometries, their integration with real-world climate data remains a critical yet underdeveloped area.

This thesis seeks to address the following key questions:

- How can climate data be effectively integrated into parametric design workflows?
- What are the most effective computational tools and simulation techniques for integrating climate-responsive strategies into parametric workflows?
- How can parametric design tools be used to optimize building performance based on climate data?

I.3 Hypothesis

The questions posed in this study prompted the formulation of hypotheses, seeking innovative solutions for integrating climate data into parametric design so can significantly enhance building performance. The aim is that the architects and engineers can develop adaptive and high-performance forms that respond dynamically to their surroundings

- Climate-responsive parametric models can enhance energy efficiency, reduce operational costs, and improve occupant comfort by optimizing parameters such as shading, ventilation, and material properties.
- The use of algorithmic modeling and simulation tools can create a data-driven feedback loop, where environmental performance directly influences design iterations, leading to more sustainable architectural outcomes.

I.4 Objectives

The objective of our study is to demonstrate that data-driven parametric design can enhance energy efficiency, thermal comfort, and overall environmental responsiveness in architectural projects.

To achieve this, the study will focus on the following specific objectives:

- Investigate the relationship between climate data and parametric design to understand how environmental factors influence architectural form and performance.
- Optimize shapes for performance efficiency using parametric modeling and simulation tools to balance design aesthetics with environmental sustainability.
- validate the proposed framework through case studies and simulations, assessing improvements in energy consumption, daylight optimization, and thermal comfort.

- Bridge the gap between computational design and environmental performance by establishing best practices for architects and engineers to integrate climate-responsive strategies into parametric workflows.

Ultimately, this research aims to demonstrate that integrating climate data into parametric design not only improves building performance but also enables more informed, sustainable, and innovative architectural solutions.

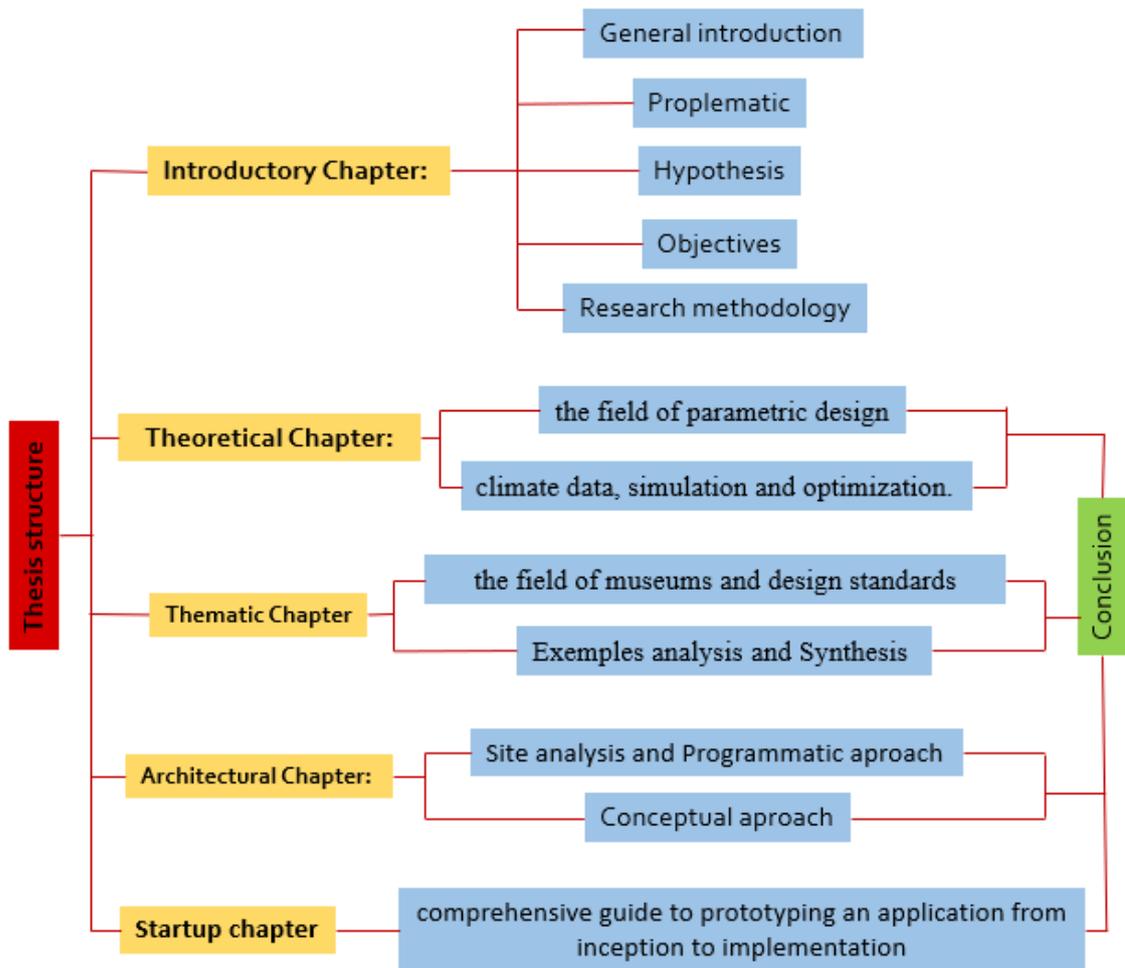
I.5 Research Methodology

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 parametric design and how it can enhance energy efficiency, thermal comfort, and overall environmental responsiveness in architectural projects.

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 the field of parametric design and its relationship with climate data, simulation and optimization.
- **Thematic Chapter:** This section will determine the field of museums and the most important aspects related to them, such as defining, function, types, and most important design standards, etc and we will involve the analysis of examples to understand various parameters of projects, including formal, functional, constructive, structural aspects, and others.
- **Architectural Chapter:** This chapter we will analyse the site and its climatic parameters using specialized software for climate analysis that aids in the design process. We additionally 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.

I.6 Research structure



**CHAPTER II: INTEGRATION OF
CLIMATE DATA INTO PARAMETRIC
DESIGN**

II. CHAPTER II : INTEGRATION OF CLIMATE DATA INTO PARAMETRIC DESIGN

“Nature-based, complex forms attained by computational, mathematical and differentiation processes are conceptual expressions of the next generation, non-standard architectural design” (Migayrou,2012,p.26- 33).

II.1 Introduction

Studies in recent decades have provided important information on parametric design, whether defining it as a philosophical/theoretical concept in contemporary architecture or as a new architectural style with specific characteristics; others have seen it as an architectural movement or a set of techniques for the production of form at the design and implementation levels. Many attempts have been made to define parametric architecture to facilitate teamwork and collaboration between architects and other engineering specialists during the design process, and several theories have been proposed in the literature to better explain parametric architecture. these are listed in Table II-1(Alazzawi & Al-Majidi, 2021b):

Table II-1:Existing research. Source : (<https://ybit.in/uXmG25>)

N°	Authors	Contribution
1	Sutherland (1963)	The first use of parametric design concepts through a graphic user interface system occurred in Sutherland's PhD research, which allowed him to draw with the computer and apply changes parametrically at the same time.
2	Morretti (1971)	Parametric architecture is the study of "relationships between the dimensions" where a design is dependent on parameters.
3	Kalay (1989)	Computational geometric relations are automatically updated when parameters change
4	chumacher (2008)	First presentation of the concept of "parametricism" as a style in the "Parametricism Manifesto"; this was followed by several related papers and a book called "The Autopoiesis of Architecture", in 2011, in which he introduced some principles of parametric design that must be followed to make a design parametric (Dogmas) and others that must be avoided.
5	Woodbury (2011)	Parametric design defined as the process of exploring associative connections of geometric concepts.
6	Frazer (2016)	Parametric architecture moving to reformulate itself as a process in a rapidly evolving process that embraces new technologies and environmental and social purposes.
7	Oxman (2017)	Parametric design described as a new paradigm of design thinking. Pioneering concepts of design thinking developed, moving from typological thinking to topological design thinking in creative design, which should be considered one of the most remarkable changes in design thinking.

II.2 Parametric architecture

II.2.1 Parametric design definition

The term parametric is derived from mathematics (parametric equation) and refers to the use of certain parameters or variables that can be modified to manipulate or change the outcome of a final equation or system “Encyclopedia of Mathematics” (Cherif, 2017).

Parametric design is a digital design concept based on correlations of models. It relies on constraints as a means of producing a geometry in variable forms. Parametric design as a tool in the geometric relations control enables the creation and modification of the elements that constitute a design by differentiation (Mendilcioğlu & Yılmaz, 2021).

Numerical algorithms form the basis of parametric design tools. Thus, it increases the designer’s control over the design geometry, allowing the designer to evaluate certain conditions. “Computationally speaking, there isn’t a difference between algorithmic and parametric systems; algorithms by default operate on parameters, and a parametric system’s fundamental component is the algorithm itself, called the schema or definition”(Ipek Gursel Dino, 2012)

II.2.2 The origin of parametric

The term parametric comes from mathematics, where parametrics refers to what the Concise Encyclopedia of Mathematics calls "a set of equations that express a set of quantities as explicit functions of a number of independent variables, known as 'parameters'(Couwenbergh, 2008).

Parametric design has a long history in mathematics; one example is James Dana’s 1837 paper On the Drawing of Figures of Crystals. In it, Dana explains the general steps of drawing a range of crystals and suggests variations using a language riddled with parameters, variables, and ratios. The remainder of the twenty-page paper contains statements that explain how various parameters filter through long equations to affect the design of various crystals. Dana’s crystal equations resemble those that would be used by architects 175 years later to develop parametric models of architecture—an architecture that has a “crystalline splendor” according to Moretti -1957/184-

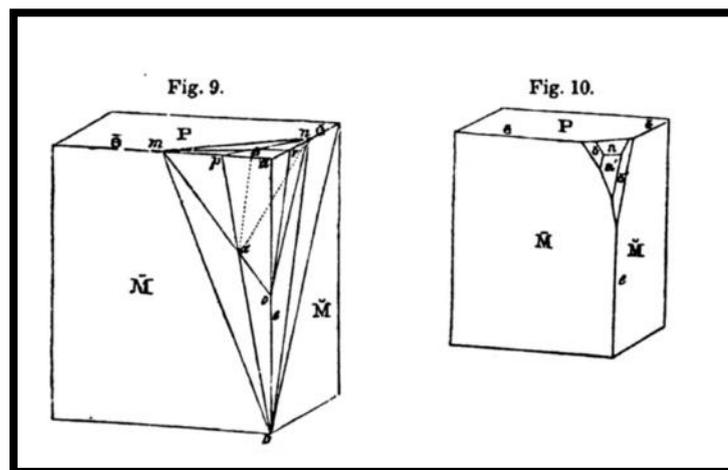


Fig II-1:Instances of James Dana’s crystal drawings
Source: (Dana 1837, 43).

but there is some debate as to when designers first started using it. David Gerber in 2007, in his doctoral thesis entitled “Parametric Practice” credited Maurice Ruitter with first using the term in a 1988 paper entitled Parametric Design, but Robert Stiles in 2006 argues that the actual provenance of parametric was a few decades earlier (Davis, 2013).

The architect Luigi Moretti was the pioneer who wrote extensively on parametric architecture, which he defined as the study of architectural systems with the aim of "defining the relationships between the dependent dimensions of the various parameters." Moretti uses the design of a stadium as an example, explaining how the stadium’s form can derive from nineteen parameters concerning things like viewing angles and the economic cost of concrete. Versions of a parametric stadium designed by Moretti were presented as part of his Parametric Architecture exhibition at the Twelfth Milan Triennial in 1960 (Davis, 2013).

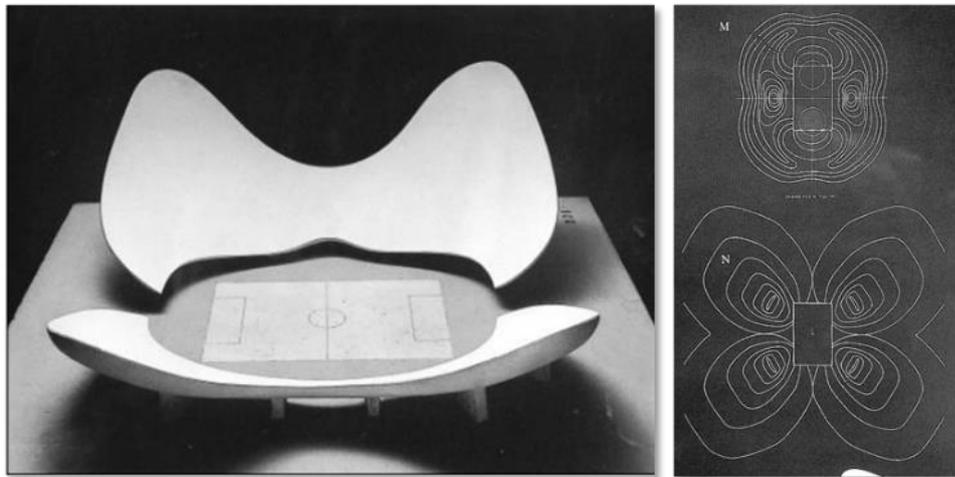


Fig II-2: left: Model of a stadium N by Luigi Moretti. In Milan. Right: The plans for stadium version.

Source: (Daniel Davis.2013).

Within five years of the exhibition, between 1960 and 1965, Moretti designed the Watergate Complex, which was the first major building project to make significant use of computers. The Watergate Complex is now best known to the many architects who today use computers to create parametric models in the manner of Moretti (Davis, 2013).



Fig II-3: The Watergate Complex.

Source: Wikimedia commons.2006

II.2.3 Principle of parametric design

The principle and implementation of parametric design Basically, the term parametric originates from mathematics, and refers to using certain parameters or variables, which can be amended in order to manipulate with the equation results. Accordingly, the principle of parametric design can be defined as mathematical design, where the relationship between the design elements are shown as parameters which could be reformulated to generate complex geometries, these geometries are based on the elements' parameters, by changing these parameters; new shapes are created simultaneously.

For example, if we need to draw an integrated model consist of venetian blinds, and these blinds have specific rotation angles responding to sun movement. Accordingly, a mathematical equation should be created for these blinds in order to get the required rotation angle. Indeed, we have to substitute in the created equation every time the sun changes its position; however, this process will be very long and time-consuming. In order to simplify this complex process; this mathematical equation can be gently done in a parametric formula using specific software, then the substitution will done automatically or in better words “parametrically”. Accordingly, any changes in the data or parameters will influence on all the other parameters in the equation, which can appear in the final model, as shown in Fig 4 (Eltaweel & Su, 2017).

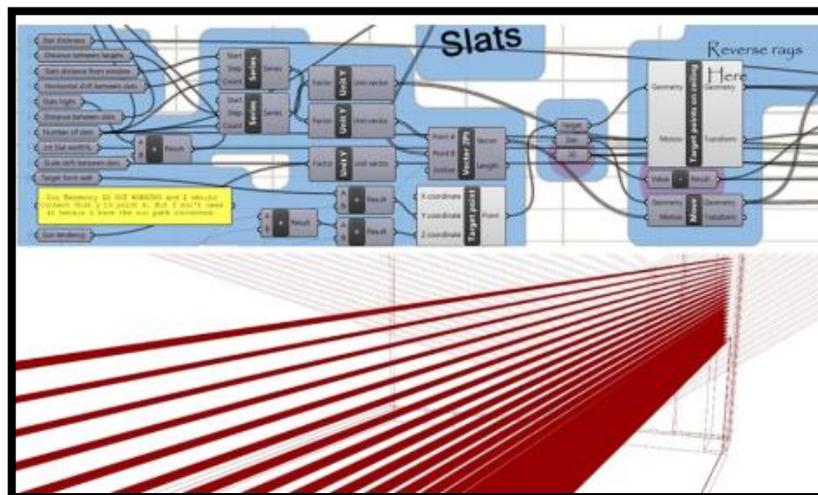


Fig II-4 : The logical sequence of the modelling process; from the mathematical equation (top), which converted to the parametrical formula (middle), going to the final result of the model respectively (bottom)

where; δ is the opposing two angles over the slat, Ω is the solar profile angle, θ is the angle between reflected light and ceiling, u is the distance from the Point c to the Point a, v is the distance from the Point a to the target Point b, and β is the slat tilt angle, see Fig II-5.

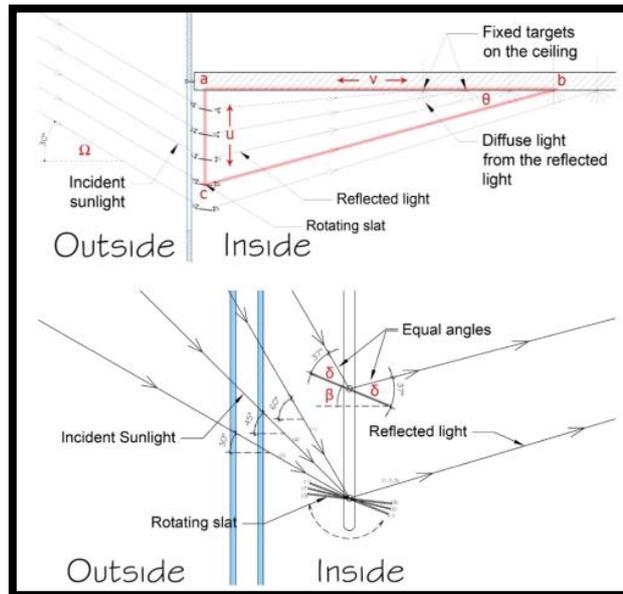


Fig II-5: Cross section in the model showing the used symbols in the equation (top), detailed cross section (bottom)

Source: <https://doi.org/10.1016/j.rser.2017.02.011>

There are previous examples of using integrated modern systems in designing, such as Antoni Gaudi, who studied the design space using analogue models to create the feeling of undulating sea and seaweed on the front in Casa Milà, which he completed between 1906 and 1912. Cast iron balcony irons aim to help the wave effect to be perceived more strongly In the parametric design approach (Eltaweel & Su, 2017)



Fig II-6: Casa Milà- Barcelona, Spain.

Source: https://www.researchgate.net/publication/350890918_PARAMETRIC_DESIGN_TOOLS_FOR_THE_DESIGN_OF_ENERGY_EFFICIENT_BUILDINGS

Recently, there are an obvious relation between parametric term and Computer Aided Design (CAD) systems, where CAD system facilitates the ways to draw a model based on geometrical relation with specified parameters and dimensions, however, if we need to edit or modify any element in the model; it will change only the parameters of this element independently regardless of other related elements. For example, if we need to change floor height of a building, we will modify the extrusion of the wall, meanwhile, other related parameters are needed to be modified as well - such as doors and windows - in order to match the room height. Accordingly, this process will be iterative and time

consuming when dealing with complicated model. On the other hand, these modifications process can be performed simultaneously, by connecting the model elements with each other in an algorithmic relation known as “parametric design”. Therefore, parametric design can be considered as an upgraded version of CAD system, while it depends on “Generative Algorithms” which is a way to explore design and algorithmic solutions through formulas rather than using normal geometries (Eltaweel & Su, 2017)

II.2.4 Implementations of parametric design:

Nowadays, parametric design is used in many fields, disciplines which consist of complex algorithmic relations, interdisciplinary work, creative forms, and multiprocessing treatments. It is not easy to control these operations using conventional tools or imagine them using our minds, so it is needed to use complex operating systems, parametric tools, and specific software. Due to this advancement in our life, we can find many implementations of parametric design in many fields like; decoration, fashion, architecture, urban planning, sonic study, structural analysis, medicine and so on (Eltaweel & Su, 2017).

a) In urban planning:

Parametric design can provide several alternatives in a wide range of design, while it gives distinctive results in iterative design process, and these results can hardly obtained using conventional methods. The discrete method of problem-solving can deal with multiple layers in urban design case by saving time in writing formula and coordinating between these layers.

For example, the pedestrian pathway in a previous study was chosen to determine the connections between the project's area, putting in consideration the smaller buildings which block the visual connection on streets. The sliced landscape was used to divide the pedestrian circulation into patterns. The formula created in this study conducted by Grasshopper was aiming to determine the shortest pedestrian pathway, as shown in Fig.

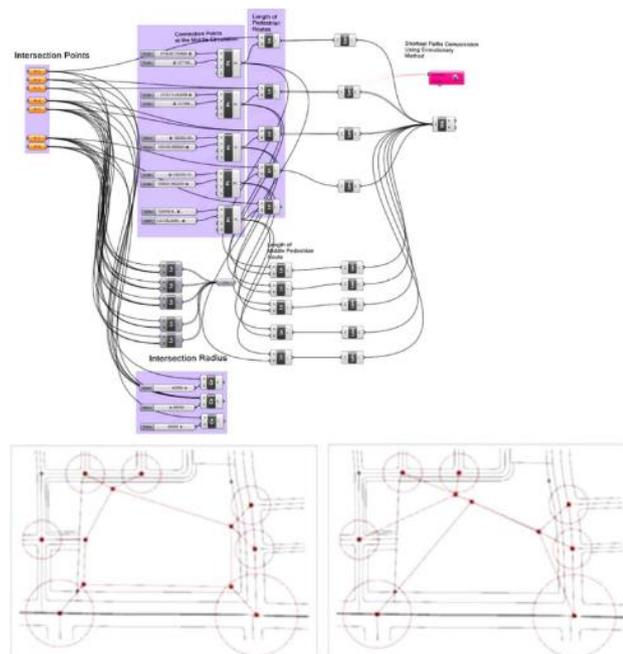


Fig II-7The pedestrian formula in Grasshopper (top), the shortest solution for the pedestrian pathway (bottom) .

Source : <https://doi.org/10.1016/j.rser.2017.02.011>

b) In architecture:

Parametric design can generate creative solutions, deal with sophisticated relations and control them parametrically, and it utilizes parameters to set relations between design elements in order to define a range of formal alternatives. Moreover, parametric design provides wide exploration of multiple solutions to architectural design problems using algorithmic methods. Therefore, parametric design provides great opportunities to utopian architect to generate creative solutions in the design process, see Fig 8.



Fig II-8: Architectural models created based on parametric design, (bottom right designed by Ahmad Eltaweel).

Source : <https://doi.org/10.1016/j.rser.2017.02.011>

c) In decoration:

Parametric design provides creative forms, iterative dynamic shapes which is inspired from the nature, and depends on algorithmic relations and connections. Moreover, it can create unlimited options of modular forms based on simple element, via adding parametric modifiers, see Fig 9 .



Fig II-9 : Ideas of parametric design in decoration .

Source : <https://doi.org/10.1016/j.rser.2017.02.011>

d) In fashion:

Nowadays parametric design is used in wide range of design fields, because it provides new unpredictable ideas with a future styles as shown in Fig 10 .



Fig II-10: Ideas of parametric design in fashion, inspired from nature .

Source : <https://doi.org/10.1016/j.rser.2017.02.011>

e) In sonic study:

Parametric programs can be used in sonic studies to calculate reflections (bounces), cast multiple rays, calculate flow paths down a sloped surface like water runoff.(Fig. 11).

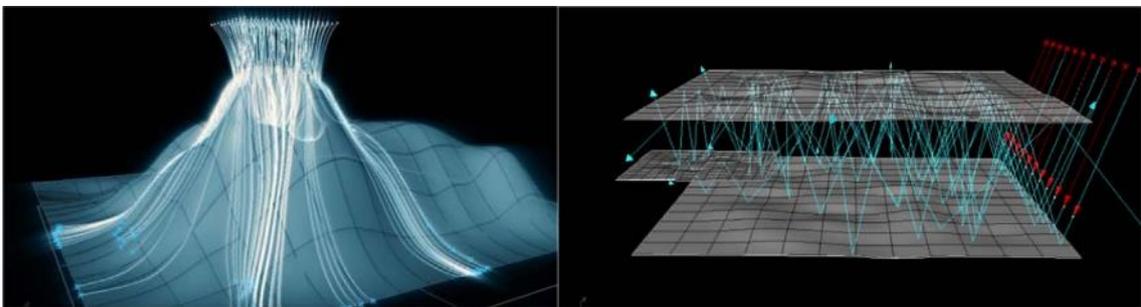


Fig II-11: Reflected rays calculated in “Sonic”, a plugin based on Grasshopper .

Source : <https://doi.org/10.1016/j.rser.2017.02.011>

f) In structure study:

Parametric design can calculate algorithmic formulas and manipulate complex connections, and create sophisticated relations with many kinds of materials as shown in Fig 12.



Fig II-12: Structure study using algorithmic calculations in Grasshopper.

Source : <https://doi.org/10.1016/j.rser.2017.02.011>

g) In environmental study:

Parametric programs can study and analyse all climatic and environmental changes such as sun movement, date, location, intensity, humidity, illumination, radiation, wind speed, heat gain, shadows, shades, and control them parametrically. In addition, it can make simulation in the 4th dimension using the time aspect which can influence on the building in the real time, and how the time can change the performance

of the building parametrically. So we can anticipate and solve many design issues the early stages of design . (Fig II-13).

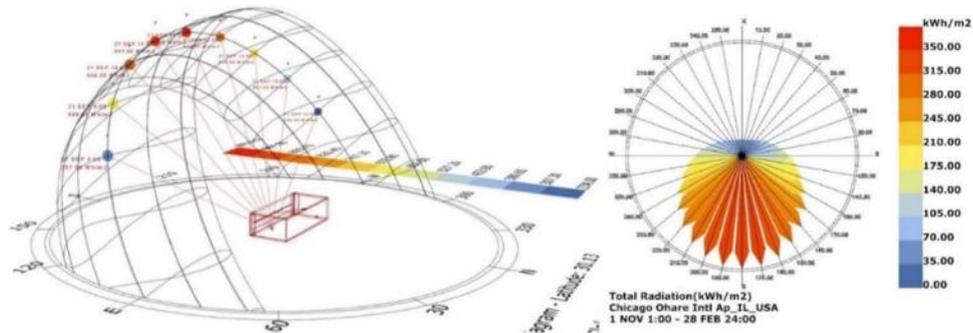


Fig II-13:Examples for sun path and daylight analysis, form our work in Grasshopper.

Source : <https://doi.org/10.1016/j.rser.2017.02.011>

II.3 Components of parametric models

Parametric design is a design based on constraints, therefore it is controlled by parameters, and by the collection of associative procedures . In the latter, the parameters of the design control the geometry in particular, and not the predefined shapes. In addition, different shapes and geometric configurations can easily be obtained by different parameter values . That is why parametric design has changed the role of architects, from designing the geometry itself to producing the geometry from the rules predefined by the designer.

Parametric models have two variable components:

- **Parameters:** geometric relations and numbers
- **Constraints:** constant fixed elements

Modeling in the parametric approach requires defined values, these are often expressed through mathematical equations. For this reason parametric design has an active role in design based on environmental quality. The established parameters become tools that automatically meet our simulation requirements in order to obtain adequate solutions during the optimization process (Cherif, 2017)

II.4 Parametric modeling

Parametric modeling is a mode of operation of current computer-aided design software. It involves defining an entity by parameters that can be easily modified. In this way, the definition of the models to be simulated can be easily changed. The parameters can be of several types: intrinsic “lengths, angles”, Cartesian “coordinates relative to a reference point”, situational “distance, angle between 2 elements” (Cherif, 2017).

II.4.1 Parametric Modeling Tools

Designing buildings and cities using parametric design and scripting tools can often look visually stunning, but for the most part, these designs tend to incorporate a lot of blind assumptions in order to respond nuancedly to real-world situations. In the world of computing, Parametric Technology Corporation (founded by mathematician Samuel Geisberg in 1985) released the first commercially successful parametric modeling software, Pro/ENGINEER (Cherif, 2017).

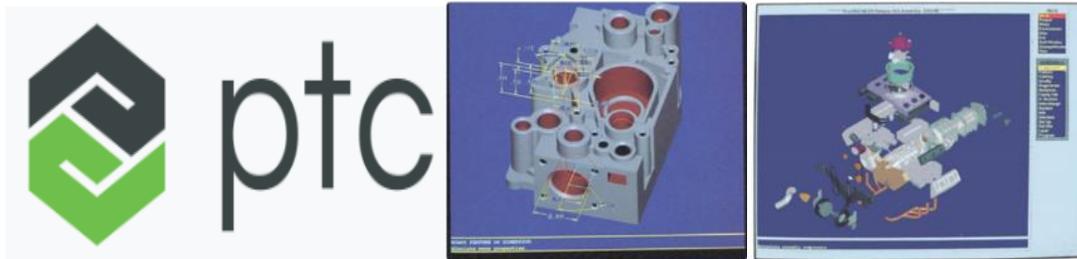


Fig II-14: The logo of Parametric Technology Corporation In addition to Pro/ENGINEER model.

Source: (David Weisberg.2023)

Today, many great designers who have engaged in parametric design over the last ten to fifteen years, this situation has led to the emergence of a large number of real-time parametric modeling and simulation software, among these tools we can cite the following:

a) Rhinoceros:

Rhinoceros (Rhino) is a software developed by Robert McNeel & Associates, specializing in 3D rational B-spline and nonuniform freeform (NURBS) modeling. Rhino was officially launched in 1998 and its development is ongoing. This modeling program is gaining ground among different design disciplines (Architecture, Structural Engineering, and Industrial Design) because it is diverse, easy to learn and use, and has a powerful set of multiple add-ons and plug-ins available. Rhinoceros' modeling capabilities are remarkable, but some plug-ins, such as Grasshopper, provide a powerful design tool for conceptualizing (Cherif, 2017).



Fig II-15: L'interface et le logo du logiciel Rhino.

Source : [http://www. http://altair-consulting.com/](http://www.altair-consulting.com/)

b) Grasshopper

Grasshopper helps Rhinoceros in constructing geometric shapes using Generative Algorithms, and requires no prior programming or scripting knowledge. Its interface allows scripts to create parametric modeling. Additionally, Grasshopper is very visual, a feature that most designers appreciate. It brings the ability to develop simple or complex parametric routines that can be applied to solving design problems while simultaneously visualizing solutions. This becomes an important tool for architectural design problem solving. McNeel provided a description of this plugin (Cherif, 2017).

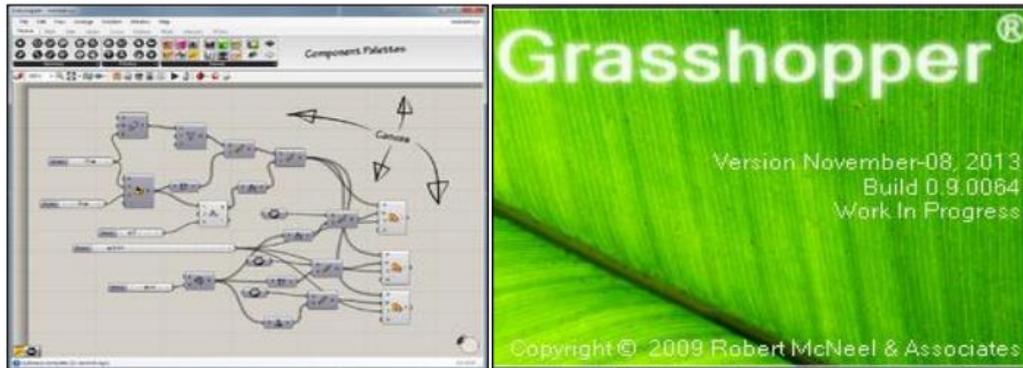


Fig II-16:L’interface et le logo du plug-in Grasshopper

Source : <http://www.arch2o.com/wp-content/>

c) Other parametric software :

Since the early 1980s, parametric software development has grown in the building and design industry.

Table II-2 shows the most commonly used software.

Table II-2 :Logiciels paramétriques utilisés pour la conception et la construction.

Source : (Cherif, 2017)

Parametric software	Description
CATIA	A three-dimensional, computer-aided interactive application and CAD/CAM/CAE platform developed by Dassault Systèmes. The application was originally developed in 1977 (known as CATI) to assist in aircraft manufacturing
SolidWorks	Launched in 1995. This CAD and 3D software was designed as a software for Windows system. Current ownership of Dassault Systems.
Generative Components	Introduced by Bentley Systems in 2003. This software is used with 3D solid modeling to provide parametric capabilities.
ParaCloud GEM	Generative Design software that acquires data from Microsoft Excel to create parametric models. It is compatible with Rhino, Maya, 3DS Max and Sketch Up. It was launched in 2008.
ArchiCAD	Launched by Graphisoft in 1987, this BIM-CAD software is capable of creating parametric 3D objects, which can be represented either in 2D or 3D
Revit	BIM-CAD software that has architectural, structural specificities, in which specific models can merge into a centralized one. It was acquired by Autodesk in 2002.
Digital Project	BIM-CAD software based on CATIA v5, developed by Gehry Technologies. Launched in 2004 as an effort to bring together AEC industry.

II.5 The inter-articulation of subsystems

The ambition to go through the differentiation of a single system towards the scripted association of multiple subsystems Eg: envelope, structure, internal subdivision. Differentiation in any system correlates with differentiations in other systems (Fig17).

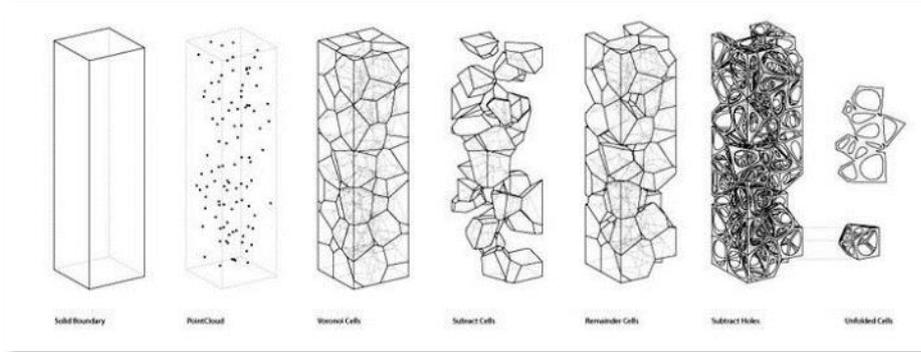


Fig II-17: Subdivision and correlation between structure and shape of the architectural envelope

Source : <http://archisupertorture.blogspot.com/2016>

II.5.1 The emphasis

The emphasis in parametricism is the enhancement of the general sense of organic integration through complex correlations that favor earlier deviation amplification than compensatory or ameliorative adaptations. For example, when generative components populate a surface with subtle curvature modulation, the correlation of the legitimate component should accentuate and amplify the initial differentiation (Fig II-18).

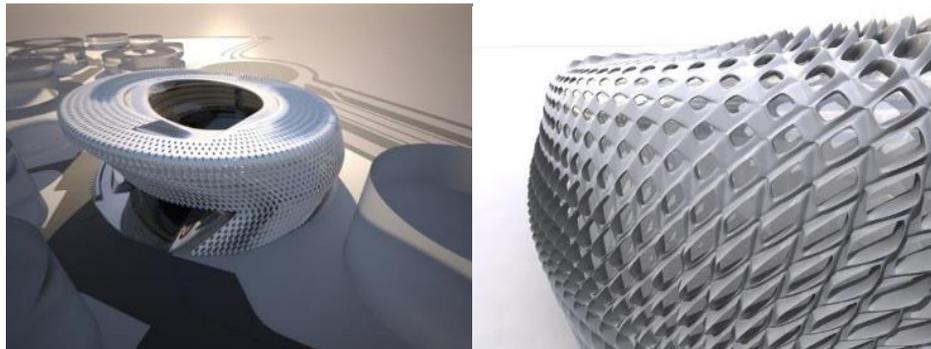


Fig II-18: Architectural envelope with curvature modulation by Zaha Hadid

Source : <http://www.patrikschumacher.com/Texts>

II.5.2 Receptivity

Urban and architectural (interior) environments can be designed with a built-in kinetic capacity that allows these environments to reconfigure and adapt in response to common patterns of use and occupancy (Fig II-19).

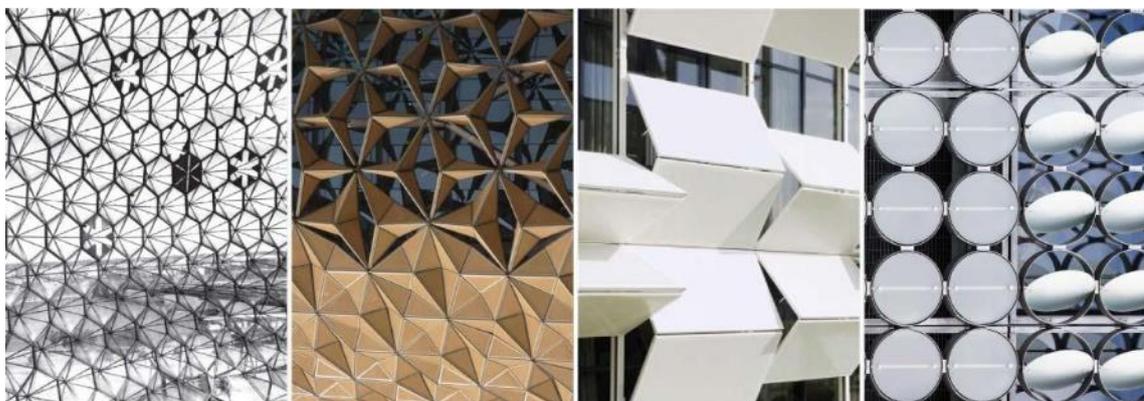


Fig II-19 : Responsive and adaptive shading systems

Source : <http://fabacademy.org/archives/2015/sa/student>

Real-time recording of usage patterns produces parameters that drive the kinetic adaptation process in real time. The cumulative recording of usage patterns gives rise to semi-permanent morphological transformations. The built environment acquires responsive agency at different time scales.

II.5.3 The figure

The parametric model can be set up so that the variables are extremely sensitive. Parametric variations trigger gestalt catastrophes, that is, quantitatively changing these parameters triggers qualitative changes in the perceived order of the configuration. This notion of parametric figuration implies an expansion of the types of parameters taken into account in parametric design. Beyond the usual parameters of geometric objects, ambient parameters (comfort, lights) and observers (variable cameras) must be taken into account and integrated into the parametric system.

II.5.4 Parametric urban planning

Parametric urban planning only involves the systematic modulation of building morphologies which produces powerful urban effects and facilitates orientation. These buildings form a field in constant evolution, with legal continuities consistent with this multiplicity of buildings. Parametric planning can also involve parametric emphasis, parametric figuration and parametric response. (Fig II-20)



Fig II-20: Mass plan proposed for the city of Istanbul by Zaha Hadid in 2006
Source : <http://www.patrikschumacher.com/Texts>

II.6 Climate data and parametric

II.6.1 Climate definition

It is the set of meteorological phenomena (temperature, humidity, sunshine, pressure, wind, precipitation) that characterize the average state of the atmosphere in a given place. In the narrow sense of the term, climate generally refers to "average weather"; more precisely, it is a statistical description based on the average and variability of relevant quantities over periods varying from a few months to thousands or even millions of years (the classic period, defined by the World Meteorological Organization, is 30 years). These quantities are most often surface variables such as temperature, precipitation and wind. In a broader sense, climate is the statistical description of the state of the climate system (BOUMEDIENE, 2016).

II.6.2 Climate data

From a scientific point of view, the factors and climatic components that determine the climate as an integration of the effects of all the meteorological factors on

earth in a long period of time in a certain region can be examined in three main groups:(Biket, 2006).

a) Sun and Temperature

Sun and therefore heat is one of the most important climate components because the generally used indicator of climatic comfort is air temperature and relative humidity. Sun is the most important energy source in lighting and heating forms and surfaces in architecture. The sun is not only a heat source but also a significant light source whose quality varies during the day and according to the seasons. While applying architectural solutions in order to utilize the sun at the maximum level in winter, refraction components are needed in order to be protected from the torrid heat of the sun in summer (Biket, 2006).

b) Pressure and Winds

Formation of a strong pressure zone is inevitable in the direction of the wind. Its possible to increase or decrease the amount of this pressure by means of corridors created between buildings. While airflow is needed in hot and humid regions, shadowing measures should be taken in hot and dry regions. For this reason, direction of buildings is determined according to the angle of sunrays in some regions while planning is made according to the dominant wind directions in summer in some other regions. Determination of wind requirement differs in each climate region. Wind requirement is important during the entire year in low latitudes, however protection is required in high latitudes. Wind factor that is needed according to climate regions should be taken into account when making decisions about planning (story height and distances between buildings) (Biket, 2006).

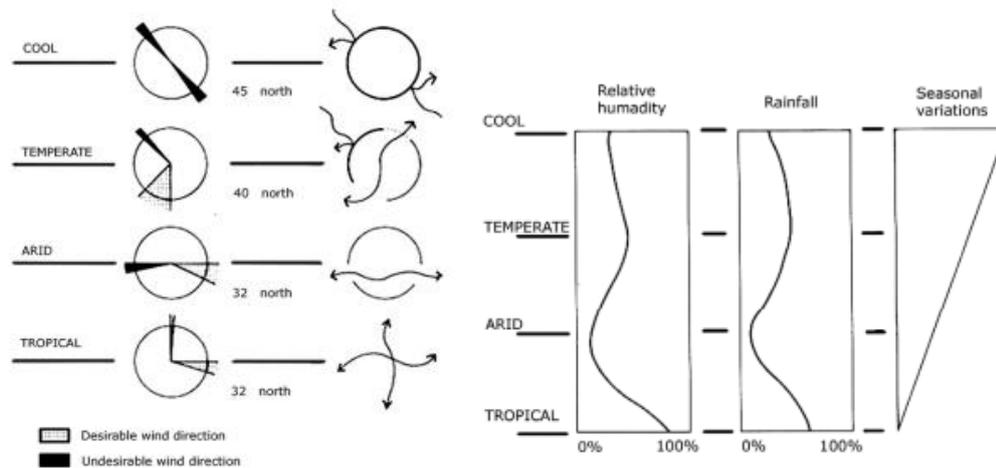


Fig II-21:right:Desirable and Undesirable Wind Directions left: Seasonal Variations

c) Precipitation and Humidity

Precipitation type and amount that varies according to geographical properties affect architectural design. Since the amount of precipitation affects humidity rate, some measures may have to be taken in order to prevent discomfort in the building and its surroundings. When various climate regions are observed, it is seen that low rate of humidity is preferred in dry climates whereas it causes discomfort in tropical climate regions (Biket, 2006).

II.6.3 Climate classification

Climate classification has been the subject of numerous studies since the end of the 19th century. Among the climate classifications, Köppen's is one of the most famous and used in the world. It was developed in 1900 based on the world vegetation maps available at the time. Since then, this classification has undergone many modifications and improvements.

In the 1920s, climatologist Wladimir Peter Köppen developed a climate classification system based solely on precipitation and temperature. A climate is thus identified by a two- or three-letter code (Dr. BEDDAL Dalila, 2021).

This is the most common climate classification in its version presented by Rudolf Geiger in 1961. A very large number of climate studies and publications have adopted one of the versions of this system. The Köppen-Geiger map remains a reference today, thanks to these frequent updates, in the fields of hydrology, geography, agriculture, biology, and climatology through its research on climate change. See Fig II-22 Fig II-22 The Köppen-Geiger climate map presented by the US National Library of Medicine at the National Institutes of Health (<https://www.nature.com/articles/sdata2018214>).

According to this classification, a climate is identified by a 02 or 03-letter code; the first letter in capital letters designates the climate type, the second letter designates the rainfall regime, and the third letter designates the temperature variations (Dr. BEDDAL Dalila, 2021).

Example: the Maghreb coast is of type Csa (temperate, dry season in summer), so it is the Mediterranean climate. We therefore obtain the following categories:

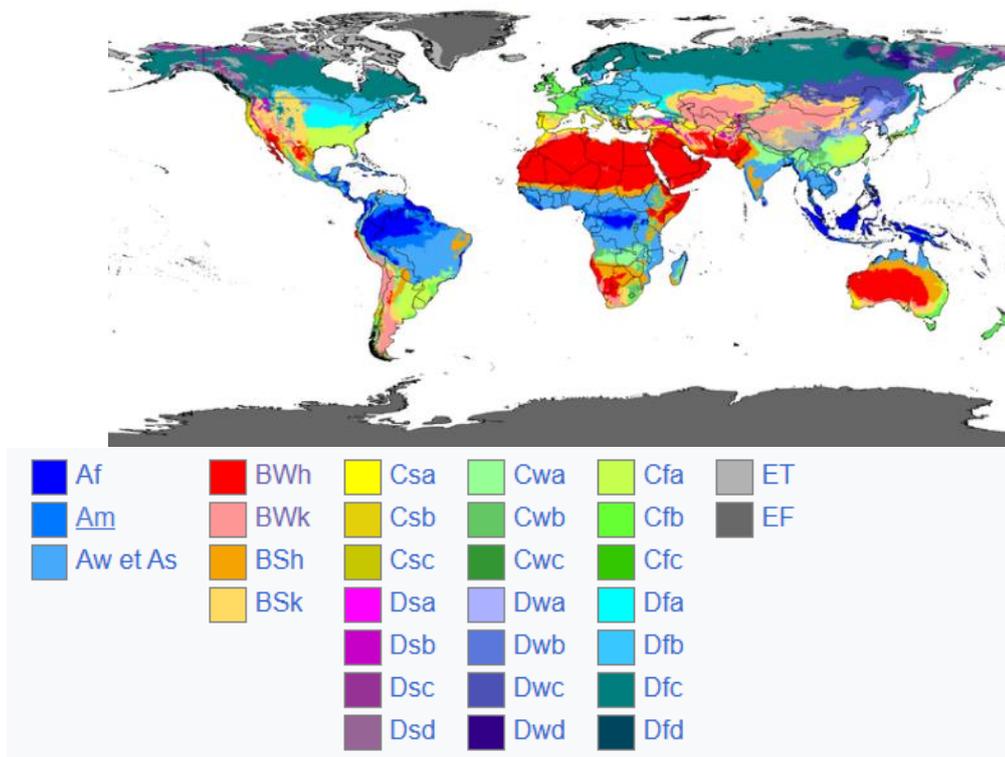


Fig II-22 The Köppen-Geiger climate map presented by the US National Library of Medicine at the National Institutes of Health (<https://www.nature.com/articles/sdata2018214>)

Table II-3: Climate classification according to Koppen (climate types) (Dr. BEDDAL Dalila, 2021)

Code	Type	Description
A	Tropical climate	<ul style="list-style-type: none"> • Average temperature of each month is above 18°C. • No winter season • High annual precipitation (higher than annual evaporation)
B	dry climate	<ul style="list-style-type: none"> • Annual evaporation greater than annual precipitation • No permanent watercourse
C	Temperate climate warm	<ul style="list-style-type: none"> • Average temperatures of the 3 coldest months between -30°C and 18°C. • Average temperature of the hottest month is above 10°C • The summer and winter seasons are well defined.
D	Cold temperate climate	<ul style="list-style-type: none"> • Average temperature of the coldest month is below -3°C • Average temperature of the warmest month is above 10°C. • Summer and winter seasons are well defined
E	Polar climate	<ul style="list-style-type: none"> • Average temperature of the hottest month is below 10°C. • The summer season is very little marked.

II.6.4 Climate zones of algeria

According to Koppen, the climate of Algeria is varied, because the country has a very large area: The northern part has a **Mediterranean climate (Csa)**, while the rest of the country has a mostly **desert climate (BWh)**. However, between these two major types of climates, there are transitional climates, in particular **the semiarid climate (BSk)** which corresponds to a Mediterranean climate with a drought no longer limited only to the summer season but to a good part of the year but also a Mediterranean climate with mountain influences, a little more continental. Nevertheless, Algeria is a country in the subtropical zone where the dominant climate is hot and dry (Dr. BEDDAL Dalila, 2021)

Algeria map of Köppen climate classification

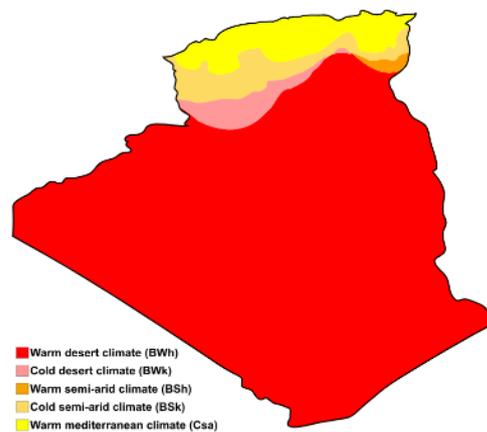


Fig II-23:climate zones of algeria

II.7 Integration of environmental simulation to parametric design workflow (Integration of climat data)

II.7.1 Case study of institution building in New Orleans,USA based on parametric, climate-based analysis

The workflow is aimed to support the early design process with passive strategies to enhance occupant thermal_comfort and daylight conditions of the building as well as its energy_efficiency. By analyzing the hot and humid climate of New Orleans and the needs of multiple spatial programs, including open spaces, workplaces, and residential units, parametric models were generated to simulate the annual thermal comfort and daylight conditions, which provides grounds for comparison among parametric models. In response to the climate analysis and bioclimatic strategies, three design steps were implemented: **self-shading, façade components, and multi-functional screens** (Lee et al., 2018b).

Unlike common expectation, outdoor thermal comfort was given higher priority for this project to harmonize the outdoor music festivals and other outdoor activities with the hot and humid climate in New Orleans, where people enjoy the modest condition of outdoor balconies that protect them from the direct sunlight.

a) Methodology

Climate-base Analysis

The environmental simulation is based on the weather database, **EnergyPlus Weather** (EPW). These Comma Separated Values (CSV) data consist of hourly values of weather data for the 8760 hours of a year, which represent the annual typical weather. Among the weather data files available for the New Orleans area, the TMY3 file recorded at New Orleans International Airport was used due to the geographically proximity and similarity (Lee et al., 2018b).

Ladybug and Honeybee:

Ladybug and Honeybee are open source plugins for **Rhinoceros3D/Grasshopper3D**, developed to resolve the discontinuity of existing simulation platforms and integrate the overall process of environmental-analysis related design .

The plugins allow users to associate the parametric geometry with climate-based simulation engines such as **EnergyPlus** (US Department of Energy), **RADIANCE** (Ward 2004) and **Daysim** .

Ladybug is recommended for visualizing weather data for climate analysis and integrating weather data as design parameters. Honeybee allows designers to build energy models and run daylight analysis by linking Rhinoceros3D and Grasshopper3D with simulation engines (EnergyPlus and Radiance). The most profitable aspect of these plugins is that it can integrate environmental simulation with complicated geometries (Lee et al., 2018b).

Design Explorer:

When designers face tens or hundreds of optional geometries, making a clear decision is challenging because it can be often subjective. If multiple aspects of options must be considered simultaneously, decision making becomes quite complicated. Design

Explorer is a web-based application for comparing possible options handy and visualizing comparison results effectively. It requires users to upload recorded values from the series of iterations as a CSV file.

b) Design Process

After the analysis of climate, urban context, and program, design strategies were established and first form study was conducted. The setting and assumptions for simulation are determined on the basis of the earlier analysis

According to the design strategies, the simulation process was divided into three steps, from larger scale to smaller scale (Lee et al., 2018b):

- Step 1: design for self shading.
- Step 2: design for façade components .
- Step 3: adding the multi-functional screen .

The design workflow was integrated with advanced energy and daylight simulation engines (EnergyPlus and Radiance) and integrative platforms and plugins (Rhinoceros3D, Grasshopper3D, Ladybug, and Honeybee).

After testing parametric geometries, the input parameters and output data were compared at DesignExplorer to select the appropriate option to adopt.

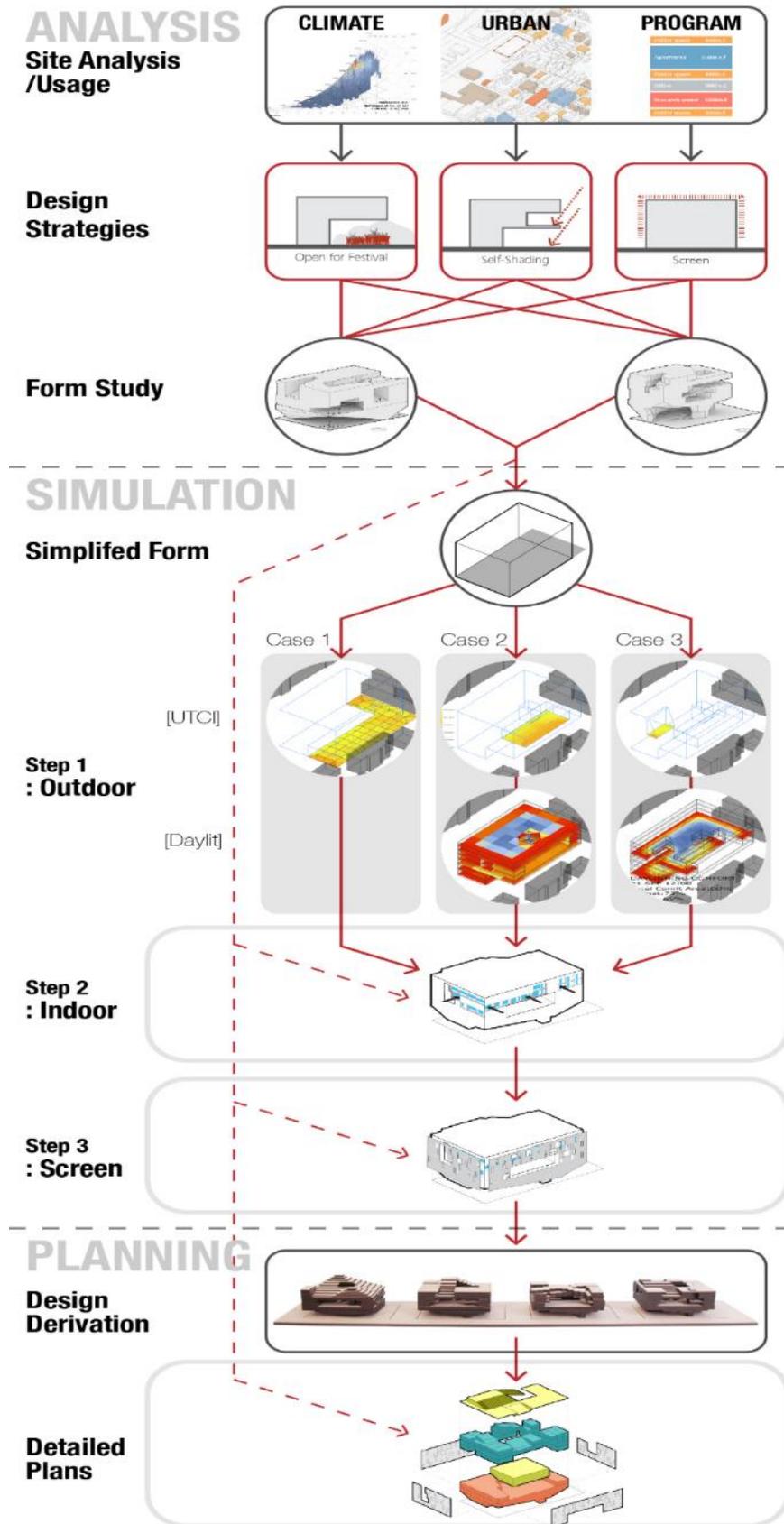


Fig II-24:Design Workflow Diagram

c) Simulation

- STEP 1: SELF-SHADING :

Climate Analysis:

As the Psychrometric chart (Figure 25) shows, a substantial hours are outside of the comfort range (the red color means the highest frequency in a year), the range demarcated by the thick line. Directing the most frequent hours of discomfort into the comfort zone can effectively increase the annual thermal comfort hours.(Lee et al., 2018b).

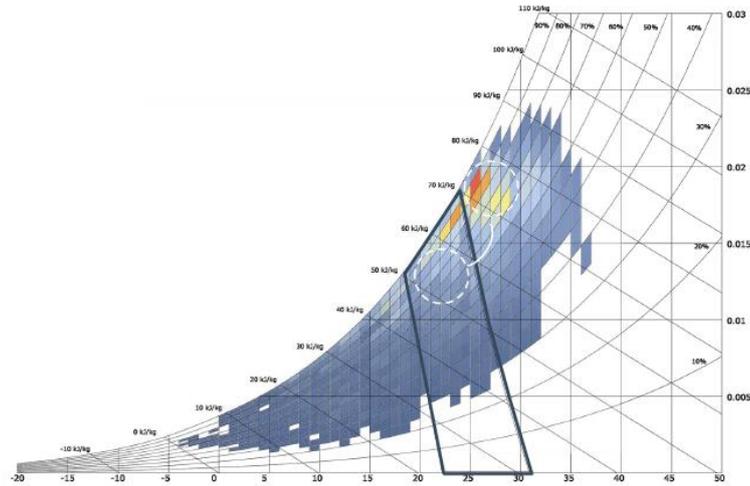


Fig II-25:A psychrometric chart of New Orleans Strategy

New Orleans's heat and humidity may prevent people from enjoying outdoor activities in the summer. Because annual comfort hours vary from 47% to 57% depending on the presence of direct solar radiation, it is expected that self-shading of the building itself increases comfort hours, encourage outdoor events, and provide a welcoming atmosphere for visitors. The variance makes a big difference, since 10% of a year equals to 12 weeks of work hours (Lee et al., 2018b).

Simulation Settings

To produce useful analysis, simulations should be set up with awareness of climate conditions, required spatial programs, and urban contexts. Three cases were tested here: (1) the outdoor space on the ground level to accommodate musical performance events, which are a prominent feature of New Orleans life; (2) the outdoor space that serves city views to visitors and distributes daylight into the residential space; and (3) a small, communal open space for intimate relaxation.(Lee et al., 2018b).

Case 1: Ground level

The open space on the ground level is planned to accommodate music festival events. By creating a shaded area with its own mass, the outdoor comfort hours could be increased by a maximum of 10% from 47% (unshaded condition) to 57% (shaded condition). Thermal comfort analysis was conducted with 81 geometries generated with variations of width (W1: 140, 180, 220 ft.) and depth (D1: 80, 100, 120 ft.) of the building mass and the width (w1: 50, 75, 100 %) and depth (d1: 50, 75, 100 %) of the void space. Selection criteria was to be in the ranges that achieve more than 50.5% of annual outdoor comfort and less than 121,000 m² of residential floor area. (Fig II-26).

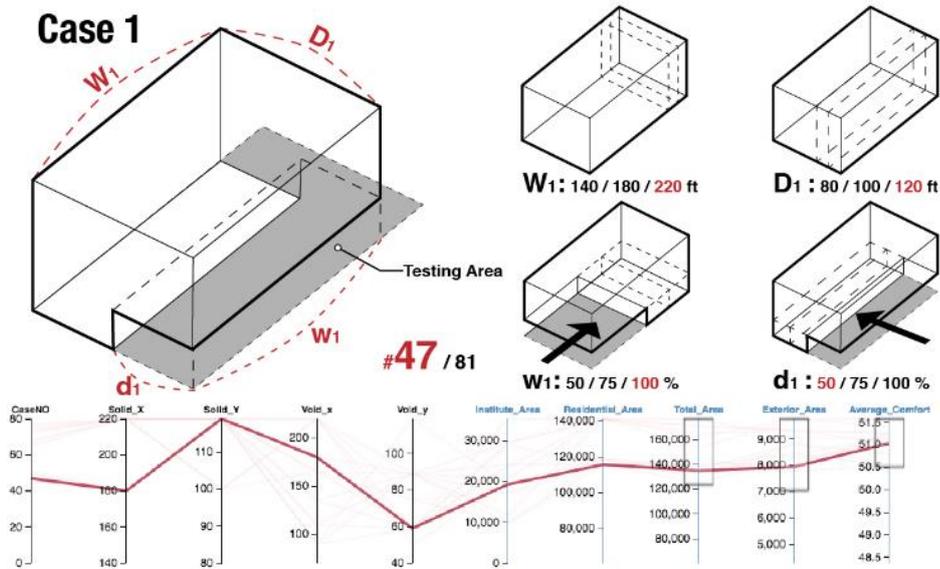


Fig II-26: Design iterations of 81 options in Case 1

Case 2: City Balcony Level

The city balcony is designed to attract visitors with city views and to distribute more natural light into the indoor space. From this case, the sDA was also tested along with outdoor thermal comfort to reveal the impacts of void space on indoor daylight conditions. Considering daylight with thermal comfort promotes the balance between indoor and outdoor conditions. Four input parameters defined the balcony's dimensions. The width ($W_2: 80, 100, 120$ ft.) and depth ($D_2: 30, 40, 50$ ft.) vary by 3 degrees separately, and the void space connected to the roof is changed in shape ($S: 20 \times 30, 25 \times 25, 30 \times 20$ ft.) and location ($L: \text{left, middle, right}$). The selected geometry has a relatively larger floor area than the other options, and the above void is placed in the middle with the square shape. The criteria for this selection were the larger exterior surface area, the longer comfort hours, and the larger daylit floor area (Fig II-27).

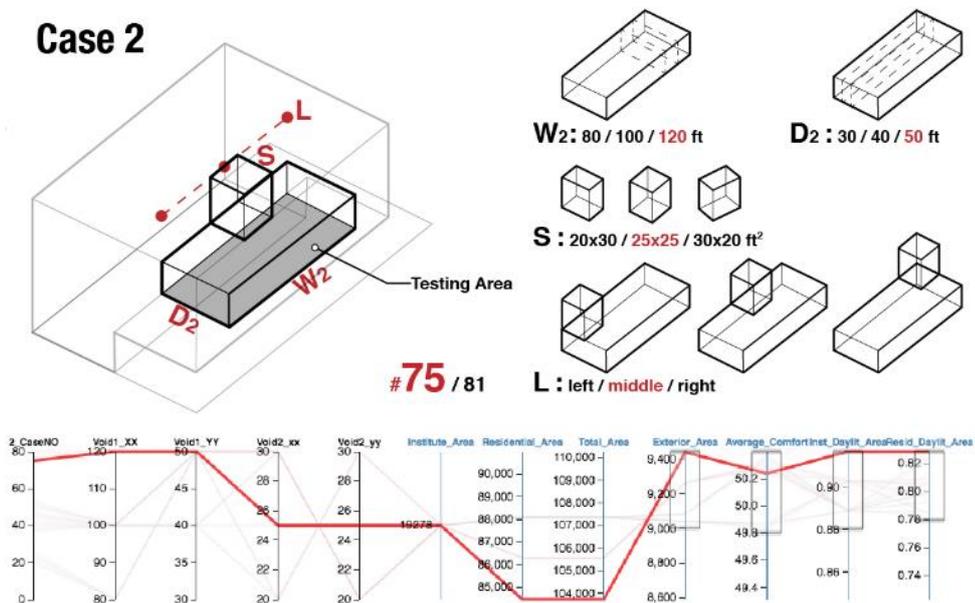


Fig II-27: Design iterations of 81 options in Case 2

Case 3: Residential Level

A communal relaxing space was integrated into residential floors to enhance daylight distribution. The design was adjusted based on depth (D3), width (W3), and the tilt angle (T) of the southeast-facing wall, modified in 5° intervals. Spaces with greater depth, narrower width, and a more inward-tilted wall provided better thermal comfort by reducing unnecessary solar radiation. This approach is useful for creating additional small open spaces. Another key factor was maximizing the exterior surface to release indoor heat efficiently.

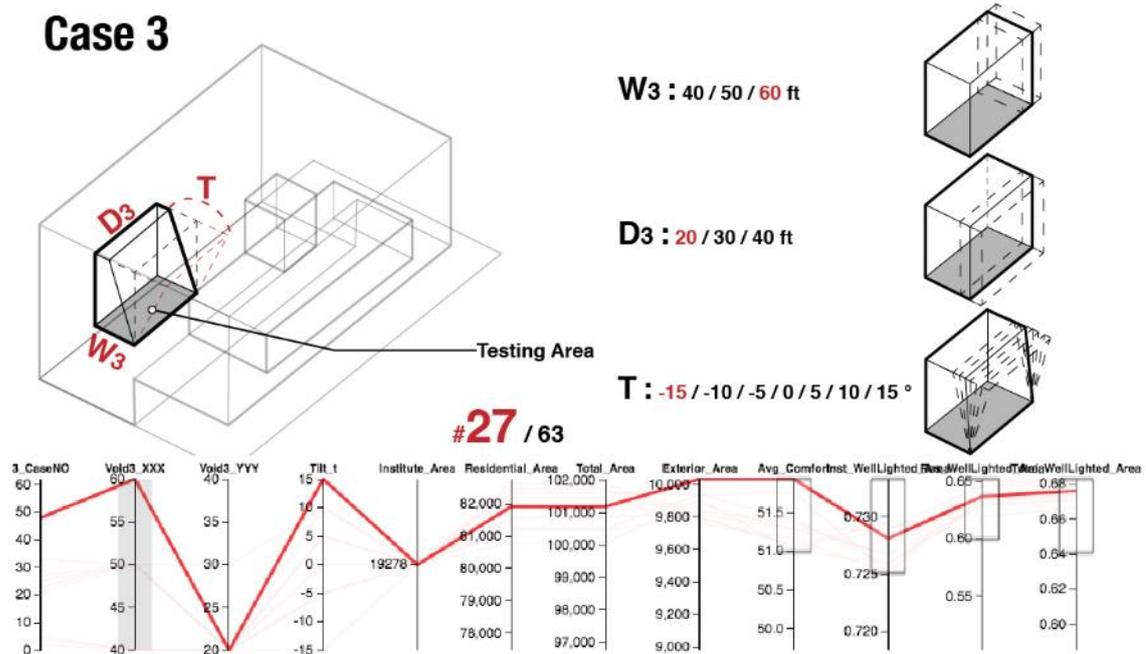


Fig II-28: Design iterations of 63 options in Case 3

Results

The geometry was finalized through three series of simulations (Fig II-29). Because simulation models tend to be simplified for efficiency, architectural design and planning should be conducted continuously to conceive a balance of building performance with realistic features of buildings (Lee et al., 2018b).

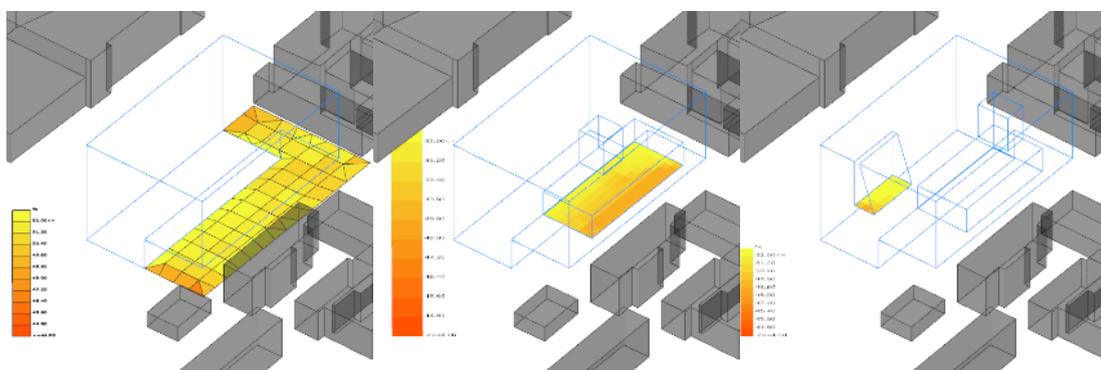


Fig II-29: Outdoor comfort simulation results

SIMULATION - STEP 2: FAÇADE:

Strategy:

In this hot climate, a conflict exists between thermal comfort and daylight. Thermal comfort depends on the reduction of solar radiation, while daylight does on the transmittance for daylight penetration. To maintain a balance, the enclosure must prevent solar heat gain and distribute daylight with proper values in WWR(Window-to-Wall Ratio), glazing type (A, B, C, D), and shading depth. The combinations of three factors were tested regarding thermal comfort and daylight availability. Multiple façade components were selected to be mix-matched rhythmically (Lee et al., 2018b).

Simulation Settings

The tested residential unit, with a southeast orientation, is 13 feet (4 m) wide and 30 feet (9 m) deep. The façade options were manipulated with the combinations of the façade’s glazing ratio (20, 40, 60, 80%), glazing type (A, B, C, D), and shading depth (0.0, 0.3, 0.6, 0.9, 1.2, 1.5 m) (Figure 30). Each type of glazing has varied values for U-Value (the rate of heat transfer through a material, the mathematical reciprocal of R-value), Solar Heat Gain Coefficient (SHGC), and Visual Transmittance (VT, the fraction of visible light through a material). Using combinations of those factors, the options were evaluated with UDI and adaptive comfort (Lee et al., 2018b).

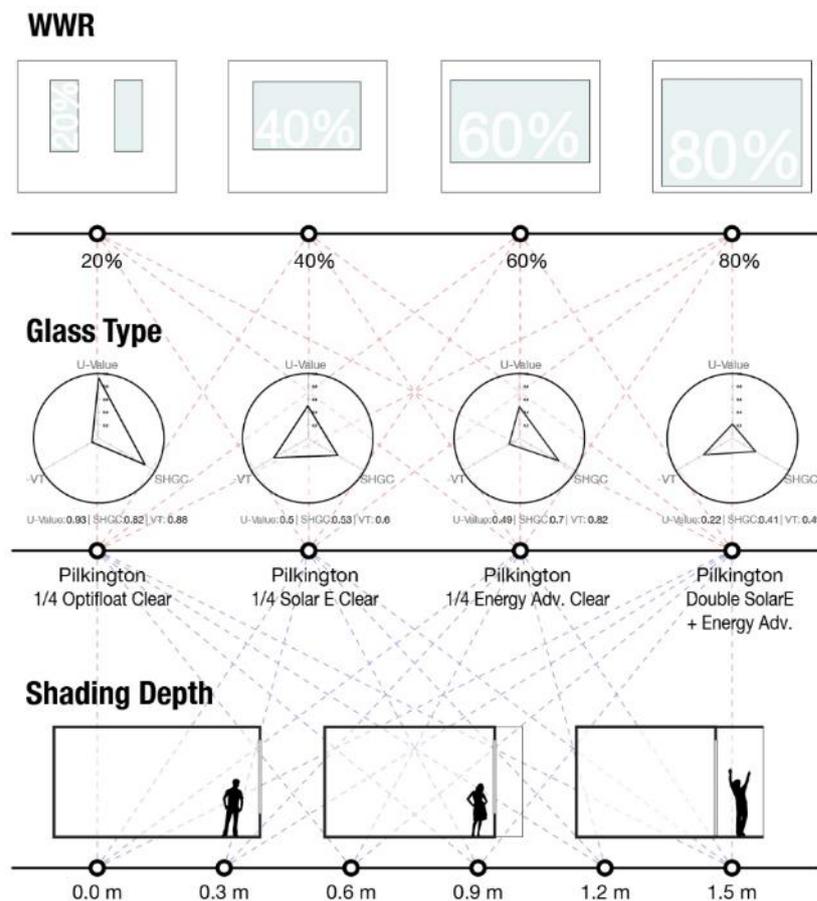


Fig II-30:Combinations of façade components

Results:

Through another upload, **Design Explorer** indicated that the UDI value (Useful Daylight Illuminance) ranged from 16% to 58% and the annual adaptive comfort ranged from 57% to 65%. Because obtaining high values for both is almost impossible, some

degree of compromise was unavoidable. Regarding the balance between UDI value and adaptive comfort, seven options were selected (Figure 31). In the case of the selected combinations, the UDI ranged from 29% to 55% and the adaptive comfort ranged from 62% to 64%. By acknowledging the incompatibility, the criterion for prototype selection became balancing conditions properly rather than achieving best value in either UDI or adaptive comfort (Lee et al., 2018b).

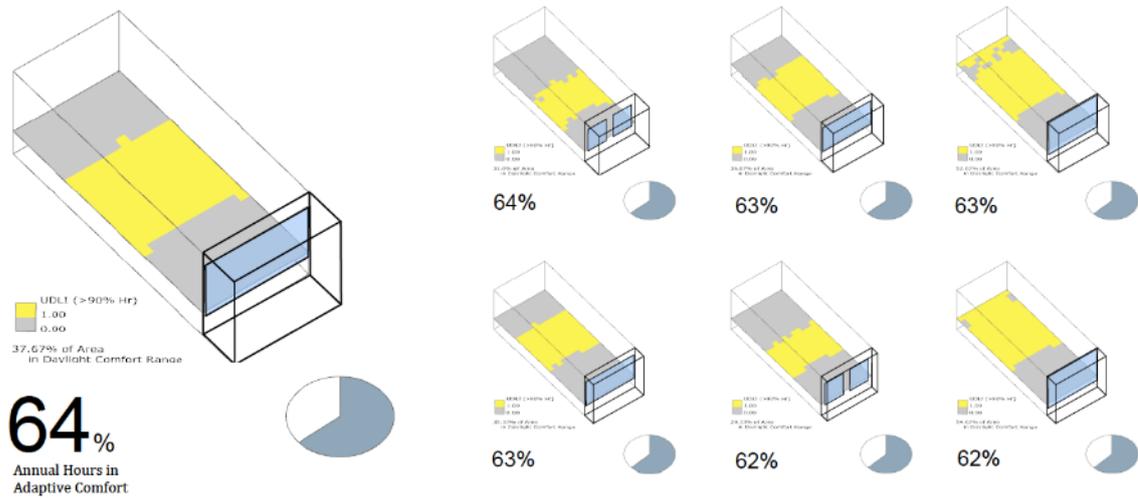


Fig II-31: Selected components of residential units
SIMULATION - STEP 3: SCREEN

Purpose

After shaping the building mass and façade details, the energy balance of the building was calculated to plan further improvements (Fig II-32). According to the chart, the indoor space was still exposed to an excessive amount of heat attributed to opaque conduction, infiltration, and solar radiation. The chart also illustrates the uncomfortable hours due to heat gain. By operationalizing three factors, it was able to reduce both the building’s peak energy loads and its annual loads significantly. The reason for considering peak energy load is to avoid peak-use tariffs and, ultimately, achieve savings on utilities (Lee et al., 2018b).



Fig II-32: Energy balance chart after step 2

Strategy

According to the differing programs between the upper and lower parts of the building, each part of the screen requires different functions that consider each occupancy schedule.

-Evaporative Cooling Screen: Office

The evaporative cooling screen enhances office comfort by transforming excessive solar heat into cooling effects during peak occupancy hours. Its feasibility was validated through a comparison with Tokyo’s BioSkin system, which successfully reduced building and surrounding temperatures. Given New Orleans’ higher temperature and humidity (Fig II-33), evaporation is expected to be even more effective. The screen, made of high water-retentive terracotta, also provides shading. Tests showed a 2.7°C temperature reduction at noon on June 21, using an efficiency-based wet bulb temperature model and Penman’s evaporation equation (Fig II-34) (Lee et al., 2018b).

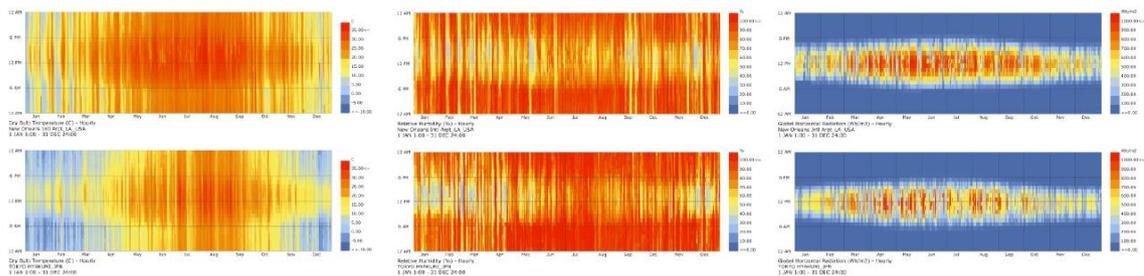


Fig II-33: Dry bulb temperature (left), relative humidity (right) (Up: New Orleans, US; Down: Tokyo, Japan)

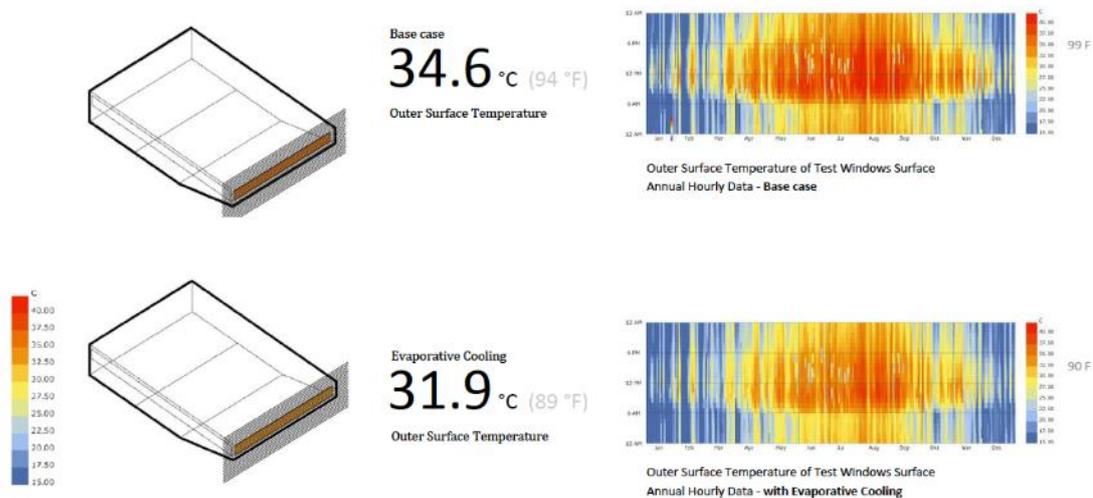


Fig II-34: Evaporative cooling effects calculated with

- Operable Sliding Screen: Residential Units

In residential units, the proposition of furniture and positions of occupants are not as predictable as they are in offices. Thus, an operable sliding screen system is a practical way to avoid glare near the window. The operable function is useful for residential spaces where people may want to move the screens around depending on sun position and their individual preference (Lee et al., 2018b).

Results

The multi-function screen system, which functions as evaporative cooling and shading, significantly reduced heat gain from solar radiation, as the energy balance chart indicates (Fig II-35) (Lee et al., 2018b).

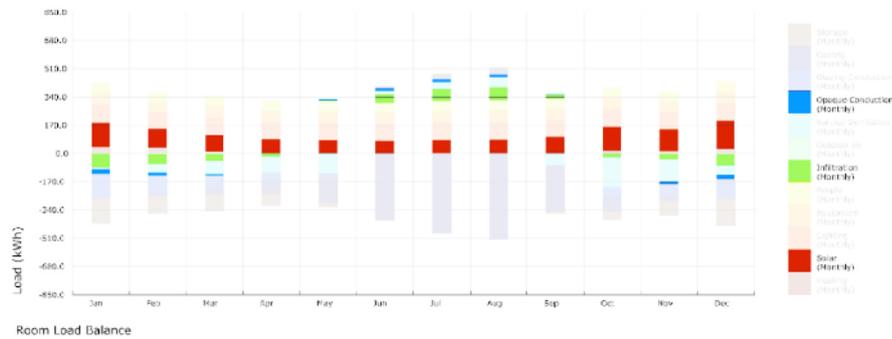


Fig II-35: The energy balance after Step 3

d) The Final results (Final model) :

The lessons of self-shading design can be summarized as follows. The wider and deeper the ground level open space is, the more outdoor thermal comfort can be obtained. Also, to achieve more thermal comfort hours and better daylight distribution, the open space on the fourth floor needs to be deeper, wider and placed in the middle of the building. For the smaller communal area, outdoor space tends to obtain better thermal comfort and daylight quality when it has a deeper floor and the wall is tilted inwards, which results in blocking more direct sunlight. Making a balance between thermal condition and daylight is challenging in design because cooling, heating, and lighting loads are intercorrelated.

The façade component design indicated that the combination of WWR and shading is important. As the WWR increases, the shading should be longer to create a balanced condition.

The last step, multi-function screen design, revealed evaporative cooling can effectively decrease the temperature of the building surface even in this humid climate and the operable sliding screen is suitable for residential units (Lee et al., 2018b).



Fig II-36: A section-perspective view of the building

II.8 Optimization framework

II.8.1 Defining performance metrics

a) Energy Efficiency

Energy efficiency refers to reducing energy consumption by utilizing less energy to power the same amount of loads such as lighting, HVAC, computers, plug loads and other devices. For example, replacing lights from incandescent or from fluorescent to LED lighting will provide the same amount of lighting but will reduce the energy consumption as seen in Fig II-37(Ximena M. Milla, 2018).



Fig II-37:Energy savings from exchanging incandescent light bulbs and compact fluorescent lights (CFL) to light emitting diode (LED) lights (<https://ybit.in/yqpVf7>)

b) Thermal comfort:

Thermal comfort is a subjective assessment by a person expressing their satisfaction with their local thermal environment. In practice, there are a number of variables that influence the body's heat balance with the environment, and in turn that person's perception of thermal comfort, including (Regnier, 2012):

Personal Factors: • Occupant activity • Clothing

Environmental Factors: • Air temperature • Radiant temperature • Air velocity • Humidity

While these are the traditional, measurable factors that influence thermal comfort and are input variables into predictive models, it should be noted that there are many other factors that can affect either the body's heat balance, or their subjective response. As examples, these might include age, gender, health, culture, climate, season, personal control, past thermal history, and expectations (Regnier, 2012).

Returning to the "classic 6" factors, however, the mechanisms that impact these factors are outlined in Figure 38. Heat transfer can occur by convection (air currents over the body, creating a cooling effect by inducing some evaporation over the skin), by conduction (contact heat transfer with other surfaces, e.g. flooring, furniture), by radiation (instantaneous infrared heat transfer with any visible object or surface at a different temperature than a person's body, e.g. the sun, the floor, the walls of a room), or by a person's biological processes (e.g. sweating, exhalation) (Regnier, 2012).

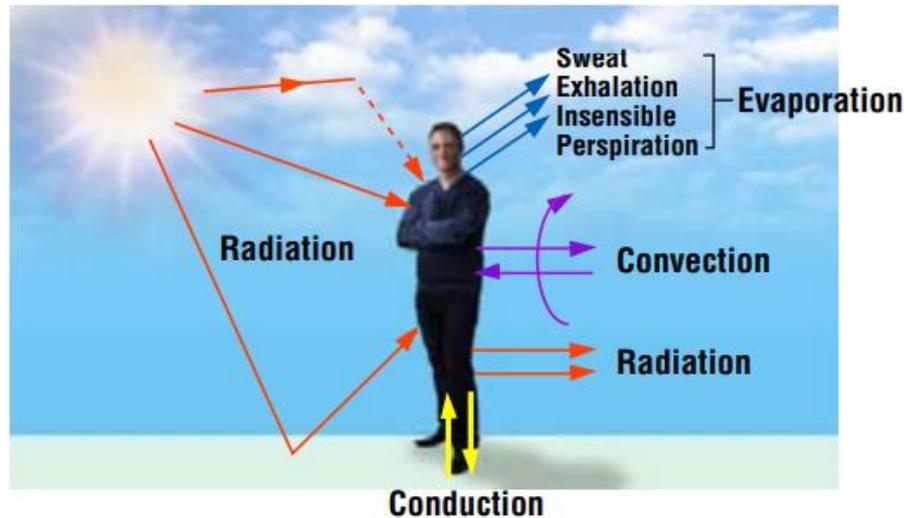


Fig II-38:Components contributing to thermal comfort source (https://ybit.in/orFq42)

c) Daylight:

All daylighting planning and strategies make use of the luminance from the sun, the sky and buildings. Daylight strategies depend on several factors: first of all, the availability of natural light (Fig II-39), which is determined by the latitude of the building site and the conditions immediately surrounding the building, e.g., the presence of obstructions. Moreover, daylighting strategies are also affected by climate; as a result, the identification of seasonal climate conditions is a basic step in daylight design. Studying both climate and daylight availability at a construction site is key to understanding the operating conditions of the building’s facades. The daylighting design solution for the building should consider all of these operating conditions (Moradi, 2014).

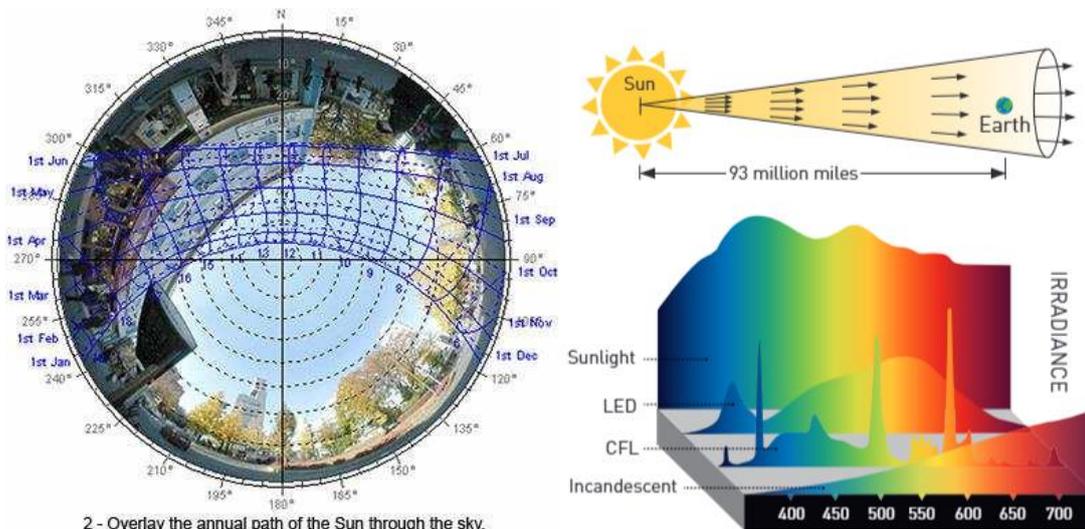


Fig II-39:Natural light Source (https://ybit.in/EwMer1)

II.8.2 From Parametric Design to Optimization algorithm

a) Genetic Algorithm

The concept of genetic algorithm transfers the theory of natural evolution to the field of optimization by imitating in a virtual environment a rapid analogy of an evaluation mechanism in nature (Cherif, 2017). See (Fig II-40).

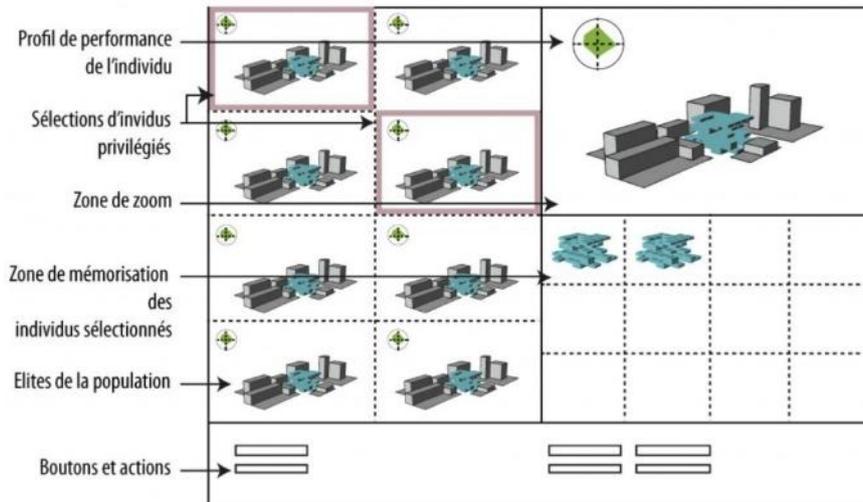


Fig II-40 :Example of a generative eco-design

Source : <http://dnarchi.fr/pedagogie/le-map-un-laboratoire>

b) Definition of Generative Design:

Generative design can be expressed as an algorithmic approach is based on design rules in which various possible design solutions can be generated. The rules of generative design can include parameters and variables. To generate a range of possible design outcomes, the parameters are applied in a systematic manner (Cherif, 2017).

c) Description of Genetic Algorithms:

The concept of Genetic Algorithms (GA) was introduced by Holland in 1975 and since then they have been used as adaptive search approaches to solve problems claiming biological evolution. New generations in GA use the Darwinian principle of reproduction and survival of natural genetic operations (Cherif, 2017).

Generic Algorithms are a world-renowned search technique for searching noisy solution spaces. The search begins with random sampling in the solution space, then stochastic operators to drive a hill climbing process based on the value of the objective function (Cherif, 2017).

In the principle of Genetic Algorithms, an individual is a unique solution to the problem, while the population is a group of solutions in progress at each step. In binary GAs, each individual is represented by a binary string called chromosome, which encodes all the parameters of interest corresponding to that individual. In addition, any specific individual that matches the objective function at a specific point called fitness.

The generation of solutions to problems is controlled and evaluated by genetic operators. See (Fig 41) There are three basic genetic operators, which are Reproduction, Crossover and Mutation.

- Reproduction: is proportional to the fitness of that solution.
- Crossover: exchange of two randomly chosen chromosomes to create a new individual.
- Mutation: change of an allele in a solution to search for new points in the solution space (Cherif, 2017).

■ Les algorithmes génétiques

■ Principe:

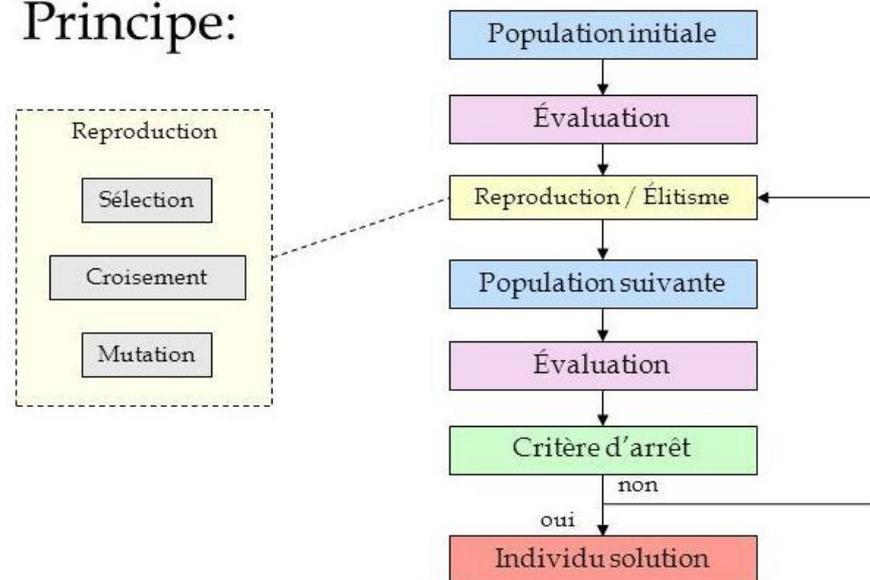


Fig II-41: Schematic diagram for genetic algorithms

Source : <http://www.slideplayer.fr/slide/1204905/>

d) The elements application of generative design in architecture:

Four elements are needed to form the generative design process:

- The input is the first phase, starting with the definition of parameters and conditions.
- The second phase is the generation technique using algorithms and a set of rules.
- The third phase is the output; it is the action of generating design alternatives.
- the last phase is to select the most efficient design, the design artifact can only be achieved in the fourth phase, so a generative system is a production system or a representative simulator (Cherif, 2017).

II.8.3 Multi-objective optimization

a) Example of multi-objective optimization application

Performance-based design using computational and parametric optimization is an effective strategy to solve the multi objective problems typical of building design. In this sense, a study has investigated the developing process of parametric modeling and optimization of a naturally ventilated house located in a region with well-defined seasons. Its purpose is to improve its thermal comfort during the cooling period by maximizing Natural Ventilation Effectiveness (NVE) and diminishing annual building energy demand, namely Total Cooling Loads (TCL) and Total Heating Loads (THL) (R. M. Sakiyama et al., 2021b).

Following the structure presented in Figure 42 shows the study workflow, divided into three significant steps: model setting with objectives definition, sensitivity analysis, and multi objective optimization (MOO), the approach used a 3D parametric modeling platform (R. M. Sakiyama et al., 2021b).

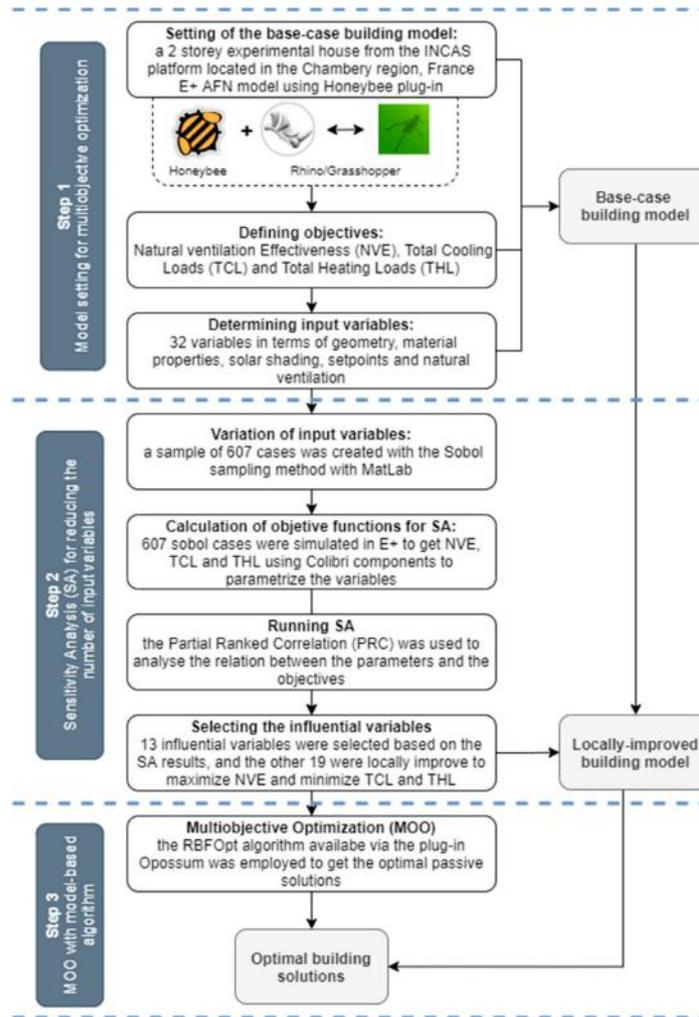


Fig II-42 :Multiobjective optimization framework.

It was used an innovative model-based optimization algorithm (RBFOpt), particularly appropriate for time-intensive performance simulations. The impact of design variables on the three-performance metrics is comprehensively discussed, with a direct relationship between NVE and TCL.

MOO results indicate a great potential for natural ventilation and heating energy savings for the residential building set as a reference, showing an improvement between 14–87% and 26–34% for NVE and THL, respectively.

The approach meets the current environmental demands related to reducing energy consumption and CO₂ emissions, which include passive design implementations, such as natural or hybrid ventilation. Moreover, the design solutions and building orientation, window-to-wall ratio, and envelope properties could be used as guidance in similar typologies and climates (R. M. Sakiyama et al., 2021b).

Finally, the adopted framework configures a practical and replicable approach for studies aiming to develop high-performance buildings through MOO.

II.9 Low-energy cooling strategies for thermal comfort in different climate types

A general strategy for identifying viable low energy cooling strategies is suggested by the following chart for various climate types. A similar process could be

followed for heating strategies, prioritizing strategies that provide heating benefits most relevant for a given climate condition. In general, for greatest energy benefits, prioritize thermal comfort strategies that improve interior conditions first, such as reducing radiant asymmetry and reducing draft. Then make best use of available natural ventilation, occupant controls and personal fans or other devices to improve comfort conditions before relying on mechanical systems to condition a space. Other measures, such as a seasonally variable dress code may also be employed to improve the viability of the proposed systems (Regnier, 2012).

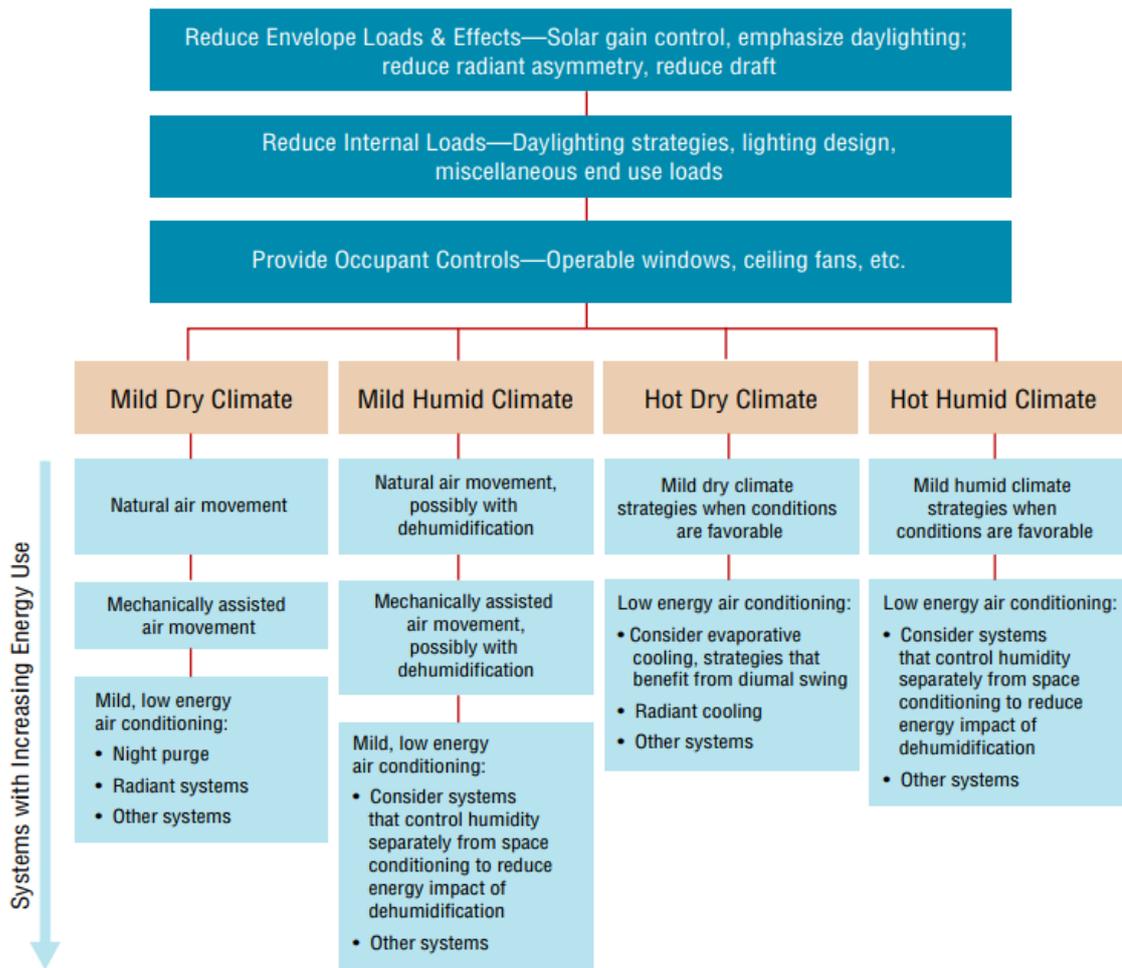


Fig II-43 : Low energy cooling strategy considerations for thermal comfort in various climate types.

Source (<https://ybit.in/orFq42>)

II.10 Conclusion

This chapter demonstrates that parametric architecture is no longer merely a formal approach or a tool for design experimentation, but rather a methodological framework that allows for the integration of multiple inputs into the architectural creative process. Parametric modeling offers broad possibilities for interaction between different subsystems, enabling the production of integrated solutions that combine functional performance, aesthetics, and technical considerations.

The importance of integrating climate data and environmental simulations into parametric workflows is also addressed. This dimension is highlighted through a case study of an institutional building in New Orleans, USA, where climate and parametric analysis tools were used to improve energy efficiency and ensure high levels of thermal comfort.

Furthermore, it is demonstrated how the transition from parametric design to optimization algorithms enables accurate and more effective solutions, particularly with regard to low-consumption cooling strategies under multiple climate patterns. This link between design and optimization highlights the value of advanced digital tools in achieving sustainability goals.

Based on the above, it can be said that parametric architecture today represents an essential tool in the search for innovative design alternatives capable of reconciling creativity with environmental awareness. Not only does it contribute to improving energy performance, it also opens new horizons for architectural practice to achieve more sustainable and resilient urban development.

CHAPTER II : MUSEUM

III. CHAPTER III : MEUSEUM

III.1 The Museums

III.1.1 Museum Definition

According to the International Council of Museums (ICOM), a museum is a not-for-profit, permanent institution in the service of society that researches, collects, conserves, interprets and exhibits tangible and intangible heritage. Open to the public, accessible and inclusive, museums foster diversity and sustainability. They operate and communicate ethically, professionally and with the participation of communities, offering varied experiences for education, enjoyment, reflection and knowledge sharing.

According to Larousse, a museum is a place or building where collections of works of art, cultural, scientific or technical goods are gathered for their conservation and presentation to the public.

Therefore, the museum is given three essential functions:

- Collect
- Preserve
- Exhibit

According to the executive decree "No. 07-160 of May 27, 2007" of the Algerian Republic, the museum is defined as: "Any permanent institution with cultural and/or scientific collections composed of goods whose conservation and presentation are of public interest and organized with a view to knowledge, education, culture and delight". (Art. 3.) [Ministry of Culture, 2008]

III.1.2 The functions of the museum

The definition of a museum typically results in a list of its functions. According to a similar definition by the International Council of Museums (ICOM), the writers Merleau-Ponty Claire and Jean-Jacques Ezrati have identified four functions of the museum: Acquire; Study and Research; Conserve; and Diffuse, to achieve one goal: to serve and develop society (Saihi, 2020).

- **Acquire** : Acquisition remains a permanent objective of museums, whether small or large, in order to save for study the material witnesses of human activity and its environment. Acquisitions are made in the form of excavations, purchases, donations or deposits, according to budgets and circumstances.
- **Study and Research**: Research conducted to establish the provenance of objects must be consistent with the museum's mission and objectives, in accordance with established legal, ethical, and intellectual practices. Analytical research methods are sometimes destructive. Their applications should be minimized. A museum that undertakes a full description of the object analyzed, with the results and subsequent studies, including publications, must register it as part of its permanent collection. Research involving human remains and sacred objects must be conducted according to professional standards, taking into account the interests and beliefs of the community or ethnic or religious groups from which the objects originate, if known.
- **Conserve**: The link between museum and conservation has been decisive for the birth and development of the institution. Some were founded to avoid the

dispersion of heritage, and to conserve it. For this, the curator must ensure the proper conservation of the works by ensuring that the conditions of presentation or storage do not subject the object to dangers.

- **Diffuse:** Mediation has grown considerably over the past twenty years. For those responsible, it has often become the main objective of their mission. In the spirit of the Revolution and of museums made accessible to the general public, it is a question of showing heritage and in particular collections (MERLEAU-PONTY Claire, EZRATI Jean-Jacques, 2005).

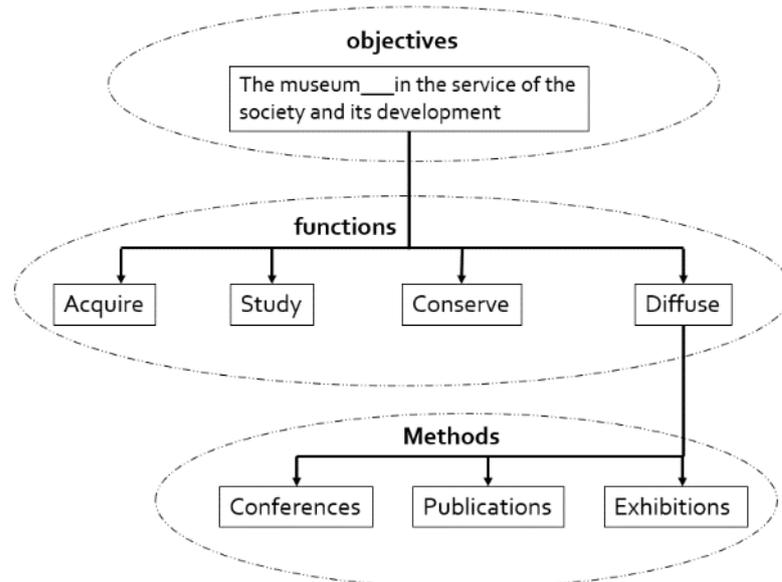


Fig III-1: The functions of the museum
Source: Jean-Jacques Ezrati readapted by the author.

III.1.3 Museum types

a) According to the concept of opening and closing

Table III-1 : Museum types according to the notion of opening and closing

Closed type	Open type:	Open-air museums:
It is characterized by an opaque articulation, this type of design focuses attention on the object e.g.: Guggenheim, Bilbao...	Museum in which glass walls play a main role. e.g.: Museum of contemporary art in the USA.	These are archaeological sites. This type of museum offers its visitors an architectural walk in contact with nature..
		
Fig III-2 :Museum Guggenheim Bilbao (https://ybit.in/LDVC01)	Fig III-3 :The Acropolis Museum of Athens (https://ybit.in/y5J7z6)	Fig III-4 :musée de Chercell (https://ybit.in/u1oXe8)

b) According to discipline

Table III-2 : Museum types according to discipline

<p>Art museums: is a museum dedicated to the conservation and exhibition of works of art.</p>	<p>Science museums are museums dedicated to science and technology, as opposed to museums dedicated to natural history. They present fixed collections of objects related to geology or industry.</p>	<p>The history museum: is generally one of all the galleries of painting and sculpture in which the works of art aim to represent events and great historical facts, forming by their assembly the history of a people.</p>
 <p>Fig III-5 :Museum of Modern Art of the City of Paris (https://ybit.in/WcKsB1)</p>	 <p>Fig III-6 :Chicago Museum of Science and Industry (https://ybit.in/nnuJr8)</p>	 <p>Fig III-7:Museum of the Second World War in Gdańsk (https://ybit.in/m7WFi6)</p>
<p>Cultural Museums: Museums, which have as their object, whose meeting allows to highlight the particularity of a country, a region, an era. Responsible for encouraging and promoting cultural events. The architectural particularities are generally similar to art museums</p>	<p>The general museum: Museum which brings together several departments which each have a different theme (science; art; culture; history; ...)</p>	<p>The specialized museum: Museum where one is particularly dedicated to a field / a thing / a branch ...etc. Ex: bolt museum, chair museum...etc. and Restrict the field of action in order to make it more efficient</p>
 <p>Fig III-8 :The Arab World Institute (https://ybit.in/7Kgcm3)</p>	 <p>Fig III-9 :The Louvre Museum in Paris (https://ybit.in/gDLE24)</p>	 <p>Fig III-10 :Mechanical Music Museum (https://ybit.in/6cOk31)</p>

III.1.4 According to the total areas:

a) The national museum:

Has various meanings depending on the country and the institutional situations. It sometimes refers to the public ownership of the collections, and their management by the State, the national museum strives to embody the heritage by sending back to the people an image worthy of appropriation. Generally speaking, the national museum is installed in the capital of a country, in a central or privileged manner.



Fig III-11: National Museum of Cameroon

Source : (<https://ybit.in/O5NcA2>)**b) The regional museum:**

Territorial museum, generally interdisciplinary, which aims to build collections and then to program exhibitions that express the history and culture of the population of a certain average area.



Fig III-12: Hail Regional Museum

Source : (<https://ybit.in/x46gq5>)**c) The local museum:**

A local museum or local history museum is a type of museum that displays the historical development of a place/region (local history) using exhibits. These museums are often small in size and usually have a low budget to cover their operating costs.



Fig III-13: Fujairah Museum, United Arab Emirates

Source : (<https://ybit.in/qTXlr8>)

III.2 The Algerian surface program

a- National museum of 5.500m²

Table III-3 National museum programme

Designation (A)	Area (m ²)	Designation (B)	Area (m ²)
A – Reception, Animation, Initiation	1080	C– Administration & Conservation	290
Entrance Hall	515	Service Access	20
General Public Reception	110	Management / Administration	216
Group and School Reception	82	Conservation	45
Offices Reception	10	Maintenance / Cleaning Rooms	9
Café / Tea Room	93	D – Logistics	920
Art Bookshop	60	Loading Area	40
First Aid Room	13	Regular Collection Storage	260
Cloakroom and Locker Area	72	Specific Storage & Consultations	80
Public Telephone	10	Storage	90
Main Sanitary Block	115	Building Storage	122
B – Core Activities	3710	Service Rooms	120
Temporary Exhibition	720	Staff Rooms	100
Permanent Exhibition	1260	Building Maintenance	58
Audiovisual Space	475	Dealer Storage	30
Public Media Library	990	Technical Rooms	120
Workshop for Initiation and Animation	265	Cleaning Rooms	100
		Security Post	120
TOTAL USEFUL AREA			5,500 m²

b- A regional museum of 1.650m²

Table III-4 : Regional museum programme

Designation (A)	Area (m ²)	Designation (B)	Area (m ²)
1. RECEPTION	289	Outdoor Terrace	160
Entrance Hall	120	4. CONSERVATION	164
General Public Reception	50	Workshops	64
Group / School Reception	30	Storage	100
Ticket Office	15	5. LIBRARY	195
Shop	25	Management and Loan Desk	35
Cafeteria	25	Reading / Children & Adults Area	80

Cloakrooms	15	Periodicals / Multimedia / Audio	30
Public Toilets	9	Library Storage	50
2. ANIMATION	139	Management and Loan Desk	35
Animation Workshops	64	6. CONFERENCE ROOM (100 seats)	200
Storage	15	7. MUSEUM MANAGEMENT	135
First Aid Room	9	8. TECHNICAL ROOMS	50
3. EXHIBITIONS	260	9. CIRCULATION AREAS	218
Permanent Exhibition	120	TOTAL USEFUL AREA	1,650 m ²
Forum	60		
Temporary Exhibition	80		

c- A local museum of 675 m²

Table III-5 Local museum programme

Designation (A)	Area (m ²)	Designation (B)	Area (m ²)
1. RECEPTION	110	6. MULTIPURPOSE ROOM	74
2. ANIMATION	54	7. MUSEUM MANAGEMENT	55
3. EXHIBITIONS	112	8. TECHNICAL ROOMS	30
4. CONSERVATION	60	9. CIRCULATION AREAS	80
5. LIBRARY	100	TOTAL USEFUL AREA	675 m ²

III.3 The spatial and functional organization of the museum

The museum's layout organizes spaces to support operations and visitor experience, separating public areas from administrative and technical zones, while facilitating resource management, visitor flow, and educational and research activities, as shown in the diagrams below:

(1): The diagram illustrates the circulation scheme of a cultural or institutional building. From the main entrance control, visitors access key spaces such as the reception, gallery, and conference hall, while administrative and technical areas (studies, curatorium, reserves) are organized around the main route. The layout ensures clear movement, functional separation, and efficient connections between public and professional zones.

(2): This schematic shows the spatial organization of a public facility. It separates administrative, exhibition, and service areas while ensuring smooth circulation. Visitors enter through a main hall leading to exhibition, conference, and commercial zones, while deliveries access the administration and service areas separately.

(3): This scheme outlines the essential operational zones of a museum, showing how collection management, conservation, administration, public areas, technical systems, and staff facilities work together to support both the care of artifacts and the visitor experience.

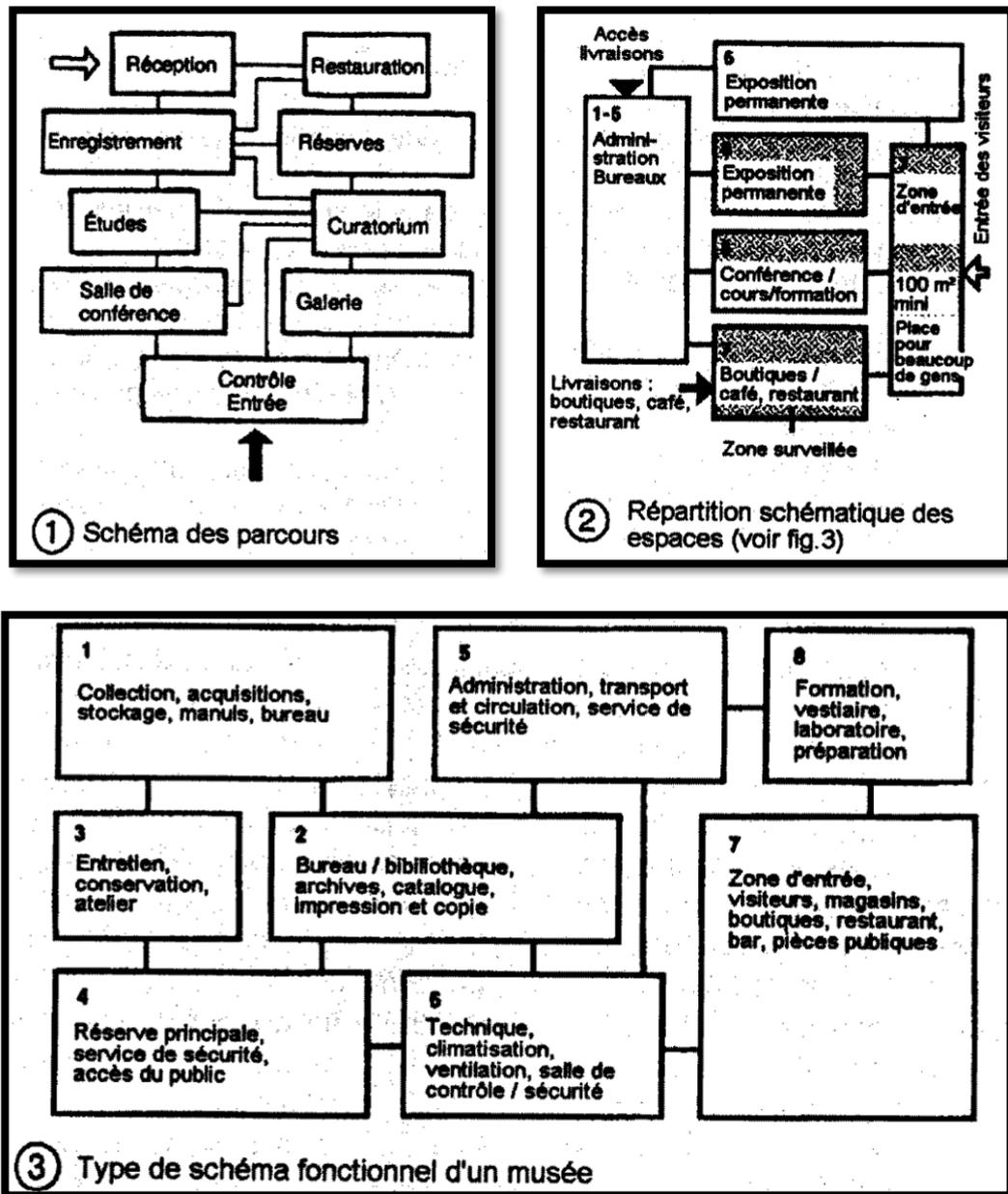


Fig III-14:(1) The circulation scheme (2) Schematic distribution of spaces (3) Type of functional diagram of a museum

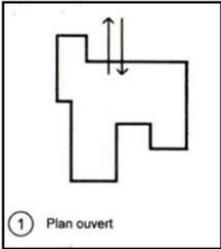
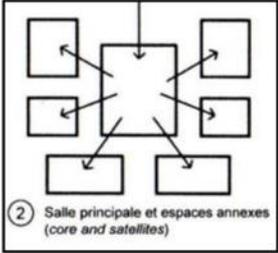
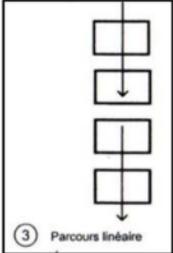
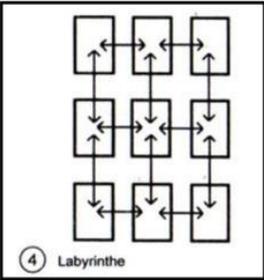
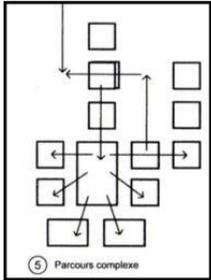
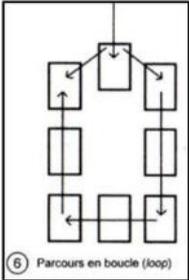
Source: (Neufert, 08th edition)

III.4 The museum design norms

III.4.1 The path:

In museum design, the organization of visitor circulation plays a crucial role in shaping the spatial experience and guiding the discovery of exhibitions. Different circulation models offer distinct ways for visitors to navigate, perceive, and interact with the displayed content. From open and flexible layouts to more structured and directional sequences, each path configuration influences orientation, movement, and engagement within the museum. We present in the Table III-6 the main types of circulation paths commonly used in museum architecture, highlighting their spatial characteristics.

Table III-6: Types of paths
Source: (neufert 10th Edition).

<p>The open path: Vast exhibition space, visually autonomous, free circulation</p>  <p>① Plan ouvert</p>	<p>The radial path: Main room used for orientation in the museum.</p>  <p>② Salle principale et espaces annexes (core and satellites)</p>	<p>The linear path: Linear spatial sequence, defined path, clear orientation, separate entry and exit</p>  <p>③ Parcours linéaire</p>
<p>The labyrinth path: Free movement, the route and direction are variable.</p>  <p>④ Labyrinthe</p>	<p>The complex path: spatial groups combined with typical features from 1 to 4, complex organization of the collection.</p>  <p>⑤ Parcours complexe</p>	<p>The loop path: Similar to the linear route, it leads back to the entrance.</p>  <p>⑥ Parcours en boucle (loop)</p>

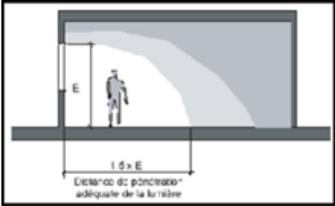
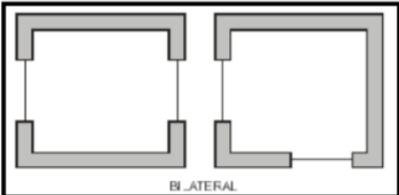
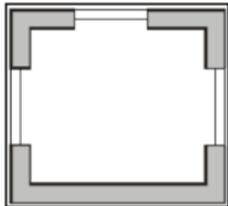
III.4.2 Lighting

For a museum, lighting is an important element as much as a factor of interpretation, as of the comfort and well-being of visitors, without forgetting its degradation action on a large number of materials.

a) Natural lateral lighting

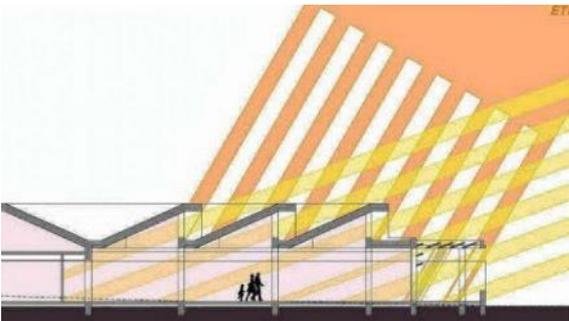
Table III-7: Lateral natural lighting

Source: (Benharket.S, 2005-2006).

Unilateral lighting	Bilateral lighting	Multilateral lighting
<p>This is lighting provided by one or more vertical openings arranged on the same facade of a given orientation. This arrangement makes it possible to achieve relief effects and harmonies of contrasts.</p>  <p>(Mohammedi.R, MohdeD.A, Mokrani.C, 2017).</p>	<p>Consists of having vertical openings on two walls, either parallel or perpendicular, of the same room. This solution remedies the major defect posed by unilateral lighting. Indeed, according to A. VANDENPLAS41, the depth of rooms lit by a bilateral device can easily reach four times the distance between the ceiling and the useful plane.</p>  <p>(Mohammedi.R, MohdeD.A, Mokrani.C, 2017).</p>	<p>Consists of having vertical openings on more than two walls, but which are in the same room. Multilateral lighting has many advantages, including: The openings reduce the risk of glare from the sky by increasing the illumination of the window walls. But it has certain constraints, the most important of which is to increase the risks of overheating in summer and heat loss in winter.</p>  <p>(Mohammedi.R, MohdeD.A, Mokrani.C, 2017).</p>

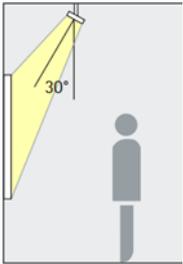
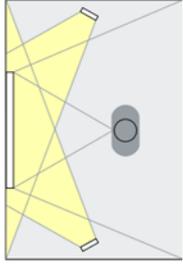
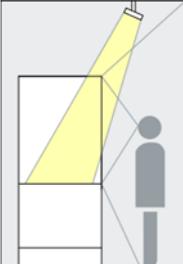
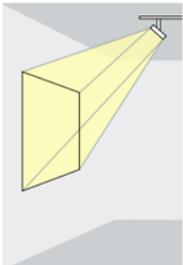
b) Natural zenithal lighting:

Table III-8:Natural zenithal lighting (Benharket.S, 2005).

Direct zenithal lighting	Indirect zenithal lighting:
<p>This is a system consisting only of an opening made in the roof. (e.g. domes, glass roofs).</p>  <p>Fig III-15 :Guggenheim Museum-New York direct zenithal lighting (https://ybit.in/LS81u0)</p>	<p>Is a system composed of two parts: an opening that captures natural light and a distribution system that reflects or diffuses this light.</p>  <p>Fig III-16 : indirect zenithal lighting (sheds). (https://www.letelegramme.fr).</p>

c) Artificial lighting:

Table III-9 : Artificial lighting (Erco, 2012).

type	Description
 <p data-bbox="320 600 858 674">Fig III-17: Correct positioning of lighting devices (Erco, 2012)</p>	<p data-bbox="922 322 1407 427">To illuminate paintings and sculptures, the optimum angle of incidence of light is 30.</p>
 <p data-bbox="280 958 895 1025">Fig III-18: Reducing the visitor's shadow (Erco, 2012).</p>	<p data-bbox="922 680 1407 824">Two projectors placed on the side illuminate the paintings without glare by reflection or forming any shadow on the painting.</p>
 <p data-bbox="309 1310 868 1391">Fig III-19: Lighting windows without glare (Erco, 2012).</p>	<p data-bbox="922 1032 1407 1249">To illuminate the display cases without glare, the display cases can also be illuminated by projectors placed outside, as long as these projectors are positioned from the observer's point of view.</p>
 <p data-bbox="312 1675 865 1749">Fig III-20: Circumscribing the beam to the contours of the painting (Erco, 2012).</p>	<p data-bbox="922 1397 1407 1503">When the beam is limited to illuminating the exposed shadow, the paintings seem to radiate light.</p>
 <p data-bbox="320 1944 855 2018">Fig III-21 : Highlighting the walls and the works (Erco, 2012).</p>	<p data-bbox="922 1756 1407 2011">To highlight the walls and the works, balanced lighting of the rooms and the exhibition results from the combination of homogeneous wall lighting, to give a feeling of clarity, and accent lighting, to model the sculptures.</p>

III.4.3 Ambiance path / light

Lighting begins outside the building, to guide the visitor to the exhibition following a clear and welcoming path. In circulation areas, such as the entrance hall, corridors or circulations, lighting also contributes greatly to the orientation of visitors (Ezrati, 2010).

Therefore, lighting plays a key role throughout the exhibition space:

- -It can be used to change the atmosphere of the place,
- It can be used to draw the eye to exhibited works,
- A subtle play of light and shadow can guide the visitor in their journey, from the entrance to the exit.

III.4.4 The museum exhibition

a) Exhibition

According to Larousse, exhibition is the presentation to the public of works of art; all the works exhibited. We have two types of exhibition:

- **The permanent exhibition:** Is an exhibition whose presentation duration is not limited (Fisli Yasmine, 2020).
- **Temporary exhibition :** Is an exhibition whose presentation duration is limited (generally between 3 and 9 months) (Fisli Yasmine, 2020).

The methods of exhibitions in museums vary depending on the type of museum, the shape of the exhibition rooms and the type and size of the pieces. These methods can be summarized in (Saihi, 2020):

- Display on the walls in the form of a hanging board as in the museums Arts.
- Presentation in the form of a portfolio hanging on the wall often glazed as in the museums of archaeology, museum of science and technology.
- Display directly on palms Based on the wall.
- Display on the floor directly without a base. This method is generally used in technical museums or museums with large exhibitions.
- Display on hanging supports as in science museums.
- Display on a base based on the floor as in museums of folk traditions or crafts.
- Display on vertical boards as in museums and literary documents and stamps.
- Display on fixed or mobile chests with various shapes and sizes based on the floor as in the Museum of Veterinary Medicine in Zurich.



Fig III-22:(Left) Display on the walls (Right) Display in the form of a hanging and glazed portfolio on the wall. **Source:** Google image..



Fig III-23: (Left) Display on the floor (Right) Display on hanging supports.
Source: Google image.



Fig III-24 :(Left) Display on a base (Right) Display on fixed or mobile chests .
Source: Google image.

b) Exhibition rooms:

According to Larousse, exhibition room is a place where works of art are presented.

Design standards for exhibition spaces:

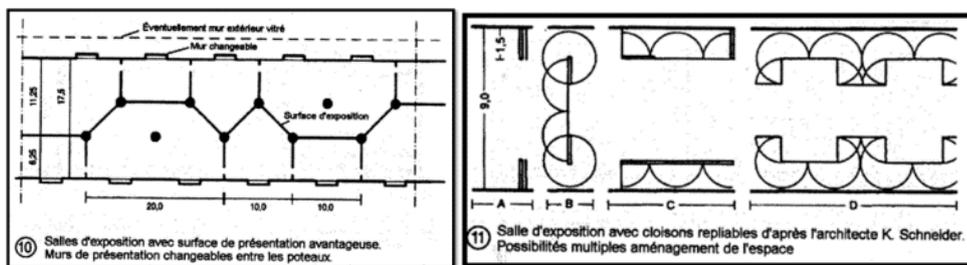


Fig III-25 :(Left) exhibition rooms with advantageous presentation area. Exchangeable presentation walls between the posts. (Right) exhibition room with folding partitions according to the architect K. Schneider multiple possibilities

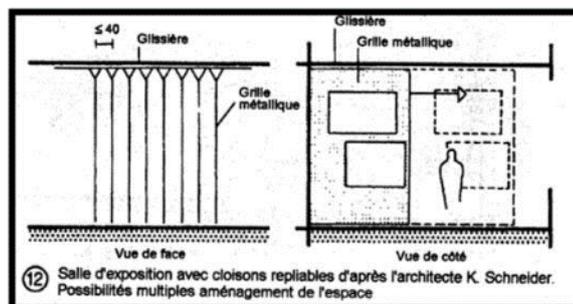


Fig III-26: exhibition room with folding partitions by architect K. Schneider, multiple possibilities for space planning.

Positioning of works of art in exhibition rooms:

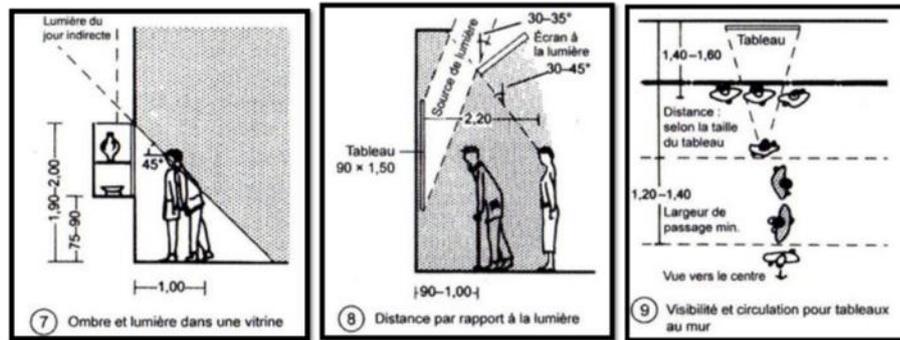


Fig III-27:(7) Shadow and light in a shop window.(8) Distance from light.(9) Visibility and circulation for wall paintings (Neufert, 10th edition)

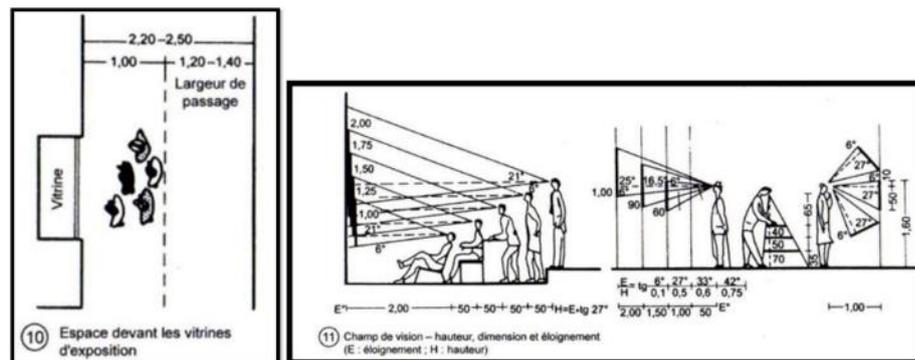


Fig III-28:(10) Space in front of the display cases (11) Field of vision – height, dimension and distance (E: distance; H: height) (Neufert, 10th edition).

III.6 Examples Analysis

III.6.1 Introduction

In this chapter, we will focus on the analytical approach of the previous aspects. We will analyze several literary examples of museums to better understand how these spaces function. Next, we will analyze the context, specifically the data from the city of Algiers, including climate analysis and site analysis. This analysis aims to take into account the specific climate data of the region and morphological data to better define strategic options at the design stage.

We will analyse the following examples :



Figure III.39 Shanghai Natural History Museum-china-



Figure III.38 MAXXI Museum (National Museum of XXI Century Arts)-italy-



Figure III.40 Matsumoto City Museum-japan-



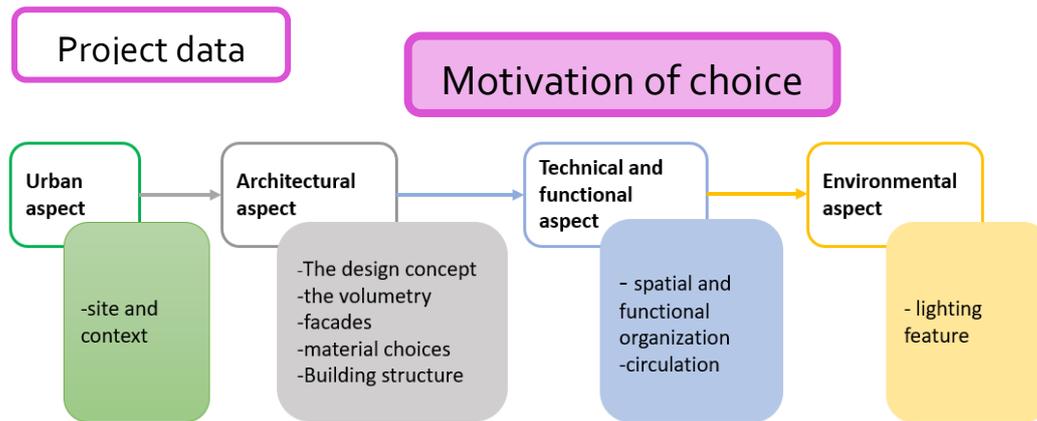
Figure III.41 Sanxingdui Museum m-china-



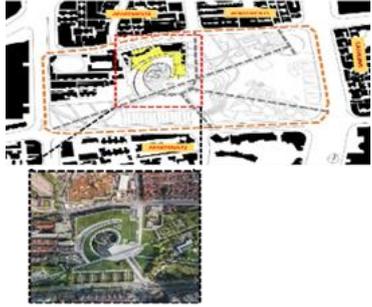
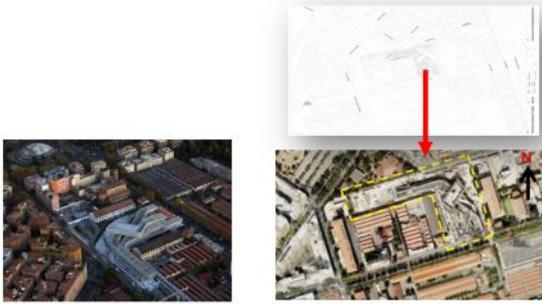
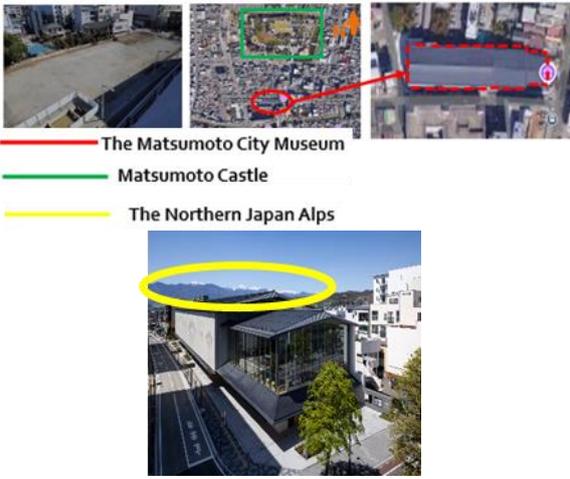
Figure III.42 Museum of Nature and human, italy-padova

III.6.2 Analysed elements

The following elements will be analysed for each example.

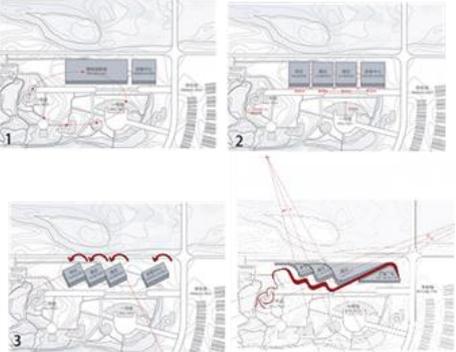


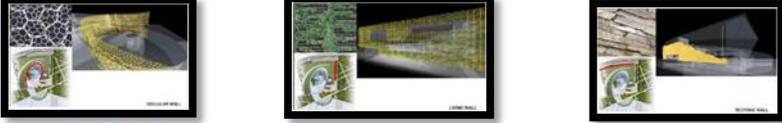
The project	Project data	Motivation of choice
 Shanghai Natural History Museum	Category: Natural History Museum Location: Shanghai, China Year of realisation: 2015 Architects: Perkins & Will Area: 44517 m ²	The choice of Shanghai Natural History Museum is due to its design, which embodies the harmony between architecture and the natural environment, making it an ideal subject for investigating the interaction between spatial and environmental design.
 MAXXI Museum (National Museum of XXI Century Arts)	Category: contemporary Museum Location: Flaminio, Rome, Italy Year of realisation: 2009 Architects: Zaha Hadid Architects Area: 27000 m ²	The choice of the MAXXI Museum is a great example of its modern and innovative design that reflects the interaction between contemporary art and nature, and the dynamic layout of the interior spaces.
 Sanxingdui Museum	Category: Exhibition Architecture Location: China Year of realisation: 2023 Architects: CSWADI Area: 54400 m ²	Sanxingdui Museum offers a rich learning opportunity, integrating elements of the region's cultural and historical heritage into its design and modernity techniques, and achieving sustainability.
 Matsumoto City Museum	Category: City Museum Location: Japan Year of realisation: 2022 Architects: KUME SEKKEI Co. Area: 2973 m ²	Selecting the Matsumoto City Museum allows for a deeper understanding of designing a museum that harmonizes with its environment and local context, balancing modernity with nature while promoting sustainability.

The project	Site and context
<p><u>Shanghai Natural History Museum</u></p>	<p>The museum is located in Jing'an Sculpture Park, a central location in Shanghai, China. It occupies a prominent site, creating a gateway to the city's cultural landscape.</p> 
<p><u>MAXXI Museum (National Museum of XXI Century Arts)</u></p>	<p>Located in Rome's Flaminio district, Zaha Hadid's MAXXI Museum combines contemporary culture with the area's traditional urban setting.</p> 
<p><u>Sanxingdui Museum</u></p>	<p>Anxingdui Site Museum park is 40 kilometers away from Chengdu, located by the Duck River in the west of Guanghan . The park is surrounded by lush vegetation and water system.</p> <p>The following centers are spread throughout the park:</p>  <ul style="list-style-type: none"> — Tourist center — The new museum — Comprehensive hall (hall 1) — Bronze museum (hall2) — Sacrificial platform — Cultural exhibition — Vip hall — Reserch center — catering — Toilet — Administrative area
<p><u>Matsumoto City Museum</u></p>	<p>Matsumoto City Museum is located near Matsumoto Castle. The historical proximity influences the design of the museum, which aims to harmonize with the traditional aesthetics of the area while maintaining its contemporary identity. Matsumoto is surrounded by the Northern Japan Alps, whose majestic peaks form a dramatic natural backdrop.</p>  <ul style="list-style-type: none"> — The Matsumoto City Museum — Matsumoto Castle — The Northern Japan Alps

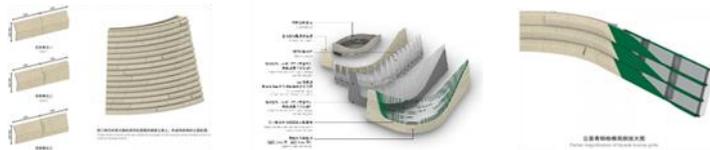
The project	The design concept
<p><u>Shanghai Natural History Museum</u></p>	<p>The museum's design expresses the harmony between humans and nature, inspired by traditional Chinese culture that values mountains and water as key elements. It represents a "mountain-water garden," with a mountain-like structure surrounding a body of water and abstract screens inspired by natural patterns providing structure and sun protection.</p> 
<p><u>MAXXI Museum (National Museum of XXI Century Arts)</u></p>	<p>The design concept of the MAXXI Museum by Zaha Hadid is rooted in her signature architectural language of fluidity, dynamism, and spatial experimentation. The museum's concept is an exploration of how space can be interconnected and flexible, breaking away from traditional rigid forms.</p> <p>Confluences of lines → Primary force of the site Unique L-Shape Footprint → Explore the possibilities of linear structure</p> 
<p><u>Sanxingdui Museum</u></p>	<p>The three undulating pile-shaped ruins left over from the city wall of the ancient Shu Kingdom and the crescent-shaped Moon Bay platform in the north form the landscape of “three stars with the Moon”, These mounds symbolize continuity and connection with the historical landscape.</p> 

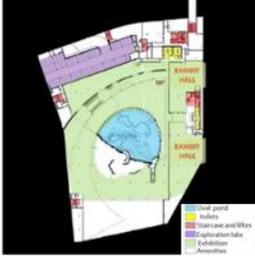
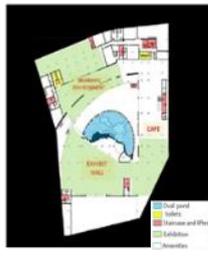
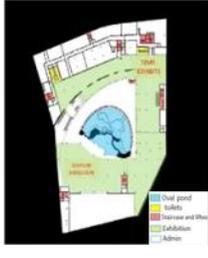
<p><u>Matsumoto City Museum</u></p>	<p>- With Historical and Urban Context Integration connection to Matsumoto Castle: The museum's design pays homage to the city's rich historical heritage by reflecting elements of Matsumoto Castle's defensive "Masugata" layout.</p> <p>-Nature as Inspiration Alpine Influence: The folded-plate steel roof structure is inspired by the jagged peaks of the Northern Alps, a prominent feature of Matsumoto's landscape.</p>	
<p>The project</p>	<p>The volumetry</p>	
<p><u>Shanghai Natural History Museum</u></p>	<p>The museum's design draws inspiration from the nautilus shell, symbolizing nature's geometric purity. Its facades reflect natural elements: a central cell wall inspired by biological structures, an eastern wall representing plant life, and a northern stone wall symbolizing tectonic plates and river-carved valleys.</p>	
<p><u>MAXXI Museum (National Museum of XXI Century Arts)</u></p>	<p>The museum is designed as a series of flowing, intersecting ribbons, forming walls, ceilings and corridors, giving the building a sense of movement and continuity. These intersecting ribbons create contrasts in height and depth, enhancing the dynamic presence of the design.</p> <p>The museum features suspended volumes, especially in the roof structure, where large sections extend outwards. These sections provide shaded outdoor areas and enhance the building's dynamic sculptural appearance.</p>	<p>Museum = "an object" → Museum = "a field of buildings"</p>

<p><u>Sanxingdui Museum</u></p>	<p>-integrating parts into a whole. -The volumes are arranged from west to east -the three volume units rotate to the southwest, shaping the panoramic view of the site area and the park. -extracted the lines from the ancient cultural relics of Sanxingdui as the control curve for the shape and internal space of the three piles.</p>	
<p><u>Matsumoto City Museum</u></p>	<p>1- Symbolism in Volumes: The design uses volumetry to reflect Matsumoto's dual identity as a historical and modern city: Lower, heavier volumes near the entrance symbolize the city's historical roots. Light, elevated structures on the upper levels represent forward-thinking modernity and openness.</p> <p>2-The building's height is capped at 18 meters, a constraint that guided the development of its layered and horizontal design. This ensures the museum blends harmoniously with the neighboring structures.</p> <p>3-Horizontal Orientation The museum emphasizes horizontal lines, creating a sense of stability and calm. This is a nod to traditional Japanese architecture, which often prioritizes horizontal expansion over verticality.</p>	  

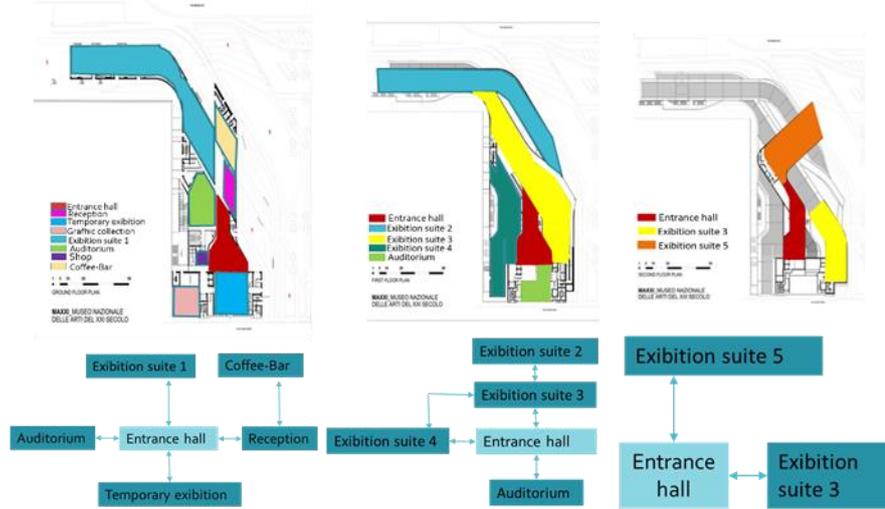
The project	Facades
<p><u>Shanghai Natural History Museum</u></p>	<p>-The central cell wall relates to the cellular structure of plants and animals. -The eastern living wall represents the vegetation of the earth's surface. -The northern stone wall suggests shifting tectonic plates, as well as canyon walls eroded by rivers.</p>    

<p><u>MAXXI Museum (National Museum of XXI Century Arts)</u></p>	<p>Dynamic Lines and Curves The facades are defined by intersecting planes, curves, and flowing lines, embodying the concept of fluidity and motion that runs throughout the building. -The design avoids traditional symmetry or grid-like organization, instead embracing an organic composition. Contrasts with Rome’s Historic Architecture: The smooth, modern facade intentionally contrasts with the richly textured and ornate historic facades of Rome. This juxtaposition emphasizes the museum’s role as a symbol of the city’s future.</p> 
<p><u>Sanxingdui Museum</u></p>	<p>Symbolic "Eyes" Design: The most striking feature of the facade is the large "Eyes," inspired by the iconic bronze masks excavated from the Sanxingdui Ruins. These "Eyes" serve as both windows and symbolic elements, representing the ancient civilization's connection with the heavens and the earth. They allow natural light to filter inside, creating a contemplative and mystical ambiance.</p> 
<p><u>Matsumoto City Museum</u></p>	<p>1. Primary Facade (Facing Daimyo-cho Street) Transparency and Engagement: The main facade along Daimyo-cho Street features large expanses of glass, creating a transparent interface between the museum’s interior and the street. This design reflects the Japanese architectural tradition of "engawa", where indoor and outdoor spaces are connected.</p> <p>2. Secondary Facades: Solid and Minimalist: The other facades feature exposed concrete walls, emphasizing solidity and permanence. The minimalist approach aligns with the Japanese aesthetic of "shibui"—understated elegance. solid walls serve as a contrast to the transparent main facade,</p>  <p style="text-align: right;">Engawa House</p>

The project	Material Choices
<p><u>Shanghai Natural History Museum</u></p>	<p>Glass: For transparency, natural light. Steel: For the primary structural framework, allowing for long spans and open spaces. Concrete: For the structural core and foundations, providing stability. Stone and Wood: for linking the building to nature. Aluminum: For exterior cladding. Green Roof and Landscaping Sustainable, Recycled Materials: Contributing to the overall eco-friendly design.</p> 
<p><u>MAXXI Museum (National Museum of XXI Century Arts)</u></p>	<p>Concrete: The primary material of the facades is smooth, light-gray reinforced concrete.</p> <p>Steel: Steel is used for structural reinforcement, particularly in the cantilevered sections and roof designs</p> <p>Glass: Large glass facades and skylights bring natural light into the structure while maintaining visual connections to the surrounding urban environment.</p> 
<p><u>Sanxingdui Museum</u></p>	<p>The exterior materials :</p> <p>Chrysanthemum Yellow Granite: The main cladding material symbolizes the earth, The granite panels are 8 cm .</p> <p>Bronze Sun Visors: Low-iron glass is installed at the eyes position, covered by an outer bronze sun visor. The sun visor is crafted from oxidized brass, these elements mimic the weathered, greenish patina found on ancient artifacts. The visors also enhance the building's connection to the Sanxingdui culture and provide shade.</p> 
<p><u>Matsumoto City Museum</u></p>	<p>Glass: ————— The extensive use of glass on the primary facade invites natural light into the building and reduces the boundary between the museum and the city.</p> <p>Concrete: ————— The use of exposed concrete reflects modern architectural practices while providing a durable, neutral backdrop for the museum's art and design.</p> <p>Steel Accents: ————— Steel detailing around windows and structural elements complements the folded roof, adding a contemporary touch.</p> 

The project	Spatial and functional organization
<p><u>Shanghai</u> <u>Natural</u> <u>History</u> <u>Museum</u></p>	<p>The Shanghai Museum of Natural History showcases a fluid “mountain water garden” design inspired by nature. It has six floors—three above and three below ground—where the lower levels display early life and fossils, and the upper levels focus on biodiversity and education. A spiral layout guides visitors upward through time, with interconnected spaces that use natural light and blend with the surrounding environment to enhance the sense of exploration.</p> <p>BASEMENT 1 LEVEL PLAN:</p>  <p>BASEMENT 2 LEVEL PLAN:</p>  <p>BASEMENT 3 LEVEL PLAN:</p>  <p>GROUND FLOOR PLAN:</p>  <p>FIRST FLOOR PLAN:</p>  <p>SECOND FLOOR PLAN:</p>  <p>Exploration labs Oval pond Exhibition hall</p> <p>Shanghai environment Oval pond cafe Exhibition hall</p> <p>Administration Oval pond Temporary Exhibition Ways of evolution</p> <p>Exhibit hall (river of life) Oval pond Rediscovering nature Lobby Gift shop</p> <p>Administration Lecture hall Exhibit hall 4D theatre</p> <p>Administration Exhibit hall 4D theatre</p>

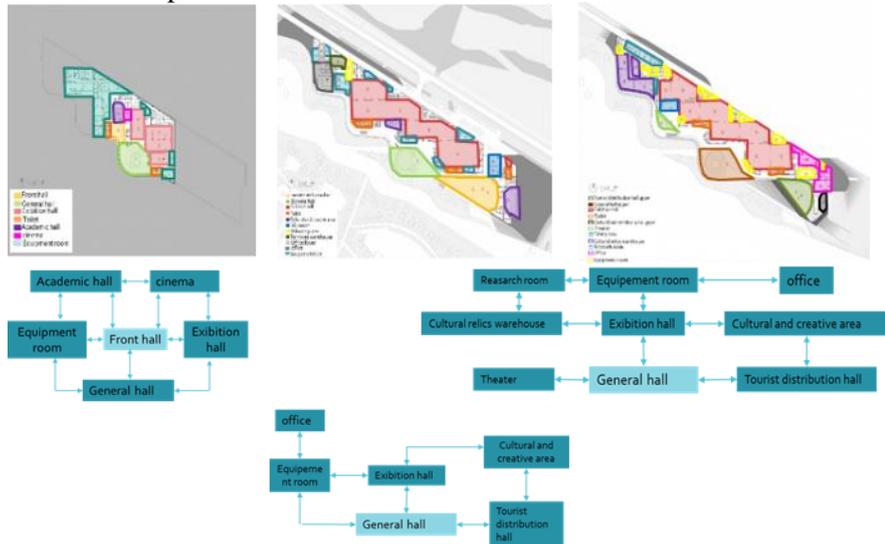
MAXXI
Museum
 (National
Museum of
XXI Century
Arts)

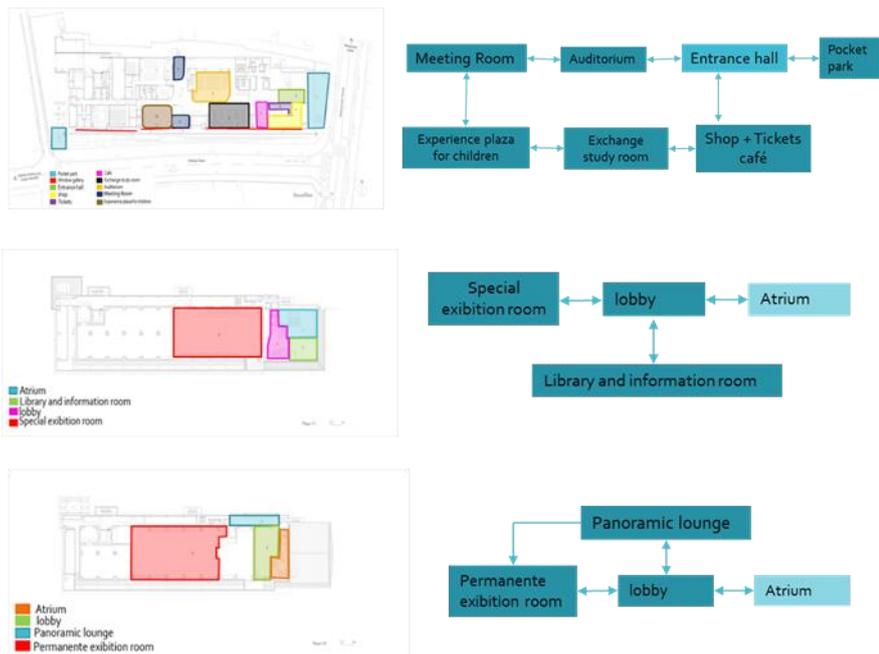


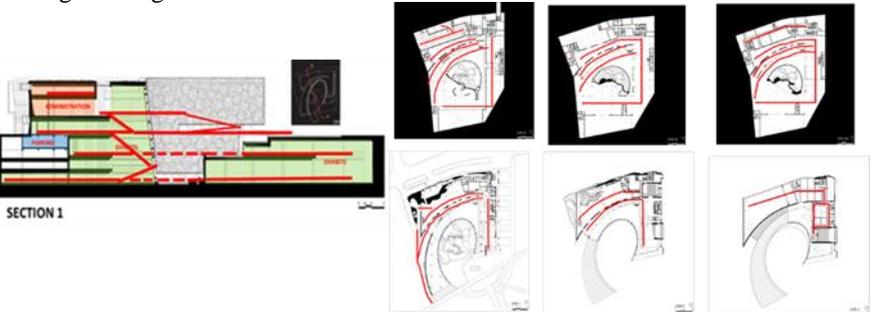
The MAXXI Museum features a dynamic, curved design with three floors of flexible exhibition spaces connected by suspended walkways and curved pathways, creating a seamless flow of movement and interaction within the building.

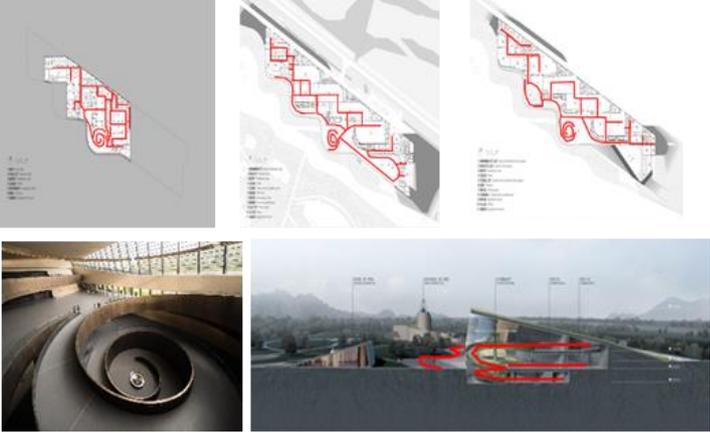
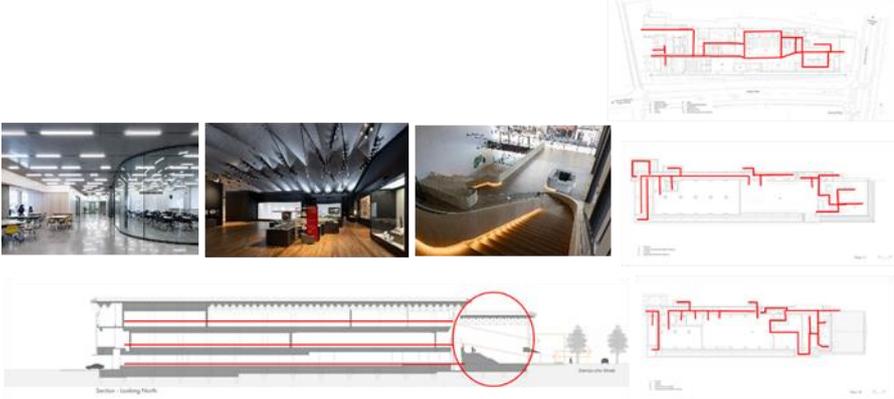
Sanxingdui
Museum

The Sanxingdui Museum has a dynamic two-storey design, featuring chronological exhibition halls, reception and service areas, with an arrangement that harmonizes with the surrounding nature and provides an interactive experience.



<p><u>Matsumoto</u> <u>City Museum</u></p>	 <p>The Matsumoto City Museum features a contemporary design that blends in with the surrounding environment and the adjacent castle. It consists of two main floors, with the ground floor housing reception areas and service facilities. The upper floor houses flexible exhibition halls arranged axially to display art and cultural exhibitions. The design enhances the connection with the local culture and historical surroundings.</p>
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<p>The project</p> <p><u>Shanghai</u> <u>Natural</u> <u>History</u> <u>Museum</u></p>	<p>Circulation</p> <p>The museum's main path follows a spiral design that echoes the nautilus shell motif that is a recurring theme in the building's design. It guides visitors on a seamless, ascending journey from ancient life forms to modern ecosystems, creating an integrated narrative arc that reflects the evolution of nature.</p> 
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<p><u>MAXXI Museum</u> (National Museum of XXI Century Arts)</p>	<p>The MAXXI Museum uses a mixed scheme of network and linear circulation schemes, with multialternative circulation routes made up of flowing tracks, ramps, and sculpture-like stairs.</p> 
<p><u>Sanxingdui Museum</u></p>	<p>One-Way Circulation: The exhibition halls are arranged in a broken-line sequence, guiding visitors in a one-way, chronological path. This ensures that the story of the Sanxingdui civilization unfolds logically, mirroring an archaeological excavation journey.</p> 
<p><u>Matsumoto City Museum</u></p>	<p>The circulation plan emphasizes horizontal and vertical movement, creating intuitive pathways for visitors to explore the museum's various spaces. Central Atrium: A central atrium serves as the main vertical circulation hub, connecting all floors.</p> 
<p>The project</p>	<p>Lighting feature</p>

<p><u>Shanghai Natural History Museum</u></p>	<p><u>Interaction with Light and Space</u> Dynamic Lighting: Natural light streams through skylights and the semi-transparent façade, creating a connection with the outside environment. The light varies as visitors move, enhancing the sense of journey and change.</p> 
<p><u>MAXXI Museum (National Museum of XXI Century Arts)</u></p>	<p>The MAXXI Museum uses glass facades, skylights, and concealed LED strips to blend natural and artificial light, enhancing its fluid design and connecting interior and exterior spaces.</p> 
<p><u>Sanxingdui Museum</u></p>	<p>Integration of Natural Light : "Eyes" Openings: The facade design maximizes lateral light penetration through narrow gaps and the symbolic "Eyes." Symbolism and Atmosphere Cave-Like Shadows: The interplay of light and shadow evokes the feeling of exploring ancient ruins, reinforcing the museum's thematic focus on archaeology and mystery Lighting for Artifacts and Displays LED lights are carefully calibrated to avoid glare and ensure the preservation of sensitive materials</p> 
<p><u>Matsumoto City Museum</u></p>	<p>The building's orientation maximizes natural light while offering views of the surrounding mountains and urban landscape. This approach enhances the visitor experience and connects the museum to its natural surroundings. The central atrium acts as a light well, bringing daylight to interior spaces and reducing the need for artificial lighting during the day</p> 

The project	Building structure
<p><u>Shanghai Natural History Museum</u></p>	<p>The structural system of the Shanghai Natural History Museum is a hybrid of steel, concrete, and glass, designed to support the building’s unique shape while maintaining flexibility for its exhibition spaces.</p> <p>Reinforced Concrete Core: The building includes a reinforced concrete core that contains vertical circulation elements, such as elevators and staircases, and houses essential services like mechanical and electrical systems.</p> <div style="display: flex; justify-content: space-around;">   </div>
<p><u>MAXXI Museum (National Museum of XXI Century Arts)</u></p>	<p>Reinforced Concrete Walls: The main load-bearing components are massive, curvilinear reinforced concrete walls. These walls are not only structural but also sculptural, creating flowing interiors and defining the museum’s overall form.</p> <p>Steel Framework: Steel trusses are used in the cantilevered roof and mezzanine structures. The suspended ceilings extend outwards prominently, incorporating steel reinforcements integrated with the concrete envelope, ensuring structural stability and effective load bearing.</p> <div style="display: flex; justify-content: space-around;">    </div>
<p><u>Sanxingdui Museum</u></p>	<p>Steel Framework: The museum's flowing, organic design requires a flexible structural system. Steel, with its high strength and versatility, is used extensively to support the curved rooflines and ribbon-like facades.</p> <p>Integration with Concrete :Composite Construction: The steel framework works in conjunction with reinforced concrete elements to create a composite structural system. This approach balances the tensile strength of steel with the compressive strength of concrete.</p> <div style="display: flex; justify-content: space-around;">   </div>

<p><u>Matsumoto City Museum</u></p>	<p>The structure is designed to handle the seasonal temperature variations and heavy snow loads typical of Matsumoto's climate and the Frequent seismic activity in Japan</p> <p>Steel Frame: Provides strength and flexibility to support the dynamic roof and open spaces, reducing the need for internal columns and providing design flexibility.</p> <p>-Folded Roof Structure: Made of lightweight, high-strength steel, designed to withstand heavy loads such as snow in Matsumoto's climate.</p> <p>-Advanced Seismic Design: Base isolation systems to reduce the impact of earthquakes on the building. Damping systems absorb earthquake energy and enhance stability.</p> <p>-Floor Systems: Consist of reinforced concrete slabs to provide durability, fire resistance, sound insulation, and add weight to counterbalance the impact of strong winds.</p> <div style="display: flex; justify-content: space-around;">   </div>
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Museum of Nature and human ,Italy -padova:-

Project data :

- Category: **Natural History Museum**
- Location : **Italy, padova**
- Year of realisation: **2021-2023**
- Architects: **Guicciardini & Magni Architects**
- Area: **3800 m²**



Figure III.43: Museum of Nature and human ,italy-padova

- Contexte :
- **Location** : The Museum of Nature and human (Museo della Natura e dell'Uomo) is located in the heart of Padua, Italy, at Corso Garibaldi 39, inside the historic Palazzo Cavalli, opposite the famous Scrovegni Chapel. The museum is located in a culturally rich historical urban area, surrounded by academic buildings, museums, and tourist facilities.
- **Motivation choice:** **The selection of the museum for study provides a unique perspective on the convergence of architecture, cultural heritage conservation, and community engagement, providing an insightful case study into the pivotal role museums play in shaping national identity and cultural development.**
- **The project environment:**

The project is located within a compact and organic historic urban fabric within the city. It features narrow streets, adjacent buildings, and small squares, reflecting the traditional character of the ancient university city.

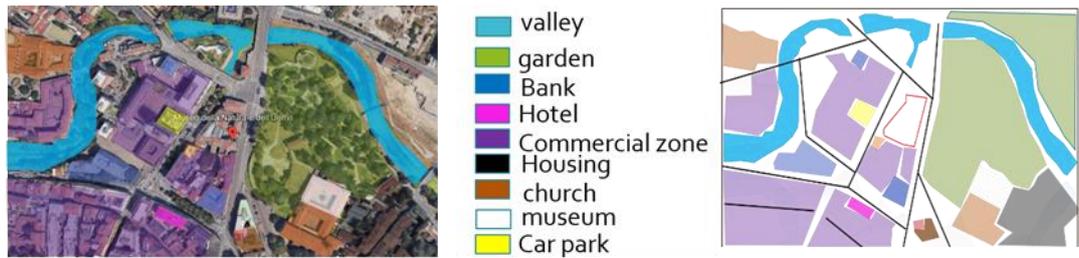


Figure III.44:(left) the distant environment of the project- (Middle), map key – (right) the immediate environment of the museum.

- The project plot:
The museum occupies almost 100% of the land area, while the remaining unbuilt portion features an open concrete space as an entrance plaza.



Figure III.45: (a) illustrate the plot of the project – (b) 3D model

- The volumetry:
The museum has a semi-rectangular form and occupies the historic Cavalli Palace, featuring a balanced Renaissance-inspired composition that blends seamlessly with its surroundings. With a moderate height of 12–15 meters, A contemporary glass structure integrated into the courtyard adds a striking contrast between tradition and modernity.
- The design concept:
The project repurposes the historic Cavalli Palace as a museum, preserving its archaeological character while incorporating a modern design focused on sustainability and visitor engagement, creating a museum experience that harmoniously connects the past with the present.

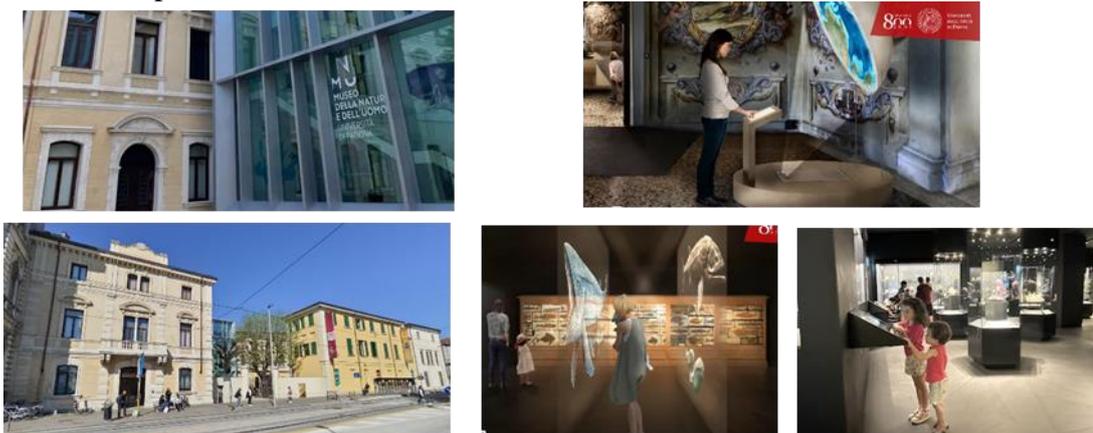


Figure III.46 design concept

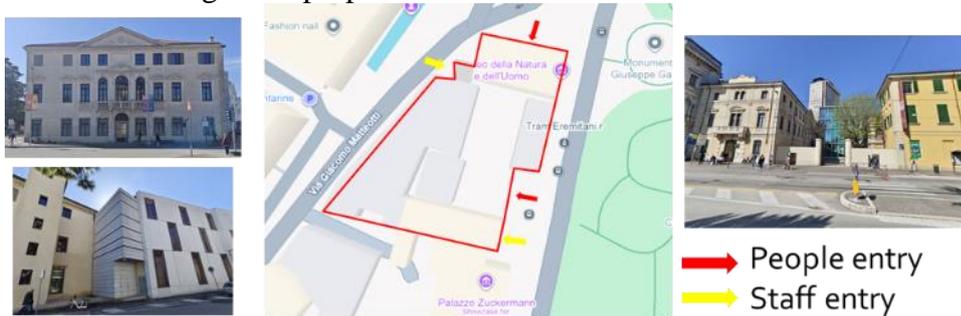
- Roads and accessibility:
The project's central location in the city provides diverse access points and transportation options for reaching it



Figure III.47: Illustrative images source: Museum's official website

- Entrees:

The museum has two entrances: one on the main facade overlooking the garden, and the other on the north side overlooking the river, facilitating access from both directions. There are also secondary entrances designated for services or administrative staff, sometimes used for logistical purposes.



- Circulation (Time-based Sequence):

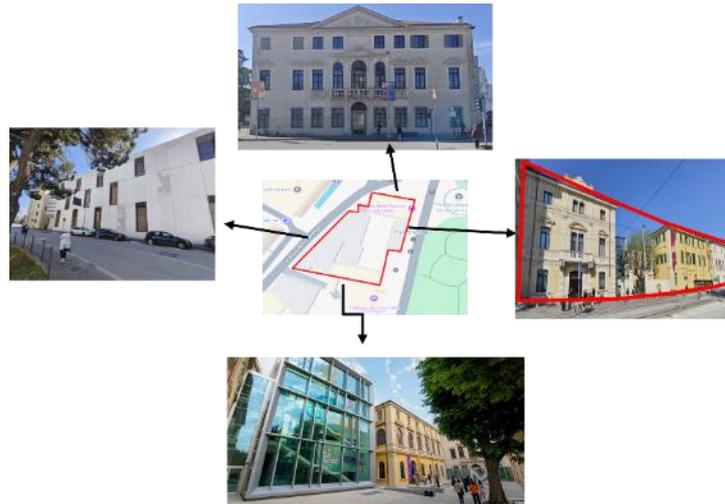


-The visitor path is organized around the concept of chronological progression. The journey begins on the ground floor or upper floor, and visitors then ascend or descend through geological eras, the evolution of organisms, and human evolution.

-This organization is based on a loop or semi-loop, allowing visitors to return to the starting point without having to backtrack.

- Facades:

The museum's two main facades reflect a richly detailed historical Baroque style, with harmonious windows and entrances. They are characterized by a classical style that respects the building's heritage value without making any notable contemporary architectural changes to the exterior.



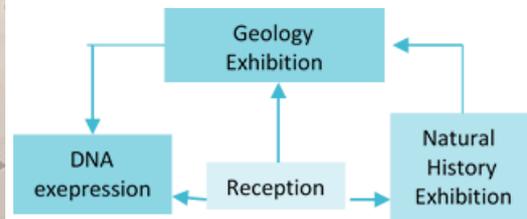
The rear façade has been renovated in a contemporary style that balances the old and the new, using glass and steel to create a transparent and light feel that contrasts with the heavy stonework of the original façades. The façade serves as an exit or secondary entrance for visitors.

The glass building in the courtyard serves as a contemporary, transparent interior facade, blending history and modernity, and providing a multi-use space that connects the palace and the courtyard in a visually and functionally harmonious manner.

- Spatial and functional organization:

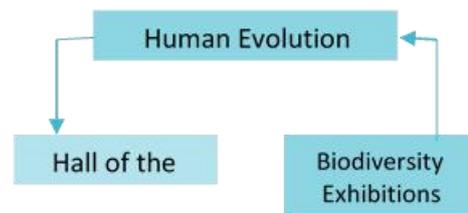
Ground floor:

- Abito / Abium
- Sala della coclea / Shell of the shell
- Sala della storia romana / Room of Roman history
- Sala della storia Ebraica / Room of Bible (1200-60)
- Sala della Palea / Paleolithic hall
- 01 Heterozidi / Heterozidi
- 02 Viaggio al centro della Terra / Journey to the center of the Earth / Discovering Heterozidi
- 04 Alla scoperta dei minerali / Minerals and former history
- 05 Minerali e arte / Minerals and art
- 03 Espressioni del DNA / DNA expressions



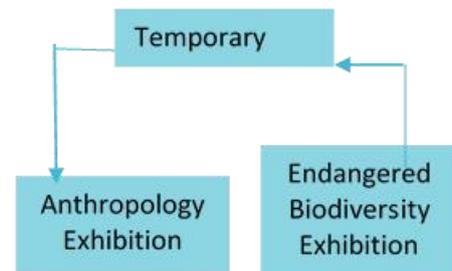
First floor:

- 06 Rocce e fossili / Rocks and Fossils
- 07 L'era dei rettili / The Age of Reptiles
- 08 Impatto / Impact
- 09 I pesci di Bolca / The Fish fossils of Bolca
- 10 I tropici nel Veneto / Tropics in the Veneto
- 11 Galleria dei grandi vertebrati / Gallery of large vertebrates
- 12 Migrazioni umane / Human migrations
- 13 Il sito di Al-Khiday / The Al-Khiday site
- 14 L'antico Egitto / Ancient Egypt
- 15 Tracce della preistoria / Traces of Times Past
- 16 Ledito e le palafitte / Ledito and the stilt houses



Second floor:

- 21 Insetti e non solo / Insects and more besides
- 22 Parassiti / Parasites
- 23 Galleria dei mammiferi / Gallery of Mammals
- 24 Uccelli / Birds
- 25 Rettili / Reptiles
- 26 Biodiversità in pericolo / Endangered biodiversity
- 27 Il cranio perduto di Petrarca / The lost skull of Petrarca
- 28 Schemi nell'arcipelago / Schemata in the coast
- 29 Giappone / Japan
- 30 Oceania / Oceania
- 31 Africa / Africa
- 32 Asia / Asia



Third floor:

A temporary exhibition on the museum's formation and exhibition design



- **Material Choices:**

Between History and Renovation:

1-Original (Heritage) Materials:

- Limestone (Pietra d'Istria)
- Red Bricks (Terracotta Bricks)
- Wood

2- Materials Used in Restoration and Contemporary Additions:

- Glass
- Stainless Steel
- Recycled Stone



- **Building structure:**

Between Authenticity and Functional Suitability-The museum building's structure combines strong historical load-bearing walls, arches, and columns, along with a contemporary structural system. A lightweight steel frame is used on the rear facade and the glass building in the courtyard, ensuring a balance between heritage preservation and functional flexibility for modern display.

- **Lighting feature:**

Lighting Hierarchy:

- General Lighting:Dim ambient lighting to create a calming atmosphere.
- Accent Lighting:Precise lighting on exhibits (skulls, skeletons, maps)
- Wall Washing:to highlight specific walls for the purpose of displaying inscriptions or visually illustrating context.
- Interactive Media Lighting:In digital displays, lighting changes based on visitor interaction.

III.6.3 Synthesis of the examples

Table III-10 Synthesis of the examples

Synthesis	
Site and context	Nature museums are located in strategic urban locations close to natural resources such as forests, mountains, coasts, or nature reserves to enhance the realistic experience, with opportunities to collaborate with nearby educational institutions and research centers to develop cultural and educational activities.
The design concept	The museums reflect unique design concepts: one represents the harmony between man and nature with designs inspired by mountains and water, another focuses on fluidity and spatial experimentation, while the third and fourth draw their inspiration from the historical context and surrounding architectural heritage, symbolizing continuity and conveying the city's culture.
The volumetry	The museums display a diverse volumetric approach: the first is inspired by the nautilus shell, the second includes overlapping volumes that give a sense of movement, the third uses dynamic volumes with curved and cylindrical surfaces to create visual impact, and the fourth features a compact and balanced volume that reflects the city's dual historical and modern identity.
Facades	The museums display a diversity of facades: the first is inspired by cellular structure and nature, the second combines dynamic curves with a smooth modern facade, the third is inspired by the bronze masks of an ancient civilization in the region, and the fourth harmonizes with the urban and historical context through the contrast between transparency and solidity.
Material Choices	Museums diverse in their use of building materials, the common materials in the four museums studied are: <u>Glass</u> : for transparency, natural light and energy efficiency. <u>Concrete</u> : for foundations, structures and facades, providing stability. <u>Steel</u> : for structural elements, allowing for long spans and open spaces. And exceptional materials in the design, such as wood, aluminum, green roofs, recycled materials, stone such as yellow granite, bronze sunshades, etc.
Spatial and functional organization	The museums' organization varies between a unique approach for each of them: the first follows a chronological floor arrangement around a central hall, the second relies on a dynamic and open design that focuses on fluidity, the third organizes the halls in an axial manner that facilitates movement, while the fourth follows a linear organization that enhances interaction with the external environment.
Circulation	The circulation patterns in libraries vary: the first adopts a spiral arrangement that provides smooth corridors around the exhibition halls; the second uses a combination of grid and linear movement with flowing paths and ramps; the third follows a one-way time movement in a discontinuous sequence; while the fourth focuses on horizontal movement and vertical circulation with visual connections with the outdoors.

Lighting feature	Museums prioritize natural light. Sunken floor designs and open facades with windows and skylights maximize sunlight, and the light changes as visitors move, enhancing the sense of journey and change. This is complemented by the interplay of light and shadow to enrich the exploration of the exhibits, with thoughtful artificial LED lighting being used to avoid glare and protect delicate materials.
Building structure	Museums use structures that combine steel and reinforced concrete to provide strength and flexibility to exhibition spaces, while resisting fire and earthquakes. This system balances the tensile strength of steel with the compressive strength of concrete, with an emphasis on sustainability and harmony with the environment.

III.7 Conclusion

This chapter demonstrated that the museum, as a cultural and architectural institution, transcends its traditional role as an exhibition space to become an interactive space that combines function, aesthetics, and modern design techniques. Examining various types of museums, in addition to the Algerian surface program, allowed for an understanding of the functional and organizational characteristics that characterize this building style. A review of design criteria, particularly those related to visitor flow and lighting, highlighted the essential importance of these elements in ensuring an integrated and effective exhibition experience.

In the analytical section, a review of the list of selected examples and the decomposition of their basic elements highlighted the different approaches adopted by architects in formulating various museum projects. The concluding synthesis of these examples allowed for the extraction of guidelines that can serve as a practical reference for developing a specific design approach that takes into account the specificities of the local context and draws on international experiences.

Thus, that this chapter established a knowledge base that combines a theoretical framework and comparative analysis, enabling the transition to the architectural chapter with a clearer approach and awareness of the requirements of contemporary museum design.

CHAPTER IV:
ARCHITECTURAL APPROACH

IV. CHAPTER IV: ARCHITECTURAL APPROACH

IV.1 Introduction

Chapter IV is dedicated to a comprehensive analysis of the project context, exploring both the broader urban and environmental framework as well as the specific characteristics of the selected site. Understanding the context is a crucial step in the design process, as it provides the foundational knowledge required to make informed decisions that respond effectively to the physical, climatic, and socio-cultural conditions of the location.

The chapter begins with a detailed presentation of the city of Algiers, highlighting its historical, urban, and geographical features, followed by an examination of the project site, POS 139 in Ouled Fayet, situated within agricultural zone 26. This section includes a justification for the choice of the site, emphasizing the opportunities it offers for architectural intervention and its alignment with the project objectives.

Subsequently, a climatological analysis is presented to assess the environmental conditions that influence the design, including temperature, solar exposure, precipitation, and wind patterns. Building on this, a site analysis is conducted through a SWOT framework (Strengths, Weaknesses, Opportunities, and Threats) to identify the key factors that will guide the design process.

The chapter then transitions into the programmatic and conceptual approaches, outlining the design methodology that underpins the development of the project. Finally, the chapter concludes with a presentation of the project plans, demonstrating how the insights gained from the contextual and site analyses are translated into architectural solutions that are both functional and responsive to the specific conditions of the site.

IV.2 Contexte analysis

IV.2.1 Presentation of the city Algiers

Algiers is located in North Africa on the Mediterranean coast. The city features diverse geography, with the Mediterranean Sea to the north and the Tell Atlas mountains to the south, separating it from the Sahara. It extends to suburban and rural areas to the east and west.



Fig IV-1 : City of Algiers

IV.2.2 Geographic location

Algiers covers an area of 809.22 km² in the north-central part of the country, bordered by: The Mediterranean Sea to the north along 80 km of coastline. Blida state to

the south. Tipaza state to the west. Boumerdes state to the east. Its geographical coordinates are:

- Latitude: Approximately 36°44'02.3"N
- Longitude: Approximately 3°04'08.0"E



Fig IV-2 :(a) and (b), geographical location of the city of Algiers; (c) administrative division map of the state of Algiers

IV.2.3 The project site:

The project site is located in Ouled Fayet, It is a municipality affiliated with the Cheraga district about 15 km west of Algiers.

The POS 139 (Ouled Fayet) is a site in agricultural zone 26, it is located in the North-West of the commune of Ouled Fayet, with an area of 449 ha including:

- 316.40 ha (more than 70%) of agricultural land
- And 62.33 ha in natural zone, it includes individual housing and activities as well as the Algiers Opera.
- It is accessible mainly from the South ring road, the Chéraga penetrating road and the wilaya road n ° 133 which constitutes the main axis of POS 139.



Fig IV-3:left :Scope of POS 139, right: Location map of Ouled Fayet

IV.2.4 Motivation of choice

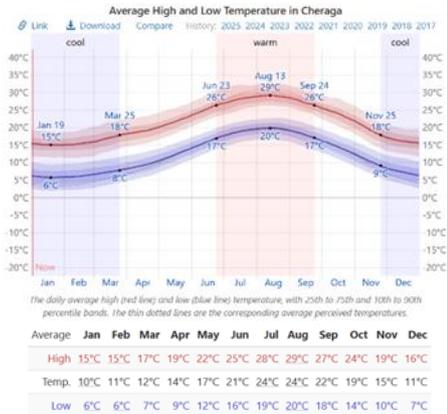
The choice of location in the capital reflects a strategic vision that combines accessibility, cultural impact, tourist attraction, and financial sustainability, making it a vital center for preserving and promoting cultural heritage:

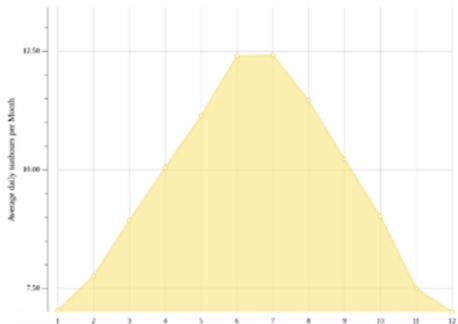
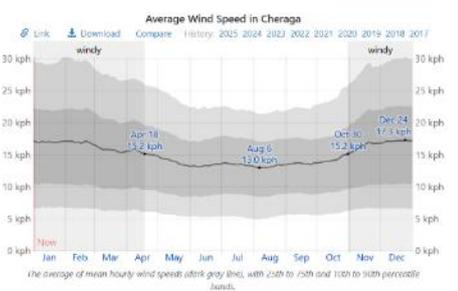
- The site is proposed for a socio-cultural center near the Algiers Opera

- Strategic location; green lung (agricultural area with a rural character) to promote environmental awareness and preserve biodiversity.
- The project’s location within a new urban development Opens the door to a host of opportunities and growth potential
- The site includes the new media city project “Dzair Media City”, thus achieving functional and aesthetic integration with the museum and reflecting the common identity between media and culture.

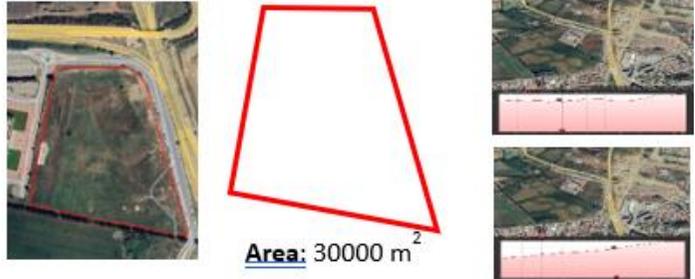
IV.2.5 Climatological analysis

Ouled Fayet has a Mediterranean climate characterized by humid, dry summers and mild, partly cloudy winters. The average annual temperature is 17.7 °C and the average annual rainfall is 615 mm.

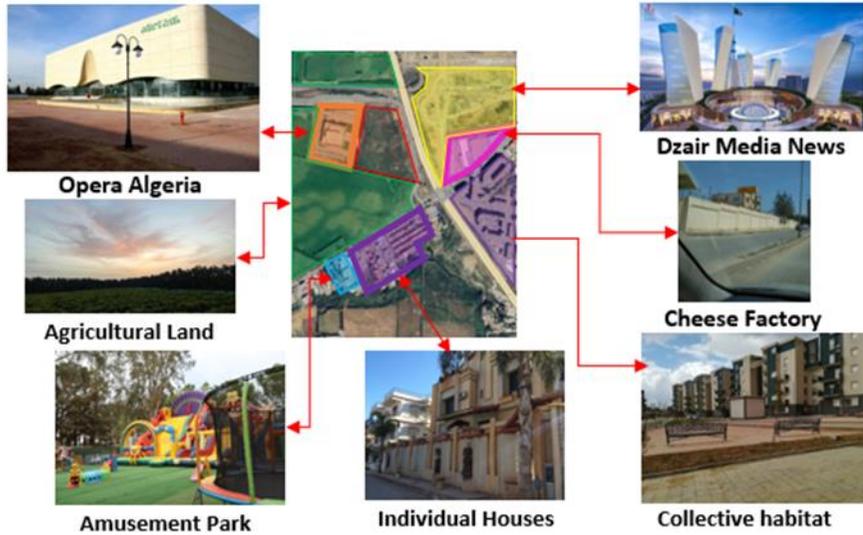
	Graphs	Observation
<p>Temperature</p>	 <p>Figure IV.5: Average High and Low Temperature in Cheraga, Algeria (https://fr.weatherspark.com)</p>	<p>It is worth noting that there are three types of temperatures: cold, moderate and hot. Summer witnesses the highest temperatures (29°C maximum and 20°C minimum), while winter remains relatively mild, with a minimum of around 6°C. This creates challenges in managing heat gain for the building during the summer.</p>
<p>Precipitation</p>	 <p>Figure IV.6: Average monthly precipitation diagramme</p>	<p>Ouled Fayet has significant seasonal rainfall variation, with a rainy period lasting 9.2 months (September to June). December is the wettest month (65 mm), while July is the driest (2 mm). Here is the average precipitation.</p>

<p>Sun hours</p>	 <p>Figure IV.7: Average daily per month in cheraga ,Algeria</p>	<p>Ouled Fayet records the most daily sunshine in July, averaging 12.42 hours per day (385.17 hours total). January has the least, with 7.01 hours daily (217.37 hours total). Annually, Cheraga receives 3501.36 hours of sunlight, averaging 291.78 hours monthly.</p>
<p>winds</p>	 <p>Figure IV.8 Average Wind Speed in Ouled Fayet.</p>	<p>Ouled Fayet’s winds show mild seasonal variation: strongest from October to April (17.2 km/h in December) and calmest from April to October (13.2 km/h in August), mainly from the east in summer and west in winter.</p>

IV.3 Site analysis

<p>1- Site location in relation to the city:</p> <p>The project site is Located on lot No. 1, parcel 515, Ouled Fayet, 16000, Alger. It is about 15 km from Central Algiers (40 minutes by car).</p>  <p>The project is easily accessible due to a well-connected road network, with key routes such as National Road 36 and the East-West Highway offering direct access to and from Algeria.</p>	<p>2- Site morphology</p> <p>Relatively flat terrain with gentle slopes. With a shape closer to an oblique trapezoid, it consists of two halves, one half is flat, which facilitates excavation and implementation, while the other half gradually ascends towards the road, requiring strategic improvement to implement the project effectively.</p> 
<p>3- environment of the project</p> <p><u>Mixed fabric:</u> Agricultural and urban fabric. It achieves a balance between urban development and the protection of natural resources.</p> 	<p>4- Built and unbuilt system</p> <p>The built-up area is relatively low compared to the unbuilt spaces. Using CADMAPPER to extract 2D and 3D drawings of the site showed that only 19% of the area is built-up, while 81% remains unbuilt, indicating that empty spaces dominate the study area.</p> <p>Topological relationship:</p> <ul style="list-style-type: none"> -Joining continuous frame east and north of the site -linear frames share a rotational axis <p>Geometric relationship:</p> <ul style="list-style-type: none"> -parallel or perpendicular axes.

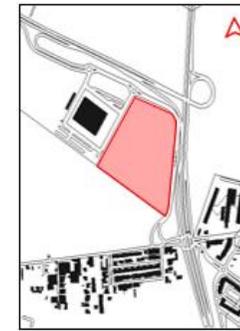
The agricultural lands are exposed to future urban expansion in new expansions agreed upon by the responsible authorities.



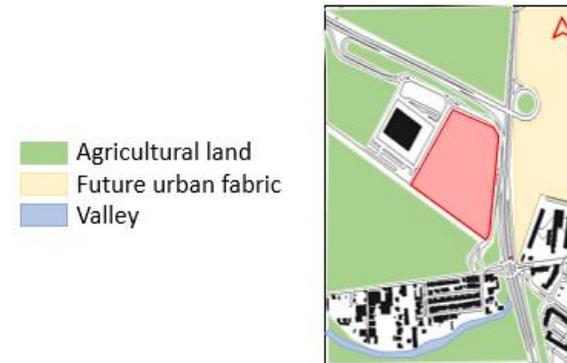
-regular figures relatively homogeneous.

Dimensional relationship:

-not very significant variation.

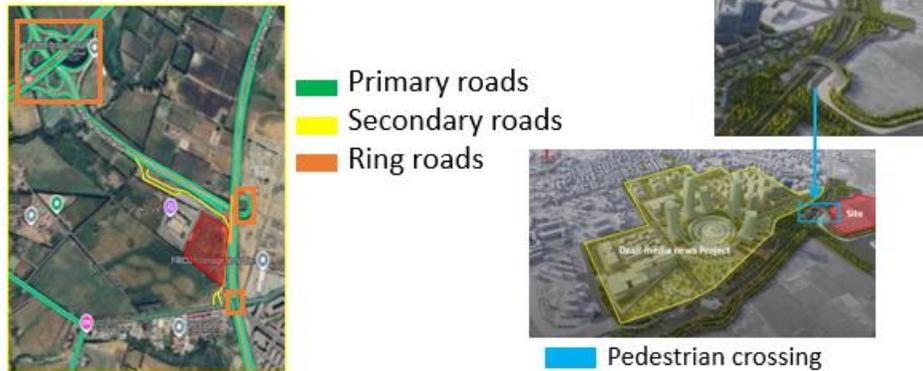


The unbuilt section, which constitutes 81% of the area, mainly represents agricultural areas and future urban areas within the study area.



5- Roads and accessibility

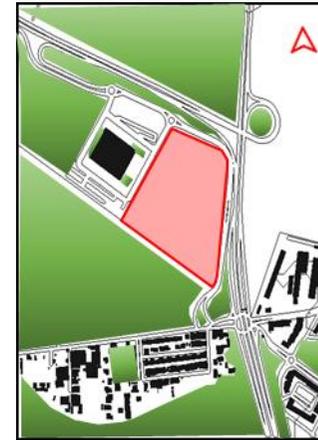
The site is surrounded by major roads, including National Road No. 36 and the South-West Highway, as well as ring roads and local streets that facilitate direct access and provide parking spaces.



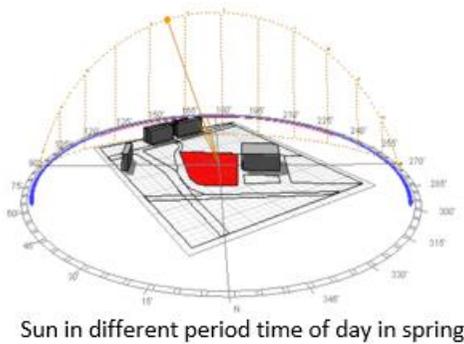
A future semi-circular pedestrian walkway linking the project site to the future neighbouring Dzair Media News project.

6- Green spaces

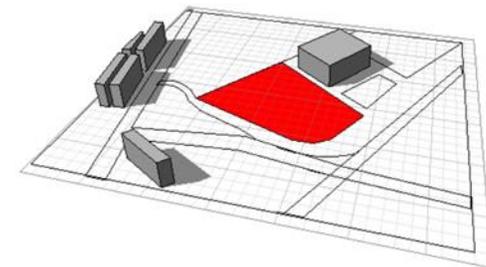
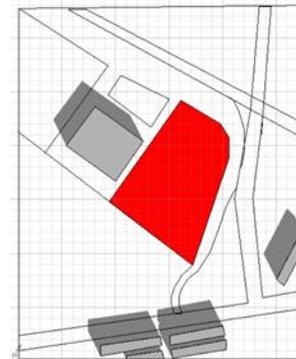
Green spaces in the area include agricultural lands, grassy areas in squares such as the Algiers Opera, and public parks near social housing, in addition to trees and shrubs along the walkways, indicating a large proportion of green spaces in the area.



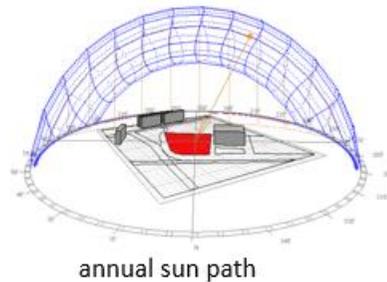
7- Sun



8- Shadow



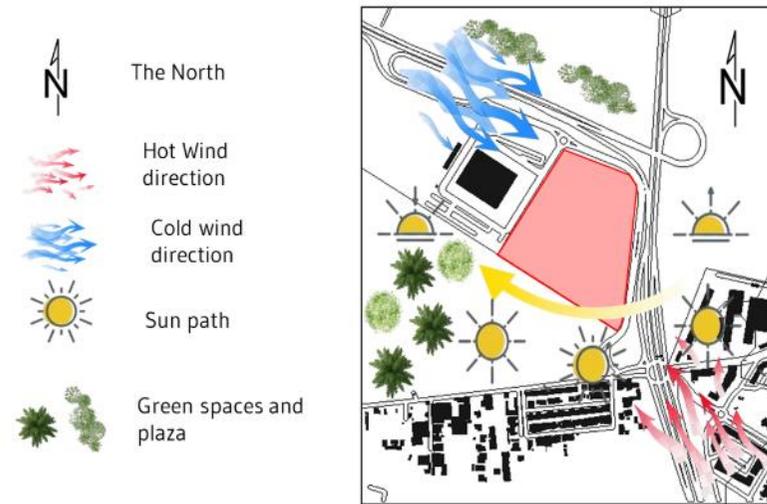
The project location in an open agricultural fabric allows it to benefit from sunlight in most directions without obstacles. In winter, the strategic benefit is from the east and south, where the sun angle is low (30-40 degrees) and solar radiation is moderate. In summer, the project benefits from sunlight from the south, where the sun angle is high (75-80 degrees) and its radiation is stronger.



Criterion	Winter	Summer
Sunrise Direction	Southeast	Northeast
Sunset Direction	Southwest	Northwest
Day Length	Short (~9.5 hours)	Long (~14.5 hours)
Solar Altitude at Noon	Low (30-40 degrees)	High (75-80 degrees)
Shadow Length	Very Long	Very Short
Solar Radiation	Moderate	Very High

The absence of adjacent buildings allows the site to take full advantage of the sun's rays throughout the day. In winter, the project benefits from the long shadows resulting from the low sun angle, which improves the thermal efficiency of the building.

9- Wind



The prevailing north and north-westerly winds come from the Mediterranean, and are cold in winter and mild in summer, with limited influence from the hot southerly winds.

Architectural Chapter

STRENGTH	WEAKNESS	OPPORTUNITIES	THREATS
<ul style="list-style-type: none"> • Strategically located along major intercity roads. • Proposed site in the new urban expansion area of the city of Algiers. • The site is located in the heart of the Algerian capital. • Multifaceted fabric (agricultural and urban), ensuring a comprehensive community experience. • Strategic engagement with the sun path, allowing for careful planning of sun exposure and shading considerations. • Proximity to residential, media and cultural facilities. • Provides open spaces to enhance natural lighting and reduce the need for artificial energy. <ul style="list-style-type: none"> • Provides privacy and tranquility in the surrounding environment. 	<ul style="list-style-type: none"> • Relative isolation, can be far from important urban facilities such as public transport. • Absence of adjacent buildings means no natural protection from wind or heavy rain, which may require additional cost in the design of the architectural structure. • Limited biodiversity despite the presence of agricultural land, may require environmental additions or the use of special plants. 	<ul style="list-style-type: none"> • The location within a new urban development opens up opportunities for growth and functional integration. • The large surface area provides potential for diverse development and the design of buildings that rely on natural ventilation. • The movement of the sun and the movement of shadows can be exploited to design sustainable buildings that provide natural lighting throughout the day and reduce the use of artificial lighting and air conditioning. • The location in the middle of an agricultural area can be a magnet for ecotourism, • The project can establish partnerships with local farmers to provide local products for restaurants or cafes within the project, thus boosting the local economy 	<ul style="list-style-type: none"> • Exposure to harsh environmental factors such as strong winds or sandstorms may affect the architectural structure and require additional protection systems. • The site may be exposed to natural noise such as wind, bird sounds and farms, which may require a design that enhances sound insulation.

IV.4 Programmatic approach

The program of the Nature Museum was developed through a carefully structured and hierarchical approach, integrating both functional requirements and the intended visitor experience. The design was conceived to offer an immersive journey through distinct ecosystems, organized vertically across the building, while preserving the natural environment by situating the parking facilities underground to maximize above-ground green spaces and The design respects the proposal of creating a pedestrian bridge connecting the project site to a nearby area, envisioned for the development of a Media City, thereby enhancing accessibility and integration with the surrounding urban context.

Reception areas, including the entrance hall, waiting spaces, VIP rooms, and luggage or changing rooms, are designed to provide a welcoming and organized entry, ensuring comfort and accessibility for all visitors. Public spaces, such as the cafeteria, gift shop, library, reading rooms, infirmary, children's experience plaza, and dining areas, are distributed to encourage social interaction, learning, and relaxation, while maintaining efficient circulation.

The museum's core activities are structured to guide visitors through a progressive exploration of natural and cosmic worlds. The basement level hosts aquatic ecosystems, including aquariums, water-based habitats, and the planetarium, creating an environment that simulates underwater and celestial conditions. The ground floor is dedicated to terrestrial ecosystems, highlighting a variety of plants, animals, and interactive displays that reflect natural habitats and biodiversity. The upper level focuses on space and planetary systems, providing an educational journey through astronomy, cosmic phenomena, and the universe. This vertical organization allows visitors to experience a gradual ascent through different environmental realms, enhancing the sense of discovery and exploration.

Administrative and logistical spaces, including offices, meeting rooms, service areas, storage, and technical facilities, are strategically located to support the museum's operational efficiency without disrupting the visitor experience. Accessibility elements, such as staircases, elevators, and dedicated areas for individuals with disabilities, are integrated throughout the building to ensure inclusivity. And underground parking accommodates visitors while preserving the site's natural and landscaped areas.

With a total area of 7,413 m², the program carefully balances functional efficiency, educational objectives, and visitor engagement. By linking each floor to a specific ecosystem and providing a coherent spatial hierarchy, the museum offers a unique, immersive journey that combines environmental awareness, exploration, and learning in a progressively ascending experience.

Function	Space	N	S U	S T(m2)
Reception	-Enterance hall and reception area	2	150	300
	-Amenities « waiting area »	2	110	110
	-Vip rooms	1	82	82
	-Changing room /luggage room	1	60	60
Public spaces	-Caféteria	1	185	185
	-Gift shop	1	110	110
	-Library	1	180	180
	-Reading room	1	150	150
	-Infermary	1	50	50
	-Experience plaza for children	1	80	80
	-Dining area	1	185	185
Basic activities	-Temporary exhibition	1	200	200
	-Permanent exhibition	1	700	700
	-Indoor jardin	1	650	650
	-Planitarium	1	280	280
	-Exploration labs (research rooms)	4	45	180
	-Space Gallery	1	800	800
Administration	-Service access	1	30	30
	-Administrative offices	10	40	160
	-Office foyer	1	25	25
	-Staff break room	1	25	15
	-Metting room	1	26	26
	-Logistics/maintenance	1	30	30
Logistic	-Museography logistics	1	50	50
	-specific consultations	1	40	40
	-Archiving	1	40	40
	-Reserves -Storage and Warehouse	1	40	40
	-Technical premises	1	100	100
Accessibility	-Staircase	5	30	150
	-Liftes	9	5	45
	-Spaces for disabilities			
Sanitary:	- restrooms	3	70	210
Parking	Parking	2	/	2000
Total	/	/	/	7413

IV.5 Conceptual approach

Our project is an invitation to embark on a journey into the heart of nature. A continuous exploration through the three major natural realms: the marine world, the terrestrial world, and the aerial world, reaching all the way to the edges of outer space. This is why we chose the name Odyssia for our project, inspired by the word “Odyssey” (from the Ancient Greek *Odýsseia*), which refers to a long, eventful, and transformative voyage rich in discoveries.

Our location, near the Algiers Opera House and the proposed Media City project, inspired a harmonious approach that blends culture, nature, and architecture.

A Concept Inspired by Nature: The Spiral as a Guiding Principle

To symbolize this journey, we selected the form of the spiral. This shape, omnipresent in nature: in seashells, cyclones, galaxies, animal horns, and plant growth patterns. The spiral symbolises movement, evolution, growth, and expansion. It perfectly represents the progressive unfolding of discovery.



Water

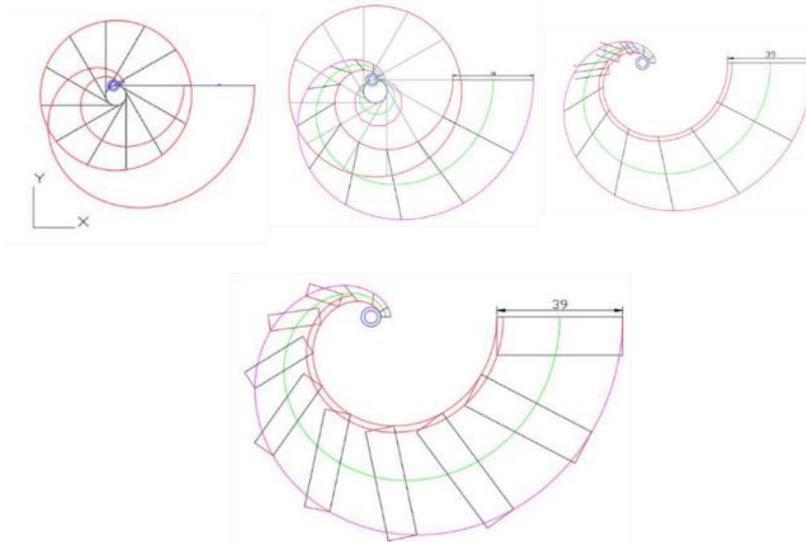
Air

Earth

In our museum, the spiral structures the entire spatial experience. It guides visitors through successive environments, from the deepest depths (the underwater world) to the highest layers of the atmosphere and the vastness of space.

The architectural form of the project was developed through a progressive composition of volumes arranged along the spiral path. Instead of opting for a single continuous mass, the design is articulated as a sequence of distinct architectural blocks that follow and reinforce the movement of the spiral.

These volumes gradually expand in size as the visitor advances along the journey. This gradual enlargement not only reflects the idea of growth inherent in natural spirals but also creates a dynamic spatial rhythm, where each volume introduces a new scale, a new atmosphere, and a new stage in the discovery of the natural worlds. The formal evolution thus becomes an integral part of the conceptual narrative, guiding visitors from smaller, more intimate spaces toward larger, more expansive environments as they ascend through the museum experience.

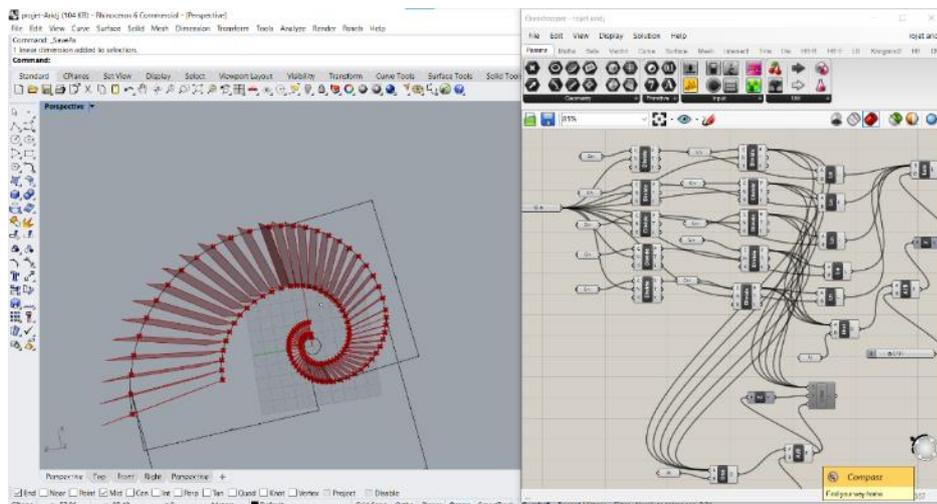


From a functional perspective, the central location allows visitors to access the simulator easily at specific moments of the route, while its vertical presence creates a sense of spatial hierarchy. By integrating this dome into the core of the project, the museum gains a strong iconic element that anchors the entire spatial narrative and enriches the visitor's experience through a powerful immersive centerpiece.

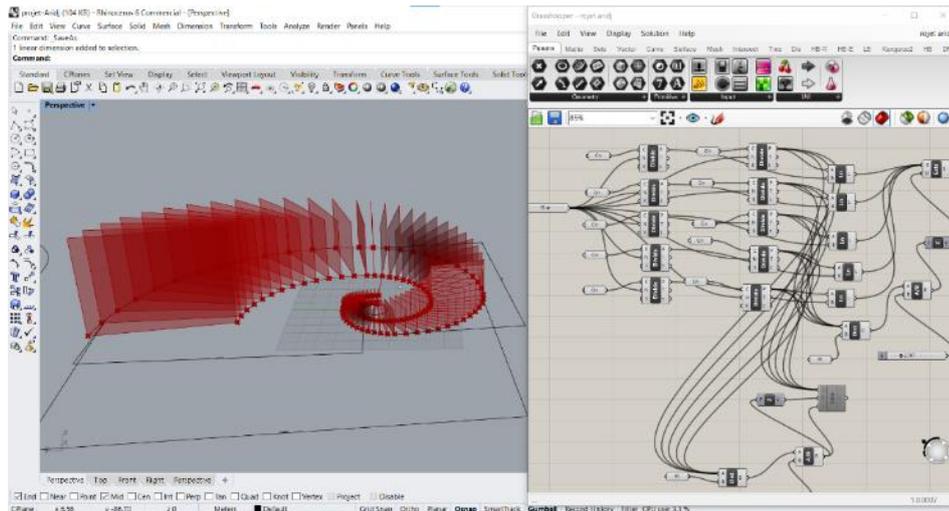
At the beginning of the spiral, a dome is positioned as the initial landmark that introduces visitors to the museum journey. This dome houses the simulator, one of the project's most immersive and interactive elements. Its placement at the entrance of the spatial sequence is intentional: it marks the symbolic point of departure, where the exploration of the natural worlds begins.

The dome's geometry contrasts with the expanding volumes of the spiral, reinforcing its role as a stable and recognizable landmark within the fluid movement of the plan.

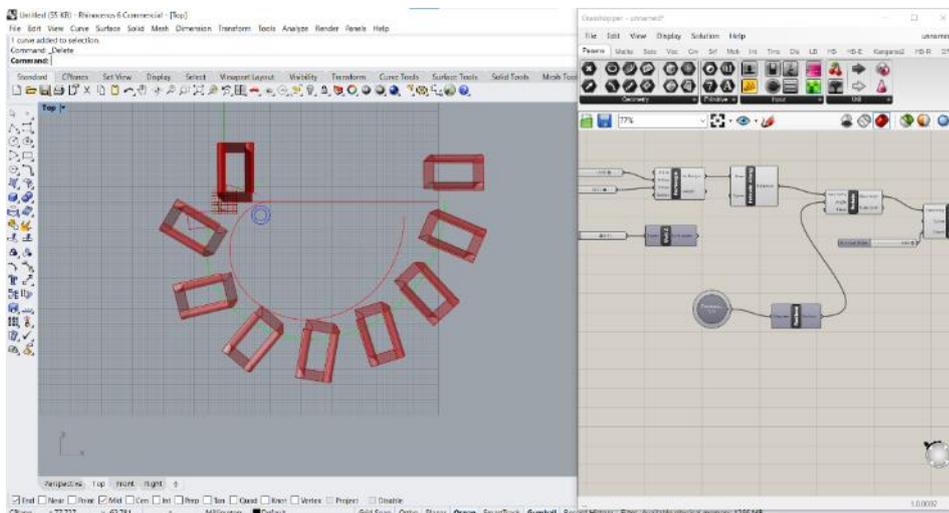
Functionally, the dome offers a spacious and controlled environment ideal for the simulator, while conceptually, it symbolises the idea of an initiation point. It is a key symbolic and spatial element within the overall architectural composition.



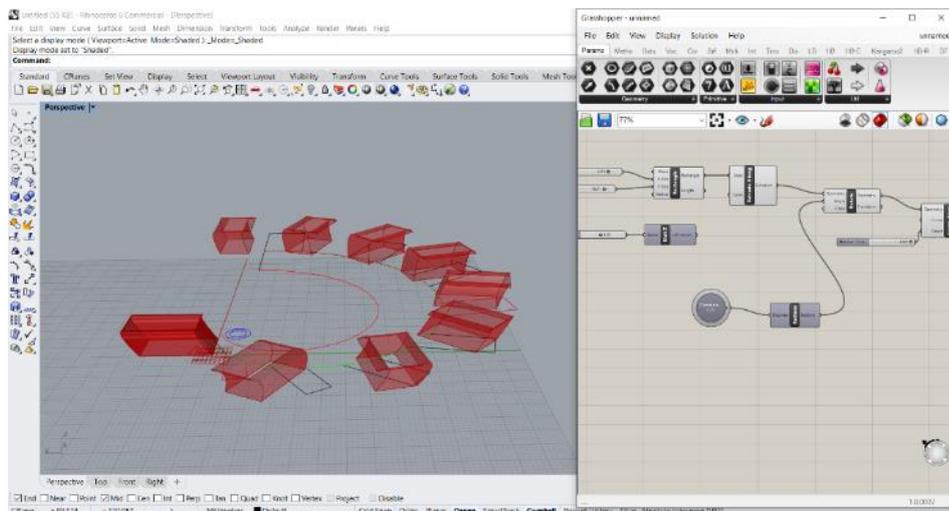
The beginning of the spiral formation is shown, where the elements are arranged gradually around a single center, expressing the initial movement of an upward journey.



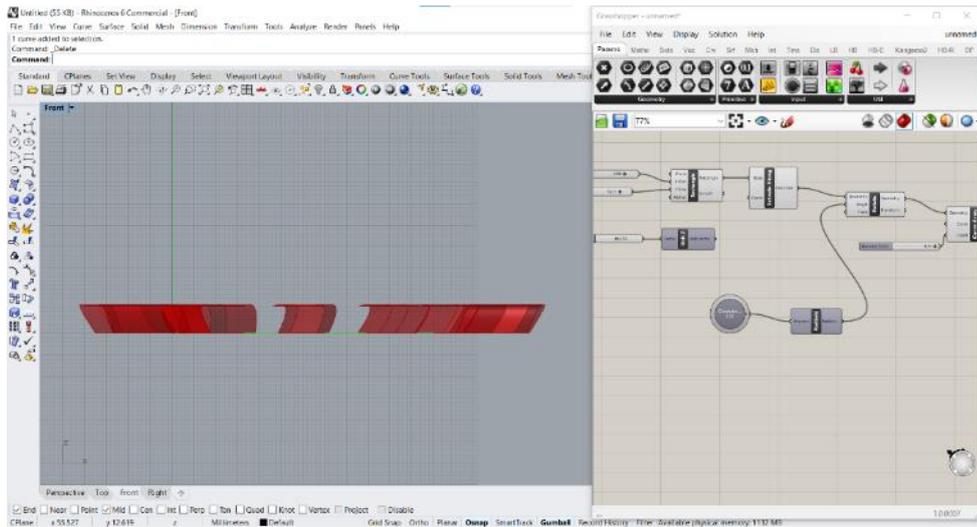
The integration of the spiral formation is highlighted by increasing heights, as the cubes begin to form a clear upward path that symbolizes the gradual development in the path shown.



The organization of the cubes appears in the same regular spiral path, where the blocks begin to be distributed around a single center to determine the rhythm of the movement.

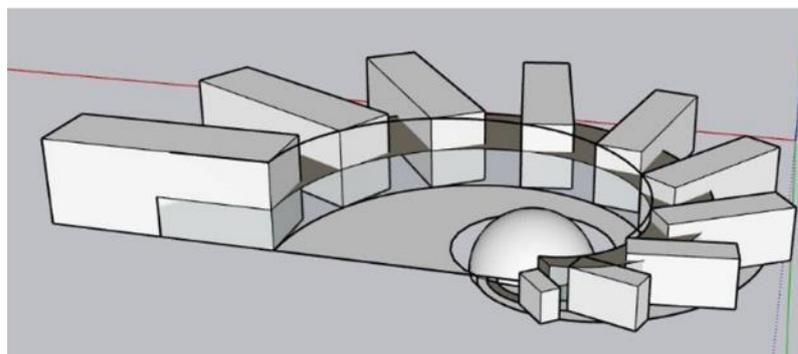
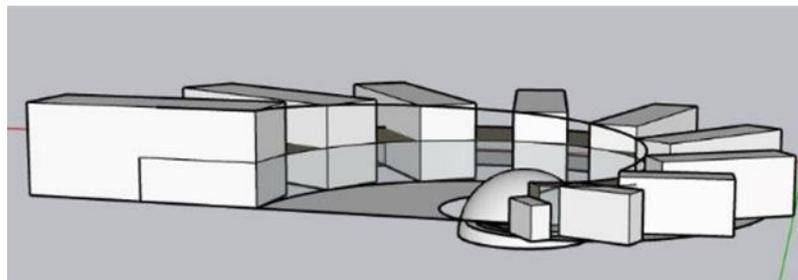
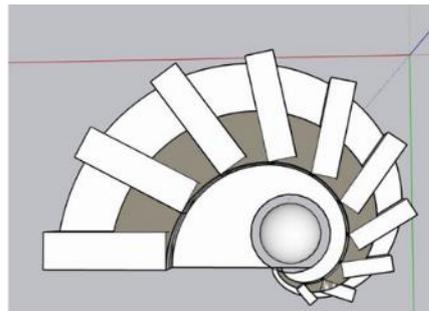


It illustrates the beginning of the transformation of the cubes from a fixed position to a freer movement, as the blocks begin to tilt and gradually open up towards an organic form.



The alignment of the cubes in a horizontal gradient hints at the transitional phase towards a smoother and more fluid composition, paving the way for the development of the final organic form.

Shape development:



IV.6 Project presentation

IV.6.1 Site Plan organization

The organization of the site plan is conceived to reinforce the conceptual narrative of the museum and to ensure a harmonious integration between architecture, landscape, and visitor circulation. The spiral geometry, which defines the overall form of the building, extends naturally into the exterior layout, structuring the pathways, open spaces, and landscape features around the museum.

The main entrance, located on the northeast side facing the Algerian Opera, serves as the primary gateway to the site, where pedestrian and vehicular movements are clearly separated to ensure fluidity and safety.

From this entrance, a dedicated road leads directly to the underground visitors' parking area, providing convenient access without affecting the overall visual composition or interrupting pedestrian movement on the upper plazas. Visitors enter through a main walkway that leads to the central courtyard, where a circular fountain forms the visual and functional focal point of the site.

The circular above-ground parking area, located in the southeastern part of the site, is designated for museum staff and administrative personnel, establishing a clear functional separation between user groups. Additional secondary entrances are provided for service access and daily users.

Pedestrian pathways are distributed radially from the center toward the edges, facilitating access to the various green and recreational spaces. The design harmoniously integrates functionality and aesthetics through gently curved paths and structured gardens that guide movement and create a cohesive architectural experience linking the Opera and the proposed building with visual clarity and fluidity.



Masse plan, Scale 1/200. Source: Author

The landscape design enhances the immersive character of the museum. by incorporating aquatic vegetation and water surfaces to evoke the marine world, and integrating dense planting, shaded paths, and native species to represent terrestrial ecosystems. This landscape design creates a coherent outdoor extension of the indoor experience.

IV.6.2 The central dome

At the beginning of the spiral stands the central dome, which acts as the nucleus of the entire project. Accessible from the basement, it symbolizes the starting point and the convergence of knowledge and sensory experiences.

This dome houses an immersive 3D simulator that allows visitors to experience unforgettable journeys: diving into ocean depths, flying over natural landscapes, or exploring the solar system virtually. This space strengthens the emotional connection between the visitor and the natural world.



IV.6.3 The underwater world

The visitor's journey begins in the basement level, where a calm and immersive atmosphere recreates the depths of the ocean and aquatic ecosystems. This intentionally dim environment highlights a series of water tanks, interactive projections, underwater soundscapes, and atmospheric lighting designed to simulate marine life.

Here, visitors discover coral reefs, marine biodiversity, and environmental issues related to ocean pollution.

A linear aquarium runs along part of the spiral, creating a continuous sense of movement reminiscent of ocean currents.



IV.6.4 The terrestrial world

Ascending the spiral leads to the main level, dedicated to the terrestrial world. This space is brighter, more open, and enriched with vegetation. The architectural

volumes become wider and more spacious, reflecting the diversity and scale of terrestrial environments. This level includes bioclimatic zones (deserts, tropical forests, mountains, etc.), educational areas focusing on flora and fauna, indoor gardens and terrariums, and a dedicated children's learning space.

The objective is not only to inspire contemplation, but also to encourage reflection on the preservation of natural terrestrial habitats.



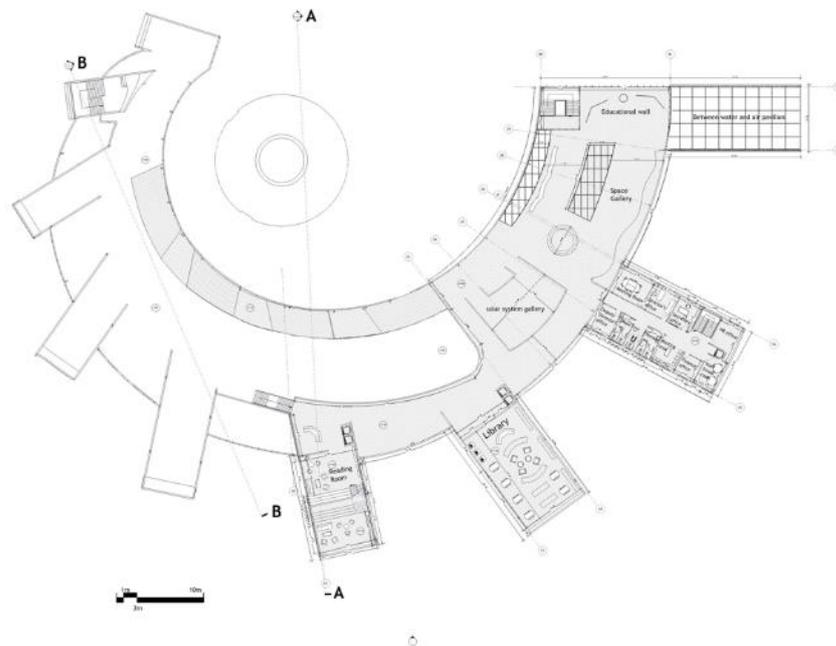
IV.6.5 Aerial and astronomical worlds

The higher the visitor ascends along the spiral, the more the architecture opens vertically and horizontally. The volumes become lighter and more transparent, with increasing natural light entering through enlarged openings. This ascending movement introduces the exploration of the aerial world and, ultimately, outer space.

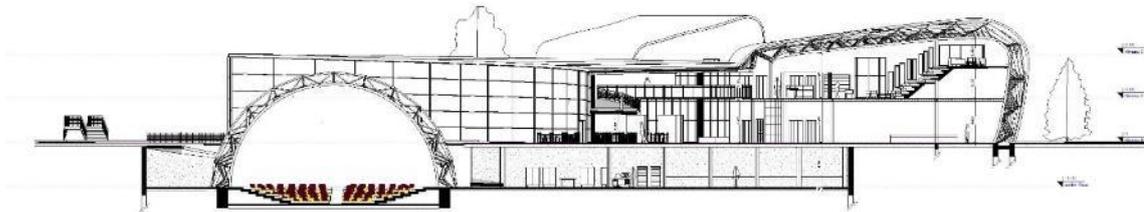
In these upper levels, visitors encounter the flight patterns of birds, the functioning of the atmosphere and meteorological phenomena, basic principles of aerodynamics, and finally, a space dedicated to astronomy, planetary systems, and space exploration.

Flight simulators, sky observation stations, and immersive projections accompany this progression toward the infinite.

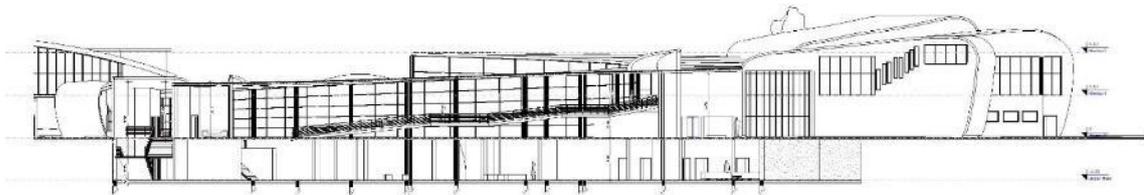




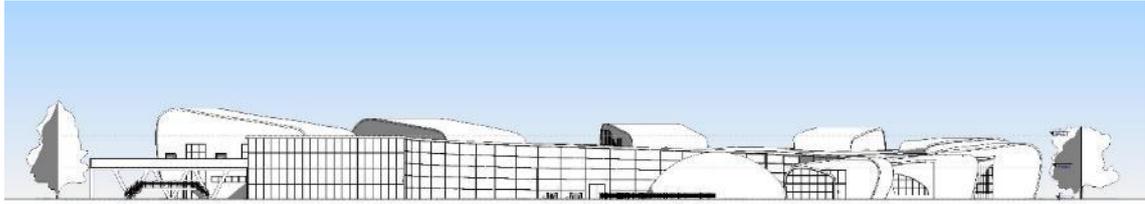
FIRST FLOOR SCALE 1/100



SECTION A-A SCALE :1/100



SECTION B-B SCALE :1/100



MAIN ELEVATION SCALE 1/100



RIGHT SIDE ELEVATION SCALE 1/100



LEFT SIDE ELEVATION SCALE 1/100

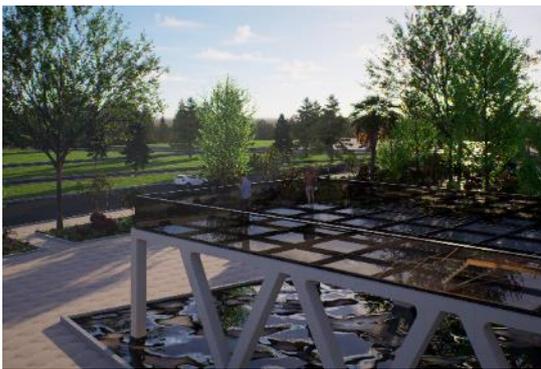


REAR ELEVATION SCALE 1/100

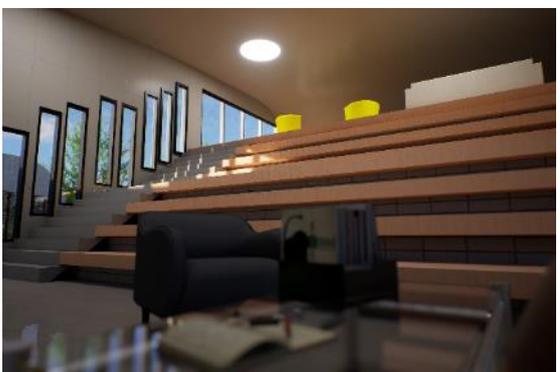
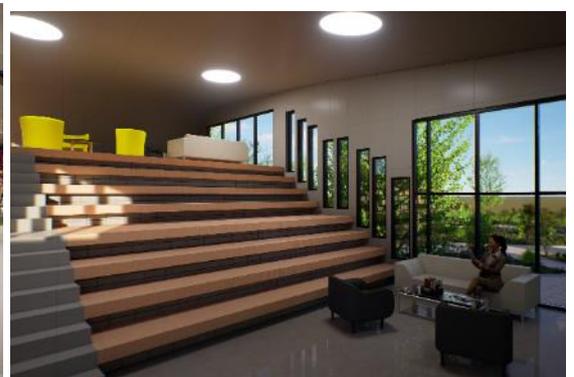
IV.6.6 Project views

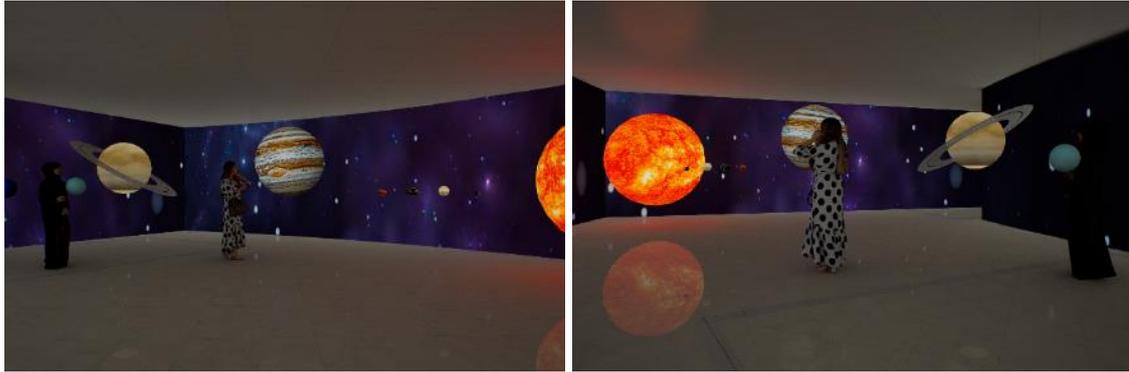
a) Exterior views





b) Interior views:





IV.7 Conclusion

This chapter IV provided a comprehensive and multidimensional analysis of the project context, establishing a strong foundation for the design of the Nature Museum. The presentation of the city of Algiers and its geographical location enabled a clear understanding of the urban, topographical, and regional factors that influence the site, while the detailed examination of the site in Ouled Fayet highlighted its unique features, opportunities, and limitations. The reasoning behind the site selection was carefully justified, considering both its strategic position and its potential to host an immersive environmental and educational experience.

The climatological study provided essential insights into temperature patterns, solar exposure, wind directions, and precipitation, guiding the development of design strategies that effectively respond to local environmental conditions. The SWOT analysis further identified the strengths, weaknesses, opportunities, and threats of the site, providing a clear framework for making informed decisions throughout the design process.

The programmatic and conceptual approaches, combined with detailed site analysis, ensured that functional requirements, visitor circulation, accessibility, and operational efficiency were all considered holistically. The design integrates a vertically organised exploration of ecosystems, from aquatic environments in the basement, terrestrial habitats on the ground floor, to space and planetary systems on the upper levels, creating a gradually immersive journey for visitors. Strategic site planning, including underground parking and carefully designed access points, improves both environmental preservation and connectivity with the surrounding urban fabric.

Ultimately, this chapter demonstrates how a comprehensive understanding of the urban, geographical, climatic, and programmatic context directly informs the architectural design, ensuring that the Nature Museum will be both functionally efficient and experientially engaging. It establishes a coherent and academically grounded basis for the subsequent design development, confirming that every design decision is rooted in a meticulous analysis of the site and its broader environment

STARTUP CHAPTER

V. CHAPTER V: “*SAMEMLI*” A DIGITAL APPLICATION

V.1 Introduction

In this section, I present a digital application titled "SAMEMLI," a smart platform that aims to connect customers with professionals in the fields of construction, design, and engineering, in response to the digital transformation and the growing need for reliable services in this field. This section presents the application's components, interfaces, and basic functions, as a project that integrates architecture and modern technology.

V.2 Problem Statement and Motivation

- Difficulty finding reliable professionals
- Lack of a specialized local platform
- Lack of a clear mechanism for communication and submitting applications.

V.3 Objectives

- Connecting clients with professionals in architecture, contracting, and technical fields.
- Facilitating the search and selection process based on location, experience, and ratings.
- Creating a trusted space for exchanging projects and technical services.

V.4 Target Audience

Clients: Individuals, business owners, real estate companies, contractors, and architecture students.

Professionals: Architects, civil engineers, interior designers, technicians, engineering firms, and contractors.

V.5 Basic functions of the application

- Create an account for a client, professional, or architectural design office, with a special offer for students.
- View professional portfolios and CVs.
- Submit project requests.
- Evaluation and feedback system.
- Direct communication interface between the two parties.

V.6 Prototype the application:

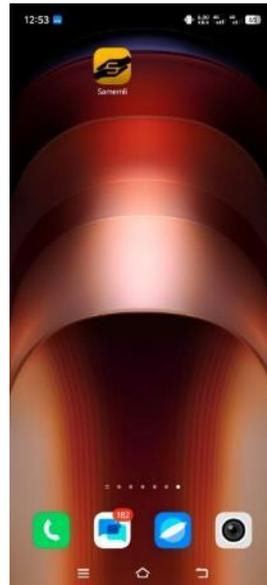


Figure VI.1: Left:the app logo Right: the shape of the app installed on the phone

Source: Author



Figure VI.2:Application interface

Source: Author

V.7 Steps to Create an Account in the "Samemli" App

The app includes a registration system designed to meet the needs of three types of users: clients, professionals (engineers, designers, contractors, etc.), and architectural design offices.

The account creation process includes the following steps.

First step : Selecting User Type

When opening the application for the first time, the user is asked to identify themselves:

- Client (Service Seeker)

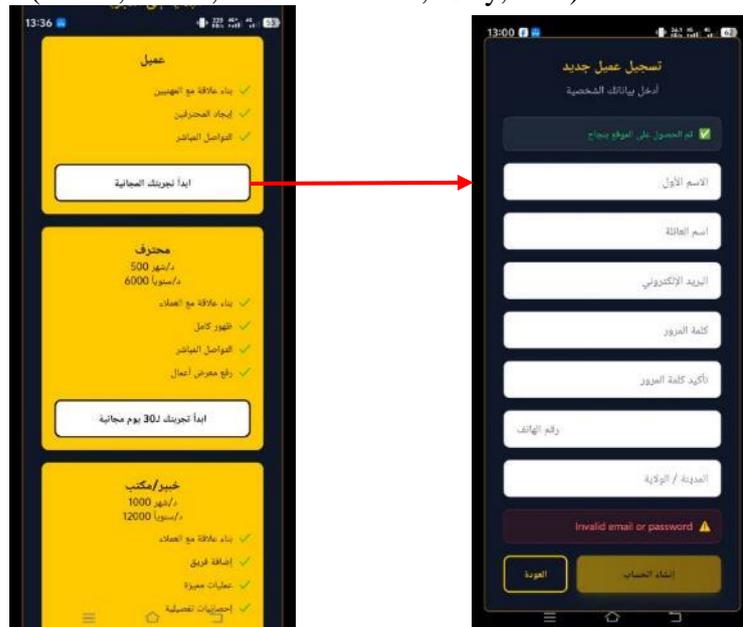
- Professional (Service Provider)
- Expert (Architectural design Office)



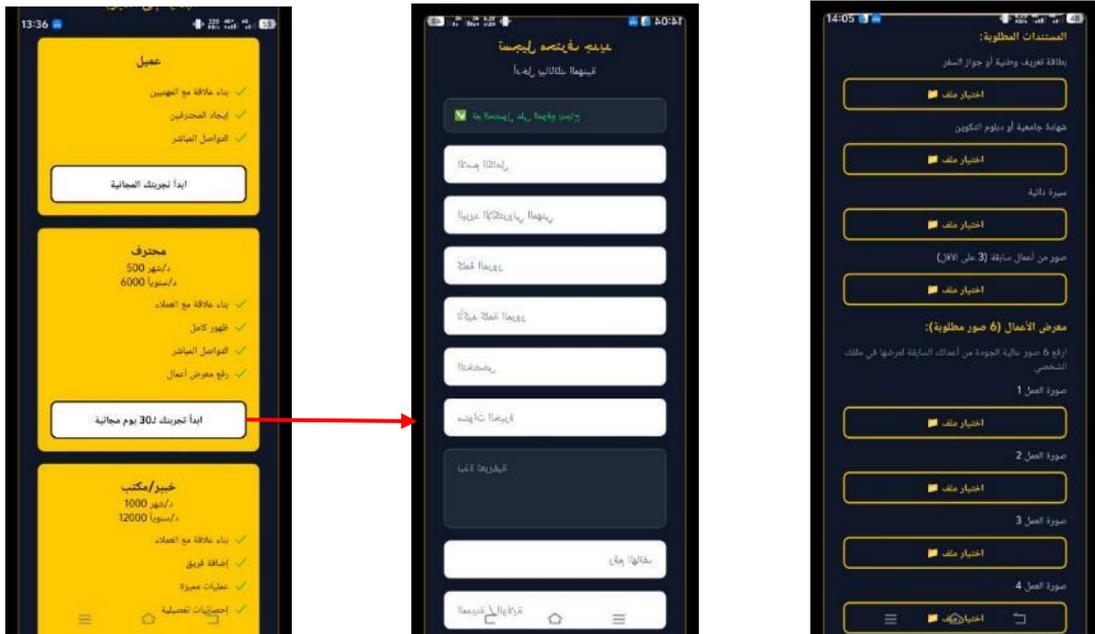
Second step: Enter basic information:

The user is required to enter a set of basic data, which varies slightly depending on the account type:

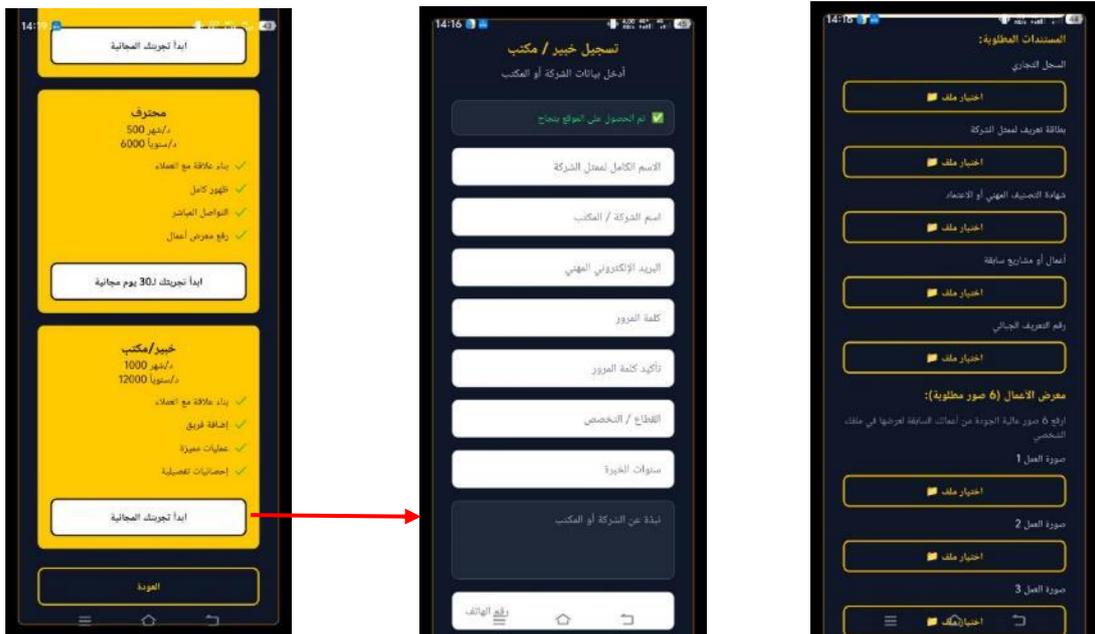
For the Client : (Name, Email, Phone Number, City, ..etc)



For the professionals:(Full Name, Specialization, Email, Phone Number, CV (Optional) Portfolio Link/Profile (Optional)...etc).



For the Experts (Architectural design Office): Full Name of Company Representative, Company Name, Sector, Years of Experience, Email, Phone Number ,Commercial Register, Certification of Accreditation ,Portfolio Link/Profile (Optional)...etc.

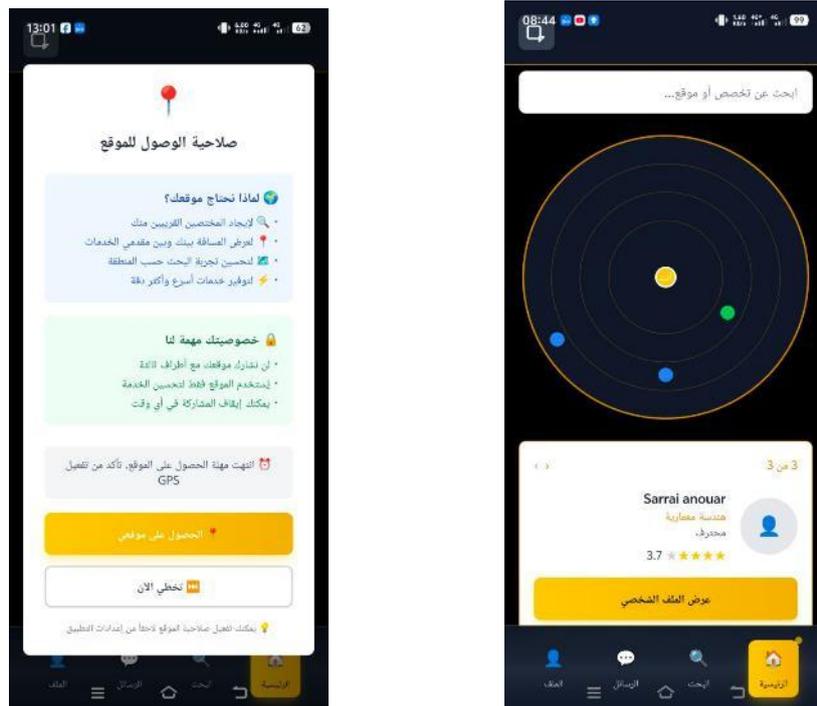


Third step: after opening the account is to see the welcome interface with the application slogan.

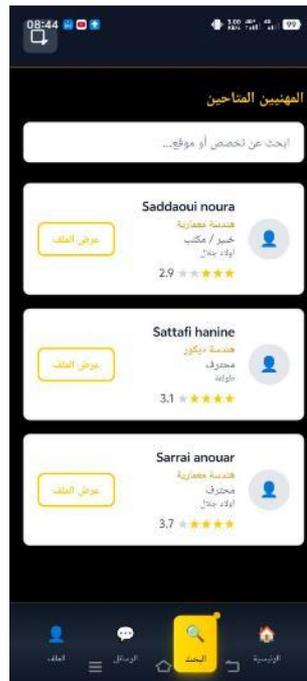


When you open the app, the user is prompted to enable GPS.

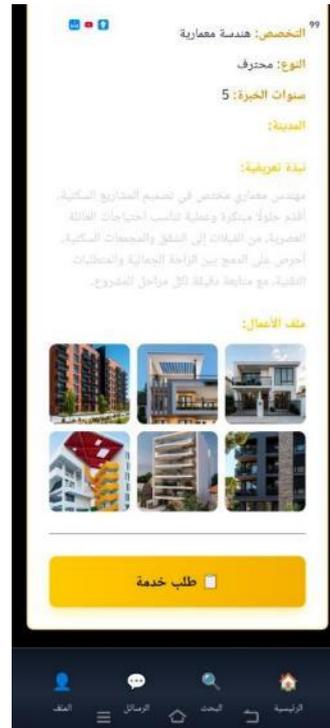
Once activated, the app automatically displays a personalized interface showing the nearest available professionals in the same area or neighboring cities, with brief information about each professional:



After the user selects the desired specialty (for example: architect, interior designer, contractor, etc.), the application automatically displays a list of professionals who are geographically closest to him and who are active in the same specialty.



When you click on a professional's name or photo in the results list, the user is taken to their detailed profile, which displays comprehensive information to help the client make the right decision. A brief overview, previous work, customer reviews and ratings, approximate location, and a service request button.



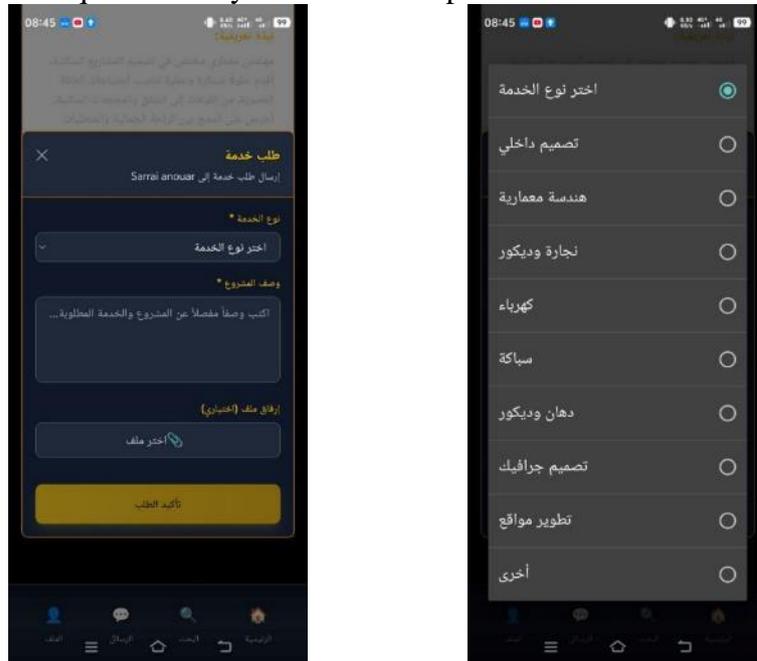
The service request process is completed through the following steps:

Click the "Request Service" button below the professional's profile.

Fill out the request form, which includes:

- Type of service requested (design, architecture, interior design, etc.)
- A brief description of the project or need

- An estimated budget (optional)
- The project's geographic location
- The ability to attach images or attachments (e.g., plans, site photos, etc.)
- Send the request directly to the selected professional.



After submitting:

The professional receives a notification of the request. They can respond with approval or contact the client for further details. The request is followed up through the chat interface.

Communication between the two parties :

If the request is accepted, a communication interface (chat) will open, allowing the exchange of messages and files to clarify project details.

After the project is completed, the client can evaluate the professional by assigning a number of stars and writing an optional comment.



Protecting User Accounts

"Samemli" app is designed to maintain the privacy and security of its users, especially when creating accounts and logging in. Therefore:

Passwords are securely encrypted and are not stored as is in the database.

Even I, as the app developer or system administrator, cannot see or access passwords.

When attempting to log in, the system compares the entered password with its encrypted version, without revealing it.

This method ensures high privacy and protects user data from any breach or exploitation.

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_id: ObjectId('686dbb1c06ac42e6f6e5d5b5')
email: "glowyboy02@gmail.com"
password: "$2a$12$0roEejhS7NmtDe5diUc0UuZ34eP29L9E9YcpYn1SPFh3361WVBqly"
name: "Ilyes Khr"
role: "client"
city: "Batna"
phone: "0669584320"
documents: Array (empty)
portfolioImages: Array (empty)
rating: 0
coordinates: Object
isVerified: false
isActive: true
createdAt: 2025-07-09T00:43:08.118+00:00
updatedAt: 2025-07-11T18:52:19.481+00:00
__v: 0
lastLogin: 2025-07-11T18:52:19.388+00:00
    
```

V.8 Website for the app

As part of the implementation of "samemli" app concept, a preliminary design has been developed for an introductory website for the app, which aims to showcase the project's concept and proposed services.

The website has not yet been programmed and remains in the design phase, in preparation for its subsequent development as part of the full version of the platform.





ادفع لكل شهر ، وليس لكل مشروع

لا حدود للمستخدمين، لا مشاكل أسعارنا مرنة مع فريقك، لتتمكن من التركيز على التطوير بشكل أفضل وأسرع. بغض النظر عن الجهة التي تحتاجها

<p>خبير/مكتب</p> <p>1000 د/شهر 12000 د/سنويا</p> <p>ابدا عمك مع:</p> <ul style="list-style-type: none"> ✓ إضافة فريق ✓ اعلانات مميزة ✓ احصائيات تفصيلية <p>ابدا تجربتك ل30 يوم مجانية</p>	<p>محترف</p> <p>500 د/شهر 6000 د/سنويا</p> <p>ابدا عمك مع:</p> <ul style="list-style-type: none"> ✓ ظهور كامل ✓ التواصل المباشر ✓ رفع معرض اعمال <p>ابدا تجربتك ل30 يوم مجانية</p>	<p>عميل</p> <p>ابدا معنا ب:</p> <ul style="list-style-type: none"> ✓ ايجاد المحترفين ✓ التواصل المباشر <p>ابدا تجربتك المجانية</p>
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الذهبية/CIB

لمزيد من التفاصيل يرجعي مراجعة الاسئلة الشائعة حول الشراء او التواصل مع مكتب التطبيق

عدد مستخدمي تطبيق صمملي شهريا

نقدم تسهيلات للطلبة والمبتدئين "حطة اكايمي" تعرف على المزيد:

"صمملي" لطلبة مجال البناء

تواصل معنا ✉ البريد الالكتروني ☎ رقم الهاتف	تعرف علينا - من نحن - قيمنا - تواصل معنا	روابط مهمة - الرئيسية - العروض - العقود معصم صمملي تابعنا على منصات التواصل الاجتماعي in f t
---	---	--

2025 جميع الحقوق محفوظة لمحافظة جامعة بسكرة
مركز المساعدة

الاسعار

**طلبة السنوات الاخيرة 100 د/شهريا
+حديثي التخرج 1200 د/سنويا**

المزايا:

- ✓ ظهور في نتائج البحث
- ✓ امكانية عرض مشروع التخرج
- ✓ ختم "طالب هندسة" يظهر للعميل

ابدا تجربتك ل30 يوم مجانية

"صمملي" يدعم الطلبة والمواهب الشابة

تواصل معنا ✉ البريد الالكتروني ☎ رقم الهاتف	تعرف علينا - من نحن - قيمنا - تواصل معنا	روابط مهمة - الرئيسية - العروض - العقود معصم صمملي تابعنا على منصات التواصل الاجتماعي in f t
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2025 جميع الحقوق محفوظة لمحافظة جامعة بسكرة
مركز المساعدة

Steps to create an account:

1- Client:

2- Professional:

3- Expert/Office:

Contact the application office :

V.9 Conclusion

This applied component represents a practical extension of the theoretical concept of the "Samemli" project and translates the general trend toward digitizing architectural and construction services into a functional, scalable digital product.

By analyzing the problem and identifying the target audience, a clear vision was developed for an application that facilitates customer access to specialized professionals, whether architects, design firms, or interior designers. This application relies on geographic location, precise classification, and a simple and seamless user interface.

This component included a preliminary design for the application and its website, showcasing the various functions that represent the core of digital services: from creating accounts, browsing professional profiles, submitting service requests, to a user experience based on geographic proximity and the required specialization.

Although the application is still in its early stages, the proposed design represents a functional prototype that demonstrates the concept's realism and technical feasibility. It also paves the way for future expansion of the platform to include additional services such as project evaluations, payment methods, and post-implementation services.

Ultimately, this section reflects the practical application of integrating the architectural specialization with digital transformation, and represents an attempt to provide a real solution to a problem that many suffer from in professional reality, within the framework of a promising emerging project that is capable of implementation and development.

General conclusion

VI. GENERAL CONCLUSION

This work aligns with current research in sustainable architecture, where energy efficiency and climate adaptation are key challenges. In response to climate change impacts and the need to develop more efficient, eco-friendly buildings, this study aims to investigate how climate data can be integrated into the parametric design process to enhance architectural forms and building performance.

We demonstrated that it is possible to transform climatic constraints such as sunlight, temperature, wind, and humidity into effective design drivers. Using parametric tools and environmental simulations, these parameters become dynamic data that enable the creation of forms better suited to the climatic context. This approach enhances thermal and visual comfort from the earliest design stages while also reducing energy consumption. Additionally, it was shown that parametric design is not only a way to create complex forms but also a powerful tool for meeting current environmental requirements.

The analysis emphasized the key principles of parametric design and the importance of incorporating climate data. Tools like Grasshopper, Ladybug, and Honeybee are crucial for modeling how architectural choices affect the environment from the early stages of a project. As a result, the shape of the building is no longer just about appearance but is designed to suit the local climate.

On the architectural level, we designed a nature museum project in Algiers. First, thematic research on museums and case study analysis enabled us to understand the various aspects of this type of project and identify its functional and architectural specificities. In addition, the urban analysis helped us identify the potentials and constraints of our site. All these elements guided the design of our project.

In the final chapter, we introduced a digital application called “SAMEMLI.” It is an innovative platform designed to connect customers with professionals in construction, design, and engineering, addressing the digital transformation and the increasing demand for reliable services in these fields.

Regarding our research topic, several limitations should be acknowledged. Using parametric models requires strong skills in digital tools and a thorough understanding of thermal and daylight simulations. Moreover, some parameters remain challenging to integrate or optimize simultaneously, which offers opportunities for future research, especially in multi-objective optimization and adaptive systems.

Future research could further explore the use of optimization algorithms, adaptive façades, or even artificial intelligence to advance the integration of climate into architectural design.

REFERENCES

VII. REFERENCES

Articles

- Alazzawi, T., & Al-Majidi, Z.** (2021a). Parametric architecture : The second international style. In *IOP Conference Series : Materials Science and Engineering* (Vol. 1067). <https://doi.org/10.1088/1757-899X/1067/1/012019>
- BENHARKAT, S.** (2006). Impact de l'éclairage naturel zénithal sur Le confort visuel dans les salles de classe. *Cas d'étude: Bloc des lettres de l'université Mentouri Constantine. Thèse de magistère, université Mentouri, Constantine, 5, 15.*
- Biket, A. P.** (2006). ARCHITECTURAL DESIGN BASED ON CLIMATIC DATA. *Built Environment.*
- BOUMEDIENE, M.** (2016). *Traitement et Intégration des données météorologiques dans un SIG pour la détection des changements climatiques du sous bassin versant d' Oued Mina Haddad.* UNIVERSITE ABDEL HAMID BEN BADIS MOSTAGANEM.
- Cherif, B.** (2017). *Les façades dynamiques; moyen de contrôle solaire pour accroître l'efficacité énergétique des équipements administratifs en climat aride—Biskra.* UNIVERSITE SALAH BOUBNIDER CONSTANTINE 3.
- Couwenbergh, J.-P.** (2008). *Introduction à la conception paramétrique.*
- Davis, D.** (2013, août 7). *A History of Parametric.* Daniel Davis. <https://www.danieldavis.com/a-history-of-parametric/>
- Dr. BEDDAL Dalila.** (2021, 2022). *Agrométéorologie.* Université Mohammed Boudiaf-M'sila Faculté des sciences Département des sciences agronomiques.
- Eltaweel, A., & Su, Y.** (2017). Parametric design and daylighting : A literature review. *Renewable and Sustainable Energy Reviews, 73,* 1086-1103. <https://doi.org/10.1016/j.rser.2017.02.011>
- Ezrati, J.-J.** (2010). L'éclairage comme élément de la scénographie. *Culture & Musées, 16,* 252-256. <https://doi.org/10.3406/pumus.2010.1578>
- Fisli Yasmine.** (2020). *Régulation des ambiances lumineuse a trevers l'envolpe architectural dans la conception des espaces d'exposition.* <https://www.theses-algerie.com>
- Ipek Gursel Dino.** (2012). Creative Design Exploration By Parametric Generative Systems In Architecture. *METU JOURNAL OF THE FACULTY OF ARCHITECTURE.* <https://doi.org/10.4305/METU.JFA.2012.1.12>
- Lee, J., Peng, M., & Kwan, S.** (2018a). *Integration of Environmental Simulation to Parametric Design Workflow : Thermal Comfort and Daylight.* 8, 374-381. https://publications.ibpsa.org/conference/paper/?id=simbuild2018_C052
- Mendilcioğlu, R. F., & Yilmaz, M.** (2021). Parametric Design as A Creation Tool for The Memory Space. *Iconarp International J. of Architecture and Planning, 9(1),* 429-454. <https://doi.org/10.15320/ICONARP.2021.166>
- MERLEAU-PONTY Claire, EZRATI Jean-Jacques.** (2005). *L'exposition, théorie et pratique.* https://liseuse.harmattan.fr/index_liseuse.asp?isbn=2747597466
- Moradi, M.** (2014). *Daylighting, Building Design and Performance.* https://www.academia.edu/18717974/Daylighting_Building_Design_and_Performance
- Patrik Schumacher.** (2011). *The Autopoiesis of Architecture, Volume I: A New Framework for Architecture | Wiley.* Wiley.Com. <https://www.wiley.com/en-us/The+Autopoiesis+of+Architecture%2C+Volume+I%3A+A+New+Framework+for+Architecture-p-9780470772980>

- R. M. Sakiyama, N., C. Carlo, J., Mazzaferro, L., & Garrecht, H.** (2021a). Building Optimization through a Parametric Design Platform : Using Sensitivity Analysis to Improve a Radial-Based Algorithm Performance. *Sustainability*, 13(10), Article 10. <https://doi.org/10.3390/su13105739>
- Regnier, C.** (2012). *Guide to Setting Thermal Comfort Criteria and Minimizing Energy Use in Delivering Thermal Comfort* (No. LBNL--6131E, 1169480; p. LBNL--6131E, 1169480). <https://doi.org/10.2172/1169480>
- Saihi, F.** (2020). *Optimisation des Ambiances Lumineuses dans Les Equipements d'Exposition (Musée)* [Working Paper]. <https://dspace.univ-guelma.dz/jspui/handle/123456789/9970>
- Schumacher.** (2012). *The Autopoiesis of Architecture, Volume II : A New Agenda for Architecture* / Wiley. Wiley.Com. <https://www.wiley.com/en-us/The+Autopoiesis+of+Architecture%2C+Volume+II%3A+A+New+Agenda+for+Architecture-p-9781119940470>
- Schumacher, P.** (2014). *Design Parameters to Parametric Design*. https://www.academia.edu/21738596/Design_Parameters_to_Parametric_Design
- Ximena M. Milla.** (2018). *Building Energy Management Systems Technology for HVAC, Lighting and Outlets with Smart Sensor Networks—ProQuest*. <https://www.proquest.com/openview/84f4d751a404c8b4283c728e50b16705/1?pq-origsite=gscholar&cbl=18750&diss=y>

Websites:

- Scribd. (n.d.). *Data Analysis*. Retrieved January 2025, from <https://www.scribd.com/document/519969529/1615991074-DataAnalysis>
- SlideShare. (n.d.). *MAXXI Construction*. Retrieved January 2025, from <https://www.slideshare.net/slideshow/maxxi-construction-50150705/50150705>
- ResearchGate. (n.d.). *The MAXXI Museum in Rome: An integrated survey experience for the restoration of contemporary architecture*. Retrieved January 2025, from https://www.researchgate.net/publication/317058904_THE_MAXXI_MUSEUM_IN_ROME_AN_INTEGRATED_SURVEY_EXPERIENCE_FOR_THE_RESTORATION_OF_CONTEMPORARY_ARCHITECTURE
- Dergipark. (n.d.). *Article file 3813076*. Retrieved January 2025, from <https://dergipark.org.tr/en/download/article-file/3813076>
- Gooood. (n.d.). *Sanxingdui Museum – Winning proposal by China Southwest Architectural Design and Research Institute Corp*. Retrieved January 2025, from <https://www.gooood.cn/sanxingdui-museum-winning-proposal-china-southwest-architectural-design-and-research-institute-corp.htm>
- Gooood. (n.d.). *New Sanxingdui Museum – China Southwest Architectural Design and Research Institute Corp. Ltd*. Retrieved January 2025, from <https://www.gooood.cn/new-sanxingdui-museum-china-southwest-architectural-design-and-research-institute-corp-ltd.htm>
- Matsu-Haku. (n.d.). *Matsuhaku official website*. Retrieved January 2025, from <https://matsu-haku.com/matsuhaku/>
- Cadmapper. (n.d.). *Generate 3D city models*. Retrieved February 2025, from <https://cadmapper.com/>

SunCalc. (n.d.). *Sun position, sunlight phases, sunrise, sunset, dusk and dawn times calculator*. Retrieved February 2025, from <https://www.suncalc.org/#/36.7365,2.9321,3/2025.01.05/01:48/1/1>

Andrew Marsh. (n.d.). *Sun Path 3D*. Retrieved February 2025, from <https://andrewmarsh.com/apps/staging/sunpath3d.html>

Scribd. (n.d.). *Mémoire M2 AERH*. Retrieved February 2025, from <https://www.scribd.com/document/625328865/memoire-M2-AERH>

Books:

Neufert, E. (2002). *Architects' Data* (8th ed.). Oxford: Blackwell Science.

Neufert, E. (2012). *Architects' Data* (10th ed.). Oxford: Blackwell Science.

- Neufert. (08th edition). Neufert 08th edition.
- Neufert. (10th edition). Neufert 10th edition.



الجمهورية الجزائرية الديمقراطية الشعبية

وزارة التعليم العالي والبحث العلمي

جامعة محمد خيضر - بسكرة

حاضنة أعمال جامعة بسكرة



رقم 42 / الحاضنة / 2025

شهادة توظيف / تحضين "مشروع مبتكر ضمن قرار 1275"

انا المعضي أسفله، السيد (ة): **مجد جلاب**

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

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رقم علامة الحاضنة : **2311223051**

تاريخ تسليم العلامة : **23 نوفمبر 2022**

أشهد أن الطالب / الطالبة التالية أسمائهم :

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سراي اريج مریم باسمين	ماستر 2	هندسة معمارية	الهندسة المعمارية و العمران و الهندسة المدنية و الري

تحت إشراف الاستاذ/الاساتذة التالية أسمائهم :

الاسم و اللقب	الرتبة	التخصص	الكلية
سحر ماقري الواجري	أستاذ محاضر	هندسة معمارية	الهندسة المعمارية و العمران و الهندسة المدنية و الري

تم احتضانه على مستوى حاضنة أعمال جامعة محمد خيضر - بسكرة بمشروع تحت اسم :

تطوير منصة + تطبيق لربط العملاء بمحرفي البناء من مهندسين معماريين، مدنيين، مصممين وغيرهم .

خلال السنة الجامعية 2024 / 2025.

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

حرر في بسكرة بتاريخ: 20.11.2024



د/ **مستحسن جيسلايا**



الجمهورية الجزائرية الديمقراطية الشعبية

وزارة التعليم العالي والبحث العلمي

جامعة جامعة محمد خيضر - بسكرة -



عنوان المشروع:

تطوير تطبيق_+منصة_ لربط العملاء بمحترفي البناء من مهندسين
معماريين، مدنيين، مصممين وغيرهم.

صورة العلامة التجارية



الاسم التجاري

صمملي

SAMEMLI

السنة الجامعية

2026/2025

بطاقة معلومات:

حول فريق الاشراف وفريق العمل

1- فريق الاشراف:

فريق الاشراف	
المشرف الرئيسي:	التخصص:
سحرماقري الواجري	هندسة معمارية

2- فريق العمل:

فريق المشروع	التخصص	الكلية
الطالبة: سراي اريج مريم ياسمين	هندسة معمارية	كلية الهندسة المعمارية والهندسة المدنية والري

عنوان المشروع : تطوير تطبيق ومنصة لربط العملاء بمحترفي البناء من مهندسين معماريين، مدنيين، مصممين وغيرهم.

فهرس المحتويات

المحور الأول: تقديم المشروع

المحور الثاني: الجوانب الابتكارية

المحور الثالث: التحليل الاستراتيجي للسوق

المحور الرابع: خطة الإنتاج والتنظيم

المحور الخامس: الخطة المالية

المحور السادس : النموذج الاولي التجريبي

عنوان المشروع: تطوير تطبيق ومنصة لربط العملاء بمحترفي البناء من مهندسين معماريين، مدنيين، مصممين وغيرهم.

المحور الأول: تقديم المشروع

ظهرت فكرة المشروع من خلال من خلال ملاحظة الفجوة الكبيرة في السوق بين حاجات الأفراد والمؤسسات لبناء وتصميم مشاريعهم، وصعوبة الوصول إلى المهنيين المؤهلين في مجالات الهندسة المعمارية، المدنية، التصميم الداخلي، والهندسة التقنية.

ففي ظل التوسع العمراني المتسارع، والتطور المستمر في معايير جودة البناء والتصميم، أصبح الوصول إلى الخبرات المتخصصة ضرورة ملحة، لا مجرد خيار.

حسب تقارير التنمية العمرانية في الدول النامية، فإن أحد أهم التحديات التي يواجهها القطاع السكني والتجاري هو غياب منصات رقمية موثوقة تربط بين العملاء وذوي الكفاءة في المجال، ما يؤدي إلى بطء في الإنجاز، وتكاليف زائدة، وحتى أخطاء في التنفيذ.

في الجزائر، وبحسب تقارير حديثة صادرة عن مراكز دراسات حضرية، يعاني السوق من تشتت في المصادر وعدم وجود نقطة موحدة يمكن من خلالها للمستخدمين مقارنة العروض، التحقق من مؤهلات المحترفين، ومتابعة سير مشاريعهم بمرونة وشفافية.

- السوق العالمي للمنصات الحرة ارتفع من 2.35 مليار دولار في 2018 إلى 3.39 مليار دولار في 2020، ويُتوقع أن يصل إلى 9.19 مليار دولار بحلول 2027 بمعدل نمو سنوي 15.3٪.

- يُتوقع أن ينمو سوق المنصات الحرة عالمياً من 5.2 مليار دولار عام 2023 إلى 25.9 مليار دولار بحلول عام 2033، بمعدل نمو سنوي مركب 17.4٪.

- وفقاً للبنك الدولي، يشكل العمل الحر بحسابات المستقلين عبر الإنترنت نحو 12٪ من قوة العمل العالمية.

- ووفقاً لإحصائيات العمل الحر العالمي من المتوقع أن يتجاوز عدد العاملين الحرّين 1.57 مليار شخص حول العالم بحلول عام 2025.

- قطاع تكنولوجيا المعلومات والمهنة الخبيرة يشكل الجزء الأكبر من فرص الاستثمار والمنصات بفضل الطلب العالي والربحية.

عنوان المشروع: تطوير تطبيق ومنصة لربط العملاء بمحترفي البناء من مهندسين معماريين، مدنيين، مصممين وغيرهم.

وعليه بما أن المستقبل المني والعمراني يتجه نحو الرقمنة والتخصص، فإن منصة "صممي" ليست مجرد وسيط رقمي، بل نقطة انطلاق جديدة نحو بيئة بناء متكاملة، مرنة، ومستدامة، تتماشى مع التغيرات الاقتصادية، التكنولوجية، والبيئية في العالم.

مجال نشاطنا يتمثل في التطبيقات الحديثة: تطوير منصة وتطبيق لربط العملاء بمحترفي البناء من مهندسين معماريين، مدنيين، مصممين وغيرهم.

فكرة المشروع (الحل المقترح)

تندرج فكرة المشروع "صممي" على إنشاء منصة رقمية ذكية وتطبيق يربط بين العملاء الذين يبحثون عن خدمات في مجال البناء، التصميم، والهندسة، والمهنيين المحترفين مثل المهندسين المعماريين، المدنيين، المصممين الداخليين، والمقاولين وحتى الفنيين.

ستقوم المنصة والتطبيق بتسهيل عمليات البحث، التواصل، التعاقد، ومتابعة سير المشروع، مع نظام تقييم يضمن الشفافية، بالإضافة إلى تمكين الشباب والمهنيين المستقلين من عرض خدماتهم والوصول إلى فرص عمل حقيقية في بيئة رقمية حديثة وأمنة.

تعريف المشروع

العنصر	الشرح
طبيعة المشروع	تطوير منصة رقمية + تطبيق لربط العملاء بمحترفين في مجال البناء والتصميم، والهندسة من مهندسين معماريين، مدنيين، مصممين وغيرهم.
اسم المشروع	SAMEMLI
مجال النشاط	تطبيقات حديثة
موقع المشروع	ولاية بسكرة
النطاق	وطني، دولي
الفئة المستهدفة	1-العملاء الباحثون عن محترفي البناء: - الأفراد - الشركات العقارية والمطورون العقاريون - أصحاب المحلات والمكاتب التجارية 2-محترفو البناء ومقدمو الخدمات:

عنوان المشروع : تطوير تطبيق ومنصة لربط العملاء بمحترفي البناء من مهندسين معماريين، مدنيين، مصممين وغيرهم.

- المهندسون المعماريون والمدنيون - المصممون الداخليون والديكور - المقاولون وشركات البناء - الفنيون والعمال المتخصصون	
	عدد العمال
تطوير منصة رقمية +تطبيق في مجال البناء	تسمية النشاط
ربط العملاء بمحترفين في مجال البناء، الهندسة والتصميم من مهندسين معماريين، مدنيين، مصممين وغيرهم.	مضمون النشاط
شخص معنوي SARL	الشكل القانوني للمؤسسة
00 دينار جزائري	تكلفه شراء الارضية

القيم المقترحة

- سهولة الوصول إلى الخبرات :يتيح التطبيق للمستخدمين الوصول السريع إلى مهندسين محترفين، مصممين، ومقاولين موثوقين، مما يسهّل إنجاز المشاريع بجودة عالية.
- حلول مخصصة لكل مشروع :يقدم التطبيق توصيات مهنية متكيفة مع طبيعة كل مشروع، سواء كان سكنياً، تجارياً أو ثقافياً، لضمان تحقيق الأهداف التصميمية والوظيفية بدقة.
- واجهة استخدام مبسطة :يتميز التطبيق بواجهة سهلة وسلسة تسهّل على العملاء تصفح الملفات الشخصية، تقييم العروض، والتواصل المباشر مع المحترفين.
- شفافية في التعامل والتقييم :يعزز التطبيق من الثقة بين الأطراف من خلال نظام تقييم ومراجعة واضح يعكس جودة الخدمة واحترافية مقدمها.
- دعم الكفاءات المحلية :يساهم التطبيق في تمكين المهندسين والمقاولين المحليين، خاصة الشباب، من الوصول إلى فرص عمل تتناسب مع مهاراتهم.
- حلول موفرة للوقت والتكاليف :يقلل التطبيق من الحاجة للبحث العشوائي أو التعاقد مع جهات غير موثوقة، مما يوفر الوقت والتكاليف على المستخدمين.
- دعم التصميم المستدام :يشجع التطبيق على العمل مع محترفين يتبنون مفاهيم الاستدامة، مما يعزز من جودة البناء وكفاءته الطاقوية.

عنوان المشروع : تطوير تطبيق ومنصة لربط العملاء بمحترفي البناء من مهندسين معماريين، مدنيين، مصممين وغيرهم.

-تحفيز بيئة عمل عادلة للمحترفين: يوفر التطبيق فضاءً تنافسيًا صحيًا يعتمد على الجودة لا على العلاقات، مما يساعد في بروز كفاءات جديدة في السوق.

-مرونة في خيارات الدفع والاشتراك: يوفر التطبيق خيارات دفع متعددة، مع اشتراكات ميسرة تناسب الأفراد والطلاب والمكاتب الصغيرة.

-إسهام في تطوير قطاع البناء الرقمي: يواكب "صممي" التحول الرقمي في قطاع التشييد من خلال أدوات تقنية ذكية وموثوقة تساعد في اتخاذ قرارات فعالة وسريعة.

فريق العمل

الدورات التكوينية	التخصص	الطالب
- شهادة لغة انجليزية مستوى B2 من مركز تكثيف اللغات جامعة بسكرة	هندسة معمارية	سراي اريج مريم ياسمين
- شهادة لغة ايطالية مستوى A1 من جامعة بادوفا -ايطاليا-		
- شهادة مشاركة في برنامج التنقل الدولي ERASMUS		
- تربص ميداني على مستوى مديرية التجهيزات العمومية لولاية أولاد جلال.		
- تربص ميداني على مستوى مديرية التعمير و الهندسة المعمارية والبناء لولاية أولاد جلال		
- دورات تكوينية حول برامج التصميم المعماري.		
- دورات تكوينية حول برامج المحاكاة 3D.		

أهداف المشروع

أهداف قريبة المدى:

عنوان المشروع: تطوير تطبيق ومنصة لربط العملاء بمحترفي البناء من مهندسين معماريين، مدنيين، مصممين وغيرهم.

- ✓ تطوير المنصة والتطبيق: تصميم نسخة أولية متكاملة من منصة و تطبيق "صممي"، بواجهة سهلة الاستخدام، تتوافق مع احتياجات العملاء والمحترفين، وتدعم اللغتين العربية والانجليزية.
- ✓ ضمان الجودة والموثوقية: اختبار وظائف التطبيق وتحسينها لضمان تجربة سلسة وأمنة، تشمل تسجيل المستخدمين، تقييم العروض، والدفع الإلكتروني.
- ✓ جذب المستخدمين الأوائل: تنفيذ حملات تسويقية رقمية موجهة لجذب أول شريحة من العملاء والمهنيين، مع تقديم حوافز للمنضمين الأوائل.
- ✓ بناء قاعدة بيانات مهنية: إنشاء شبكة أولية من المهندسين، المصممين، والمقاولين المحليين الموثوقين لتوفير خيارات حقيقية للعملاء.
- ✓ إطلاق برنامج خاص بالطلبة: توفير مساحة للطلبة والخريجين الجدد لعرض مهاراتهم بشكل احترافي والاستفادة من فرص مشاريع مصغرة.

أهداف متوسطة المدى:

- ✓ توسيع نطاق الخدمات: تطوير المنصة لتشمل خدمات أكثر تخصصًا مثل إدارة المشاريع، تصميم ثلاثي الأبعاد، وتقدير التكاليف.
- ✓ التكامل مع منصات الدفع والخرائط: ربط المنصة بخدمات خارجية مثل الدفع الإلكتروني، التتبع الجغرافي، والمواعيد الذكية لتسهيل عملية المتابعة.
- ✓ التأثير الاقتصادي المحلي: دعم الاقتصاد المحلي من خلال تعزيز فرص العمل الحر في قطاع البناء والتصميم، خاصة للشباب والكفاءات المحلية.
- ✓ إنشاء شراكات استراتيجية: التعاون مع معاهد معمارية، بلديات، أو جمعيات مهنية لتعزيز الحضور في السوق وزيادة الموثوقية.
- ✓ تفعيل نظام الاشتراك الشهري: تطوير خطة اشتراكات مرنة للمحترفين تضمن مزايا مثل الظهور المميز وتحليل الأداء.

أهداف بعيدة المدى:

- ✓ تحقيق الريادة الوطنية: جعل "صممي" المنصة الأولى في الجزائر لربط العملاء بمحترفي البناء، مع الاعتراف بها كمرجع موثوق في المجال.
- ✓ التوسع المغربي والعربي: فتح فروع رقمية للمنصة في بلدان الجوار (تونس، المغرب، مصر...) مع تكييف الخدمات حسب خصوصيات السوق المحلي.
- ✓ دعم التحول الرقمي في قطاع البناء: الإسهام في رقمنة قطاع التشييد والتصميم، من خلال أدوات رقمية حديثة تسهّل الإجراءات وتزيد من الشفافية.
- ✓ نشر ثقافة التصميم المستدام: تشجيع المشاريع التي تراعي معايير الاستدامة البيئية والطاقوية، وربط العملاء بمحترفين ملتزمين بها.

عنوان المشروع : تطوير تطبيق ومنصة لربط العملاء بمحترفي البناء من مهندسين معماريين، مدنيين، مصممين وغيرهم.

✓ تحقيق الاستمرارية المالية: ضمان نمو المنصة وزيادة الإيرادات من خلال الاشتراكات، الإعلانات، والخدمات المميزة، مما يضمن الاستقلالية والاستدامة.

المحور الثاني: الجوانب الابتكارية

1. طبيعة الابتكارات : ابتكارات تكنولوجية

2. مجالات ابتكارية :

- التميز في الربط المباشر: "صمملي" هو أول تطبيق جزائري متخصص يربط العملاء مباشرة بالمهندسين والمقاولين من مختلف التخصصات، في منصة موحدة تعتمد على معايير احترافية.
- نظام مطابقة ذكي: يستخدم التطبيق تقنيات الذكاء الاصطناعي لمطابقة احتياجات المشروع مع الملفات الأنسب من المهنيين، وفقاً للخبرة، الموقع الجغرافي، والتقييمات السابقة.
- توصيات تصميم مخصصة: يقدم التطبيق توصيات مدروسة للمستخدمين (أفراد أو شركات) حول نوع المهني المناسب، نطاق الميزانية، والخدمات الأنسب لكل مشروع.
- سهولة الاستخدام: واجهة استخدام مبسطة وبديهية تتيح لأي مستخدم - حتى غير المتخصص - تصفح العروض، التواصل، وإطلاق مشروعه بخطوات قليلة وواضحة.
- تحفيز التصميم المستدام: يشجع التطبيق المشاريع التي تعتمد حلولاً معمارية مستدامة من خلال تصنيف خاص بالمحترفين ذوي التوجه البيئي، وتمييزهم داخل المنصة.
- الشفافية والتقييم: نظام مراجعة وتقييم متكامل يسمح للمستخدمين بمشاركة تجاربهم، مما يعزز من موثوقية المحترفين ويسهل على العملاء اتخاذ القرار بثقة.
- دعم الشباب والمبتدئين: يتيح التطبيق فضاءً خاصاً بالطلبة والخريجين الجدد لعرض خدماتهم، مع تنظيم مسابقات وفرص مشاريع صغيرة لرفع كفاءاتهم العملية.
- خدمات فورية ومتنوعة: يقدم "صمملي" خدمات سريعة مثل طلب استشارة فورية، مراجعة تصميم، أو تقدير تكلفة، مما يجعل المنصة أكثر من مجرد وسيط تقليدي.
- تنوع التخصصات: يجمع التطبيق مختلف فئات محترفي قطاع البناء (معماري، مدني، داخلي، كهرباء، سباكة، مقاولات...) في واجهة موحدة ومتنوعة تلي كل الاحتياجات.
- بناء مجتمع مهني تفاعلي: يسعى التطبيق إلى خلق مجتمع من المحترفين والعملاء يتبادلون الأفكار والتجارب والنصائح، عبر مساحات تفاعلية داخل التطبيق.

عنوان المشروع : تطوير تطبيق ومنصة لربط العملاء بمحترفي البناء من مهندسين معماريين، مدنيين، مصممين وغيرهم.

المحور الثالث: التحليل الاستراتيجي للسوق

1. تحليل PESTEL :

العوامل السياسية	العوامل الاقتصادية	العوامل الاجتماعية	العوامل التكنولوجية	العوامل البيئية	العوامل القانونية
-دعم الدولة للتحويل الرقمي وريادة الأعمال في الجزائر يمثل فرصة لتوسع المنصة.	-وجود أزمة سكن وبحث مستمر من المواطنين عن خدمات البناء والتصميم يدعم الطلب.	-وعي متزايد بين الجزائريين بأهمية التصميم المعماري الجيد والراحة البصرية والوظيفية.	-ارتفاع نسبة استخدام الهواتف الذكية في الجزائر يسهل الوصول إلى التطبيق.	-إمكانية تسويق المنصة كداعم للتصميم المستدام من خلال ربط العملاء بمهنيين مهتمين بالبناء الأخضر.	-ضرورة احترام قوانين حماية المستهلك الإلكتروني وقوانين التجارة الرقمية في الجزائر.
-وجود مبادرات حكومية لتشجيع الاقتصاد الرقمي والمقاولات الناشئة (Startups).	-ارتفاع تكاليف المواد والخدمات الهندسية يدفع العملاء للبحث عن حلول أرخص عبر الإنترنت.	-وجود ثقافة الاعتماد على المعارف الشخصية في اختيار المهندسين قد تعيق تبني المنصة في البداية.	-تطور تقنيات الذكاء الاصطناعي يمكن أن يُستخدم لتحسين نظام المطابقة بين العميل والمحترف.	-يمكن تشجيع اعتماد مواد وتقنيات صديقة للبيئة من خلال المنصة وتوجيه العملاء نحوها.	-احترام حقوق الملكية الفكرية للمهندسين من خلال حفظ تصاميمهم داخل المنصة.
-احتمال وجود عراقيل بيروقراطية في تسجيل الشركة أو التعاملات المالية الرقمية.	-بطء في اعتماد التجارة الإلكترونية بشكل كامل من قبل بعض الفئات.	-حاجة الطلاب والخريجين الجدد لفضاء يمكنهم من عرض كفاءاتهم بسهولة.	-إمكانية دمج تقنيات مثل GIS والواقع المعزز في مستقبل التطبيق لتقديم تجربة غنية.	-تصاميمهم داخل المنصة وتوجيه العملاء نحوها.	-وجوب تنظيم العقود الرقمية أو التعاقدات عبر المنصة بطريقة قانونية وأمنة.
-بعض القيود على الدفع الإلكتروني أو المعاملات البنكية الدولية قد تؤثر على التوسع.	-فرص كبيرة في دعم العمل الحر في قطاع البناء نتيجة ارتفاع البطالة بين المهندسين الشباب.	-تنامي الاهتمام بالاستقلالية المهنية لدى الشباب، ما يجعل المنصة جذابة لهم.	-الحاجة إلى توفير البنية التحتية الرقمية (خوادم، أمان، دعم تقني) بشكل موثوق.	-عدم وجود قيود بيئية مباشرة على نوع المشروع، لكن هناك فرص لإدراج معايير الاستدامة.	-احتمال وجود تحديات قانونية تتعلق بتسوية النزاعات بين العملاء والمزودين.

2. تحليل S.W.O.T :

نقاط الضعف (Weaknesses)	نقاط القوة (Strenghts)
<ul style="list-style-type: none"> - قلة الوعي بالمنصة في البداية: الحاجة لحملة توعية قوية لشرح وظيفة التطبيق. - الثقة المحدودة في التعاملات الرقمية: بعض المستخدمين لا يزالون يفضلون الطرق التقليدية في اختيار المهنيين. - تحديات قانونية وتنظيمية: خاصة فيما يخص العقود الرقمية، الدفع الإلكتروني، وفض النزاعات. - نقص الموارد المالية: قد يؤثر على التسويق، التوسعة، أو التطوير التقني السريع. 	<ul style="list-style-type: none"> - فكرة مبتكرة محلياً: "صممي" من أوائل المنصات المتخصصة في قطاع البناء في الجزائر، ما يمنحه ميزة السبق. - واجهة استخدام سهلة وجذابة: تسهل على المستخدمين التفاعل حتى دون خبرة تقنية. - تنوع المحترفين: يضم المنصة مهندسين معماريين، مدنيين، مصممين، مقاولين وغيرهم، ما يوفر حلاً متكاملًا للمستخدم. - نظام تقييم وشفافية: يعزز الثقة بين العميل والمحترف ويقلل من فرص الاحتيال أو التعامل العشوائي. - دعم الطلبة والناشئين: يشجع المنصة شريحة واسعة من الشباب على الانخراط المهني وتطوير الذات.

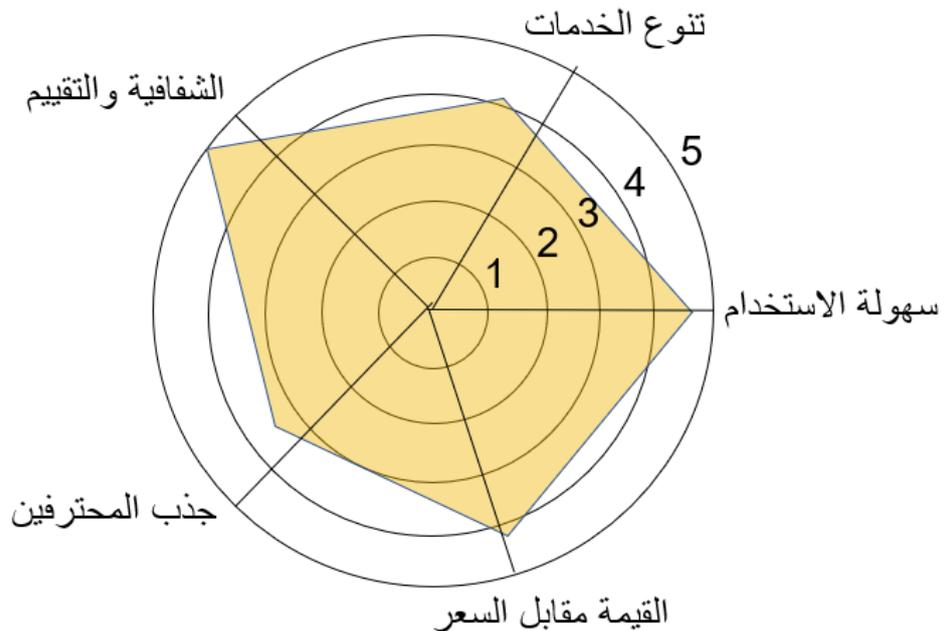
التحديات (Thearts)	الفرص (Opportunities)
<ul style="list-style-type: none"> - منافسة مستقبلية من تطبيقات دولية قد تدخل السوق. - تغييرات مفاجئة في القوانين أو الضرائب على المشاريع الرقمية. - صعوبة إقناع بعض الحرفيين أو الشركات التقليدية بالانضمام إلى المنصة. - بطء اعتماد أنظمة الدفع الإلكتروني بشكل كامل في الجزائر. - مشاكل تتعلق بأمان البيانات وحماية الخصوصية. 	<ul style="list-style-type: none"> - ارتفاع الطلب على البناء والخدمات السكنية في الجزائر. - دعم الحكومة للمشاريع الرقمية والشركات الناشئة. - قلة المنافسة الرقمية المتخصصة في المجال. - إمكانية التوسع مغاربيًا وعربيًا على مراحل. - رغبة العديد من المحترفين في عرض خدماتهم بطريقة حديثة واحترافية. - ارتفاع استخدام الإنترنت والهواتف الذكية خاصة بين فئة الشباب

عنوان المشروع : تطوير تطبيق ومنصة لربط العملاء بمحترفي البناء من مهندسين معماريين، مدنيين، مصممين وغيرهم.

3. تحليل PORTER :

التحليل	درجة التأثير	القوة التنافسية
دخول شركات أجنبية بمنصات جاهزة (مثل Upwork أو Houzz بنسخ موجهة للسوق المغربي) قد يكون سريعاً إذا نضج السوق.	منخفضة إلى متوسطة	تهديد دخول منافسين جدد
في حالة "صممي"، الموردون هم المهنيون (مهندسون، مقاولون...) عددهم كبير، ما يقلل من قدرتهم على فرض شروطهم.	ضعف إلى متوسط	قوة الموردين
العملاء لديهم خيارات محدودة حالياً، لكنهم حساسون للأسعار والجودة.	قوة متوسطة	قوة المشترين
الطرق التقليدية (التوصيات الشخصية، الحرفيين المحليين، مجموعات فيسبوك...).	موجودة لكن قابلة للتجاوز	تهديد المنتجات البديلة
المنافسة الرقمية في مجال ربط العملاء بمحترفي البناء في الجزائر لا تزال ضعيفة، والمنصات المتخصصة قليلة.	منخفضة إلى متوسطة	شدة المنافسة الحالية

1-3 مخطط خمس نجوم Radar chart :



عنوان المشروع: تطوير تطبيق ومنصة لربط العملاء بمحترفي البناء من مهندسين معماريين، مدنيين، مصممين وغيرهم.

4. المزيج التسويقي :

الاحتياجات التي يلبيها	خصائص ومميزات منتجاتك/خدماتك	المنتج/ الخدمة
<ul style="list-style-type: none"> - الحصول على محترف موثوق بسرعة دون الحاجة للبحث العشوائي أو التوصيات غير المضمونة. - الوصول إلى شريحة واسعة من العملاء خارج نطاقهم الجغرافي المباشر - الحصول على فرص تدريب أو مشاريع صغيرة لتقوية المهارات العملية. - رقمنة قطاع البناء والهندسة ودمجه في الاقتصاد الرقمي. 	<ul style="list-style-type: none"> - عرض محترفين موثوقين يقدمون خدمات تغطي كل مراحل البناء(تصميم معماري، تصميم داخلي، دراسات هندسية، هيكلية، تنفيذ، متابعة، استشارات). - يعتمد على الموقع الجغرافي، نوع الخدمة، الميزانية، والتقييمات. - يتيح للمهندسين والمقاولين إنشاء ملف مهني احترافي يشمل الخبرة، الصور، المشاريع السابقة، وتقييمات العملاء. - فضاء خاص للطلبة والخريجين الجدد يمكنهم عرض أعمالهم وخدماتهم، واكتساب تجارب أولية بتشجيع من المنصة. - كل عميل يمكنه تقييم المحترف بعد إنهاء المشروع، مما يعزز الثقة ويضمن جودة الخدمة. - نظام اشتراك شهري مرن للمحترفين يشمل ميزات إضافية مثل الظهور المميز وتحليلات الأداء وعرض الاعمال . 	<p>منصة رقمية+تطبيق لربط العملاء بمحترفين في مجال البناء التصميم، والهندسة من مهندسين معماريين، مدنيين، مصممين وغيرهم.</p>

5. السعر:

-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.

عنوان المشروع : تطوير تطبيق ومنصة لربط العملاء بمحترفي البناء من مهندسين معماريين، مدنيين، مصممين وغيرهم.

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

تسعير مرن:

تقديم حزم تسعير متعددة لتلبية احتياجات مختلف العملاء (مثل العملاء، المحترفين، الخبراء/مكاتب الدراسات، طلبة السنوات الاخيرة وحديثي التخرج).

6. 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 بالجهاز. المشاركة في المؤتمرات والمعارض الخاصة بالبناء والتكنولوجيا للترويج للتطبيق والتواصل مع الشركاء والعملاء المحتملين.	مجاني
التسويق عبر العلاقات	تقديم برامج حالة للمستخدمين الحاليين لتشجيعهم على دعوة الآخرين لاستخدام الجهاز. توفير خدمة عملاء ممتازة لدعم العملاء وحل مشاكلهم بسرعة وكفاءة.	مجاني
مقابلة	من خلال الذهاب للمؤسسات وعرض الخدمة	تكلفة النقل=2000دج

عنوان المشروع : تطوير تطبيق ومنصة لربط العملاء بمحترفي البناء من مهندسين معماريين، مدنيين، مصممين وغيرهم.

7. التوزيع :

الطريقة الأولى:

- نشر التطبيق على منصات التحميل الرقمية مثل App Store وGoogle Play لضمان وصول سهل إلى المستخدمين.

- إنشاء المنصة الرقمية الخاصة بالتطبيق يوفر معلومات شاملة وروابط تحميل مباشرة.

الطريقة الثانية:

الشراكات: التعاون مع شركات البناء والتطوير العقاري لترويج التطبيق.

إقامة شراكات مع مقدمي الخدمات التكنولوجية لتوسيع نطاق الوصول إلى العملاء المحتملين.

طريقة الدفع تتم إلكترونياً في حساب المؤسسة

8. عرض القطاع السوقي :

السوق المستهدف: مالكو مشاريع، مهندسون مستقلون، مكاتب دراسات

السوق المحتمل: سكان الأرياف، المغتربون، الخريجون الجدد

سوق متخصص: شركات ناشئة، تصميم مستدام، مؤسسات تعليمية.

تحليل السوق:

الزبائن
اصحاب مشاريع بناء
المهندسين من شتى مجالات البناء
مكاتب الدراسات
طلبة الهندسة المعمارية
مستثمرون عقاريون
مقاولين
مهندسون وفنيون
ممولون في مجال البناء

عنوان المشروع : تطوير تطبيق ومنصة لربط العملاء بمحترفي البناء من مهندسين معماريين، مدنيين، مصممين وغيرهم.

تحليل المنافسين:

منافسين عالميين :

الخبرة	الوظيفة	الدولة/الاقليم	اسم المنصة/التطبيق
16 سنة	منصة تصميم داخلي وربط العملاء بالمحترفين	الولايات المتحدة (دولي)	Houzz
17 سنة	ربط العملاء بمحترفين في مجالات متنوعة منها البناء	الولايات المتحدة	Thumbtack
13 سنة	منصة للمهندسين المعماريين والمصممين + مقالات وأفكار تصميم	ألمانيا (دولي)	Homify
16 سنة	شبكة تواصل وعرض مشاريع لمهندسين معماريين	إيطاليا (دولي)	Archilovers
16-20 سنة	منصات للعمل الحر تشمل خدمات التصميم والهندسة	دولي	Upwork / Freelancer

منافسين اقليميين:

14 سنة	دليل للمقاولين وخدمات الترميم والبناء	مصر	Bey2ollak
10 سنة	منصة للعمل الحر للمهندسين فقط	لبنان (موجه للعالم العربي)	Handiss
8-5 سنوات تقديرياً	دليل للمهندسين المعماريين	المغرب	Architectes Maroc
منذ ظهور فيسبوك محلياً (2010~) 15 سنة	قنوات غير رسمية للربط بين العملاء والمقاولين	(خدمات معمارية / بناء) الجزائر	مجموعات فيسبوك

استراتيجيات التسويق:

- التسويق الرقمي المحلي: إطلاق حملات إعلانية مستهدفة عبر فيسبوك، إنستغرام، ويوتيوب موجهة لسكان المدن الكبرى (الجزائر، وهران، قسنطينة...) لجذب المستخدمين الأوائل.
- الشراكات الأكاديمية: التعاون مع كليات الهندسة المعمارية والمدنية لتقديم عروض خاصة للطلبة والخريجين الجدد، وتشجيعهم على استخدام المنصة لبناء ملفهم المهني.
- إنتاج محتوى رقمي توعوي: فيديوهات قصيرة تشرح كيف تستعمل التطبيق، كيف تختار محترفاً، وفوائد المنصة مقارنة بالطرق التقليدية.
- الترويج المباشر: المشاركة في معارض وفعاليات صناعية لعرض التطبيق وجذب العملاء المحتملين

عنوان المشروع : تطوير تطبيق ومنصة لربط العملاء بمحترفي البناء من مهندسين معماريين، مدنيين، مصممين وغيرهم.

استراتيجيات التوسع:

تحديثات دورية ذكية: إطلاق ميزات جديدة بناءً على استخدامات العملاء (مثل: محادثة صوتية، تخطيط المشروع، استعراض D3 للتصاميم، الدفع التلقائي...)

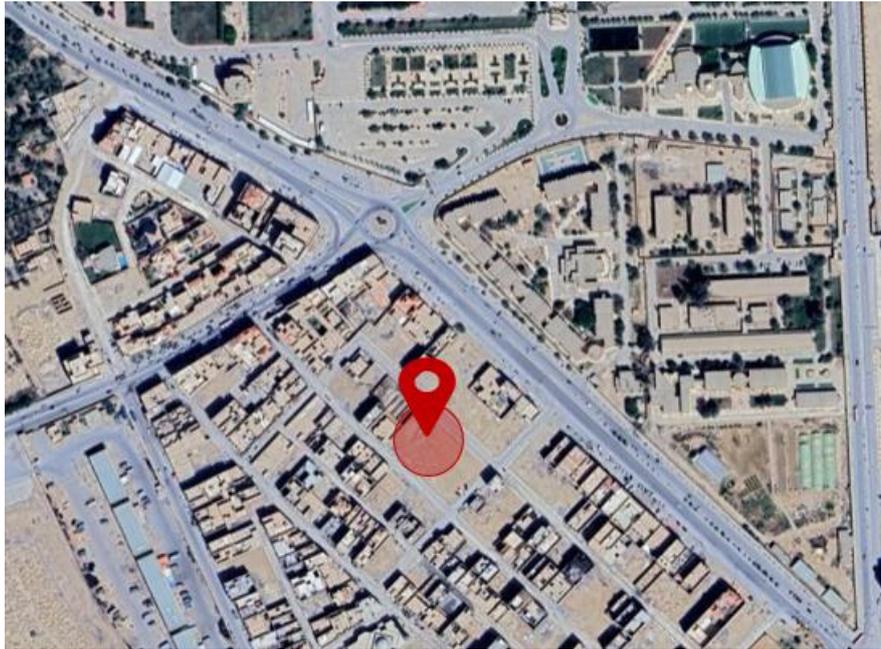
عقد شراكات مع شركات مواد البناء والمكاتب الكبرى: لتقديم خدمات متكاملة من التصميم حتى التنفيذ، وزيادة موثوقية المنصة كمحور مهني كامل.

الاستماع المستمر للمستخدمين: فتح قناة اقتراحات وملاحظات داخل التطبيق، وتحليل بيانات الاستخدام لتطوير تجربة المستخدم.

التوسع القطاعي التدريجي: إضافة فئات جديدة من المحترفين (مصممي حدائق، مستشاري طاقة، حرفيين...) لتغطية كل احتياجات البناء والتجديد.

المحور الرابع: خطة الإنتاج والتنظيم

مخطط الإنتاج:



الموقع: يقع عقار المشروع في طريق سيدي عقبة-بسكرة، مقابل 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 248م.

احتياجات المشروع:

عنوان المشروع : تطوير تطبيق ومنصة لربط العملاء بمحترفي البناء من مهندسين معماريين، مدنيين، مصممين وغيرهم.

اسم العتاد	العنصر	العدد المقترح	السعر بالدينار	السعر الاجمالي بالدينار
حواسيب	حواسيب مكتبية أو محمولة	4	110,000	440,000
شاشات إضافية	شاشات 24-27 بوصة	2	35,000	70,000
راوتر إنترنت	اتصال عالي السرعة + موزّع	1	18,000	18,000
طابعة وماسح	طابعة ليزر متعددة الوظائف	1	50,000	50,000
كاميرا ويب / مايكروفون	اجتماعات عن بُعد بجودة عالية	2	12,000	24,000
سماعات رأس	دعم الاجتماعات / خدمة العملاء	3	6,000	18,000
مكاتب عمل خشبية	/	4	30,000	120,000
كراسي مريحة	/	4	18,000	72,000
خزانة ملفات	/	1	25,000	25,000
انارة اقتصادية	(LED)	4 وحدات	4,000	16,000
مكيف هواء اقتصادي	/	1	90,000	90,000
مزود طاقة احتياطي	(UPS)	1	25,000	25,000

إجمالي التقدير التقريبي:

- الحد الأدنى: حوالي 662,000 DZD
- الحد الأعلى: حوالي 968,000 DZD

(دون احتساب تكاليف الكراء، الانترنت الشهري، الخدمات، أو الأثاث الإضافي مثل القهوة، الستائر، إلخ)

نظام الإنتاج: خطوات التشغيل في منصة "صممي"

أولاً: تسجيل المحترفين

- التأكد من هوية المهندس أو المكتب الهندسي.

عنوان المشروع : تطوير تطبيق ومنصة لربط العملاء بمحترفي البناء من مهندسين معماريين، مدنيين، مصممين وغيرهم.

- رفع الوثائق والتراخيص المهنية.
- تصنيف التخصص (عمارة، مدني، تصميم داخلي، مقاولات...).

ثانياً: تسجيل العملاء وطلباتهم

- التواصل مع المحترف المطلوب.
- إدخال وصف المشروع (نوع الخدمة، الموقع، الميزانية، الخ...).

ثالثاً: مطابقة بين المحترفين والعملاء

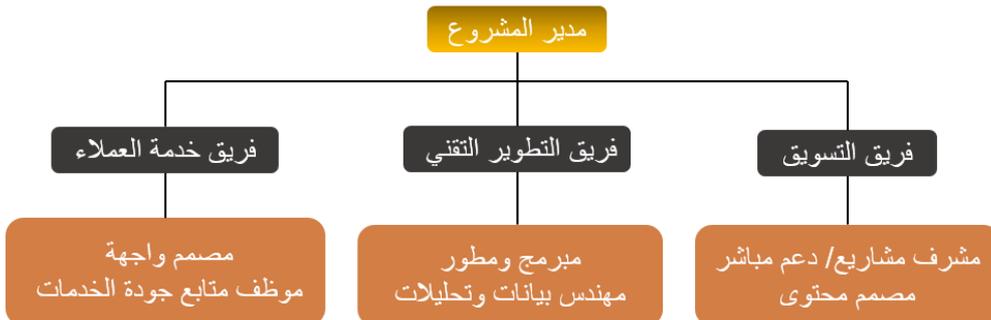
- ترشيح أفضل المهنيين بناءً على الموقع والتخصص والتقييمات.
- إرسال إشعارات للطرفين.
- تمكين العميل من مقارنة العروض أو التواصل.

رابعاً: متابعة المشروع عبر المنصة

- تبادل الملفات والمخططات.
- تحديثات تقدم المشروع.
- دعم فني وتقييم نهائي.



المخطط التنظيمي :



عنوان المشروع : تطوير تطبيق ومنصة لربط العملاء بمحترفي البناء من مهندسين معماريين، مدنيين، مصممين وغيرهم.

الشركاء المحتملون في المشروع:

الشريك	اهمية الشريك
شركات تطوير برمجيات	برمجة المنصة وصيانتها وتحديثها (تطبيق وموقع ويب).
كليات الهندسة المعمارية والمدنية	دعم توظيف الطلبة الجدد، اختبارات المنصة، تقديم تدريبات.
حاضنات أعمال	دعم المشروع في بداياته، احتضان قانوني ومالي.
شركات مقاولات وبناء صغيرة	تنفيذ المشاريع بعد ربطهم بالعملاء عبر المنصة
مزودو مواد البناء	عروض ترويجية أو تخفيضات للمشاريع القادمة من صمملي.
وكالات إعلانات	إطلاق الحملات الممولة وتوسيع الوصول.
بنوك أو مؤسسات تمويل مصغر	دعم مشاريع البناء الصغيرة التي تتم عبر المنصة.

المحور الخامس: الخطة المالية PLAN FINANCIER

تكاليف المشروع واهتلاك الاستثمار التكاليف التشغيلية

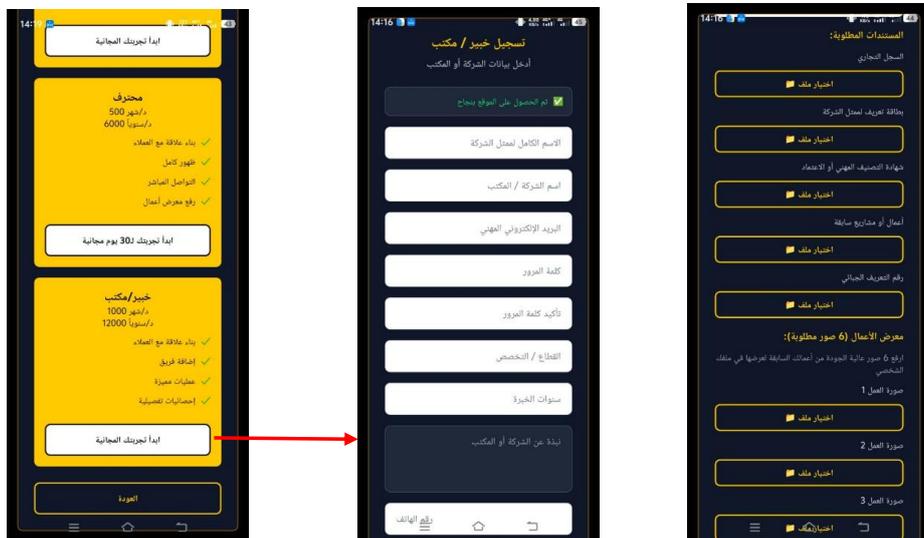
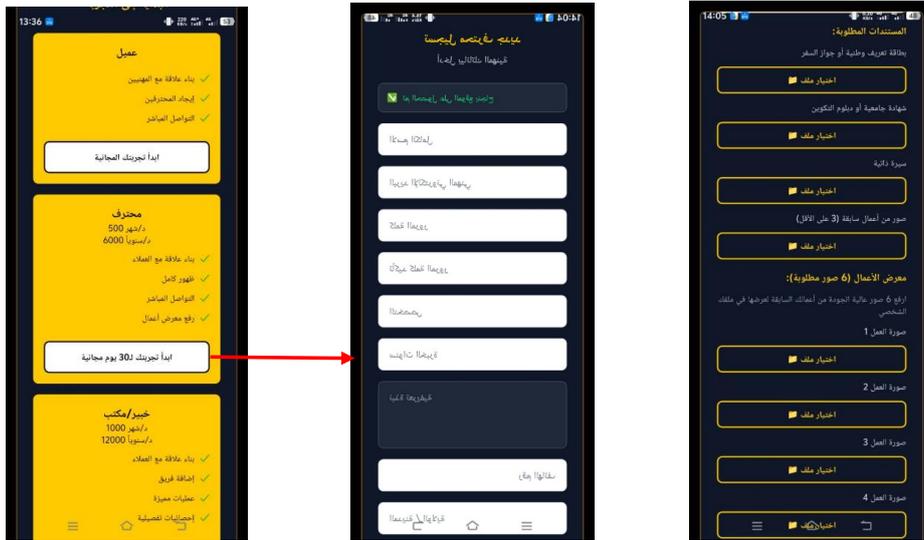
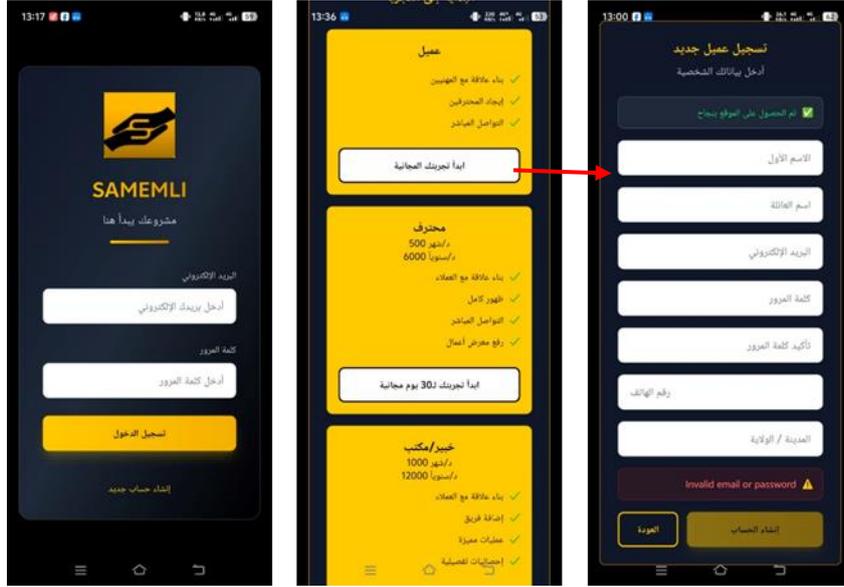
الأصول	التكلفة
الأجور	2 640 000,00
الهاتف والانترنت	30 000,00
الكهرباء والماء	70 800,00
المجموع	2 740 800 دج

تقدير المبيعات

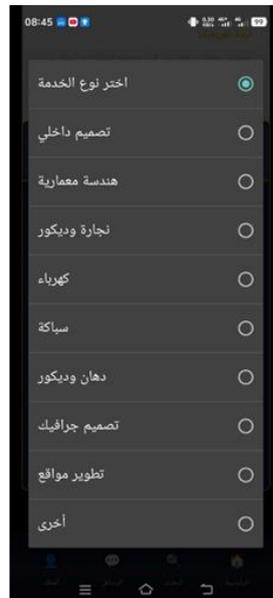
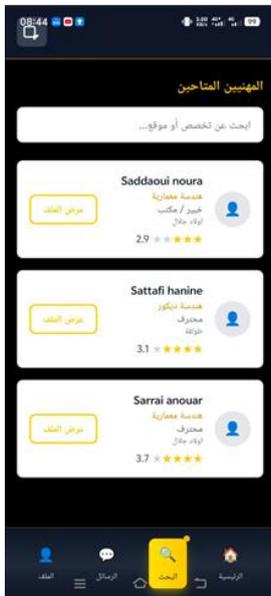
	/	جانفي	فيفري	مارس	أفريل	ماي	جوان	جويلية	أوت	سبتمبر	أكتوبر	نوفمبر	ديسمبر	المجموع
	2024(60%)	14520	29040	43560	58080	72600	87120	101640	116160	130680	145200	159720	174240	1132560
	2025(70%)	16940	33880	50820	67760	84700	101640	118580	135520	152460	169400	186340	203280	1321320
	2026(80%)	19360	38720	58080	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
														7550400
														1170312000 دج
														مجموع المبيعات ل5 سنوات
														سعر المبيعات ل5 سنوات

عنوان المشروع : تطوير تطبيق ومنصة لربط العملاء بمحترفي البناء من مهندسين معماريين ، مدنيين، مصممين وغيرهم.

المحور السادس : النموذج الاولي التجريبي (التطبيق) :



عنوان المشروع : تطوير تطبيق ومنصة لربط العملاء بمحترفي البناء من مهندسين معماريين ، مدينين، مصممين وغيرهم.



عنوان المشروع : تطوير تطبيق ومنصة لربط العملاء بمحترفي البناء من مهندسين معماريين، مدنيين، مصممين وغيرهم.



عنوان المشروع : تطوير تطبيق ومنصة لربط العملاء بمحترفي البناء من مهندسين معماريين، مدنيين، مصممين وغيرهم.

نموذج اولي تصويري للمنصة (موقع ويب) للتطبيق:



ضع موقعك



اختر المحترف



تواصل معه



ابدأ العمل

شركاء النجاح



اشترك معنا الآن

تجارب عملائنا

تفكر ببناء شركتك طويلة الأمد مع صلاتنا، حيث ستكون تجاربهم شهادة حقيقية على التزامنا بالجودة والابتكار



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الملحق رقم 04: نموذج العمل التجاري:

<p>الشركات الرئيسية</p> <p>شركات تطوير برمجيات كليات الهندسة المعمارية والمدنية حاضنات أعمال شركات مقاولات وبناء صغيرة مزودو مواد البناء وكالات إعلانات بنوك او مؤسسات تمويل مصغرة</p>	<p>الانشطة الرئيسية:</p> <p>- إنشاء الحساب وتحديد الملف الشخصي - البحث والتصفّح واختيار المحترفين بناء على الموقع والتخصص والتقييمات -التواصل وتبادل الملفات -التعاملات والتقييم</p>	<p>القيم المقترحة :</p> <p>-سهولة الوصول إلى الخبرات: يتيح التطبيق للمستخدمين الوصول السريع إلى مهندسين محترفين، مصممين، ومقاولين موثوقين -واجهة استخدام مبسطة: يتميز التطبيق بواجهة سهلة وسلسة تمهّل على العملاء تصفح الملفات الشخصية، تقييم العروض، والتواصل المباشر مع المحترفين. -شفافية في التعامل والتقييم: يعزز التطبيق من الثقة بين الأطراف من خلال نظام تقييم ومراجعة واضح يعكس جودة الخدمة واحترافية مقدمها. -دعم الكفاءات المحلية: -حلول موفرة -تحفيز بيئة عمل عادلة للمحترفين: يوفر التطبيق فضاءً تنافسيًا صحيًا يعتمد على الجودة لا على العلاقات، مما يساعد في بروز كفاءات جديدة في السوق. -إسهام في تطوير قطاع البناء الرقمي.</p>	<p>العلاقات مع العملاء:</p> <p>علاقة اوتوماتيكية مع العموم خاصة مع المؤسسات والشركات</p>	<p>شرائح العملاء:</p> <p>اصحاب مشاريع بناء المهندسين من شتى مجالات البناء مكاتب الدراسات طلبة الهندسة المعمارية مستثمرون عقاريون مقاولين مهنيون وفنيون ممولون في مجال البناء</p>
<p>هيكل التكاليف</p> <p>تكاليف ثابتة: اجار العاملين، تكاليف مهينة المقر، تكاليف شراء الآلات والمعدات. تكاليف متغيرة : تكاليف الصيانة</p>		<p>المصادر والإيرادات</p> <p>الإعلانات الرسوم</p>		