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Department of Architecture

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Theme:

Shading strategies for housing projects in arid zones

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Individual housing

Examiner's committee

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قال الله تعالى " لئن شكرتم لازيدنكم"

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I hope that this memorandum will be a useful building block for the future.

Dedication

(وَآخِرُ دَعْوَاهُمْ أَنِ الْحَمْدُ لِلَّهِ رَبِّ الْعَالَمِينَ)

All praise and thanks to Allah… for the love, the gratitude, and the grace that embraced both the beginning and the end.

This journey was not short, nor was the path lined with ease... but I did it.

Thanks to Allah who facilitated the beginnings and granted me the strength to reach this point. I dedicate this achievement first and foremost to my ambitious self, who endured the setbacks, persevered through every challenge, and never gave up.

With all my love, I dedicate the fruit of my efforts and graduation:

To the one words fail to describe, The one who was the light in my darkness, Whose sincere prayers were the secret behind my success, The one who sacrificed endlessly and stood by me through every moment, The one who worked tirelessly, expecting nothing in return,

The one who always dreamed of seeing this day...My heaven on earth: **my beloved mother**.

May Allah bless her with long life, health, and happiness.

To the man whose name I carry with pride, **my dear father**, thank you for being my strength and my example.

To those who gave me strength and stood beside me, the springs from which I drew comfort, the joy in my days, **my sisters and my only brother**… may you always remain my solid ground.

To the one I met during my academic journey, the one my soul never tires of talking to, the one who makes me laugh when I can't … **My dearest friend, Ibtissem.**

And to the companion of my heart and soul, the one who believed in me, supported me with patience and tenderness, whose presence inspired and motivated me to push through every hardship... **My fiancé, Taki Eddine.**

To everyone who believed in me and stood by my side …Thank you for being a part of my journey. This project is my gift to you all.

"As long as we believe in ourselves, nothing can stand in the way of our dreams."

Abstract :

This research examines the integration of shading techniques into the design of Individual housing in arid zones to enhance thermal comfort, energy efficiency, and urban living. This research identifies architectural solutions that harmonise function, cultural identity, and environmental adaptation.

The theoretical research addresses principles such as solar orientation, thermal mass, ventilation, and behaviour of materials in hot and dry climates. The study subsequently applies these principles to a proposed Individual housing development project in Biskra, Algeria. The design proposal takes into account self-shading volumes, interlinked courtyards, and locally modified materials to reduce solar gain while maintaining daylight and air flow.

The study concludes that effective shading not just reduces loads for cooling but also aids in sustainable housing trends that respect the climatic and social environment in order to promote user satisfaction in future housing projects.

Key words: housing, individual house, shading, arid zone, Biskra.

ملخص:

تبحث هذه الدراسة في دمج تقنيات التظليل في تصميم المساكن الفردية في المناطق القاحلة من أجل تحسين الراحة الحرارية وكفاءة الطاقة والحياة الحضرية. تحدد هذه الدراسة الحلول المعمارية التي توفق بين الوظيفة والهوية الثقافية والتكيف البيئي.

تتناول الدراسة النظرية مبادئ مثل التوجه الشمسي والكتلة الحرارية والتهوية وسلوك المواد في المناخات الحارة والجافة. ثم تطبق الدراسة هذه المبادئ على مشروع مقترح لتطوير المساكن الفردية في بسكرة، الجزائر. يأخذ اقتراح التصميم في الاعتبار أحجام التظليل الذاتي والساحات المترابطة والمواد المعدلة محليًا لتقليل اكتساب الطاقة الشمسية مع الحفاظ على ضوء النهار وتدفق الهواء.

تخلص الدراسة إلى أن التظليل الفعال لا يقلل فقط من أحمال التبريد، بل يساعد أيضًا في اتجاهات الإسكان المستدامة التي تحترم البيئة المناخية والاجتماعية من أجل تعزيز رضا المستخدمين في مشاريع الإسكان المستقبلية.

الكلمات الرئيسية: الإسكان، المنزل الفردي، التظليل، المنطقة القاحلة، بسكرة.

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General introduction

General introduction

Introduction

Due to their harsh climatic conditions, arid regions are among the most challenging natural environments for human habitation. These include extreme daytime temperatures, significant thermal fluctuations between day and night, water scarcity, and frequent sandstorms. Such factors directly impact the quality of life and necessitate the adoption of intelligent and sustainable architectural solutions capable of adapting to this demanding environmental context.

Within this framework, shading strategies emerge as a fundamental component of environmental architecture. They contribute significantly to achieving thermal comfort within buildings, reducing energy consumption, and minimising dependence on mechanical cooling systems. Shading is not merely an aesthetic or technical element; rather, it functions as a vital tool for controlling indoor environmental conditions and regulating solar radiation exposure in architectural spaces.

This study analyses and evaluates the shading strategies applied in individual housing projects located in arid zones. It does so by examining local and regional case studies and exploring natural and artificial shading methods to enhance thermal performance and energy efficiency. The city of Biskra is selected as the application model, as it represents a realistic example of a Saharan city that requires specialised architectural treatments.

The research adopts an analytical methodology that integrates theoretical insights by defining core concepts of thermal comfort and shading with applied analysis through the examination of real housing projects. The objective is to propose feasible and context-responsive design solutions that employ shading as an environmental strategy in support of sustainable architecture.

Background

One of the main challenges of living in arid regions is adapting to the harsh climatic conditions that characterise these regions, such as high heat, drought, and large variations between day and night temperatures. Although these regions can sometimes be rich in other natural resources such as minerals and solar energy, the harsh environmental conditions pose challenges to building design and water resources, requiring innovative and sustainable solutions.

In order to counteract the effects of extreme heat in arid regions and maintain a comfortable living environment, effective shading is essential. Shading helps reduce heat absorption in buildings, reducing the need for industrial cooling and mitigating excessive energy consumption. By combining smart architectural design, the use of insulating materials, and renewable energy solutions such as solar energy, the quality of life in these regions can be improved while promoting environmental and economic sustainability.

Problem Statement

In Algeria, the issue of housing remains a major challenge, particularly in arid regions, where rapid urban expansion and demographic pressure often lead to poorly adapted architectural models. Many dwellings are built without taking into account the specific climatic

General introduction

constraints of these environments, resulting in high thermal discomfort and excessive energy consumption. These shortcomings highlight the urgent need to rethink architectural practices by integrating climate-responsive and sustainable design strategies adapted to local conditions.

Arid regions face complex architectural and environmental challenges as a result of extreme climatic conditions such as high heat, water scarcity, thermal fluctuations between day and night, as well as sandstorms and environmental degradation. These factors significantly affect the quality of life in these areas, necessitating the adoption of sustainable architectural strategies to adapt to this challenging environment. In this context, shading strategies play a crucial role in reducing heat inside buildings. Effective shading helps protect buildings from direct solar radiation, enhancing thermal comfort and reducing the need to use costly cooling systems. Using techniques such as shades, plants, and reflective surfaces, a sustainable residential environment can be achieved that contributes to minimising energy consumption and protecting environmental resources in these arid regions.

Research Questions

In desert cities with hot and dry weather, people try to stay away from the sun and look for shaded areas, because it is one of the hardest places to live. Using sustainable design in housing projects is very important in these regions. It helps solve environmental problems and supports the global fight against climate change. This also helps build a better and more sustainable future for people living in dry areas.

Based on this idea, this research will try to answer the following questions:

- How can shading strategies be used in housing projects in arid regions to give better thermal comfort, save energy, and still keep the building beautiful and functional?
- What sustainable materials can be used in shading designs to improve energy performance in houses built in hot and dry areas?
- On another level, how can we design a modern housing project that meets the needs of today's residents but also respects and fits into the local culture?

Research Objectives

This work is part of a broader reflection on the adaptation of individual housing to the climatic constraints of arid regions in Algeria. The main objective is to examine the role of shading strategies as a sustainable architectural solution for improving thermal performance and quality of life in such housing contexts. Based on this general objective, the specific goals are as follows:

- To highlight the limitations of currently widespread individual housing models in Algeria's arid regions when confronted with climatic challenges such as extreme heat, direct solar radiation, and thermal fluctuations.
- To explore and apply passive shading strategies suitable for individual housing in arid climates, while taking into account architectural, cultural, and environmental specificities, and to implement them in the proposed project.
- To develop architectural recommendations adapted to individual housing in arid zones, integrating efficient and sustainable shading solutions.

- To promote a climate-responsive design approach for housing, focusing on the integration of shading elements as key levers for enhancing comfort, sustainability, and overall quality of life.

Methodology

This thesis is based on a study of shading strategies in the design of individual dwellings in arid environments, such as the city of Biskra. To answer the question posed at the beginning of the research and understand the various requirements related to the subject of the study, a multi-stage methodology was adopted that combines theoretical research and field analysis.

In the first stage, desk research was conducted, including a review of the available literature on the basic concepts related to the topic of "shading strategies in housing projects," drawing on various sources such as specialized books, academic theses, and scientific articles. This theoretical research aims to build a solid knowledge base and identify key concepts that will be used later in the applied study.

In the second stage, a group of successful housing projects that applied effective shading strategies in climatically similar environments was analyzed. This analysis employs a comparative approach that enables us to identify common elements and techniques used to achieve thermal comfort, thereby building a deeper understanding of design measures suitable for dry environments.

To support the study and achieve the research objectives, a questionnaire was used as a survey tool to gather the opinions of architecture professors and students on their perceptions and needs regarding the application of shading strategies in housing. The results of this questionnaire contribute to guiding architectural design towards more effective options relevant to the context of use, allowing for the formulation of recommendations that support the development of a residential model capable of ensuring thermal comfort for residents through the thoughtful integration of shading strategies.

Thesis Structure

This work is divided into two main parts:

A theoretical and descriptive part, which presents the main concepts related to the research topic.

An analytical and practical part, which studies case examples and then moves to the design phase.

The structure of the work includes three main chapters, in addition to a general introduction and a general conclusion, as follows:

General Introduction

This section presents the topic by stating the research problem, defining the main hypotheses and objectives, and explaining the methodology followed throughout the study.

Chapter 1 – Theoretical Study

This chapter builds the conceptual and scientific framework of the research. It explains the key concepts related to the topic and reviews relevant literature to support the study with solid academic references. It also highlights the latest developments in the field through recent articles and university studies.

Chapter 2 – Analytical Study

This chapter analyzes examples of successful residential projects that used effective shading strategies in arid environments.

It also gives a short presentation of the study area (the city of Biskra), focusing on its climatic and urban characteristics.

Then follows a field analysis, supported by a questionnaire used to understand the opinions of local residents.

At the end of this chapter, the functional program is presented. It will serve as the starting point for the architectural design.

Chapter 3 – Design Phase: Architectural Proposal

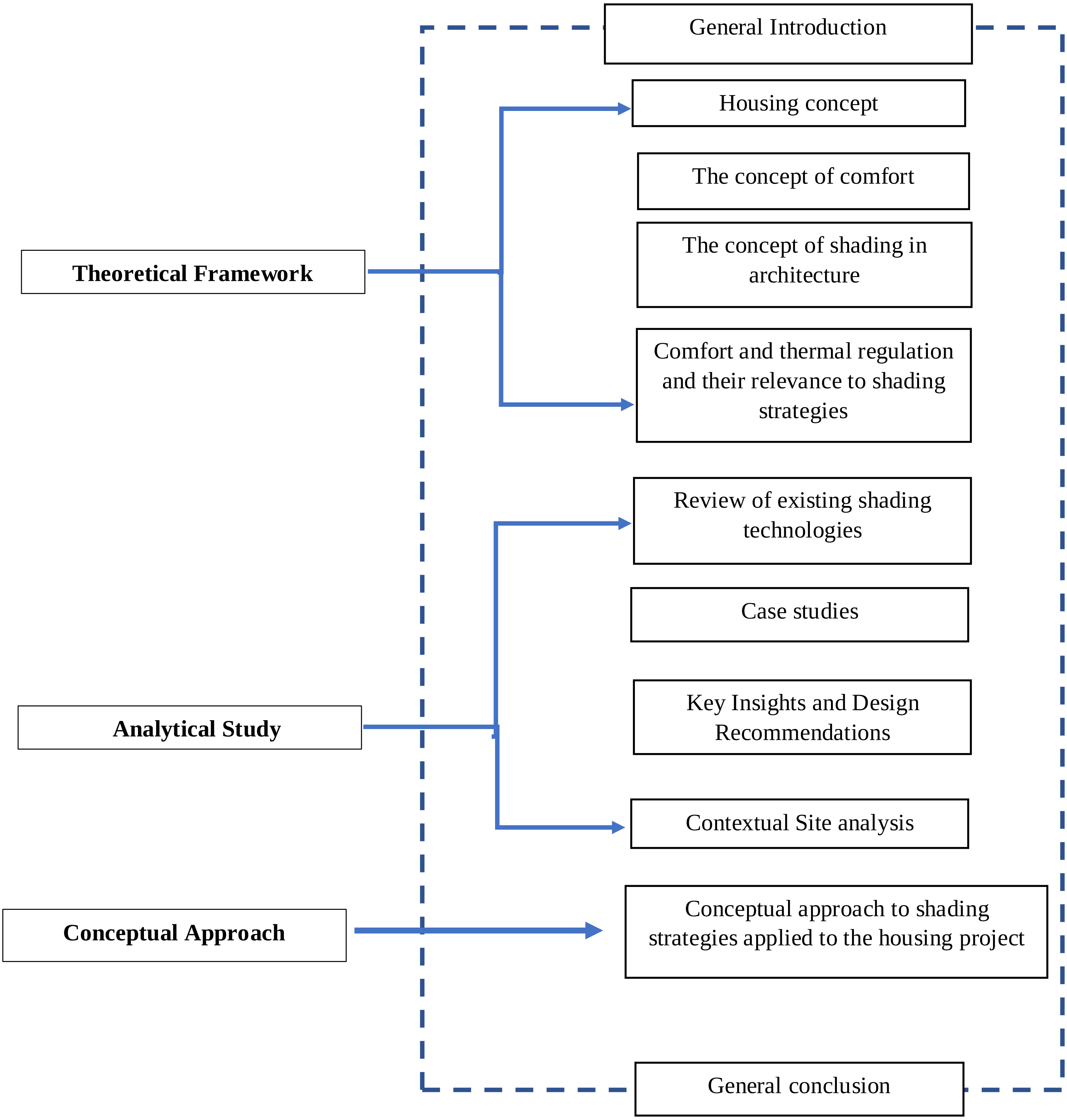
This chapter moves from analysis to design thinking. It presents the design intentions and goals, and introduces the initial idea of the project based on the collected data. It also shows the development of the design process, using drawings and diagrams to explain the proposed architectural solution. The aim is to create a residential project that respects the conditions of arid environments and makes effective use of shading strategies.

General Conclusion

This section answers the main research question stated at the beginning. It summarizes the key steps and methods used throughout the study.

It also gives a set of recommendations that could help future housing projects better integrate with desert environments by using efficient shading solutions.

Thesis outline:



Chapter 01 : Theoretical Framework

Introduction

Due to their harsh climatic conditions, arid regions are among the most challenging natural environments for human habitation. These include extreme daytime temperatures, significant thermal fluctuations between day and night, water scarcity, and frequent sandstorms. Such factors directly impact the quality of life and necessitate the adoption of intelligent and sustainable architectural solutions capable of adapting to this demanding environmental context.

Within this framework, shading strategies emerge as a fundamental component of environmental architecture. They contribute significantly to achieving thermal comfort within buildings, reducing energy consumption, and minimizing dependence on mechanical cooling systems. Shading is not merely an aesthetic or technical element; rather, it functions as a vital tool for controlling indoor environmental conditions and regulating solar radiation exposure in architectural spaces.

This study analyzes and evaluates the shading strategies applied in individual housing projects located in arid zones. It achieves this by examining local and regional case studies and exploring both natural and artificial shading methods to enhance thermal performance and energy efficiency. The city of Biskra is selected as the application model, as it represents a realistic example of a Saharan city that requires specialized architectural treatments.

The research employs an analytical methodology that integrates theoretical insights by defining core concepts of thermal comfort and shading, and applies this analysis to real housing projects. The objective is to propose feasible and context-responsive design solutions that employ shading as an environmental strategy in support of sustainable architecture.

1.1. Housing concept

Numerous fields, including philosophy, architecture, and urban planning, have studied the deep and complicated idea of dwelling. To the act of living in a place, but it has a deeper meaning that involves a relationship over time. And significant about the environment. This may involve elements like security, the Commodity, health, identity, culture, and memory. The habit may also be seen as a way to get involved in social and cultural life. It may manifest as a physical location, but also as a group of people or a culture. Additionally, habitat can have some repercussions on human behavior and lifestyle.

According to the Oxford English Dictionary habitat is defined as: “the place where a particular type of animal or plant is normally found”.

According to the Cambridge Dictionary, habitat is defined as: “The natural environment in which a plant or animal lives. And The place where something is commonly found”.

According to Henri Lefebvre (1991), “inhabiting is a daily act by which inhabitants transform themselves into inhabitants”.

In short, the concepts of habitat and habitus are essential for understanding the links between the physical structures of human existence and the living conditions of its inhabitants. They offer a better understanding of how individuals live and use their environment, and of the attitudes and dispositions that influence decisions about where to live

1.1.1. Historical evolution

Over the centuries, housing has undergone significant evolution, influenced by numerous environmental, cultural, economic, and social factors. This evolution bears witness to changes in human lifestyles, the evolution of architectural techniques, and the transformation of societies. The evolution of housing over the centuries can be classified into several major stages, from ancient times to the modern era.

Figure 1: prehistoric human from the Lascaux cave in France source: Arabic encylopedia,2000

1.1.2. Prehistoric Shelters

In prehistoric times, humans built simple shelters using materials they found in nature such as wood, leaves, stones, and animal skins. These homes were used mainly for protection from weather and wild animals.

Figure 2 : Mezhyrich Mammoth Camp Reconstruction. Source : mezhyrich.com.ua

1.1.3. Ancient Civilizations

In early civilizations like Egypt, Mesopotamia, Greece, and Rome, housing became more structured. People built houses with stone, mud bricks, and wood. Rich families had large homes with courtyards, water systems, and decoration, while the poor lived in smaller, simpler homes.

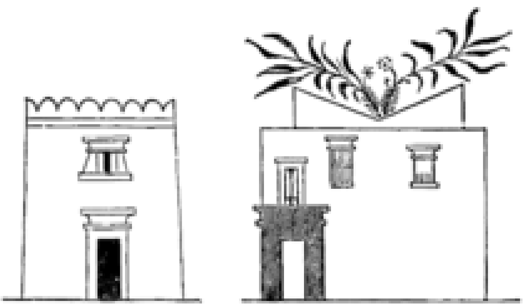


Figure 3 : The layout of houses in ancient Egypt

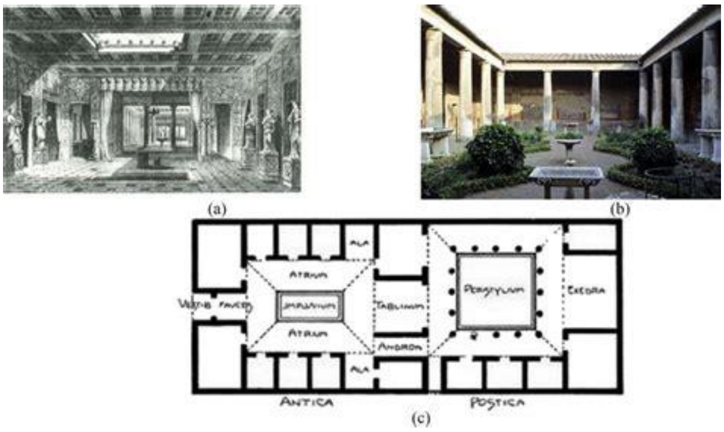


Figure 4 [Roman house atrium and layout.
Source: https://tse4.mm.bing.net/th?id=OIP.cJmqjEUhNFK0sneoPkF6dAHaEX&pid=Ap

1.1.4. Medieval Period

During the Middle Ages, houses in cities were made of wood and built close together. Fire was a common danger. In rural areas, homes were built using clay, thatch, and wood. Most houses were small with few rooms, often shared with animals.

Figure 5 medieval house
source : https://www.maraisvisites.com/maisons-moyen-age-marais-rue-francois-miron.htm

1.1.5. Renaissance and Enlightenment

In these periods, architecture started to reflect ideas of order, beauty, and function. Homes for the wealthy became more elegant with better light, space, and decoration. Comfort and privacy began to matter more in housing design.

Figure 6 renaissance house
source : https://fr.wikipedia.org/wiki/Maison_Renaissance_de_Beaulieu-sur-Dordogne

1.1.6. Industrial Revolution

This period brought big changes. Many people moved to cities to work in factories. Workers lived in crowded, poor-quality housing near their jobs. Governments and planners started thinking about public health, hygiene, and better living conditions.

Figure 7 Industrial Revolution's house
source : https://tse2.mm.bing.net/th?id=OIP.I-R8EAk_4fCaP7kNvuOh3AHaHz&pid=Api

1.1.7. Modern and Contemporary Housing

In the 20th and 21st centuries, housing became more varied and influenced by technology, culture, and environment. In hot or dry areas, people use smart designs like shading, thick walls, and ventilation to stay cool. Sustainability and energy efficiency are important goals today.

1.2. Epistemological definitions of housing to live

Installed in a location. Living in a place is not the same as travelling through it. Living requires a certain relationship with both time and space. Habituation incorporates the length of time, the seasons, the years, and the consecutive generations.[1]

1.5.2.1 Home:

It's a happy home based on the feeling of home. Thus, a field of senses or a built shape is created that takes into account less than the stability of the stay, the sense of protection, and the satisfaction of living in a political territory.

1.5.2.1 The House:

Historically, the house has served the family in the broadest sense, encompassing multiple generations as well as domestic or related individuals. The Latin word "manere," which means "to stay," is the source of the French word "la maison." Other toponyms include "manse," "manoir," "manant," "mesnil," and "mas." Therefore, the house is etymologically the place of sedentary behaviour, where one remains, and where one returns.

1.5.2.1 Housing:

Le Littré (dictionary of the French language) gives for the term «housing» the following definition: To lodge someone is to give him a house residence, to reside in a place that has been comfortably accommodated. Housing indicates both a functional unit where the layout of space meets the cultural norms of society and the time, but the size, form, internal organization, and the level of equipment in the dwelling are also related to the economic and social structure.1 It is also the way in which each person lives his or her nights and days, while living with the other in a variety of ways.[2]

1.3. Housing typology:

Housing is one of the most important elements of urban planning, reflecting indicators of life and different cultures. Housing varies according to different criteria such as demographic hand, urban planning, and social functions. According to UN-Habitat's definition, integrated housing is “a sophisticated technological unit that provides a living evolution of the basic requirements of shelter, security, and privacy”[3] At a modular level, housing can be viewed from several angles:

- Individual housing
- collective housing
- semi-collective housing

[1] Goubaa,2018
[2] Le Littré, 1998
[3] UN-Habitat, 2020

1.3.1. Individual Housing (Single-Family Housing)

Individual housing is a type of housing where just one family resides in a private area made up of a plot of land with natural features like gardens and a course. as contrast to a collective habitat, which consists of multiple dwellings in a single building. Characterised by a private residence or patio, an individual's habit tends to develop around a collective habit.

1.5.2.1 Self-Built Housing:

This term is a more advanced solution for individuals who find it challenging to construct or rent a residential building without construction costs, consisting of Build Small built-in by their construction type instead of renting an ordinary business hire company. This could be a house or housing units that you have constructed with building materials sourced in person from a local source. [1]

Figure 8 : Favela neighborhoods in Brazil

This type of housing is common in informal rural and urban areas, where residents do not have access to government or private housing projects.

According to Pojani (2019), “cities with informal growth largely rely on self-constructed housing, making it a hallmark of informal urbanization in developing countries”[2]

1.5.2.1 Planned Housing:

Planned individual housing refers to a systematically designed and regulated residential development where single-family dwellings are built following urban planning guidelines that ensure infrastructure efficiency, environmental sustainability, and community coherence."[3]

Figure 9 :Masder city
Source : web masder city

According to Madhoo, planned housing is “a group of residential units that are designed and implemented according to specific urban plans, to achieve an organized urban environment that meets the needs of the population, while providing integrated infrastructure and services”[1]

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[1](The Self-Build Manual: A Do-It-Yourself Guide to Building Your Own Home" , Mike and Nancy Roberts)

[2] Pojani,2019

[3] Hall, P. (2014). Cities of Tomorrow: An Intellectual History of Urban Planning and Design in the Twentieth Century. Wiley-Blackwell.

[1] Madhoo, 2016

1.5.2.1 Vernacular Housing:

Traditional housing is "an architectural style that reflects the local environment and culture, relies on locally available materials and techniques, and is naturally adapted to the surrounding climate"[2]

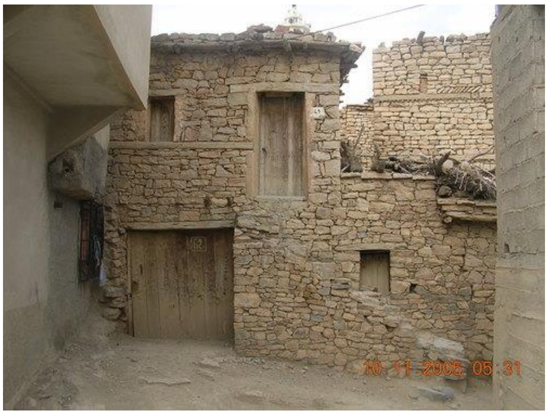

Figure 10: vernacular house.
Source : https://www.mbarchitecture.xyz/2016/12/les-maisons-traditionnelles-en-algerie.html

This type of housing relies on natural building materials such as mud, stone, and wood, and uses construction techniques that are adapted to different climatic conditions Traditional housing is defined as "an architectural style that evolves naturally over time, influenced by local resources, environmental factors, and cultural traditions"[3]

1.3.2. Semi-Collective Housing (Low-Density Multi-Family Housing):

According to Encyclopædia Universalis, 'Semi-collective housing is a type of housing that lies between individual and collective housing. It is characterised by the coexistence of It is characterised by the coexistence of private dwellings and communal areas intended for collective use.

Semi-collective housing is in fact, a type of housing that lies between individual and collective housing, wherein some dwelling units are clustered together in the same structure or complex, but each unit has its own private living space and entrance, as well as shared living amenities like gardens or swimming pools and common parking spots.

Examples

Figure 12 :68 Housing units from single-family to semi-detached
source: http://www.ivars-ballet.com/projet

Figure 11 : 11 Semi-Collective Housing units
Source : https://www.caue-observatoire.fr/

[2] Aziz & Shawket, 2011
[3] Rapoport, 1969

1.3.3. Collective Housing (High-Density Multi-Family Housing):

Collective housing refers to any multi-storey building used to house multiple separate households. It can take the form of a large house, a bar, or a tower; if its structure is particularly high, it is classified as a skyscraper. The interior of the building is always divided into a large number of housing units, known as flats.

Laborde describes it as follows: " Collective housing refers to buildings divided into several dwellings, giving a higher population density per hectare than individual housing" 2

Example

Figure 13 : Example of collective housing
Source: www.pinterest.com , 2024

Figure 14: Collective housing
Source: Collective Housing – Archilist

1.3.4. Additional Types and Subcategories:

Mixed-Use Housing:

Mixed-use housing is an architectural model that integrates residential and commercial spaces within the same project, promoting urban sustainability and reducing the need for long commutes

Combining residential and commercial spaces in the same building reduces the need for commuting and promotes sustainable communities.[2]

Example: Towers with residential apartments at the top and shops on the lower floors.

Cluster Housing

The houses are arranged in small clusters with shared green spaces and are used in residential projects that focus on environmental sustainability.

Co-Housing:

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2 Laborde Pierre, 1989

[2] Grant, 2002

Cohousing is 'a housing model that relies on residents sharing common spaces and amenities, while maintaining private housing units for each individual or family'[3].

Such as shared kitchens and gardens, fosters social relationships and minimizes resource consumption.

1.3.5. characteristics of arid zones of dwelling

Designing housing for arid environments requires careful consideration of extreme climatic conditions, including high temperatures, low humidity, and scarce resources. The following summarizes key characteristics of housing design tailored to such regions, focusing on material selection and energy efficiency:

a. Thermal Performance and Passive Design

Arid environments experience significant temperature variations, requiring housing designs that optimize thermal comfort:

- **Thick Walls and Thermal Mass:**

Use materials like adobe, rammed earth, or concrete, which have high thermal mass to store heat during the day and release it at night. Helps maintain stable indoor temperatures.

- **Compact Design:**

Dwellings are often clustered or feature small windows to minimize heat gain and reduce exposure to the sun.

- **Courtyard Layouts:**

Central courtyards with shaded areas promote natural ventilation and create cool microclimates.

- Insulation:

Effective roof and wall insulation to minimize heat gain during the day and prevent heat loss at night.

b. Material Selection

Materials used in arid housing should address thermal performance, sustainability, and local availability:

- **Local Materials:**

[3] 1 Tummers, 2016

Adobe, mudbrick, stone, and rammed earth are commonly used for their low environmental impact and high thermal mass. Locally sourced materials reduce transportation costs and environmental footprint.

- **Reflective Surfaces:**

Light-colored or reflective finishes on walls and roofs help reflect solar radiation. Whitewashed walls are common in traditional arid-region housing.

- **Natural Ventilation Features:**

Materials like perforated screens or lattice structures allow airflow while providing shade.

c. Water and Energy Efficiency

Scarcity of water and energy resources in arid regions necessitates innovative solutions:

- **Rainwater Harvesting:**

Incorporate systems to collect and store rainwater from roofs or courtyards.

- **Energy Efficiency:**

Solar panels harness abundant sunlight.

Solar water heaters for domestic hot water needs.

Use of energy-efficient appliances and LED lighting to minimize energy use.

- **Greywater Recycling:**

Systems to reuse greywater for irrigation or non-potable uses.

d. Ventilation and Cooling

Efficient ventilation reduces reliance on mechanical cooling systems:

- **Wind Catchers (Malqaf):**

Traditional wind towers direct breezes into the building for cooling.

Cross Ventilation:

Strategically placed windows and vents facilitate air circulation.

- **Evaporative Cooling:**

Use of water features, such as fountains or pools, to cool air through evaporation.

- **Shaded Openings:**

Windows are often recessed or shaded to reduce heat gain while maintaining ventilation.

1.4. The concept of Comfort

The aim of studying the concept of thermal comfort is to place comfort in indoor spaces for dry climates.

1.4.1. Comfort Definition:

According to J. DESMONS: “Comfort is a subjective concept. A given atmosphere may satisfy one individual and not another. Comfort depends on many factors apart from the environment itself. These factors are: health, age, the way you are dressed, habits, your psychological state at the time, etc. It is, therefore, almost utopian to hope to satisfy all the individuals in the same enclosure. In the same air-conditioned enclosure.”

Comfort is anything that contributes to the well-being of individuals through the convenience of physical, intellectual, and social life.

The concept of comfort encompasses a wide range of meanings and interpretations across disciplines such as psychology, healthcare, ergonomics, and environmental design. It generally refers to a state of comfort or satisfaction

Comfort is an atmosphere that prevents the body from reacting to external conditions and provides energy from metabolism.

Understanding comfort requires examining its physical, psychological, social, environmental, and cultural dimensions.

1.4.2. Comfort Dimensions:

In architecture, comfort can have two major influences:

Physiological comfort: thermal comfort, light (lighting), sound, olfactory comfort...

Psychological comfort: Visual (perception of space, contact with the outside world, visibility, etc.), and gives brief definitions of the other dimensions of comfort.

a. Thermal Comfort

“Thermal comfort has been defined as the condition in which no significant stress is imposed on the body's thermoregulatory mechanisms. Thermal comfort enables optimum conditions to be obtained for all the body's functional systems, as well as a high level of work capacity .... Thermal comfort is the balance between the thermal exchanges of the human body and the surrounding environment.”[1]

b. Acoustic Comfort:

1 www.echr.coe.int consuter

Acoustic comfort is defined by Navai and Veitch (2003) as "a state of contentment with acoustic conditions".

Acoustic comfort is the state of well-being we feel in a favorable acoustic environment, where noise is controlled and managed. This comfort goes beyond a simple decibel measurement: It encompasses sound quality and its impact on our concentration, communication, comfort and health. Acoustic comfort includes the control and timing of reverberation, which has a significant impact on the clarity of voices and conversations. All materials used for thermal insulation have an acoustic capacity for airborne noise. The choice of partition materials and interior doors will determine the acoustic performance between rooms.

c. Visual comfort :

Visual comfort is a subjective impression related to the quantity, distribution, and quality of light. As also described by MUDRI (2002), "the term visual comfort is taken to indicate the absence of discomfort that could cause difficulty, pain and psychological tension, whatever the degree of this tension".

1.4.3. Definition and parameters of Thermal Comfort:

Thermal comfort refers to the psychological state of being satisfied with the surrounding thermal environment. It is a subjective feeling of well-being related to the perception of temperature, influenced by both.

Environmental and personal factors. Achieving thermal comfort is a key goal in designing architectural and engineering spaces.

1.4.3.1 Parameters Related to Individuals:

These are the unique factors for each person that affect how they perceive thermal conditions:

- ✓ **Metabolic Rate:** The rate at which the body generates heat, influenced by physical activity. Higher metabolic rates (such as during exercise) generate more heat, affecting comfort.
- ✓ **Clothing Insulation:** The type and amount of clothing a person wears determines the insulation provided, affecting heat retention and loss.
- ✓ **Individual Differences:** Age, gender, health conditions, and acclimatization can also influence thermal comfort.

1.3.5.2 Parameters Related to the Environment:

Environmental conditions significantly impact thermal comfort, including:

- ✓ **Air Temperature:** The surrounding air temperature is the most obvious factor affecting comfort.
- ✓ **Air Velocity (Wind Speed):** Moving air enhances heat loss through convection and evaporation, which can be soothing or uncomfortable depending on the speed.

- ✓ **Humidity Levels**: High humidity makes it harder for the body to cool itself through evaporation, leading to discomfort.
- ✓ **Mean Radiant Temperature (MRT):** The average temperature of all surrounding surfaces (walls, ceiling, floor) affecting heat exchange through radiation.

1.5.2.1 Thermal Exchange between Humans and Their Surroundings:

Humans maintain thermal balance through four main processes:

- ✓ **Conduction:** Heat transfer through direct contact with a surface (e.g., sitting on a cold seat).
- ✓ **Convection:** Heat transfer through air or fluid movement over the skin (e.g., feeling cold in a breeze).
- ✓ **Radiation:** Heat exchange with surrounding surfaces without direct contact (e.g., warmth from sunlight).
- ✓ **Evaporation:** Heat loss through the evaporation of moisture, especially sweat, from the skin surface.

1.5. The Concept of Shading in Architecture

In architecture, shading is the intentional design and placement of systems and techniques to control the sunlight and thermal building ingress. It is also concerned with the thoughtful manipulation of sunlight and shadow to optimize the thermal performance of the building as well as the beauty of its design. This work also becomes critical in contemporary building design as it affects sustainability, energy use, and occupant wellbeing.

Shading systems can help save energy by reducing:

- cooling loads in summer/heat loads in winter
- needed artificial lighting (redistribute daylight)

Shading systems play a pivotal role in improving the indoor environment, enhancing the visual comfort of users by reducing glare levels and improving contrast ratios. While these systems reduce heat loads and thus reduce cooling energy consumption, they can lead to an increased reliance on artificial lighting by reducing the penetration of natural light into interior spaces. Designing effective shading systems requires a careful balance between several factors: Preventing heat gain in the summer and utilizing it in the winter, while ensuring adequate levels of ventilation and natural light at all times.

1.5.1. Definition of Shading in Architecture

"Effective shading makes a building not only comfortable to live in but also a symbol of harmony with nature." Norman Foster

"By controlling shadow, the architect controls the emotion and environment within the architectural space." Tadao Ando

Shading in architecture refers to any design element or strategy that aims to block, filter, or redirect sunlight before it enters or affects a building. This essential architectural tool has been used across cultures and throughout the ages, from elaborately designed mashrabiya in traditional Islamic architecture to automated slat systems in contemporary buildings.

Here are some important aspects of shading in architecture:

- Purpose of Shading

- Thermal Comfort: Shading helps regulate indoor temperatures by reducing heat gain from direct sunlight, reducing cooling costs, and improving occupant comfort.

- Glare Reduction: Proper shading minimizes sunlight glare, making activities such as reading, working, and screen viewing more comfortable.

- Daylight Control: Shading optimizes the transmission of natural light and reduces reliance on artificial lighting while allowing daylighting strategies that avoid excessive heat and glare.

- Privacy: Shading devices can increase occupant privacy by blocking views from the outside.

- Types of Shading Devices

- Overhangs and Awnings: horizontal projections that block high-angle summer sunlight while allowing low-angle winter sunlight in.

- Louvers and screens: Adjustable or fixed slats that control solar radiation and airflow while preserving the view.

- Pergolas and trellises: outdoor structures that provide shade through a beam framework and can support climbing plants for additional shading.

- Shutters and blinds: movable indoor/outdoor elements that can be adjusted according to time of day and season.

- Green roofs and vertical gardens: plants provide natural shading and cooling effects, contributing to biodiversity and aesthetics.

- Design Considerations

- Orientation: The orientation of the building relative to the path of the sun is important in determining the effectiveness of shading devices.

- Climate: Different climates require different shading strategies. For example, in hot climates, extensive shading may be effective, while in temperate climates, a balance is needed to account for winter insolation.

- Building shape: The shape and size of the building will affect how shading devices are incorporated and their effectiveness.

- Materials: The choice of materials for shading devices affects their durability, maintenance, and the aesthetics of their integration with the building.

- Sustainability and Energy Efficiency

Shading is an important element of passive solar design, which aims to maximize energy efficiency by utilizing natural resources. - Effective shading reduces the need for mechanical cooling systems, resulting in reduced energy consumption and a lower carbon footprint.

- Aesthetic Considerations

- Shading devices can enhance the architectural character of a building and contribute to its visual identity and relationship to the surrounding environment.

- The interplay of light and shadow created by shading devices adds depth and interest to facades and outdoor spaces.

- Technological Innovation

- Technological advances have led to the development of dynamic shading systems that can automatically adjust to the intensity and angle of sunlight, improving energy efficiency and occupant comfort.

- Smart building technology can integrate shading controls with other systems, such as HVAC and lighting, to optimize performance.

1.5.2. Types of shading strategies: natural vs. Artificial

Shading is an essential element of building design, especially in dry regions. Strategies can be categorized into two main types: natural and artificial. Each type has certain characteristics and performs different roles depending on the climatic context, architectural design, and cost.

1.5.2.1 Natural shading

Natural shading in architecture is a design strategy that utilises natural elements, such as vegetation and topographical features, to provide effective protection of buildings from direct solar radiation. This approach is economical and environmentally friendly as it naturally blends in with the surrounding environment without the need for extensive mechanical cooling systems.

Tree canopies, for example, significantly reduce outdoor temperatures, providing effective natural cooling. Natural shading also minimises solar heat gain, enhancing thermal comfort inside buildings and supporting sustainable design principles by reducing energy consumption.

Key Elements of Natural Shading :

Vegetation:

Trees and Shrubs: Planting deciduous trees on the south and west sides of a building can provide shade in the summer while allowing sunlight to penetrate in the winter after the leaves fall. Evergreen trees can provide year-round shade.

For the summer shading (Kamal, 2012), we should look at the following points.

1. Summer shade is provided by deciduous trees and breezes, but winter access is possible. In winter, the sunlight can reach indoors if these trees drop their leaves.

2. Trees with high foliage obstruct the rays of the sun and cast a thick shadow. The roof, walls, and windows can be shaded with high-branched canopy trees. On the south and the

west, evergreen trees provide optimal safeguards against the environment of summer sun and cold winter winds.

3. For east and west walls and windows in the summer, the vertical shading is best suited in order to safeguard against intense sunlight at small angles, for instance, screening by thick tree trunks, feeding vines with frame support, and bushes combined with trees. See Figure

4. Horizontal shading is best for windows facing south. For instance, caduceus plants such as decorative grape or wisteria can be cultivated on a pergola for summer shading (which loses foliage in the winter)

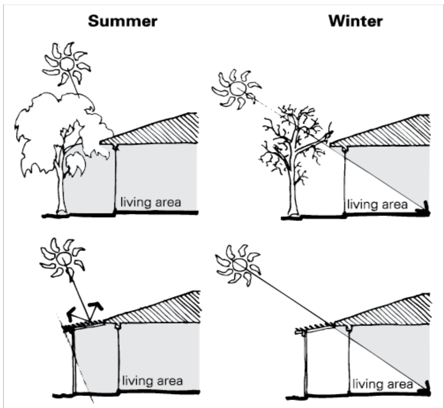


Figure 15: Deciduous trees which provide shade in summer and allow sun rays during winter source: (Esru, 2019)

Green Roofs and Walls:

Vegetative roofs and living walls can help insulate buildings and provide shade, reducing heat absorption. The roof can be shaded with a cement or plant roof, canvas, or pots of earth, etc. External shading should not interfere with cooling at night.

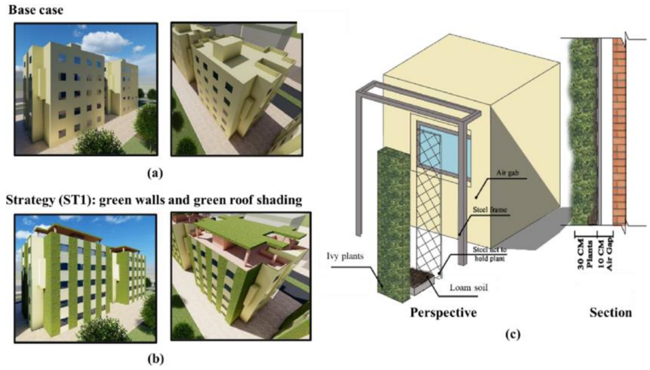


Figure 16: green walls and green roof shading The proposed scenarios for the youth housing sector using ENVI-met software: (a) the base case, (b) the strategy ST1 of green walls and green roof shading, and c) green wall components on building walls. A.S.H. Abdallah, R.M.A. Mahmoud / Mansoura Engineering Journal 48 (2023) 1e15 5 source: Amr S.H. Abdallah,Randa M.A. Mahmoud,2023

Building Orientation:

Site Planning: The orientation of a building can be strategically planned to minimize direct sunlight exposure. For example, positioning long facades to face north or south can reduce heat gain from the sun.

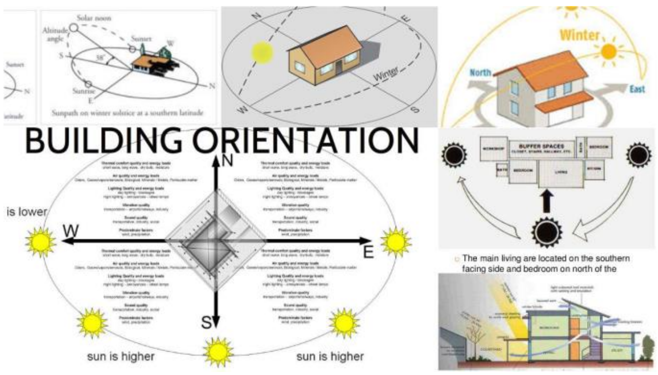


Figure 17: Building Orientation source: ArchiGuelma

Window Placement:

Careful placement of windows can maximize natural light while minimizing direct sunlight, especially on the east and west sides.

There are several methods that tries to find out the optimum orientation of buildings depending on their climatic zones and local climatic data, such as[1].

- "Sun method," which considers mainly solar radiation from windows
- "Rogers et al, method" that considers cooling loads
- "Shewiv method" which focuses on desired shading periods 10
- "Etzion method" that considers a better design for shading
- "Ok method", which interpreted mathematical formulas to find out the shading areas of the shaded parts.

Topography: Natural Landforms: Utilizing hills, mountains, or other geographical features can provide shade and reduce direct sunlight exposure on buildings.

Building form: The shape of a building is one of the fundamental factors in architectural design, especially in the conceptual stage, due to its direct impact on energy efficiency and aesthetic aspects. The configuration of the architectural mass not only affects the environmental response of the building, but also determines how it interacts with the surrounding climatic conditions. Wang et al. (2006) point out that the shape of a building can improve energy performance by controlling the orientation of the external envelopes and their interaction with the external environment.

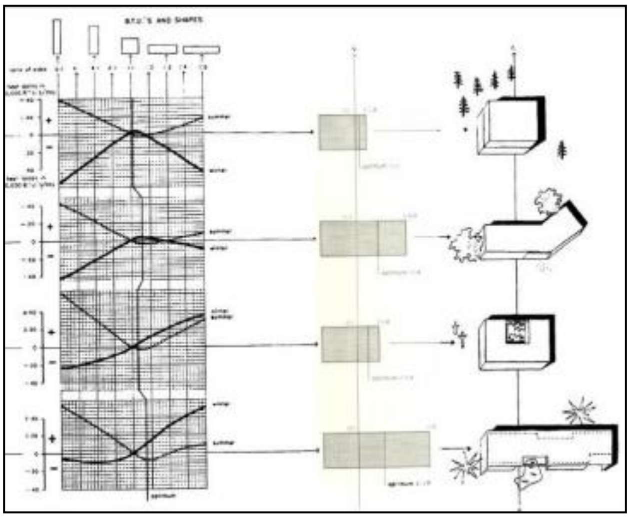


Figure 18: Building form
source : (Olgyay, 2015)

An elongated rectangular shape on an east-west axis is considered effective in hot environments, as the southern extension of the building allows low sunlight in winter, while easily limiting radiation in summer through the use of fixed shading elements such as overhangs (Dekay and Brown, 2013).

For his part, Steadman (1975) discusses the issue of surface area and energy efficiency in his book Energy, Environment, and Building, noting that western walls are the most exposed to solar radiation, which requires special consideration in design. Victor Olgyay also believes

[1] (Varoglu et al., 2017).

that rectangular buildings extending from east to west are among the most effective shapes in this context.

Architectural Features:

Overhangs and Eaves: Designing roof overhangs or eaves can block high summer sun while allowing lower winter sun to enter the building.

Balconies and Porches: These features can provide shade to lower windows and outdoor spaces.

Case Calculation for Natural Shading Efficiency:

- **Example:** Tree canopy reduces solar heat gain on a façade area of 20 m² by 70%.
  Solar Radiation without shading = 800 W/m²
- ✓ **Heat Gain without Shading:**
  Qno_shade=800×20=16000 WQ_{no_shade} = 800 \times 20 = 16000 \, WQno_shade =800×20=16000W
- ✓ **Heat Gain with Shading:**
  Qshade=16000×(1−0.7)=4800 WQ_{shade} = 16000 \times (1 - 0.7) = 4800 \, WQshade=16000×(1−0.7)=4800W

Thus, the tree reduces heat gain by **11.2 kW**, significantly reducing cooling demand.

1.5.2.1 Artificial Shading Strategies :

Artificial shading strategies involve the use of man-made elements and techniques to control sunlight and heat acquisition, and this includes devices such as umbrellas, suspensions, lofers, and sludge (sunscreens). These devices can be static or dynamic (adjustable) and designed to prevent or filter sunlight before entering the building. Artificial shading systems can be automated to respond to environmental conditions, improve energy use, and enhance passenger comfort.

Key Elements of Artificial Shading :

Fixed Shading Devices:

Fixed shading devices (eaves, awnings, pergolas, and louvres) can regulate solar access on northern elevations throughout the year, without requiring any user effort.

Summer sun from the north is at a high angle and is easily excluded by fixed horizontal devices over openings, and Winter sun from the north is at a lower angle and penetrates beneath these devices if correctly designed.

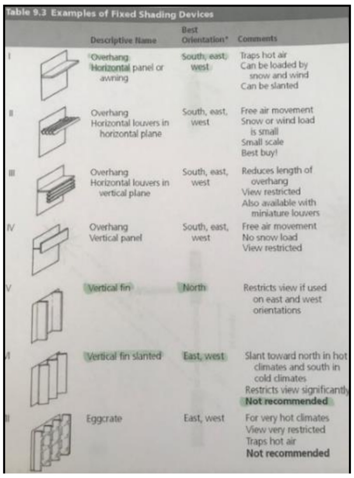


Table 9.3 Examples of Fixed Shading Devices

	Descriptive Name	Best Orientation*	Comments
I	Overhang Horizontal panel or awning	South, east, west	Traps hot air; Can be loaded by snow and wind; Can be slanted
II	Overhang Horizontal louvers in horizontal plane	South, east, west	Free air movement; Snow or wind load is small; Small scale; Best buy!
III	Overhang Horizontal louvers in vertical plane	South, east, west	Reduces length of overhang; View restricted; Also available with miniature louvers
IV	Overhang Vertical panel	South, east, west	Free air movement; No snow load; View restricted
V	Vertical fin	North	Restricts view if used on east and west orientations
VI	Vertical fin slanted	East, west	Slant toward north in hot climates and south in cold climates; Restricts view significantly; **Not recommended**
VII	Eggcrate	East, west	For very hot climates; View very restricted; Traps hot air; **Not recommended**

Figure 19 : Example of fixed shading devices source : Lechner, Heating, Cooling and Lighting, pg. 239

Adjustable Shading Devices:

Operable blinds and shades: blinds and shades inside or outside can be adjusted manually or automatically to control the amount of sunlight entering the buildin Automated Louvers: Can be programmed to open or close based on the intensity of sunlight, providing dynamic shading control.

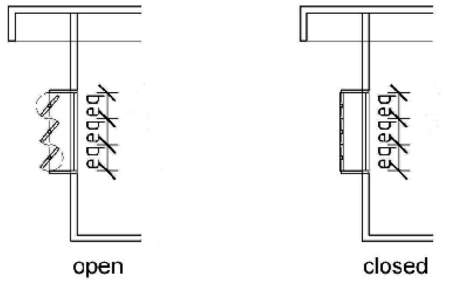


Figure 20: Adjustable shading devices
source : Pattaranan Takkanon,2006

Shading by overhangs:

Shading equipment is one of the key elements that effectively contributes to reducing high temperatures during the summer by limiting solar heat gain in buildings. To achieve this function, the dimensions of this equipment must be precisely determined, especially during winter, so that its design is carefully considered to provide the required balance between allowing natural light to enter in winter and providing shade in summer. The performance of this equipment depends on the type of shading system used, the degree of inclination, the direction of the facade, and the geometric shape of the building.

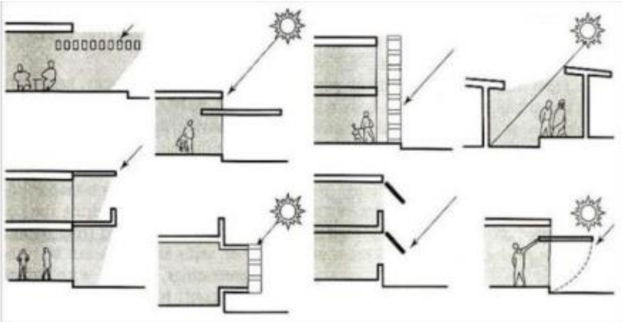


Figure 21: Different types of shading devices
Source : (Kamal, 2012)

Efficiently designed shading systems, whether integrated into the building structure or separate from it, not only reduce the need for cooling, but also enhance the quality of natural light within interior spaces. Customized shading solutions can be developed based on the solar orientation of each facade, with fixed shades proving particularly effective in summer when used to shade windows facing high solar angles.

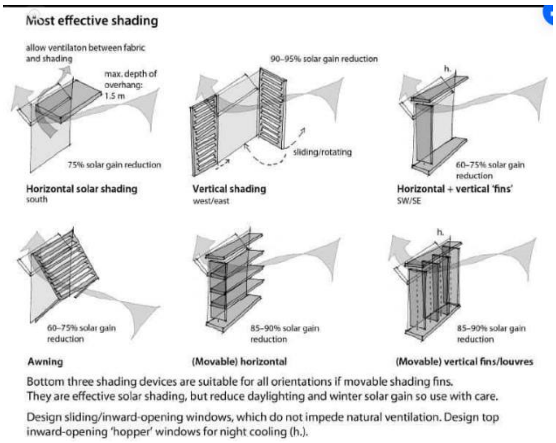


Figure 22: Effective shading
source: design-passive-cooling-heating-system.pdf

Smart shading systems:

Smart shading systems play a pivotal role in enhancing the comfort and energy efficiency of modern buildings. By controlling the amount of natural light and heat entering a space, smart shades greatly contribute to the creation of a comfortable indoor environment as they help to maintain consistent temperatures, reduce glare, and protect against UV rays.

Advanced technologies can also integrate sensors and controls to adjust shading devices based on real-time conditions, such as sunlight intensity, temperature, and occupancy. Building Management Systems (BMS) can improve shading alongside heating, ventilation, and air conditioning systems (HVAC) to improve energy efficiency.

Reflective Surfaces:

Reflective Glazing: Windows with reflective coatings can reduce solar heat gain while allowing natural light to enter.

Light Shelves: These horizontal surfaces can reflect sunlight deeper into a building while providing shade to lower windows.

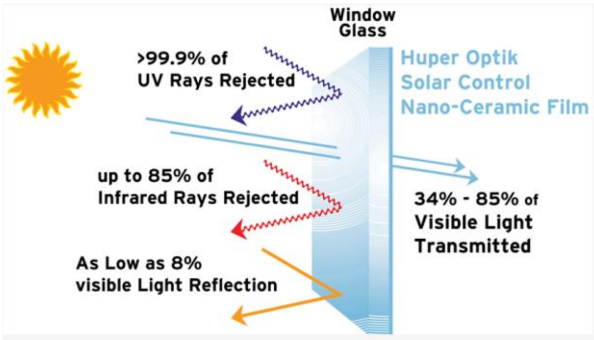


Figure 23: Reflective Surfaces
source: https://www.windowtintla.com/residential/government-tax-credit

Case Calculation for Artificial Shading:

- **Scenario:** A dynamic shading system reduces solar heat gain on a 15 m² façade by 85%.
- Solar Radiation without shading = 900 W/m²
- **Heat Gain without Shading:**

Qno_shade=900×15=13500 WQ_{no_shade} = 900 \times 15 = 13500 \, WQno_shade =900×15=13500W

- **Heat Gain with Shading:**

Qshade=13500×(1−0.85)=2025 WQ_{shade} = 13500 \times (1 - 0.85) = 2025 \, WQshade =13500×(1−0.85)=2025W

This represents a heat gain reduction of **11.475 kW**, leading to significant energy savings.

1.5.2.1 Comparison of Natural and Artificial Shading :

Table1: Comparison of Natural and Artificial Shading

Aspect	Natural Shading	Artificial Shading
Source	Originates from natural elements like trees and other vegetation	Generated by human-made devices and technologies like architectural structures, shading fabrics, and screens
Sustainability	Highly sustainable, promotes biodiversity.	Varies; can be energy-efficient but may require energy for operation.

Cooling efficacy	Comparable to artificial shading in reducing air temperature, mean radiant temperature, and thermal stress. Studies show average cooling effects are similar for both types.	Offers similar cooling performance to natural shading, effectively reducing heat stress in outdoor environments
Availability and contorl	Readily available during the day when the sun is visible, but not directly controlled by humans. We can only take advantage of it by positioning ourselves in areas with more or less shading.	Available according to our needs and can be controlled in terms of brightness, color temperature, and on/off functions to meet our preferences
Energy Efficiency	Reduces energy consumption passively	Can significantly reduce energy use when designed effectively
Advantages	Affects the tone of colors and makes skin appear healthier and more natural than does artificial lighting. It has been shown to improve mood, raising well-being, productivity, and overall happiness, and can decrease eyestrain.	Provides extra time for work, schoolwork, and relaxation, and can dramatically change the mood and beauty of an interior room without windows. Certain artificial lights can even mimic some of the features of natural light.

1.5.3. Sun Control and Shading Design in Architecture :

Sun control and shading design in architecture involves the strategic implementation of natural or human-made systems to manage the amount of heat and sunlight entering a building. Effective sun shading enhances building aesthetics, increases comfort, and improves energy efficiency by regulating internal temperatures and minimizing artificial cooling needs

Understanding Sun Control and Shading Design

The primary objective of sunlight control is to manage the penetration of sunlight into buildings to regulate indoor temperatures, reduce glare, and enhance energy efficiency. This approach provides many benefits, including improving energy efficiency by reducing cooling requirements, resulting in lower energy costs. In addition, it promotes comfort by reducing excessive heat and glare. From an aesthetic perspective, sun control strategies can also contribute to visually attractive building designs that blend functions and architectural beauty.

Types of Sun Shading Devices :

Two primary forms of sun shading include vertical and horizontal shading devices. Each of these is strategically positioned and installed on building facades to function as practical sunlight management tools without moving components and requiring no energy to function. The type you use will depend on the sort of window and which side of the building you are working on.

1. **Vertical shading devices**

Some options include louvers or fins, and you can place these strategically on building exteriors to manage sunlight on east and west facades effectively.

Horzontal sadow angle (HSA)

The horizontal shadow angle (HSA) describes the performance of a vertical shading device. It is the difference in azimuth between the sun's position and the orientation of the building façade under consideration.

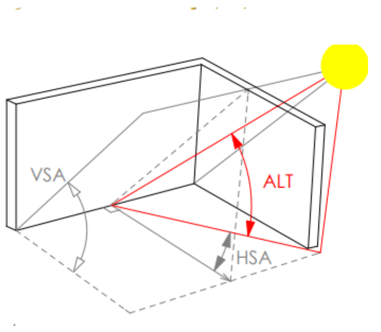


Figure 24: Horizontal shadow angle (HAS source: the book "Sun shading catalogue"

It can be calculated using the following equation:

HSA = AZI – ORI

2. **Horizontal shading devices:**

Another means of regulating interior temperature is to use horizontal shading devices, including overhangs and awnings. These options are best suited to protecting against sunlight on south facades — in the northern hemisphere — to prevent excessive heat buildup and light.

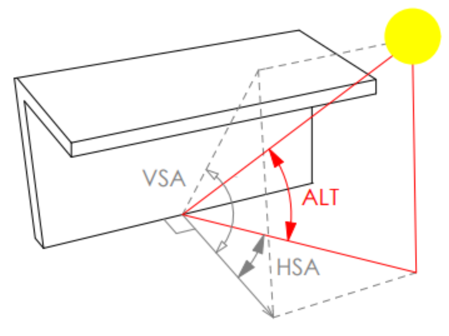


Figure 25: Vertical shadow angle (VSA) source: the book "Sun shading catalogue"

Vertical shadow angle (VSA)

The vertical shadow angle (VSA) is required for (or cast by) horizontal shading devices. It is the angle between a horizontal plane of the building façade under consideration and a tilted plane that contains the sun or the edge of the shading device (Figure 22). The following equation can be used to calculate VSA.

$$VSA = \arctan\left(\frac{\tan(altitude)}{\cos(HSA)}\right) \quad (eq.2)$$

Shade dimensions :

These two angles, HSA and VSA, can then be used to determine the size of the shading device required for a window. The depth of the overhang, its width (additional

$$Overhang\ Depth = \frac{Height}{\tan(VSA)} \qquad Width = \frac{Depth}{\tan(HSA)}$$

$$Fin\ Depth = \frac{Width}{\tan(HSA)} \qquad (eq.3)$$

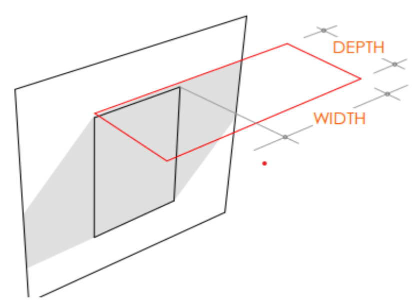


Figure 26: Width of the shading overhang (extents from the opening) source: the book "Sun shading catalogue

projection from the side of the window (Figure 23)), and the fins can be determined using the following equations:

Calculating Sun Angles:

The angle of the sun in the sky at noon can be easily calculated for the solstices and equinoxes as follows:

- **Equinox** = 90° — latitude
- **Summer solstice** = Equinox + 23.5°
- **Winter solstice** = Equinox — 23.5°

The diagram for Darwin below shows why southern façades must be shaded in tropical locations to keep out the summer sun — buildings need to be able to be shaded all year round.

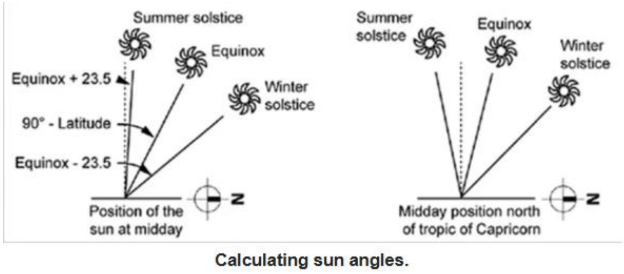


Figure 27: Calculating sun angles source: Archi-Monarch

Shading design steps :

The following steps may be used to determine the appropriate size of the shading devices:

1. Determine the overheated period, i.e., the dates and times when shading is desired. For this

Exercise, shading was designed for all the months between 9 AM and 4 PM.

2. Use the appropriate sun path diagram (suitable for the location in question) to obtain the azimuth and altitude of the sun at each time of the cut-off periods.

3. Use the solar shading protractor to determine the HSA and VSA. They can also be established using equations 1 and 2.

4. Design the actual shading device to satisfy the performance specifications

1.5.4. Role of shading in thermal regulation

Shading strategies are essential in architectural design, particularly for thermal regulation. They help manage heat gain and loss, contributing to energy efficiency and occupant comfort

1. **Thermal Regulation**

Heat Gain Reduction:

Shading devices block direct sunlight, significantly reducing heat gain during hot months. This is crucial for maintaining comfortable indoor temperatures and minimizing reliance on air conditioning.

Example: Overhangs and awnings can effectively shade windows from high-angle summer sun while allowing lower-angle winter sun to enter.

Heat Retention:

In colder climates, shading strategies can help retain heat by preventing excessive heat loss during winter. Properly designed shading can allow sunlight to warm spaces while blocking cold winds.

Example: South-facing windows with appropriate overhangs can capture winter sunlight while providing shade in summer

2. **Energy Efficiency**

Reduced Energy Consumption:

Effective shading strategies can lead to significant energy savings by reducing the need for mechanical heating and cooling systems.

Statistics: Studies indicate that external movable shading can reduce cooling demand by more than 60%.

Integration with Building Systems:

Automated shading systems can adjust in real-time based on environmental conditions, optimizing energy use and enhancing indoor comfort.

Example: Sensors can trigger shading devices to close during peak sunlight hours, reducing cooling loads.

3. **Improved Indoor Comfort**

Glare Reduction:

Shading devices minimize glare from direct sunlight, enhancing visual comfort for occupants, especially in workspaces.

Example: Adjustable blinds or louvers can be used to control light levels and reduce glare on screens.

Consistent Temperature Control:

By regulating the amount of sunlight entering a space, shading strategies help maintain stable indoor temperatures, contributing to overall comfort.

Example: Dynamic shading systems can adapt to changing sunlight conditions throughout the day

4. **Aesthetic and Functional Benefits**

Architectural Aesthetics:

Shading devices can enhance the visual appeal of a building, contributing to its overall design and character.

Example: Decorative screens or trellises can provide both shade and an artistic element to the façade.

Natural Ventilation:

Shading strategies can work in conjunction with natural ventilation systems, allowing for better airflow and cooling without mechanical systems.

Example: Properly placed trees and vegetation can provide shade while facilitating cross-ventilation.

5. **Environmental Impact**

Mitigating Urban Heat Island Effect:

In urban areas, shading strategies can help reduce the heat island effect by cooling surfaces and improving thermal comfort in outdoor spaces.

Example: Green roofs and shaded public spaces can lower surrounding temperatures and enhance outdoor comfort.

Sustainable Practices:

Incorporating shading strategies aligns with sustainable architecture principles, promoting energy efficiency and reducing carbon footprints.

Example: Using renewable materials for shading devices can further enhance sustainability.

1.6. Comfort and Thermal Regulation and their relevance to shading strategies :

Thermal comfort is a crucial aspect of building design, impacting occupant well-being, productivity, and health. It's a complex sensation influenced by a variety of environmental and personal factors. Shading strategies play a significant role in achieving thermal comfort by directly affecting thermal regulation within a building.

Thermal Comfort Explained:

It is a situation where individuals feel comfortable and uncomfortable as a result of ambient temperatures. The rest depends on the balance between the body's heat acquisition and its loss to the environment. Shading strategies are an essential part of buildings' climate design to ensure this balance is achieved, especially in areas with hot or changing weather.

Thermal comfort is a subjective state where individuals feel thermally neutral, neither too hot nor too cold. It's not simply about air temperature; it's a holistic sensation influenced by the interplay of several factors.

Parameters Affecting Thermal Comfort:

Air Temperature: The most commonly considered factor, but not the sole determinant.

Radiant Temperature: The temperature of surrounding surfaces (walls, floors, ceilings). High radiant temperatures can make a space feel hotter even if the air temperature is moderate.

Humidity: Affects how we perceive temperature. High humidity can make warm temperatures feel oppressive, while low humidity can make cold temperatures feel harsher.

Air Velocity: Moving air can increase convective heat loss, making us feel cooler.

Clothing: Insulating properties of clothing influence how much heat our bodies retain.

Metabolic Rate: The level of physical activity affects heat generation within the body.

The Role of Shading in Thermal Regulation:

Shading strategies directly impact thermal regulation by controlling solar radiation, a primary source of heat gain in buildings. Effective shading can:

- **Reduce Solar Heat Gain:** By blocking direct sunlight, shading devices minimize the amount of solar radiation entering a building, thus reducing the heat load. This is especially critical during peak sun hours and in hot climates.
- **Moderate Radiant Temperatures:** Shading external surfaces (walls, roofs) reduces their temperature, consequently lowering radiant heat transfer to the interior spaces.
- **Improve Thermal Comfort:** By minimizing heat gain and controlling radiant temperatures, shading contributes to a more comfortable indoor environment, reducing the need for mechanical cooling.
- **Enhance Natural Light:** While blocking direct sun, well-designed shading can diffuse and distribute daylight, reducing glare and improving visual comfort. This can also decrease the reliance on artificial lighting, saving energy.
- **Create Usable Outdoor Spaces:** Shaded outdoor areas become more comfortable and usable, extending living space and promoting interaction with the natural environment.

Relevance of Shading to Different Climates:

The importance of shading varies depending on the climate:

Hot Climates: Shading is essential for reducing heat gain and maintaining comfortable indoor temperatures.

Temperate Climates: Shading can still be beneficial, particularly during the warmer months, to minimize cooling loads and improve comfort.

Cold Climates: While the primary focus is on maximizing solar gain, shading can be strategically used to prevent overheating during shoulder seasons or on sunny winter days.

Conclusion

In this chapter, we have provided a comprehensive overview of the basic concepts related to housing and thermal comfort, including their definitions, historical development, and importance in the architectural context. We have also discussed how these two concepts relate to housing projects that rely on shading strategies, especially in hot and dry climates.

Shading strategies in housing projects are not limited to formal or architectural aspects, but also incorporate environmental and functional dimensions aimed at improving the quality of life within the residential space. From an environmental perspective, we sought to identify the basic principles and guidelines that should be taken into account when designing housing in arid regions. This approach is essential for the development of sustainable housing projects that are adapted to difficult climatic conditions.

Based on this, the second analytical chapter will pave the way for a deeper understanding of the project requirements through field and analytical studies that will enable us to formulate appropriate design solutions that meet the environmental and functional needs of the user.

Chapter 02 : Analytical Study

Introduction

This chapter includes three main sections: defining the project and its characteristics, an analytical study of examples, case studies, and survey results, and finally, the proposed functional program. In the first section, the architectural project will be presented in terms of its nature, and how the research topic will be applied within it will be explained. A set of theoretical and real-life examples will also be highlighted and analyzed with the aim of deriving the strategies adopted in shading within successful housing projects, followed by a summary of the data extracted from these examples.

In the second part, we will focus on the case study of the city of Biskra, starting with a brief historical overview, followed by a comprehensive analysis of the project site. This analysis will be divided into two parts: The first is devoted to studying the general climatic characteristics of the region, and the second to a detailed field analysis of the selected plot of land. This analysis aims to understand the climatic specificities of the region to guide design choices towards effective shading strategies adapted to the local context, with a comprehensive summary of these results.

The chapter concludes with the third section, where the functional program of the project will be proposed based on the results of the analysis of previous examples, climatic data, site requirements, and the conclusions of the questionnaire conducted within this framework.

3.1 Review of Existing Shading Technologies

Shading techniques are essential to enhance thermal comfort and energy efficiency in building design, especially in arid climates where solar radiation is severe and extreme temperatures. The strategic use of shading devices is indispensable for improving the thermal performance of buildings. Exploring various shading devices enables architects and designers to improve thermal regulation, reduce cooling loads, and generally improve internal comfort.

Detailed Analysis of Shading Technologie

Table2: Detailed Analysis of Shading Technologies

type of Device	Description	Advantages	Disadvantages
Overhangs	Fixed horizontal extensions above windows.	Cost-effective and require minimal maintenance.	Limited effectiveness based on the sun angle.
Louvers (Fixed or Adjustable)	Horizontal or vertical slats. Adjustable louvers provide flexibility.	High shading efficiency and ventilation control.	Higher initial cost for adjustable systems.
Vegetation (Natural Shading)	Trees, climbing plants, and green walls.	Provides natural cooling and improves air quality.	Requires maintenance and irrigation in arid climates.
Canopies and Pergolas	Structures with open or semi-open roofs.	Reduce heat gain near facades and create shaded outdoor areas.	May require structural reinforcements.
Brise-Soleil	Perforated screens attached to facades.	Aesthetic appeal and effective light diffusion.	Fixed solutions may not adapt well to seasonal changes.
Dynamic Shading Systems	Automated blinds or motorized louvers.	Precise control of light and heat gain.	High installation and maintenance costs.

Comparative Effectiveness of Shading Devices in Arid Climates

Table3: Comparative Effectiveness of Shading Devices in Arid Climates

factor	Overhangs	Louvers	Vegetation	Dynamic Systems
Solar Heat Reduction	Moderate	High	High	Very High
Flexibility	Low	High	Low	Very High
Energy Savings	Moderate	High	High	Very High
Aesthetic Value	High	High	Very High	Moderate
Maintenance	Low	Moderate	High	Moderate
Cost Efficiency	High	Moderate	Moderate	Low

Detailed analysis

Overhang: It is best suited for blocking summer sun from south-facing windows and is simple and cost-effective, and requires minimal maintenance.
Louvers: flexibility for shading and ventilation control, and adjustable systems provide dynamic solutions to different solar angles.

Vegetation provides shading and air cooling through evaporation.

Green facades and surfaces are highly effective but require accurate irrigation in the arid climate.

Dynamic Systems: high efficiency but expensive.

Integrated with smart construction technologies to improve shading based on environmental conditions

3.2 Case Studies

Shading is an essential element of architectural design for arid environments, helping to minimize heat gain, improve thermal comfort, and reduce energy consumption. Here is an analysis of some successful residential projects that have adopted innovative shading strategies:

2.2.1. Book examples:

A. Example 01: 21 villa of Dar Al Zain

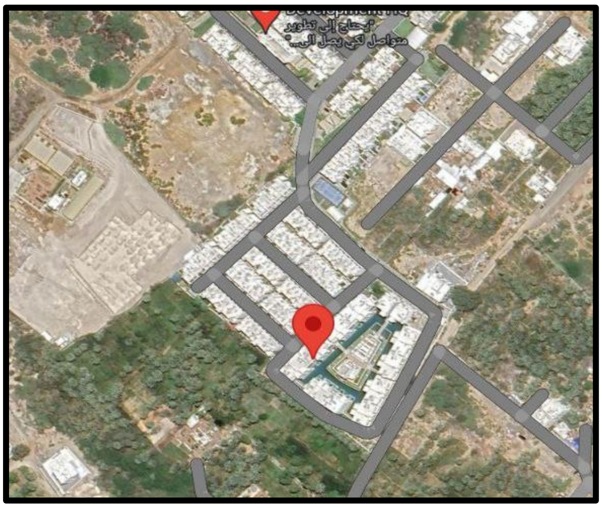


Figure 28: Site plan for villas of Dar al Zain source: Google Maps,2024

Selection criteria :

- The project is located in an arid zone
- Individual housing
- Use of shading strategies

Presentation of the project

- **Contractor:** A & D Designers Architects
- **Owner:** Noor Oman Realty
- **Program:** Covers the construction of 21 spacious first-level villas covering
- built area of 1,360 square meters each
- Surface area: 153,500 m2
- **Location**: Oman – masquat
- **The number:** 21 individual villas

  Dar Al Zein is Oman's largest residential development located just 1.5 kilometers from The magnificent Seeb Beach and close to Muscat's thriving neighborhoods. Spread over an area of 153,500 square meters, the project includes 600 residential units within a luxurious, fully enclosed gated community.

Figure 29: Site plan for villas of Dar al Zain, source: Zain Property development

Offering an ideal living environment for families, the project features, integrated and modern facilities that include 24-hour security and maintenance, open green spaces, private gardens, and multiple recreational facilities such as sports fields, separate gyms for men and women, swimming pools, and a children's daycare center. Five of the six planned phases have been completed, and the project is progressing on schedule, setting a new Benchmark for family lifestyle in Oman.

The residential phase – phase 5

Phase 5 of this unique project consists of 21 luxurious and spacious villas with each measuring 382 m2, including parking, and comes equipped with the finest finishes and high-end home fixtures. Residents can enjoy exclusive access to a scenic 1021 square meter island with a variety of recreational and sports facilities, a sprawling

1020 square meter shaded family picnic area, a large communal garden and a café. Another very special feature of this neighborhood is the 1,370 square meter swimming pool.

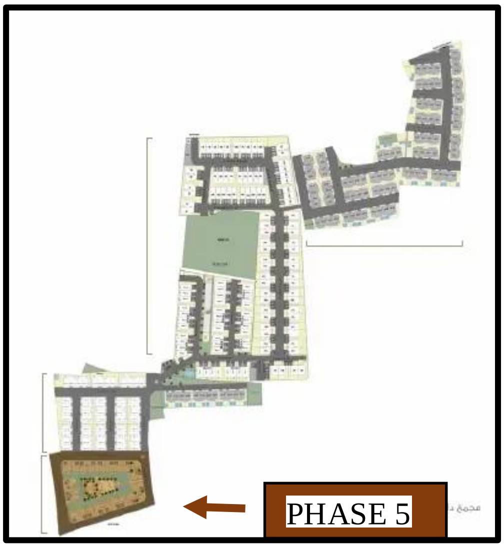


Figure 30 : site plan for Dar Al-Zain Phase 5
source: https://www.scribd.com-dar-al-zain-brochure-phase-5

site plan study

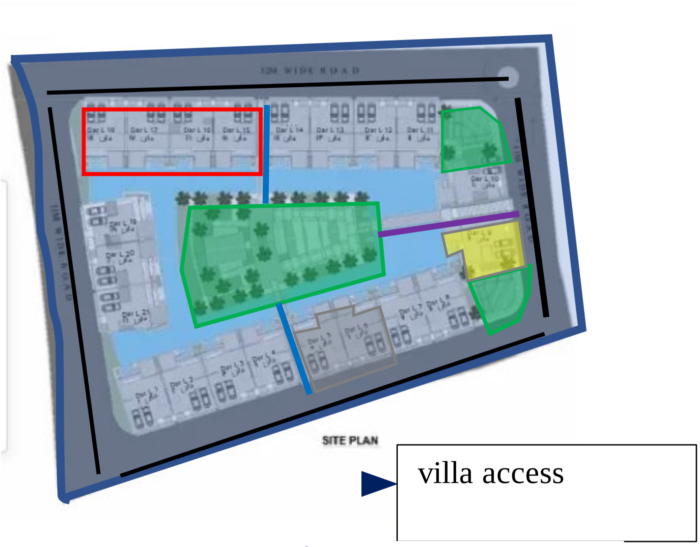


Figure 32 master plan for Dar Al-Zain Phase 5
source: https://www.scribd.com-dar-al-zain-brochure-phase-5

Figure 31 :master plan for Dar Al-Zain Phase 5
source: https://www.scribd.com-dar-al-zain-brochure-phase-5

Mechanical traffic hubs around residences.

“Peripheral mechanical traffic”

Pedestrian traffic hubs inside.

unbuilt 81 %	Building 19%	green space	island	plot	unté	secondair mechanical pedestrian axis	main pedestrian mechanical axis	main mechanical axis

Hierarchy :

Table4 :Hierarchy of 21 villa of Dar Al Zain-phase5

Public	Semi public	Private
Mechanical axis	Driveways Common areas	Residential access

Table5 :Hierarchy of 21 villa of Dar Al Zain-phase5

Study the plans:

Figure 33 :ground floor plan for Dar Al-Zain Phase 5
Source : https://www.scribd.com-dar-al-zain-brochure-phase-5

Figure 34 : floor plan for Dar Al-Zain Phase 5
Source : https://www.scribd.com-dar-al-zain-brochure-phase-5

Figure 35 :second floor plan for Dar Al-Zain Phase 5
Source : https://www.scribd.com-dar-al-zain-brochure-phase-5

Ground floor:

- It has a parking lot for two cars
- Maid's room with a bathroom
- Living room and toilet, and kitchen with a glass facade that opens to the private pool

First floor :

- Living room
- Bathroom outside the hall
- Master bedroom with bathroom
- Balcony
- Bedroom

Second floor :

- Two bedrooms with a bathroom in each room
- Spacious private balcony for each room
- double height

The layout of interior spaces:

Table6The layout of interior spaces of the plan 21 villa of Dar Al Zain

space	Nomber	Surface m2
Master bedroom	01	28
Bedroom	03	25
Living room	02	25
Kitchen and dining room	01	28
Maid’s room	01	14
Bathroom	03	6
garage	01	28

Study of facades :

The facades are characterized by a modern contemporary design, combining clean and simple lines with innovative architectural touches The architectural units are basedon overlapping techniques of geometric blocks, giving the building a dynamic and attractive appearance.

Figure 36 : façade of Dar Al-Zain Phase 5
source: https://www.scribd.com-dar-al-zain-brochure-phase-5

Prominent elements of the design:

- The use of mashrabiya, inspired by Omani heritage, it enhances privacy and minimizes the impact of the sun's rays.
- Cold beige and light white colors and soft texture
- Main entrance o Secondary entrance (garage)

Figure 37Prominent elements of the design of the villas Dar Al-Zain Phase 5
source: https://www.scribd.com-dar-al-zain-brochure-phase-5

Shading strategies incorporated into the design:

Shading devices in the form of decorative elements

- Each unit has overhangs that cover the windows and help minimize solar heat gain.
- Facades are designed with deliberate angles to avoid direct sun exposure, especially in the southern and western directions.
- [2]Ponds in front of the facades promote natural cooling, helping to reduce the ambient temperature of the building.

Figure 38 : Shading strategies incorporated into the design of the villas, Dar Al-Zain Phase 5
source: https://www.scribd.com-dar-al-zain-brochure-phase-5

these facades are a cutting-edge model of contemporary design for dry regions. Thermal comfort is ensured, and energy Consumption is reduced through the use of insulating materials and natural shading that blends with the environment around.

B. Example 02: Villas at Al Zohra in Ajman, United Arab Emirates

Selection criteria :

- The project is located in arid zone
- Individual housing
- Use of shading strategies

Location

- **City:** Ajman, UAE

Proximity: Situated along the coast, it offers easy access to the major cities of the UAE, including Dubai and Sharjah.

This strategic location provides a tranquil escape while still being close to urban amenities

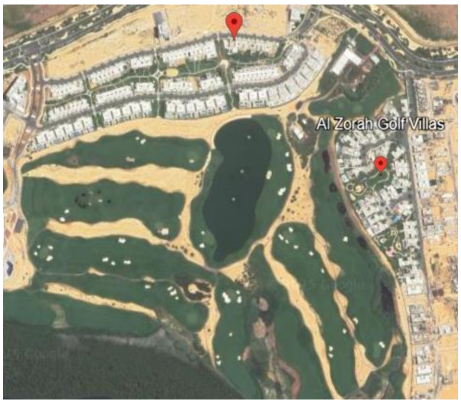


Figure 39: Site plan for Villas at Al Zohra in Ajman source: Google Maps,2024

Year of construction: The project began development in 2014 and was completed in successive phases over the following years, with some villas being fully completed by 2018.

Designer: Solidere International

Al Zorah Villas is a luxurious residential development located in Ajman, UAE, offering a harmonious blend of natural beauty and modern amenities. The community is designed to provide residents with a tranquil living experience, featuring stunning views of mangroves, beaches, and lagoons.

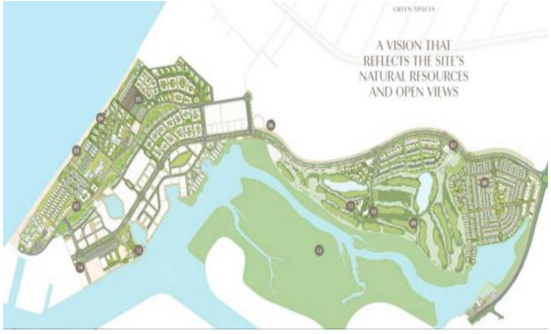


Figure 40 : Site plan for Villas at Al Zohra in Ajman Source Brochure Al Zorah Development Company

Location:

Linked directly to Sheikh Mohammed Bin Zayed Road, Al Zorah is a 25-minute drive from Dubai International Airport and only 20 minutes from Sharjah International Airport. This unique the destination is also easily accessible by boat or yacht, thanks to its four state-of-the-art marinas, which offer convenient, year-round berthing Nestled along the scenic coastline of Ajman, This area enjoys the status of both a free trade zone and a freehold area. The coastal terrain of

Al Zorah City, covering more than 58 mln sq. ft, is distinguished by its unique green spaces. With over 60% of its territory dedicated

Figure 41: Site plan shows the composition of Villas at Al Zohra in Ajman Source Brochure Al Zorah Development Company

to lush landscapes, it fosters a profound connection with nature

site plan study :

Located along a natural peninsula on the coastline of Ajman, the flagship project is spread over an area of 5.4 million sq m. I

Figure 42 :Site plan for 13 Villas of Al Zohra in Ajman Source Brochure Al Zorah Development Company

Al Zohra villas :

In the heart of the beachfront district of Al Zorah, there are two typologies of villas with In a secure, gated community. The natural environment of sea and sand, and the many offerings of the greater Al Zorah community,provide an ideal. Coastal living experience for wholesomewellbeing.

TYPE VILLAS :

Type one: FOUR-BEDROOM SIMPLEX VILLAS :

The project consists of 4 rows of large luxury villas, have 13 villas With spectacular sea views and private beach access, located on the second and third rows of the secure, gated neighborhood

The layout of these large villas offers an ultra-modern, multi-functional interior that blends seamlessly with the ample Lush outdoor areas

Figure 43 : master plan FOUR-BEDROOM SIMPLEX VILLAS Source Brochure Al Zorah Development Company

study plan

The simplex units will be spread over an area of 6,744 sq. ft. These villas will come with ultra-modern interiors and lush outdoor areas. There will be en-suite bedrooms, a family room, a maid’s room and a fully-fitted kitchen. Other features will include a Jacuzzi, pool and living terrace.

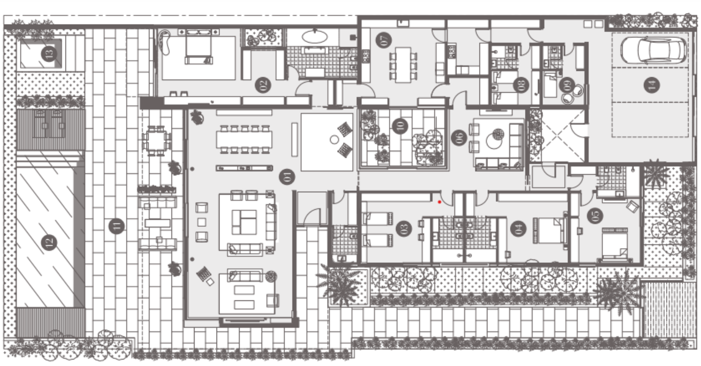


Figure 44: ground floor plan FOUR-BEDROOM SIMPLEX VILLAS Source Brochure Al Zorah Development Company

1- DINING AND LIVING	2- MASTER BEDROOM	3- BEDROOM 1
(147.7m²) 7.5m X 15.4m	(68.8m²) 6m X 5.5m	(36m²) 5m X 5m
4- BEDROOM 2	5- BEDROOM 3	6- FAMILY ROOM
(36m²) 5m X 5m	(34m²) 5m X 4.6m	(24.5m²) 5.5m X 4.5m
7- KITCHEN	8- STAFF BEDROOM	9- DRIVER BEDROOM
(58.9m²) 6.1m X 6.3m	(14.6m²) 3.5m X 2.4m	(12.5m²) 3m X 2.4m
10- COURTYARD	11- LIVING TERRACE	12- POOL
	(24.8m²) 6m X 4.1m	
13- JACUZZI	14- PARKING	

TYPE TWO : FOUR-BEDROOM DUPLEX VILLAS

Located on the fourth row of the neighborhood, the wellthought-out architecture and landscaping of these duplex villas provide a sanctuary for relaxation in harmony with their surroundings and ensure remarkable views of the sea from the second level.

Figure 45 :master plan FOUR-BEDROOM DUPLEX VILLAS Source Brochure Al Zorah

LAND AREA	689.99 m2
BUILT-UP AREA	631.83 m2
DUPLEX UNITS	10

Plan's study :

Duplex units will cover an area of 6,763 sq. ft. The ground floor will have a living area, guest bedroom, kitchen and a powder room. The second floor will feature bedrooms, two balconies and a game room. Other features will include a pool and garden.

Ground floor

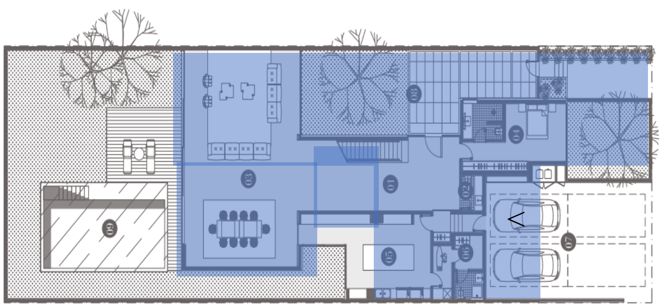


Figure 46 :ground floor plan FOUR-BEDROOM DUPLEX VILLAS Source Brochure Al Zorah Development Company

1- LOBBY
2- POWDER ROOM
3- DINING AND LIVING
4- GUEST BEDROOM
5-KITCHEN
6-STAFF AREA
7- PARKING
8- ENTRY COURT
9- POOL

DAYTIME SPACE

Floor plan

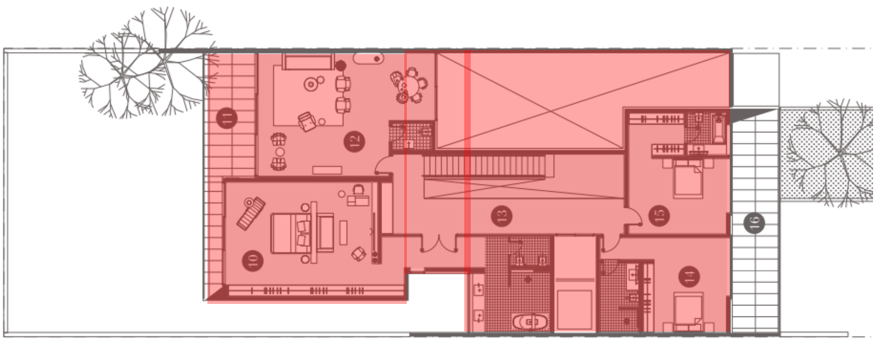


Figure 47 : floor plan FOUR-BEDROOM DUPLEX VILLAS Source Brochure Al Zorah Development Company

10-BALCONY 1
12- GAME ROOM
13- CORRIDOR
14- BEDROOM 2
15- BALCONY 2

NIGHT SPACE

A functional distribution was adopted that distinguishes between spaces according to their nature; the ground floor (first floor) was allocated to accommodate daytime and service facilities of a general nature (such as living room, kitchen, and dining room), while the upper floor (second floor) is dedicated to private nighttime facilities, such as bedrooms, thereby reinforcing the separation between social life and private family activities and ensuring privacy and comfort for family members.

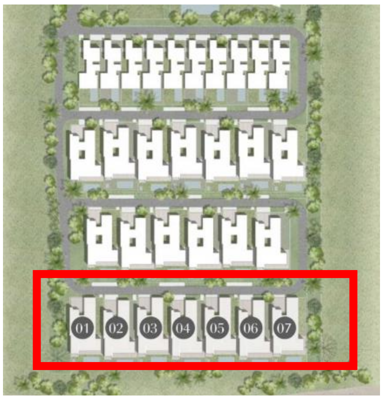


Figure 48 : master plan 5-BEDROOM SIMPLEX VILLAS
Source Brochure Al Zorah Development Company

Type three : 5-BEDROOM SIMPLEX VILLAS

Sea Glints Mansions is an off-plan luxurious community of seven villas in Al Zorah,Ajman. Developed by Solidere international, these 5-bedroom oceanfront grand residences are located within a gated community adjacent to the popular, oberoi Beach Resort

LAND AREA	1,198.45 m2
BUILT-UP AREA	681.73 m2
DUPLEX UNITS	07

Study plan :

The dining and living areas are connected with a grand lobby. The master bedroom comes with a dressing area, a master bathroom, and a courtyard. There are four more bedrooms, each with its own dressing area and bathroom. The family room is perfect for relaxation, while the kitchen is spacious with a service kitchen. Additional features include a powder room, staff anddriver bedrooms, laundry facilities, and a central courtyard. For added luxury, there is a living terrace, pool, jacuzzi, and ample parking.

Figure 49 :site plan 5-BEDROOM SIMPLEX VILLAS
Source Brochure Al Zorah Development Company

Figure 50: ground floor plan 5-BEDROOM SIMPLEX VILLAS
Source Brochure Al Zorah Development Company

1-living 2-bedroom 01 3-bedroom 02
4- bedroom 03 5-Bedroom 04 6- bedroom 05
7-Family Sitting 8-kitchen 9- Maid Room
10- Driver Room 11- yard 12- Living Terrace
13- pool 14- Jacuzzi 15-parking

ENTRANCE :

The entrance features a custom-designed timber ceiling and wall panelling that serves as a distinctive element, marking The arrival area encircles the green courtyard. The bespoke timber ceiling adds a unique touch to the entrance and guides individuals towards the private rooms.There are three entrances to the residence – a general guest entrance , a special family entrance, and a separate one for staff.

Figure 51 :Entrance for 5-BEDROOM SIMPLEX VILLAS
Source Brochure Al Zorah Development Company

1. Oak wall panelling
2. Marble stone floor
3. Oak ceiling panelling
4. Feature metal and glass joinery with bench stone

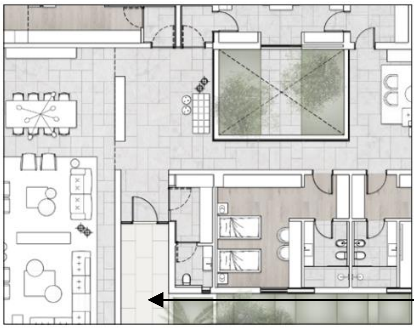


Figure 52 : Entrance for 5-BEDROOM SIMPLEX VILLAS
Source Brochure Al Zorah Development Company

ENTRANCE :

FAÇADE'S STUDY:

Inspired by minimalist Mediterranean architecture with modern aesthetics, the complex design features a linear configuration and simple geometric shapes that blend seamlessly with the environment and allow the most efficient use of space.

Figure 53 : facade for four-BEDROOM SIMPLEX VILLAS
Source Brochure Al Zorah Development Company

Section plan

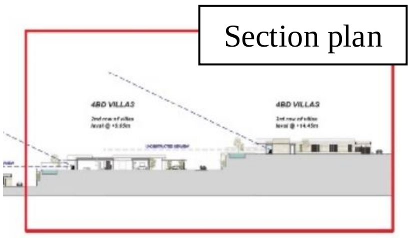


Figure 54 : section plan for four-BEDROOM SIMPLEX VILLAS
Source Brochure Al Zorah Development Company

Figure 55 : facade for four-BEDROOM DUPLEX VILLAS
Source Brochure Al Zorah Development Company

They have stunning panoramic sea views from the first floor. The villas feature stunning exterior elevations inspired by the surrounding landscape.

Figure 56 :facade for 5-BEDROOM SIMPLEX VILLAS
Source Brochure Al Zorah Development Company

Each is positioned with the beach directly in front, offering residents picturesque ocean views. The community features landscaped areas and ample walkways for strolls.
Section plan

Section and view form row (2&3)		1st row of villas Leval +3.65m  *Figure 57 : Section plan for four-bedroom SIMPLEX VILLAS* *Source Brochure Al Zorah Development Company*
PROJECT FEATURES • Community access with a private and secure entrance • Full landscaping for private and common areas • Ample pedestrian walkways • Direct beach access • 10-km professional cycling track within the development		
Type one: four-bedroom simplex villas	Type two: four-bedroom duplex villas	Type three: 5-bedroom simplex villas

The summary

- Mechanical peripheral traffic with parking spaces, pedestrian traffic, and bike paths
- Green spaces, squares, and water features
- Buildings can be up to one story in height
- Each house has its private garden or courtyard and a private swimming pool

C. Example: Mshereib, Doha, Qatar

Architects: AECOM, Allies and Morrison, Arup

Site Area: 31 hectares

Location: Doha, Qatar

Project Timetable: Construction commenced in 2010, Construction completion is scheduled in phases

Residential Units: 800+

Parking Spaces: 10,000+

Building Height Range: 3 to 30 storeys

Figure 58 : Mshereib, Doha, Qatar
Source: www.msheireb.com

Msheireb Downtown is a mixed-use development project aimed at revitalizing Doha’s historic business district. It is designed to be one of Doha’s most sustainable and smart neighborhoods, serving as a new hub for living, recreation, and commercial activities.

Location

Mohammed Bin Jassim District is located in the heart of central Doha, bordered by Al Rayyan Road to the north, Jassim Bin Mohammed Street to the east,Wadi Msheireb Street to the south, and Al Diwan Street (part of the A Ring Road) to the west. The site is immediately adjacent to the Amiri Diwan, the seat of the government and the residence of the Ruler of Qatar. It is also located near the redeveloped Souq Waqif, a successful mixed-use destination inspired by the traditional Qatari market, as well as the historic Al Koot Fort. These surroundings give the district significant urban and cultural value, positioning it as a strategic location that blends heritage, identity, and modernity.

Figure 59 :site plan of Mshereib, Doha, Qatar
Source: www.msheireb.com

Design Concept

The challenge was to design a uniquely "Qatari" piece of the city that is both modern and historically significant, and encourages sustainable habits.

*The project is based on the concept of a "Traditional smart city", combining the traditional urban fabric of Doha with modern smart systems. The core idea is to revitalize the Qatari spirit in design through squares, alleys, and human-scale buildings.

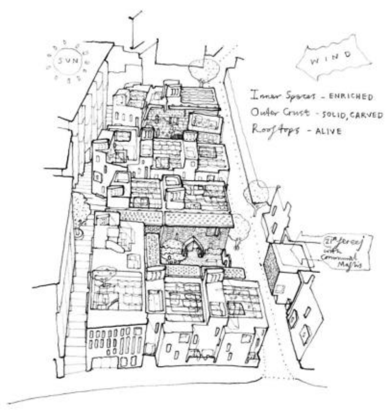


Figure 60 : Msheireb Challenge Sketch of Mshereib, Doha, Qatar
Source: https://urbandesignlab.in/revitalizing-heritage-msheireb-downtown-doha-masterplan/

The Seven Steps

Msheireb has developed a new architectural language that blends traditional Qatari architecture with modern technologies, through the ‘Seven Steps’ that aim to revitalize local identity and promote sustainability and social ties

Figure 61 : The Seven Steps of Mshereib, Doha, Qatar
Source: https://urbandesignlab.in/revitalizing-heritage-msheireb-downtown-doha-masterplan/

Master Plan

Plan Insights

The plan features a mixed-use district divided into five main quarters, including over 800 residential units, extensive commercial and retail spaces, hotels, museums in heritage buildings, a school, mosques, and ample parking. Designed as a walkable, pedestrian-friendly area, it incorporates shaded streets and cooling Gulf breezes. A clean-energy tram, bike paths, and pedestrian lanes enhance connectivity. Sustainability is prioritized through over 6,400 rooftop solar panels, a 70% reduction in non-potable water use, and smart infrastructure with automated waste collection and recycling systems.

Figure 62: master plan shows predominant usage
Sousce : Msheireb Properties

Construction Phases :The Four Phases

From 2010 to 2021, the project was built in four phases, as follows:

The first phase: It consists of three parts: 1A, B, and C

Phase One A [2010]: It includes the Diwan Amiri Quarter, Msheireb Prayer Ground, Amiri Guard Building, mosque, Qatar National Archive, and Msheireb Museums.

Phase one B: It includes commercial and retail spaces, townhouses, flats, municipal buildings, and a school.

Phase One C: It was

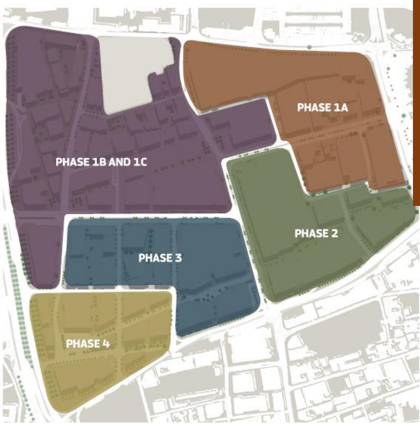


Figure 63 :construction phases of master plan

S

Phase two: It contains a supermarket, office space, residences, a hotel, and the Galleria, which houses a movie theater and children's entertainment.

Phase three: It consists primarily of a residential neighborhood with apartments, a hotel, shops, restaurants, and commercial spaces, as well as a magnificent department store and other facilities.

Phase four [2021]: It contains Sahat Al Nakheel, which takes up a substantial amount of the final phase of the development and serves as the primary transportation hub for Msheireb Downtown Doha.

1-Souq Waqif 2-Al Koot Fort 3-Amiri Diwan 4-Cultural Forum

5-Msheireb Museums 6-Sahat Al Nakheel 7-Mohammed Bin

8-Msheireb Prayer Ground 9-Sikkat Wadi Msheireb 10-Retail Galleria 11-Department Store 13-Qatar National Archive 14-Amiri Guard Building

15-Diwan Annexe

Figure 64 : Character Areas of master plan
Sousce : Msheireb Properties

Developing the master plan:

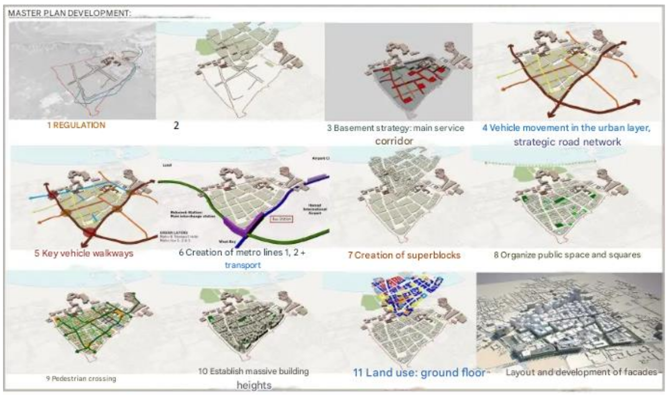


Figure 65 : Developing the master plan
source : https://www.scribd.com/document/778130952/El-msheireb-downtown-DOHA-2

ROAD SYSTEM:

City-wide main street

Neighborhood-wide main street

Secondary street

Tertiary street

Figure 66 : road systen of master plan
source : https://www.scribd.com/document/778130952/El-msheireb-downtown-DOHA-2

the traditional pedestrian-only sikka,pedestrian sikka routes extended to tram lines and public squares in the fereej sub-areas, and primary routes allowing all modes of travel, including tram and vehicles.

Figure 67 : road systen sketch
Source: https://urbandesignlab.in/revitalizing-heritage-msheireb-downtown-doha-masterplan/

Non-built system :

MAIN PLACES:

Msheireb's main square, at the heart of the project, features a formal geometric design with decorative stone paving and native citrus trees. Water features visually connect it to a wadi feeder route and other areas of Msheireb. BARAHAT MSHEIREB

The largest covered public square in the region, dotted with upscale boutiques and outdoor restaurants, offers events throughout

SECONDARY PLACES: Secondary squares in Msheire. Strategically positioned to provide visual and physical separation from traffic on major roads, these squares incorporate a grid of trees to create spaces within the urban density. They highlight transition points, suitable for recreational purposes.

Figure 69 : main and secondary places
source : https://www.scribd.com/document/778130952/El-msheireb-dc

PUBLIC SPACES

The system of public squares is divided into two types: main squares and secondary squares:

Secondary

Main

Figure 68 : public spaces systen in master plan
source : https://www.scribd.com/document/778130952/El-msheireb-downtown-DOHA-2

Study urban façade :

The facades are inspired by traditional Qatari architecture (mashrabiya, arches, cornices) but treated in a contemporary style through modern materials. Sand and beige colors dominate the design, with recurring shading elements that reflect the site's climatic and environmental character.

Figure 70 : urban façade of Msheireb QUARTERS
Source : Msheireb Properties

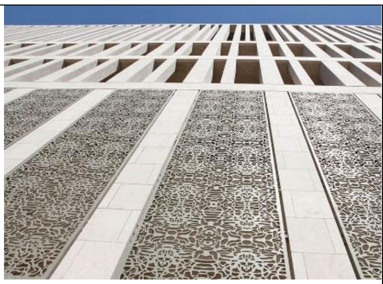


Figure 71 : façade mashrabiya of Msheireb QUARTERS
Source : Msheireb Properties

Figure 72 : façade of Msheireb QUARTERS
Source : Msheireb Properties

Composition and proportion:

Suitable for facade treatments inspired by traditional housing

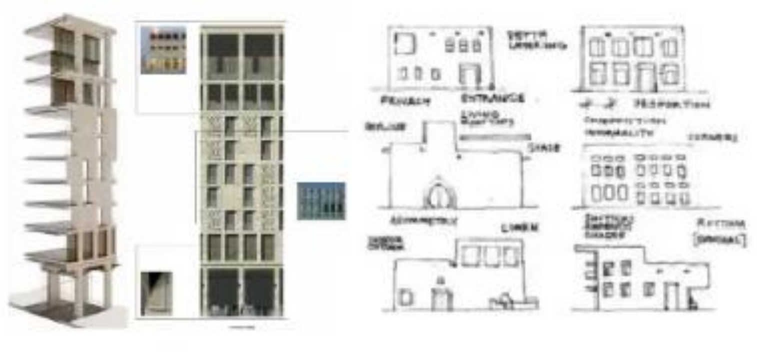


Figure 73 : Composition and proportion for facade of Msheireb QUARTERS
source : https://www.scribd.com/document/778130952/El-msheireb-downtown-DOHA-2

DYNAMIC SKYLINE :

Figure 74 : DYNAMIC SKYLINE for urban facade of Msheireb QUARTERS
source : https://www.scribd.com/document/778130952/El-msheireb-downtown-DOHA-2

Seasonal wind has been used to be recycled on the site by tall buildings to maximize the benefit of seasonal co-factorial

The template

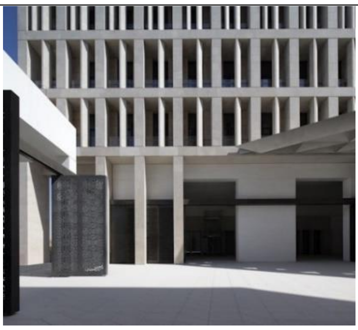
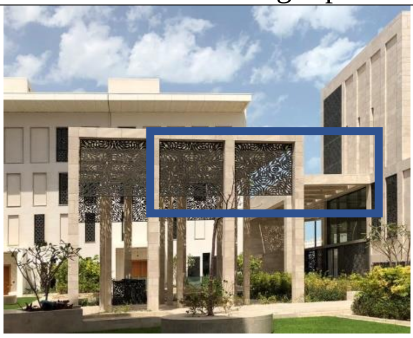
The template is divided into 3 major parts

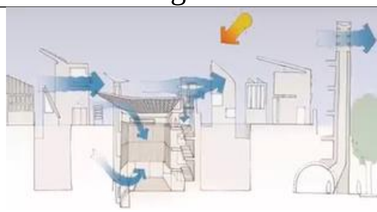
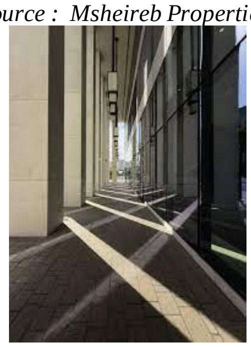
The upper part, whose template is too high, it is between R+7 and R+30. The intermediate part, which has a more or less high template, is between R+6 and The lower part, which contains the lowest template, is less than R+3

Figure 75 : the template of master site
source : https://www.scribd.com/document/778130952/El-msheireb-downtown-DOHA-2

Analysis of shading strategies at Msheireb Heart of Doha

Table7 Analysis of shading strategies at Msheireb Heart of Doha

Classification	Strategy	Description
Architecturally	Deep, multi-layered interfaces	 *Figure 76 : multi-layered interfaces of Msheireb Heart of Doha* *Source : Msheireb Properties* Designing facades with multiple layers and depth provides self-shade and minimizes direct sunlight penetration inside
	Traditional architectural elements (decorative shading screens)	 *Figure 77 : Traditional architectural elements of Msheireb of Doha* *Source : Msheireb Properties* Using design elements inspired by traditional Qatari architecture that also serve as shading solutions.

	Strategic Building Orientation	 *Figure 78 : Strategic Building Orientation in facade of Msheireb of Doha* *Source : Msheireb Properties* Building masses are oriented in proportion to the movement of the sun to maximize self-shading between them.
	Air handlers (air handlers):	 *Figure 79 : Air handlers in section of Msheireb of Doha* *Source : An Architect's Tale with Ahmed Ali* Traditional roof-level vents that help bring in cool air and expel hot air
culturally	Covered walkways and shaded walking areas	 *Figure 80 : shaded walking areas of Msheireb of Doha* *Source : Msheireb Properties*  *Figure 81 : Covered walkways Msheireb of Doha* *Source : Msheireb Properties* Walking paths between buildings are thoughtfully designed to create shaded and comfortable walkways for pedestrians

	Narrow street grid	 *Figure 82 : masyer plan of Narrow street grid in Msheireb* *Source : Msheireb Properties* The urban design of the project relies on narrow, straight streets that mimic the layout of old Gulf cities, providing natural shading for pedestrians.
	Integrating traditional markets and plazas	 *Figure 83 : Integrating traditional markets and plazas in Msheireb* *Source : Msheireb Properties* Such as Msheireb Baraha, which has permanent shades and semi-enclosed spaces that reduce heat and stimulate social activity
Modern technological	Movable awnings	 *Figure 84 : Movable awnings in Msheireb* *Source : Msheireb Properties* Smart awnings that are controlled by the direction of the sun to create dynamic shading in courtyards.
	Smart Facades	 The use of materials that change performance depending on the intensity of solar radiation. *Figure 85 : smart facade in Msheireb* *Source : Msheireb Properties*

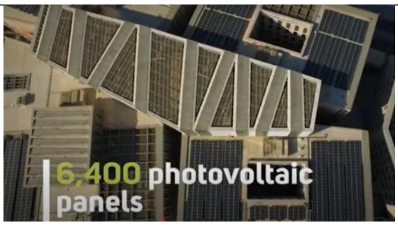
	High-performance insulating glass	 Reduces heat infiltration without blocking natural light. *Figure 86: High-performance insulating glass in Msheireb* *Source: Msheireb Properties*
	Climate Control Systems	 *Figure 87: Climate Control Systems in Msheireb* *Source: Msheireb Properties* Smart technologies that monitor temperature and radiation and automatically adjust ventilation and shading systems.
Environmental shading strategies	Utilising solar energy	 *Figure 88: Utilising solar energy in Msheireb* *Source: Msheireb Properties* More than 6,400 rooftop solar panels lower the ambient temperature and generate clean energy.

Table8 Analysis of shading strategies at Msheireb Heart of Doha

2.2.2. 1.2.2 Existing examples

D. Example 03: 72 housing units in Sidi Okba, Biskra, Algeria

Presentation on the project :

Location: N83, Sidi Okba-Biskra Road

Project type: Individual housing

Type of housing: F5

Number: 72 housing

Employer: Fawzi Barakat Studies Office

Figure 89 : 72 housing units in Sidi Okba, Biskra
source :the writer ,2025

The idea is the design principles of the project

The buildings are characterised by their simple shape and are placed along the main roads and side roads in the form of plots.

Figure 90 : mastre plan 72 housing units in Sidi Okba, Biskra
source : Fawzi Barakat Studies Office

Study Mass Scheme

Type of distribution of residential complexes :

Figure 91 : site plan of mastre plan 72 housing units in Sidi Okba, Biskra
source : google maps,2025

Green Spaces

Residential Buildings

Entrances

The project has several entrances allowing access to the project from several directions

Figure 92: Accessibility of the site plan of the master plan 72 housing units in Sidi Okba, Biskra
source: Google Maps,2025

Accessibility :

The surrounding streets, Route Nationale No. 83

The site is accessible by vehicles from the highway (national street no. 83) and all surrounding streets. Footbridges have been included for pedestrians.

Study of access to the plot:

- Pedestrian and mechanical access:

There is a hierarchy in the accessibility of the project:

Highway, vehicle connections, and pedestrian entrances.

Pedestrian access, Mechanical access

Study plan

Type 01: Haunted Area: 135.00 m2

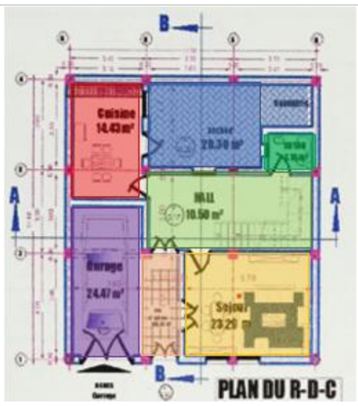


Figure 93: ground floor plan type one of the master plan, 72 housing units in Sidi Okba, Biskra source: Fawzi Barakat Studies Office

GROUND FLOOR PLAN

Kitchen
Garage
Living room
Hall
Entrance
Bathroom
Drying Room

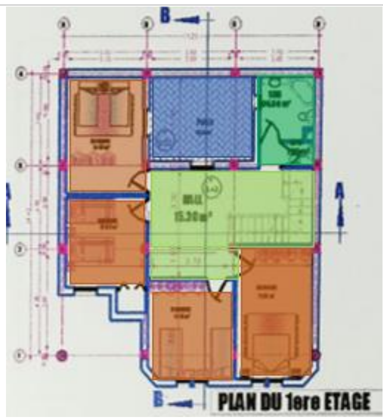


Figure 94: floor plan type one of the master plan, 72 housing units in Sidi Okba, Biskra source: Fawzi Barakat Studies Office

FIRST FLOOR PLAN

Hall
Bedrooms
Bathroom
Balcony

The layout of interior spaces:

Table9 :The layout of interior spaces of 72 housing units in Sidi Okba, Biskra

space	Nomber	Surface m2
Kitchen	01	14.43
Garage	01	24.47
Living room	01	23.29
hall	02	10.50
bathroom	02	1.10 /6.00
Bedrooms	04	14.00 /12.00
Drying room	01	20.30

Type 02: Haunted Area: 142.00 m2

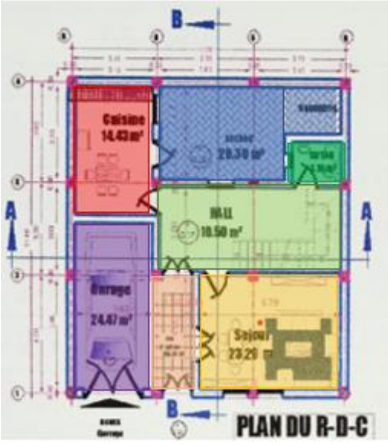


Figure 95: ground floor plan type two of the master plan, 72 housing units in Sidi Okba, Biskra source: Fawzi Barakat Studies Office

GROUND FLOOR PLAN

Kitchen

Garage

Living room

Hall

Entrance

Bathroom

Drying Room

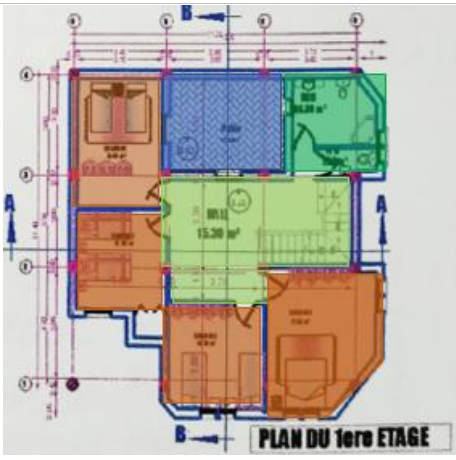


Figure 96: ground floor plan type two of the master plan, 72 housing units in Sidi Okba, Biskra source: Fawzi Barakat Studies Office

FIRST FLOOR PLAN

Hall

Bedrooms

Bathroom

Balcony

Study of facades :

Repeated several times to form the assembled Unit.

Figure 97 : facade of 72 housing units in Sidi Okba, Biskra source : the writer,2025

Architectural Style:

The buildings exhibit a modern vernacular style With traditional influences, likely inspired by local Desert architecture.The design includes rectangular volumes with minimal ornamentation, creating a simple but effective aesthetic. Arched windows are a common element in traditional architecture, helping tointegrate.cultural identity into the design

Integration and colours:

Buildings use earthy tones (yellow and red),which blend with the natural desert environment and reduce the visual effect.The lower section is sandy yellow, likely to reflect heat, while the upper red section provides a contrast and may be symbolic of conventionalearthy materials.

Shading and sun protection elements:

Projected upper floors act as self-shading elements, Reducing direct exposure to sunlight on the bottom windows.

Small arched windows help reduce heat increase while maintaining indoor daylight. The lack of visible shading Or, extended shading devices refer to relying on thermal mass rather than active shading.

Figure 98 : Shading and sun protection elements in facade
source : the writer,2025

E. Example 04: 216 individual housing units in the new urban centre in Gharb Zahoun – Biskra

Figure 99 : 216 individual housing units in the new urban centre in Gharb Zahoun – Biskra
source : the writer,2025

Project presentation

Location: New Urban Pole ZHUN West, Commune of Biskra

project type: single-family homes

Number: 216 units

Development: In three phases (Phase 1: 112 homes,

Phase 2: 52 homes, Phase 3: 52 homes)

Housing typology :

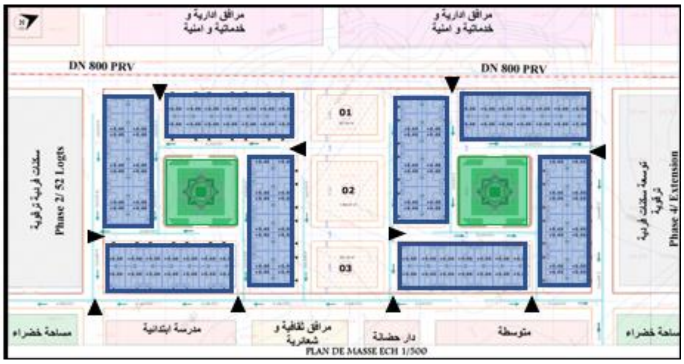
- F5 R+1 (112 units)
- F5 R+2 (52 units)
- F5 R+1 (52 units)

Divided into 3 phases

Figure 100: master plan of 216 individual housing units in the new urban centre in Gharb Zahoun – Biskra
source: Studies Office

PHASE 1 N°= = 112 housing units

TYPE F5 (R+1) : N°112



Green Spaces
Residential Buildings
Entrances

The project has several entrances allowing access to the project from several directions

Figure 101: PHASE 1 master plan of 216 individual housing units in the new urban centre in Gharb Zahoun – Biskra
source: Studies Office

Accessibility :

Pedestrian access
Mechanical access

There is a hierarchy in the accessibility of the project: highway, vehicle connections, and pedestrian entrances.

The presence of green spaces in large quantities revitalizes the

Figure 102: Accessibility of the PHASE 1 master plan of 216 individual housing units in the new urban centre in Gharb Zahoun – Biskra
source: Studies Office

Study plan:

Figure 103: PHASE 1 master plan of 216 individual housing units in the new urban centre in Gharb Zahoun – Biskra
source: Studies Office

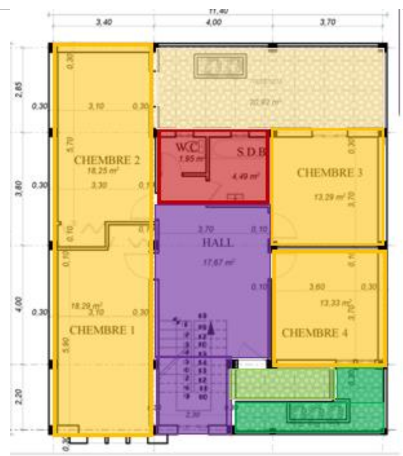


Figure 104: PHASE 1 master plan of 216 individual housing units in the new urban centre in Gharb Zahoun – Biskra
source: Studies Office

GROUND FLOOR PLAN	FIRST FLOOR PLAN
Kitchen	Hall
Garage	Bathroom
Hall	Bedrooms
Living room	Balcony
Bathroom	Veranda
Veranda	

The layout of interior spaces:

Table10: The layout of the interior spaces of 216 individual housing units in the new urban centre in Gharb Zahoun – Biskra T1

space	Surface m2
Kitchen	16.28
Garage	20.92
Hall 01	20.02
Hall 02	17.67
Living room	23.26
Bathroom 01	18.29
Bathroom 02	18.25
Bathroom 03	13.29
Bathroom 04	13.33
Veranda	11.22
Courtyard	20.92
Bedroom	4.49
Balcony	2.4

Ensuring a smooth flow between spaces

Study of facades :

- Rhythm

Axis of symmetry
Facade boundaries

In the assembled units the facades have a repeating rhythm

Figure 105: facade PHASE 1 of 216 individual housing units in the new urban centre in Gharb Zahoun – Biskra source: Studies Office

The façade composition consists of a long rectangle in the centre and two small rectangles on the sides that are repeated

several times to form the assembled unit.

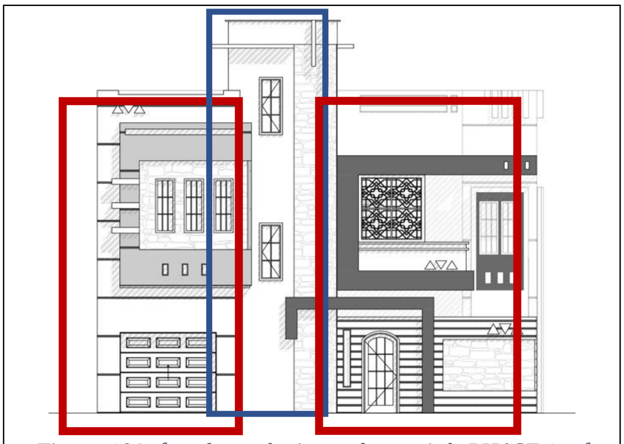


Figure 106: facade aesthetics and materials PHASE 1 of 216 individual housing units in the new urban centre in Gharb Zahoun – Biskra
source: Studies Office

Aesthetics and materials:

Modern facades combine stone elements with white paint and geometric motifs for a contemporary look, Flat roofs with integrated elements

Bioclimatic aspects:

Orienting homes to maximise natural sunlight, shading public spaces to reduce the effects of heat, And well-placed windows and openings for good ventilation. The walls are a combination of white paint and stone cladding, which gives a modern feel and enhances the walls' resistance to weathering.

Figure 107 : facade aesthetics and materials PHASE 1 of 216 individual housing units in the new urban centre in Gharb Zahoun – Biskra
source: Studies Office

Visual composition and balance in facades:

Protruding and hollow blocks were employed to create a dynamic visual effect and break the monotony with the use of neutral colors with stone accents for aesthetic and functional integration and a contrast between horizontal and vertical via protruding bars and entrances, creating an attractive visual harmony.

PHASE 2 N°= 52housing units

TYPE F5 (R+2) : N°52

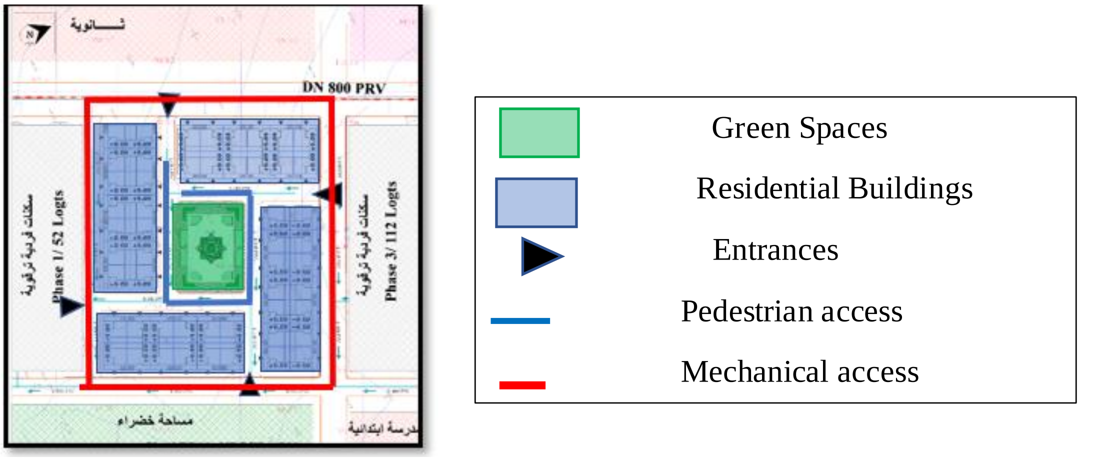


Figure 108: PHASE 2 master plan of 216 individual housing units in the new urban centre in Gharb Zahoun – Biskra
source: Studies Office

Study plan:

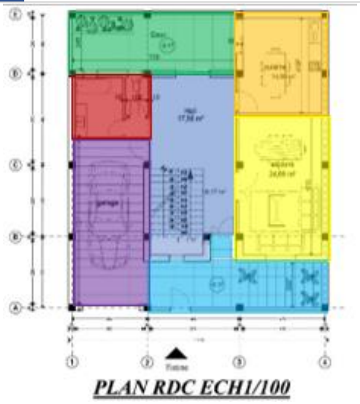


Figure 109: Ground floor plan PHASE2 master plan of 216 individual housing units in the new urban centre in Gharb Zahoun – Biskra
source: Studies Office

Figure 110: floor plan PHASE2 master plan of 216 individual housing units in the new urban centre in Gharb Zahoun – Biskra
source: Studies Office

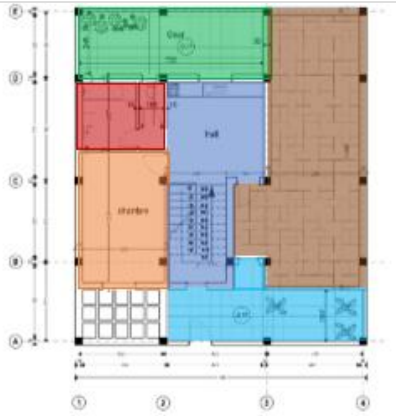


Figure 111: second floor plan, PHASE2 master plan of 216 individual housing units in the new urban centre in Gharb Zahoun – Biskra
source: Studies Office

GROUND FLOOR PLAN
Kitchen
Garage
Hall
Living room
Bathroom
Veranda
Courtyard

FIRST FLOOR PLAN
Bedrooms
Hall
Balcon
Bathroom
Veranda
Courtyard

Second floor plan
Bedroom
Hall
Terrasse
Bathroom
Veranda
courtyard

The layout of interior spaces:

Table11 : The layout of interior spaces of 216 individual housing units in the new urban centre in Gharb Zahoun – Biskra T2

space	Surface m2
Kitchen	14.80
Garage	20.92
Hall 01	19.17
Hall 02	18.89
Hall 03	17.58
Living room	24.69
Bathroom 01	15.54
Bathroom 02	16.17
Bathroom 03	15.27
Bathroom 04	16.28
Veranda	14.28
Courtyard	17.64
Bedroom	9.9
Balcony	4.38

Study of facades :

In the assembled units, the facades have a repeating rhythm The facade is characterised by a balance composition that combines vertical and horizontal elements, creating a sense of movement and harmony Different sizes of Windows and doors were used to Enhance aesthetics and functionality

Figure 112 : facade PHASE 2 of 216 individual housing units in the new urban centre in Gharb Zahoun – Biskra source : Studies Office

The interface is divided into three main blocks,With different heights and depths, it creates a sense of movement and dynamism. There is partial symmetry between the left and right sides, where details differ but maintain visual balance.

Summary of the Housing Examples Analysis :

Project	Urban Aspects	Architectural Aspects	Design Techniques	Shading strategies
Summary of book examples				
Dar Al Zain (Oman)	Fragmented layout, pedestrian lanes, low density.	Use of courtyards at the master plan, local materials, compact shapes, and simple volumes	The project is oriented towards an ecological approach, using local materials, optimising energy performance and adding water spaces in the inner courtyard around the residential units.	adapted orientation, thick walls
Al Zahra Housing (UAE)	Dense texture, narrow streets, shared access.	Simple sizes with recessed balconies and cosy pergolas. Linear spatial organisation	Functional simplicity, limited flexibility, and direct climatic response.	Recessed balconies, mutual shading through layout, and types of units
Msheireb Downtown (Qatar)	A dense, mixed-use, walkable area inspired by traditional urban areas	Cohesive patterns, localised materials, and smart slang.	Integrating intelligent design, passive design, and heritage integration.	Balconies, arcades, screens, and narrow shaded streets.
Summary of existing examples				
72 units of housing Sidi Okba (Algérie)	Linear organization, semi-public pedestrian alleys	Solid facades Linear spatial organisation	Organizing around courtyards Separating day and night spaces	Simple and small openings solid walls, strategic orientation

216 units of housing (Gharb Zahoun)	Compact layout, grouped taxonomies, and method sequencing.	Standardised design, basic private space	Space efficiency and microclimate integration.	Routing and cluster ordering

Table12 : Summary of the Housing Examples Analysis :

Summary of examples found in an arid zone:

- Materials used: Have a high thermal mass.
- Mashrabiyas, courtyards, and patios Act as thermal regulators to control the amount of light.
- Exterior walls are light-colored

Conclusion

Comparing the selected housing schemes in various arid contexts demonstrates a disparate but coherent manner of integrating shading solutions into residential architecture. Despite size variations, cultural setting, and urban context, each of these projects reflects an attempt to alter the constructed environment to counteract aggressive climate conditions without sacrificing spatial and social identity.

This analysis highlights that climate-responsive design is not concerned with one kind of aesthetic or technology solution, but rather a thorough understanding of culture, site, and user behaviour.

3.3 Contextual Site Analysis

2.2.3. Site Selection and Justification :

The site chosen for the proposed residential project is located in the Lebchech neighbourhood in the city of Biskra, Algeria. This area was selected based on multiple climatic, urban, and architectural criteria in line with the objectives of the study.

A climatic perspective	Biskra is located in a hot arid region, characterized by extreme summer temperatures and low humidity. These conditions make it an ideal context to study and apply shading strategies to optimize thermal comfort in residential environments.
At the urban level	Lebchech is part of an area within the city's urban expansion plan, a long-term and short-term programmed Land Use Plan (POS) of individual dwellings. and the site covers about 5 hectares, providing enough space to implement an individual residential scheme
Culturally and socially	Biskra has a rich architectural tradition of courtyard houses and shaded public spaces, supporting the integration of vernacular design principles into contemporary solutions. The choice of this site allows for a context-sensitive design approach that respects the local identity while addressing environmental challenges.

Table13 : Site Selection and Justification

In short, the choice of the site in Lebchach, Biskra, provides ideal conditions for testing and applying shading techniques, making it an appropriate and purposeful choice for this research project.

1.5.2.1 Biskra's city presentation

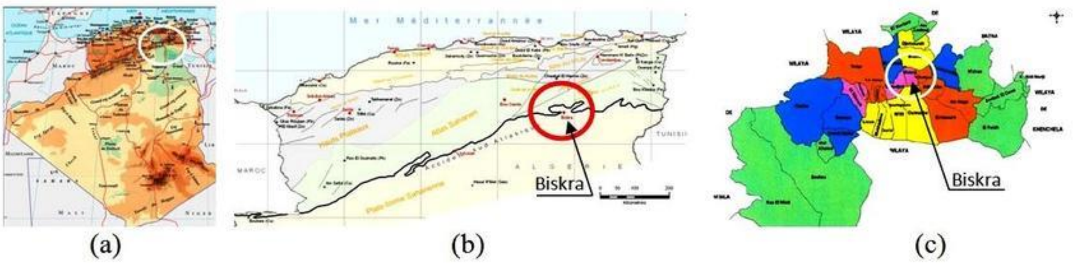


Figure 113 : (a) and (b), geographical location of the city of Biskra; (c) administrative map, wilaya of Biskra, source : https://www.researchgate.net/figure/a-et-b-Situation-geographique-de-la-ville-de-Biskra-c-carte-de-decoupage_fig3_317259488

Geographical location: Biskra is located in the southeast of Algeria, in the northern part of the desert at 34.8 degrees latitude, 5.73 degrees longitude, and 87 meters altitude. It has an area of 21,509.80 km^2, with a population density of 34 inhabitants/km^2.

History of Biskra: Biskra has a rich history that spans the ages, from the Roman and Byzantine era, during which it was known as "VESCRA", through its prosperity in the Middle Ages with the settlement of the Zenata tribes, to the Islamic period, when it came under the rule of the Umayyad state led by Uqba ibn Nafi. Several dynasties ruled North Africa, reflecting its strategic location between the desert and major cities. In the colonial era, Biskra came under French control and witnessed significant local resistance. During the Liberation Revolution, it was attached to the Sixth Province (Sahara), and after independence, it became an autonomous province in southern Algeria.1

Climatic data for the city of Biskra:

Climate: Alternating seasons. Due to its geographical location, Biskra is classified as having an arid climate. According to Marc Cote in his book "Rural Mutations in Algeria" (1980), this climate is characterized by very cold and dry winters and hot and dry summers. For this reason, the climatic parameters are defined as follows2:

La température : La température à Biskra est caractérisée par l'alternance de deux saisons relativement distinctes. Un hiver désertique qui dure de novembre à mars, avec des nuits froides, et un été qui dure plus de six mois, avec des températures dépassant les 40 degrés centigrades.

[1] Benharra, 2016
[2] ABDOU,2022

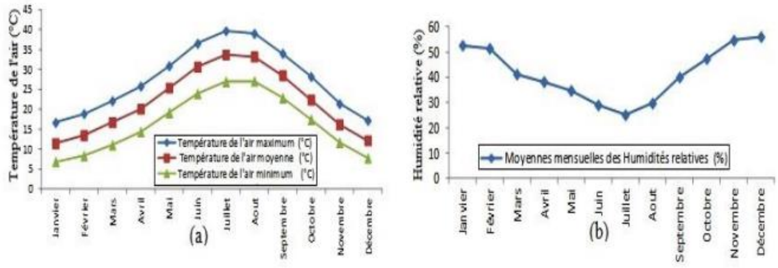


Figure 114 : (a) Graphe relatif à la moyenne mensuelle des températures de l'air de la période 67-2005. (Source: Données station météorologique de Biskra)
(b) Graphe relatif à la moyenne mensuelle des humidités relatives de la période 1975 – 1984. (Source: Données atlas climatologique national)

prevailing winds:

Biskra is located within a semi-arid climate characterized by high temperatures in summer and relatively cold temperatures in winter, with a large discrepancy between daily and annual temperatures. Weak and irregular rainfall is recorded, which enhances the dry character of the area. Winds play a prominent climatic role, as cold, humid winds prevail in winter, coming from the northwest at an average speed (35 km/h). In the spring and fall, dust-laden southerly winds blow at speeds of up to 80 km/h, leading to material and agricultural damage. In summer, however, the "Shehili" (Sirocco) appears, a hot, dry wind coming from the southeast at a speed between 6 and 12 m/s, and although it is less frequent, its effect is visible on buildings and crops (Abdou Y, 2014).

The humidity:

The average relative humidity is low, around 47%, with a maximum of 90% in December and a minimum of 10% in July and August. This variable remains one of the weakest that characterizes this climate; in addition, this region experiences a significant evaporation, which reaches 2600 mm as an annual average. (Alkama 1995).

Incident solar radiation :

The incident solar radiation is very intense and of the order of 7680 Wh/m2, on a horizontal plane during July (a), which corresponds to a duration of sunshine of 383 hours, (b) and which can exceed 12 hours per day. In winter, it reaches its minimum during the month of December for an intensity of 2712 Wh/m2 , which corresponds to a duration of insolation of 219 hours/ month, or 7 hours/ day. All this contributes to the harsh climate of Biskra.

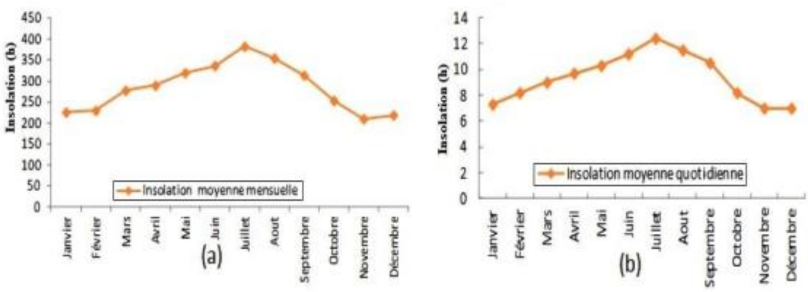


Figure 115 : (a) Graphe relatif à la durée moyenne d'insolation mensuelle ; (b) graphe relatif à la durée moyenne d'insolation quotidienne de Biskra source : stratégie d'amélioration du confort thermique d'une place publique dans une saharienne "Biskra/Algérie"

1.5.2.1 Site analysis:

Location of the site:

The land is located in an urban development and creep area programmed as a habitat area (individual), located close to a group of facilities (university housing city, primary schools, kindergarten, mosque...), to the east limited by a large palm orchard and on the west and north side of old neighbourhoods in the south opposite a new military scheme. The land is located on an area of 5 hectares.

Figure 116: Terrain site plan
source : Google Earth, 2025

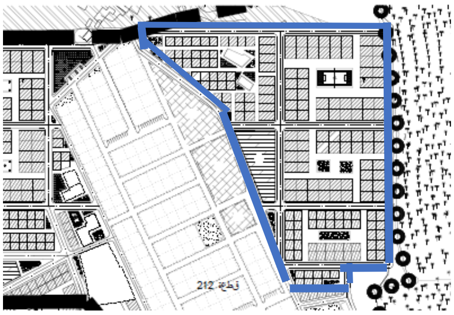


Figure 117: The boundaries of the field according to POS 1
Source: APC documents, 2024

Figure 118: The perimeter and equipment surrounding the field.
Source: Google Earth modified by the author, 2020

Physical and natural environment:

The plot of land is slightly elongated. In longitudinal and transverse sections, the terrain had a flat morphology

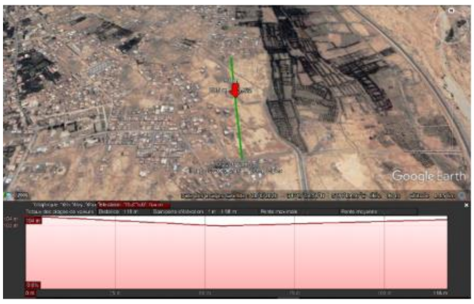


Figure 120 : coupe longitudinale
Source: Google Earth,2025

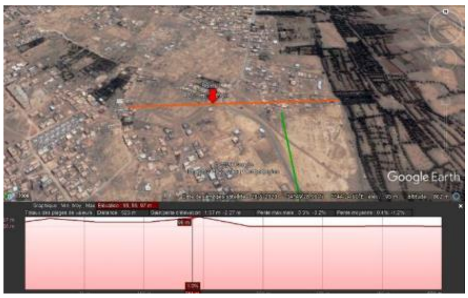


Figure 119 : coupe transversale.
Source: Google Earth,2025

Sunshine and terrain shading:

According to the Sun path, the figure shows that the terrain is well sunny, as it does not have obstacles that obscure the sun's rays; however, the terrain lacks shade.

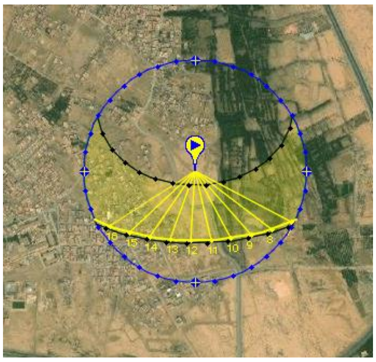


Figure 122: The solar path
Source: Sun Earth tools.com

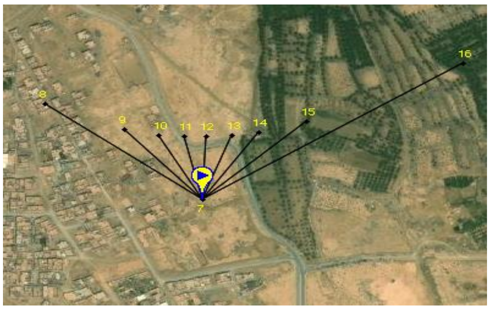


Figure 121: The shading path
Source: Sun Earth tools.com

The curve shows that solar radiation reaches its peak during the summer months (June-August), which is in line with the sun's rise in the sky during this period. In winter (December and January), radiation values decrease markedly due to the low angle of the sun and short daylight.

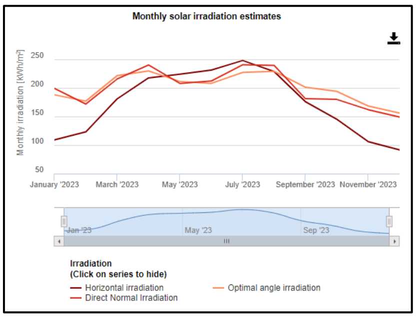


Figure 123: The attached curve shows estimates of the monthly solar radiation of the Lebechach a biskra site in 2023.
Source: Sun Earth tools.com

Temperature :

The curve displays average monthly temperatures starting at a gradual high from January (~ 10 ° C) and peaking in July (~ 35 ° C), reflecting high summer heat. It then gradually decreases as winter approaches,reaching its lowest

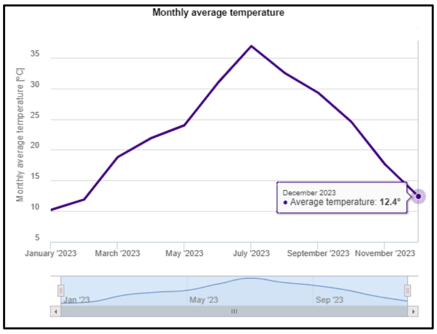


Figure 124: The curve displays average monthly temperatures in the area of Lebchech Biskra for 2023.Source: Sun Earth tools.com

level in December (12.4 ° C). This indicates a mild seasonal climate, with a relatively hot summer and cold winter.

Visual sequence:

Figure 125: Some views of the different accesses to the site.
Source: Author, 2025

The field analysis summary:

- High visibility and readability of the site (strategic location).
- Accessibility (easily accessible from different parts of the city)
- The proximity of several facilities.
- The site is located on a major pedestrian axis;
- The site has a large and unaffected area.
- Warm southeasterly, cold north-westerly winds.

3.4 Survey Methodology :

In this study, a survey-based methodology was adopted through the use of a structured questionnaire. The aim was to analyze the opinions and knowledge of architecture professors and students regarding housing and shading strategies in arid climates. The collected answers served as valuable input for addressing the main research question and achieving the primary goal of integrating these perspectives into the analysis and design process. This approach allowed for a better understanding of how academic stakeholders perceive climate-responsive housing design.

2.3. The questionnaire :

The questionnaire is a data collection tool consisting of a series of questions addressed to a specific category of the population targeted by the evaluation, based on real facts. Its purpose is to obtain individual responses, identify needs, and ultimately develop recommendations for action. (Hap, 1990, pp. 3–4).

An organized questionnaire with 18 questions was drafted and structured into three main sections: general information, dry climate characteristics, and housing design shading solutions in dry climates. This structured format enabled systematic exploration of the research query, as well as aiding in the organization of key concepts. The questionnaire was issued to a group of 66 participants, for example, professors and students, at varying levels of study within the Department of Architecture. The answers provided helped provide insightful feedback that enabled the derivation of relevant conclusions and recommendations that informed the initial surface-level project design.

Analytical Reading of Previous Studies and Survey Results :

Findings of the questionnaire among professionals from the architecture profession—students and professors—indicated that this academically and analytically trained group places high emphasis on climate-responsive design approaches, particularly in warm climates. Shading, proper orientation, and well-balanced public and private space provision are cited as key strategies. These specialists highlighted that it is not a question of simply providing the area with more facilities and services, but of integrating sustainable design techniques adapted to the local climatic and social context.

On the other hand, the previous work conducted in the Lebchech neighborhood and also the survey conducted in the field with the residents themselves revealed that the neighborhood suffers from clear urban isolation. This is reflected in the lack of urban planning and the absence of what matters to quality of life—like parks, public spaces where individuals can interact with one another, and cultural or social amenities. The residents live in an area that is mainly just shelter, without any significant social or environmental component to improve their everyday lives. Nevertheless, the majority of them had an intense passion to transform their neighborhood into a multifunctional, vibrant, and livable space, improving their quality of life.

Therefore, the findings of the previous studies and the field studies were adopted as a reference point at the base level for the analytical and design task of this research. In the meantime, special attention was given to integrate the complementary inputs of architecture experts whose better comprehension allows them to bring up solutions that are responsive climatically as well as rooted socially in response to local people's aspirations.

Recommendations adopted from the previous study

-The absence of public spaces, spaces that strengthen social relations between people.

-The hope of reviving old Biskra by promoting compact fabrics, palm grove, water (saguia).

-The absence of protections against prevailing winds and sand winds. -The environment is very exposed to the sun all day, with the absence of outdoor covers.

-Promote Wast Eddar inside the dwellings.

-Gardens, productive gardens, as a source of autonomy at the home level.

-Maximum limitation of contact with the outside (privacy).

-Deal with radiation from the West.

-Minimize consumption bills.

Global Interpretative Synthesis – Key Findings:

Solar radiation and heat as central design problems:

The study identified the greatest problem in design for arid climates to be excessive solar radiation and ambient temperatures. Both students and faculty members consistently listed these as major issues to functional building performance and thermal comfort. This highlights the need for climate-responsive design that directly addresses the hot and dry climate conditions.

Overwhelming preference for natural, vegetation-based solutions

The respondents largely preferred passive and nature-based shading solutions, specifically the use of vegetation. Vegetation and green cover were seen as effective means not only for shade but also for improving the microclimate, increasing humidity, and elevating environmental quality. Architectural devices like awnings were mentioned as secondary, while vegetation was the most comprehensive solution.

High demand for functional applications and climate-focused design materials

The survey brought out a strong interest among the respondents in more comprehensive educational content for climate analysis and principles of sustainable design. The respondents wanted to know about utilizing local materials and natural resources to achieve energy efficiency and thermal optimization. There is a demand for more hands-on, experiential learning in architectural programs.

Demand for climate adaptation in architecture practice:

Finally, the responses highlighted the importance of designing according to the local climate. With the hot, arid conditions and seasonality that dominate a large part of the respondents' regions, architecture must be adapted both technically and culturally. Effective solutions must consider local materials, customs, and social context, including sustainability both in architectural education and in actual practice, in order to promote livability and resilience.

3.5 Programming :

Jean-Pierre Epron (1995): “The architectural program is a set of needs and constraints formulated by the client, which serve as the basis for the design of the architectural project.”

In architecture, Le Programme refers to a set of functional requirements and needs that define the nature and objectives of an architectural project. An architectural program is an essential element of the design process, providing the frame of reference that guides architects and planners in developing design solutions that respond to the functional and aesthetic requirements of a building or urban space.

The program is a statement of the precise characteristics of a building to be designed and built, given to candidate architects to serve as a basis for their study and the establishment of their project. According to the Larousse dictionary

This program is a process that we must follow and go through to master our project.

The choice of housing and the development of a housing estate program were based on :

- Requirements extracted at the site level
- Site potential
- The examples analyzed in part

Among the factors influencing the determination of the program for such a project are :

Needs felt at site level: Symbolic of the town

small urban square -garden -green spaces -playground

Site potential :

Lebchich suffers from a lack of public spaces, such as playgrounds and gathering places, as well as green spaces, both public and private, and basic facilities, such as shops, a mosque, and a school. Therefore, these needs were taken into consideration when preparing the program.

Secondly, following the PDAU of the wilaya of Biskra and the POS 1 of the south of the city, we extracted the essential field data for programming:

POS 1 of the southern zone of the city of Biskra :

- Total land area: 19.5 ha
- Density: 35 dwellings per hectare (individual housing).
- Type of housing: individual.
- COS of land studied:
- TOP: F3 - F4 - F5.
- Dwelling height: maximum (R+2).
- Housing surface area: from 180m^2 upwards.

The examples analyzed in part :

proposed program:

space	**Official Program Area**		**21 villa of Dar Al zain**	**Villas at Al Zohra in Ajman**	**72 hossing units in Sidi Okba Biskra**	**216 individual housing units in the new urban centre in Gharb Zahoun – Biskra**		**Proposed program**			
	N	S				TYPE 01(R+1)	TYPE02(R+2)	F3	F4	F5	N
Entrance			4 m	6 M^2	4.8 m^2	11.22 m^2	14.28 m^2	x	8 m^2	10 m^2	1
Living room	01	22m^2	25m^2	158.55 M^2	23.29 m^2	23.26 m^2	24.69 m^2	20 m^2	25 m^2	30 m^2	1
Family room		18m^2	X	41.70 m^2	x	X	X	x	20 m^2	40 m^2	
Bedroom1		15m^2	25 m^2	34m^2	14.43 m^2	13.33	15.27 m^2	15 m^2	18 m^2	28 m^2	1
Bedroom2		15				15	14	x	20	20m^2	1
Bedroom3		15				18.29	16.28 m^2	x	x	18m^2	1
Master suite		X	28 m^2	68.68 M^2	x	x	x	22 m^2	25 m^2	28 m^2	1
Bathroom	02	6 m^2	6 m^2	6-7 M^2	1.10 m^2 /6.00 m^2	4.49 m^2	9.9 m^2	6 m^2	6m^2	6m^2	2
Kitchen	01	14 m^2	18 m^2	58.28 m^2	14.43 m^2	16.28 m^2	14.80 m^2	14m^2	18m^2	20m^2	1
Dining room	01	10 m^2	10 m^2	20 M^2	20.30 m^2	x	x	x	12m^2	12m^2	1
Hall	01	8 m^2		x	10.50 m^2	17.67 m^2- 20.02 m^2	17.58 m^2- 19.17 m^2	5m^2	8m^2	10m^2	2
Courtyard	01	20 m^2	X	24.98 M^2	20.30m^2	20.92 m^2	17.64 m^2	20m^2	25m^2	25m^2	1
Balcony		17 m^2	2 m^2	3.38 M^2	x	2.4 m^2	4.38 m^2	6 m^2	8m^2	10m^2	1
garage	01	14 m^2	28 m^2		24.47 m^2	20.92 m^2	20.92 m^2	14m^2	18m^2	20m^2	1

dressing room		X		6m²	3-6 M²	x	x	x	3m²	5m²	6m²	2-4
Total		F3	80	153,500	681.73 m²	145.00m²	149.91 m²	149.91m²	125m²	150m²	200m²	
		F4	100									
		F5	120									

Only 60% of the total area of the plot was allocated for housing functions, after 40% of it was taken out to meet urbanization requirements, which included road networks and shared public spaces.

This distribution aims to achieve an urban balance between residential density and ensuring the quality of the urban framework by providing effective infrastructure and public spaces that contribute to improving the daily life of residents, in line with the principles of sustainable planning.

Density and residential distribution:

Based on a density of 30 housing units per hectare, the total site area of 3.5 hectares yields a projected 104 dwelling units.

F3	F4	F5
50% ____ 52 u	25 % ___ 26 u	30 %____ 26 u

Conclusion

This chapter is composed of a collection of reference examples and models in which the significance of shading methods in architectural design is emphasized. These were consulted to study them, to examine them, and extract to the fullest the common requirement of a residential project, and address these strategies in arid climates. The case study was centered on the city of Biskra, addressing with special consideration the specific site of the project by examining its climatic, urban, and social factors.

The results of the questionnaire sent to different professionals and users were also analyzed to gather diverse perspectives on housing needs in this climate situation, and to bring clarity to perceptions regarding the concept of "adequate housing" for the region. This examination allowed us to obtain quantitative and qualitative information that was used to develop the functional program proposed for the project.

These initial steps create a required knowledge base and methodology that can be employed to move towards the architectural design phase. These provide tight integration between the theoretical framework and practical application, ensuring an integrated architectural proposition, rooted in context, and directed towards enhancing the quality of life within arid zones.

Architectural Conceptual Approach to Shading Strategies

Introduction

Architectural design is the essence of the creative process in completing any architectural project, as it represents the stage in which ideas are embodied and transformed into tangible solutions that respond to site requirements, climate data, and the functional needs of users.

In this chapter, the methodological steps that were followed to design the project will be presented, starting from defining the architectural orientation, all the way to crystallizing the design idea and developing it to suit the requirements of the climatic and social context. It will also highlight the basic design decisions, approved references, and architectural strategies that supported the formulation of the final project proposal and the attempt to implement all the mentioned elements. Finally, we will review all the technical offers of the project.

3.1. Objectives :

- Using local materials with modern insulation.
- Design neighborhoods to enhance shade and privacy.
- Using the built-up block itself as a means of climate control.
- Make buildings close together without losing privacy.
- Making the building take from the spirit of ancient architecture and not be foreign to it, so the imitation is not only in form but also in function.
- Create a traditional design of the dwelling in a modern form (rooting modernity).

3.2. The principes and concepts :

1. Climatic and social centrality

The project is organized around a central, multifunctional space, whose role is not limited to promoting urban social life and intimacy, but also acts as a micro-climate regulator. This space is designed using local materials with high insulation efficiency.

2. Gradient spaces for shade and comfort

The principle of gradualism allows a functional sequence between public, semi-public, and private spaces, in a way that ensures ease of movement and exchange of meetings between residents, while achieving the greatest possible amount of natural shade.

3. Introversion as a strategy for climate control and identity preservation

Relying on the principle of introversion inspired by traditional architecture, the openings are directed towards shaded inner courtyards, providing natural protection from high temperatures and promoting social relations within a confined and safe framework. Public spaces are also designed to complement the home space.

3.3. Design concept :

Referencing oasis architecture by drawing inspiration from the shape of palm trees as a source of shade and refreshment, from the shape of the valley, the project transforms into a modern residential oasis. The residential units are distributed around internal courtyards and a community center at the heart of the neighborhood. These units vary slightly depending on their orientation.

3.4. The idea

Inspiration for the idea

The conceptual idea for our project came from observing the city of Biskra, considering shading strategies. After the information we gathered in the course of our work, we began to draw inspiration from old Biskra and contemplate the city's ancient fabric, the first core of the city of Biskra, and looking at the land, which on one side is close to the Nakhil oasis, we were inspired to revive the traditional residential oasis in a contemporary way.

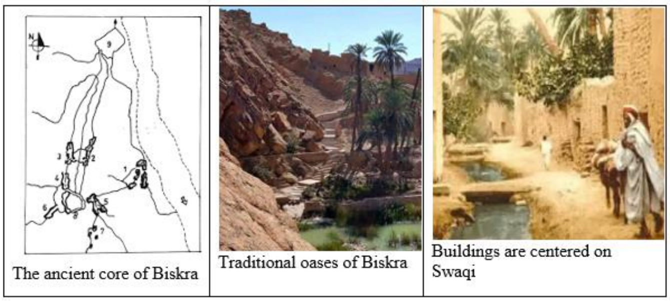


Figure 126: Inspiration for the idea
source: Author, 2025

The idea of the mass plan:

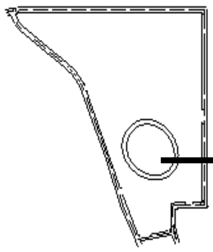


Figure 127: Diagram of the first master plan
source: Author, 2025

the central organization of the urban fabric of the old core of

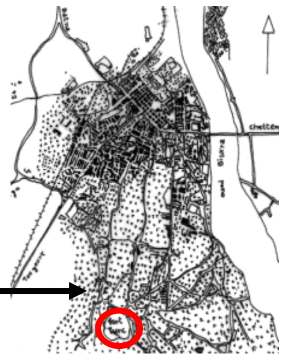


Figure 126: Situation of the city of Biskra, map from 1972
source: PUD 1974 from biskra

For the second phase, we divided the plot into a main axis inspired by the valley that separates the city of Biskra

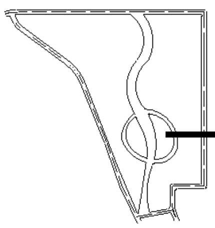


Figure 128: Diagram of the first master plan
source: Author, 2025

Figure 129: Site plan of Biskra
Source: Earth Google,2025

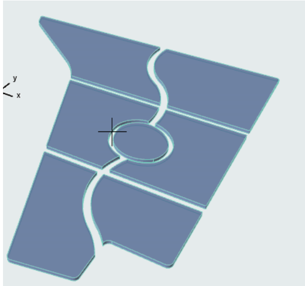


Figure 130 : Initial layout of the location of the master plane. source: Author, 2025

In the third phase, we defined a route and adopted the Sakia principle, which follows The route of the old Biskra neighborhoods

The idea of clustering and the cell:

- **Clustering:**

Our idea of aggregation is based on the examples studied and the principles already mentioned. So we started thinking about the principle of an urban fabric integrated with the environment in traditional oases characterized by urban planning, where housing is distributed in a compact, interconnected, and close manner, which provides shade and reduces the effect of heat. This design improves natural ventilation and reduces energy consumption.

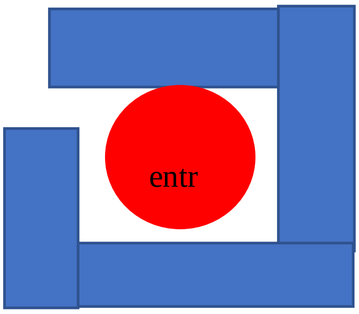


Figure 131: Diagram of the first master plan source: Author, 2025

The cell:

the cell design idea is based on the shape of the floor and the central piece of the interior, the "courtyard."

Where the interior courtyard was designed in a contemporary architectural form inspired by the characteristics of the arid environment, the courtyard is a vital organizational element in the design, as it interacts flexibly with the functional spaces surrounding it, through its connection to three main axes:

The residential axis, which includes bedrooms, the social axis, represented by living and reception spaces, and the service axis, which includes the kitchen and pantry.

3.5. Shading strategies to be applied in the project :

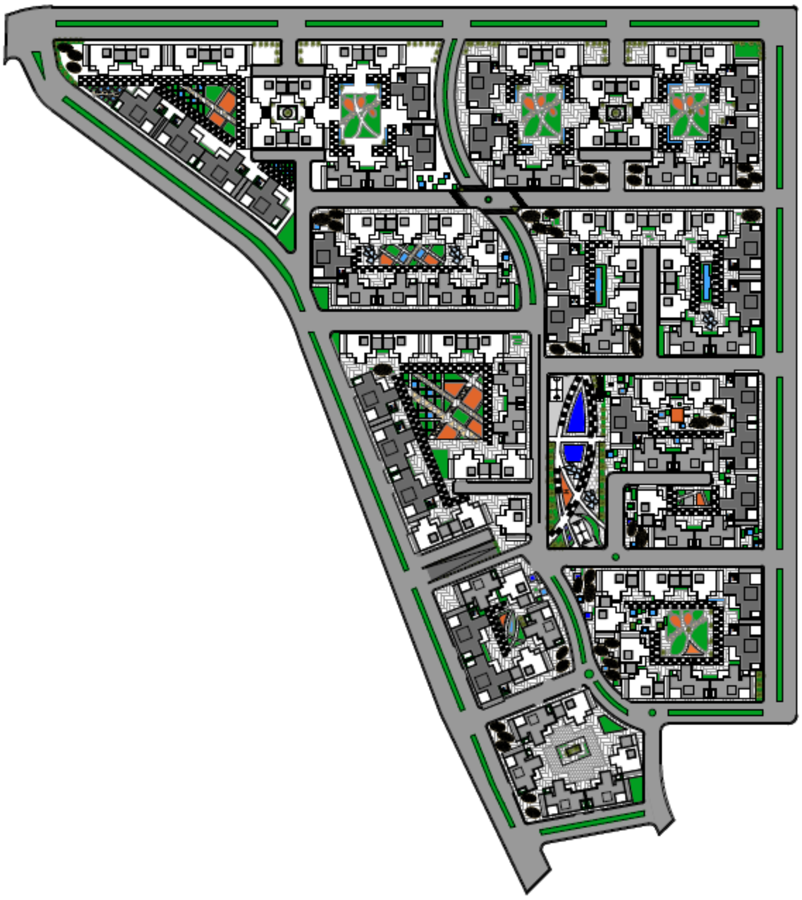
In terms of the site plan:	Density: Compact Urban Form	Implementing this strategy reduces the areas exposed to sunlight throughout the day and enhances shade.	
	Shaded walkways	Positive shaded walkways	Negative shaded corridors
		Creating naturally shaded walkways without the need for additional elements,	This strategy was implemented in addition to umbrellas to create shade and

		through the careful distribution and overlapping of volumetric blocks to provide shade.	make the spaces less exposed to the sun.
	Built Barriers	Using certain blocks as natural sunshades to shade courtyards	
	Smart, well-thought-out orientation	This strategy was adopted through an urban design based on the convergence of built blocks and their organization according to a stepped system that takes into account differences in elevation. Residential units were oriented and distributed gradually from south to north, as well as along east-west and "west-east" axes, allowing each unit to benefit from the shade of the unit above it. This gradation in heights creates mutual shadows between buildings, limiting the exposure of facades to direct sunlight and contributing to reducing the heat load on residential blocks.	
	Green Buffers	Planting large trees between buildings or in public squares creates natural shade in summer and fall in winter to create natural lighting.	
At the cellular level:	Compact Urban Form	Reducing the distances between buildings helps to create mutual shadows, especially when they are arranged in a gradient of heights.	
	Architectural projections (Avancées architecturales)	Such as balconies that shade openings and deep recesses that let in more light and prevent direct sunlight from entering the interior.	
	Solar screens (Brise-soleil)	Elements installed on windows to reduce radiation leakage according to the angle of the sun. They can be horizontal or vertical depending on the direction of the sun.	
	Moucharabiehs (perforated carvings)	A traditional technique that provides privacy while allowing ventilation and partial shading of windows, with added aesthetic appeal.	

3.6. Project presentation:

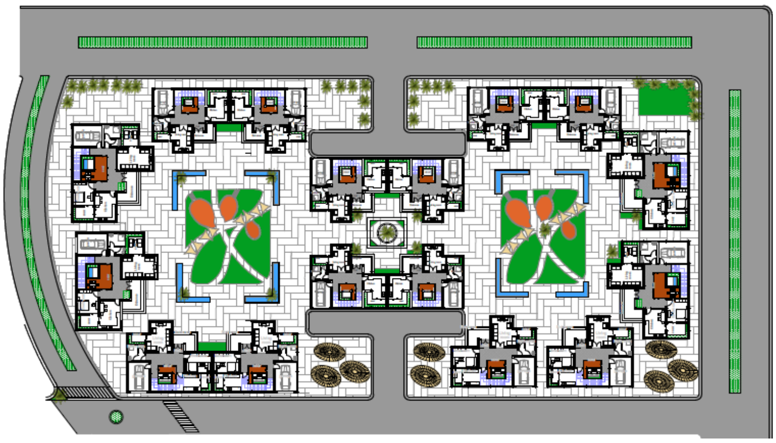
After the conceptualization phase of the project, we will move on to the presentation phase of the different phases of project

Master plan :



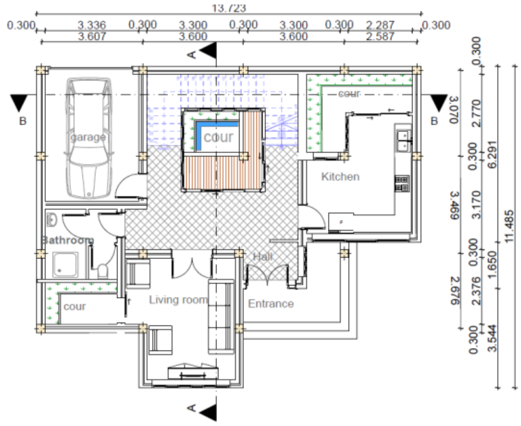
Assembly drawing :

The following figure shows the assembly plan for 16 cells.

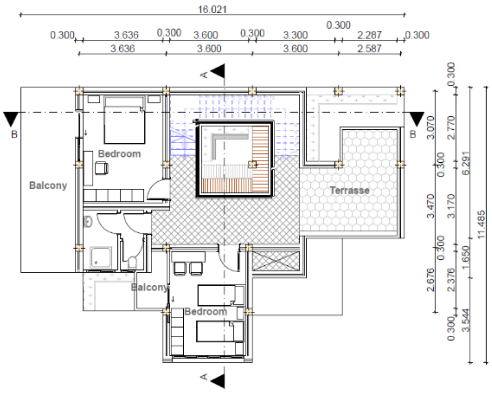


Type I cell plan :

Ground floor plan

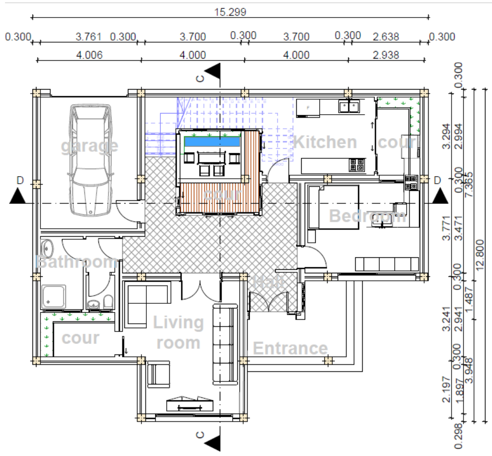


1st floor plan

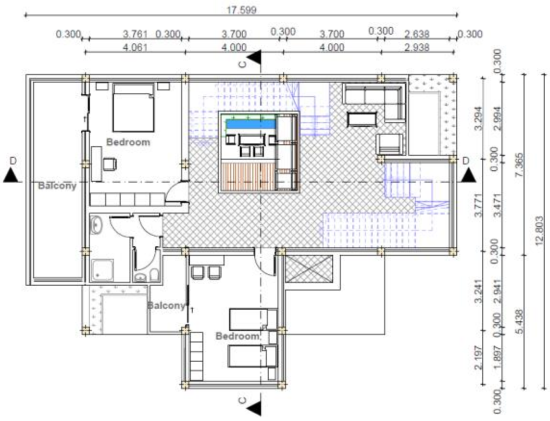


Type II cell plan :

Ground floor plan



1st floor plan

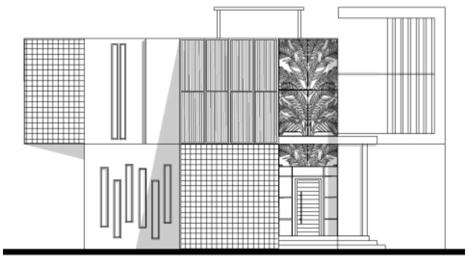


Facade processing:

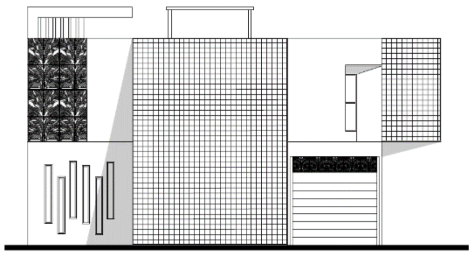
The facade treatment is inspired by the traditional oasis in its simple symbolic form, incorporating the mashrabiya element into the façade. We also use the concepts of shading strategies, adding sunscreens, and small openings in the sun-exposed facades.

Type I

Main façade

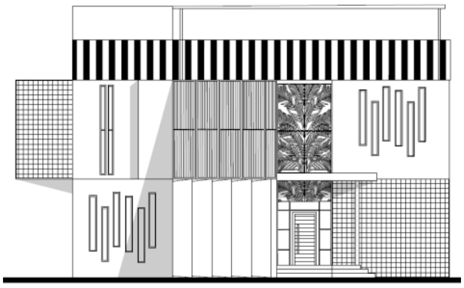


South facade

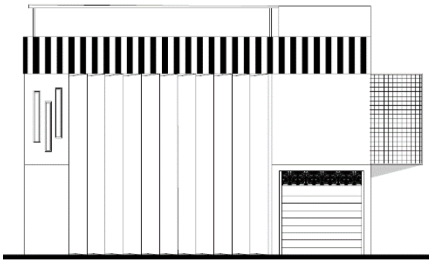


Type II

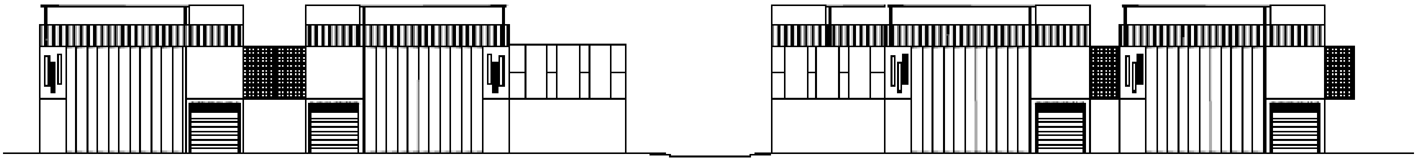
Main façade



South facade



Urban façade



Application of the theme shading strategies in the project:

Density: Compact Urban Form

Implementing this strategy reduces the areas exposed to sunlight throughout the day and enhances shade.

Smart, well-thought-out orientation

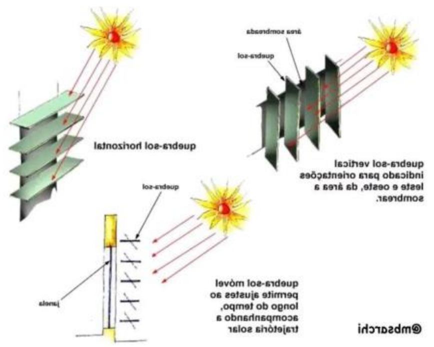
This strategy was adopted through an urban design based on the convergence of built blocks and their organization according to a stepped system that takes into account differences in elevation. Residential units were oriented and distributed gradually from south to north, as well as along east-west and "west-east" axes, allowing each.

Shaded walkway:

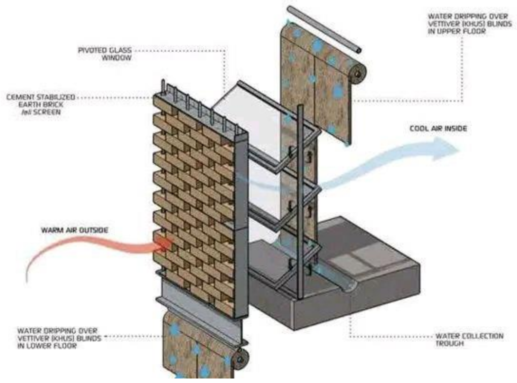
Positive shaded walkways

Negative shaded corridors

Solar screens (Brise-soleil)



Moucharabiehs (perforated carvings)



External views of the project :




General conclusion

conclusion

Through this study, we have attempted to highlight the importance of integrating shading strategies into housing design, particularly in arid regions such as the city of Biskra, where controlling solar radiation and heat is a decisive factor in improving user comfort and reducing energy consumption. In this paper, we addressed basic concepts such as housing and thermal comfort and focused in particular on shading strategies as an effective design tool that can be implemented through architectural solutions from traditional architecture and others supported by modern technologies. Relying on these strategies helps us in our work to design individual housing complexes in the city of Biskra that adapt to their environment and ensure the comfort of their residents.

Through this work, which consists of three chapters, a theoretical chapter and two practical chapters on the analytical part and project implementation, in the first chapter on concepts and theories, we first defined the concept of "housing" based on its definitions according to different perspectives: functional, architectural, and the different words that fall under the term "housing." The evolution of housing over time. To provide an overview of major historical developments, we reviewed the types of housing, especially individual housing, its definition, and its different types of arrangements: detached, semi-detached, etc. Second, we began by defining the concept of thermal comfort, its types, and its relationship to housing. We then addressed the topic of our research, shading strategies in architecture, where we separated it into concepts and definitions by different architects, its natural and industrial types, methods of calculation, and its relationship to thermal comfort, followed by a general summary of this chapter.

In the second chapter of the analytical study, we began by analyzing various examples of successful individual dwellings in which shading strategies were used. The theoretical and realistic examples analyzed showed how shading solutions contributed to enhancing thermal comfort within dwellings, which is in line with the climatic characteristics of Biskra. The site analysis also enabled us to understand solar radiation behavior and wind patterns, allowing us to select appropriate shading strategies for facades, outdoor spaces, and architectural massing. In addition, the field survey helped us to identify the real aspirations of the region's inhabitants in terms of housing requirements, giving us a realistic basis for translating this data into the project's functional program.

The final chapter deals with the design phase of the project, based on the previous data, defining the design intentions and objectives that guided the transition between the different levels. This process culminated in an integrated design concept that reflects the principles adopted in the project. This chapter includes a presentation of the various stages of design development, from the initial concept to the final vision.

We can therefore conclude that our hypothesis has been confirmed: individual dwellings can be designed in a dry environment such as the city of Biskra by employing effective and integrated shading strategies, whether traditional or modern, that take into account the specific characteristics of the climate and strike a balance between environmental and economic performance and the daily comfort of residents.

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Appendices

Appendices

استبيان حول استراتيجيات التظليل في مشاريع الإسكان في المناطق الجافة

مقدمة :

أهلاً وسهلاً،

أنا طالبة ماستر في الهندسة المعمارية وأعمل على مذكرة تخرج حول موضوع "استراتيجيات التظليل في مشاريع الإسكان في المناطق الجافة". الهدف من هذا الاستبيان هو جمع آراء الطلاب وأعضاء هيئة التدريس في الهندسة المعمارية حول الإسكان واستراتيجيات التظليل في المناخات الجافة. سيتم استخدام هذه الآراء في تحليل البحث وتطوير استراتيجيات فعّالة لتحسين بيئة الإسكان في هذه المناطق.

معلومات شخصية :

1. العمر__________ :
2. الجنس:
   - ☐ ذكر
   - ☐ أنثى
3. التخصص الدراسي / الوظيفي:
   - ☐ طالب هندسة معمارية
   - ☐ عضو هيئة تدريس في قسم الهندسة المعمارية
4. السنة الدراسية / الرتبة الأكاديمية:
   - ☐ طالب في الطور الأول (ليسانس)
   - ☐ طالب في الطور الثاني (ماستر)
   - ☐ طالب في الطور الثالث (دكتوراه)
   - ☐ أستاذ جامعي

الأسئلة:

1. المعرفة حول المناخات الجافة:

1.1 هل سبق لك أن درست تأثير المناخ الجاف على تصميم المباني؟

- ☐ نعم
- ☐ لا

1.2 برأيك، ما هي أبرز تحديات التظليل في المناطق الجافة؟

- ☐ ارتفاع درجات الحرارة
- ☐ الشمس المباشرة لفترات طويلة
- ☐ الجفاف وقلة الرطوبة
- ☐ الرياح الصحراوية
- ☐ أخرى (يرجى التحديد : ______________________________

2.استراتيجيات التظليل:

2.1 هل لديك معرفة أو خبرة مع استراتيجيات التظليل في المشاريع المعمارية؟

- ☐ نعم
- ☐ لا

2.2 من بين الخيارات التالية، أي من استراتيجيات التظليل تعتبرها الأكثر فعالية في المناخات الجافة؟ (يمكنك اختيار أكثر من إجابة واحدة في هذه الحالة قم بوضع رقم ترتيبي من الأهم إلى الأقل أهمية)

- ☐ استخدام المظلات (شرفات، ستائر شمسية)
- ☐ الزجاج المظلل أو المعالج
- ☐ الأسطح العاكسة أو الطلاء العاكس
- ☐ نباتات تظليل أو زراعة في الهواء الطلق
- ☐ مظلات ثابتة (مثل الحوائط، الأسطح العلوية)
- ☐ أخرى : ______________________________

2.3 كيف تقيم تأثير استراتيجيات التظليل على توفير الطاقة وتخفيف الحرارة؟

- ☐ فعال جداً
- ☐ فعال
- ☐ محايد
- ☐ غير فعال
- ☐ لا أعرف

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3. تصميم الإسكان في المناطق الجافة:

3.1 هل تعتقد أن تصميم الإسكان في المناطق الجافة يحتاج إلى تحسينات خاصة لتحسين الراحة الحرارية؟

- ☐ نعم
- ☐ لا
- ☐ لا أعرف

3.2 في رأيك، ما هي أهم العوامل التي يجب أخذها بعين الاعتبار عند تصميم الإسكان في هذه المناطق؟

- ☐ التهوية الطبيعية
- ☐ استخدام مواد بناء معزولة حراريًا
- ☐ استراتيجيات التظليل الفعالة
- ☐ التحكم في التدفئة والتبريد
- ☐ غير ذلك، يرجى التحديد : ______________________________
-

3.3 هل تعتقد أن استخدام التكنولوجيا الحديثة يمكن أن يساعد في تحسين استراتيجيات التظليل؟

- ☐ نعم
- ☐ لا
- ☐ ربما
- ☐ لا أعرف

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4. توجهات الطلاب والممارسات المستقبلية:

4.1 هل تتوقع أن تكون استراتيجيات التظليل جزءاً مهماً من تعليمك المستقبلي في مجال الهندسة المعمارية؟

- ☐ نعم
- ☐ لا
- ☐ ربما

4.2 ما الذي تود تعلمه أو تطويره في مجال استراتيجيات التظليل للمناطق الجافة؟

- ☐ تحسين الأداء الحراري للمباني
- ☐ طرق مبتكرة لاستخدام الظلال الطبيعية
- ☐ تصميم فاعل وبتكاليف منخفضة
- ☐ فهم العلاقة بين التصميم المعماري والمناخ
- ☐ أخرى (يرجى التحديد : ______________________________

.5 السياق الجغرافي والمناخي:

5.1 في أي منطقة جغرافية تقيم حالياً؟

- ☐ منطقة حضرية
- ☐ منطقة ريفية
- ☐ أخرى (يرجى التحديد : ______________________________

5.2 كيف تصف مناخ منطقتك؟

- ☐ جاف
- ☐ شبه جاف
- ☐ متوسطي
- ☐ معتدل
- ☐ أخرى (يرجى التحديد : ______________________________

5.3 ما هي أبرز التحديات المناخية التي تواجهها منطقتك فيما يتعلق بالإسكان والراحة الحرارية؟

- ☐ الحرارة المرتفعة خلال الصيف
- ☐ قلة الرطوبة
- ☐ الرياح القوية
- ☐ درجات الحرارة المنخفضة في فصل الشتاء
- ☐ أخرى (يرجى التحديد : ______________________________

ملاحظات إضافية:

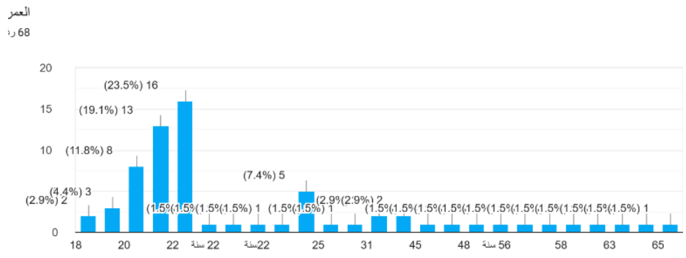
يرجى إضافة أي تعليقات أو اقتراحات حول هذا الموضوع:

نشكركم على مشاركتكم في هذا الاستبيان. سيكون لمساهماتكم دور كبير في إثراء البحث وتطوير استراتيجيات معمارية

Analysis of survey results: Shading strategies in dry regions

1. age distribution

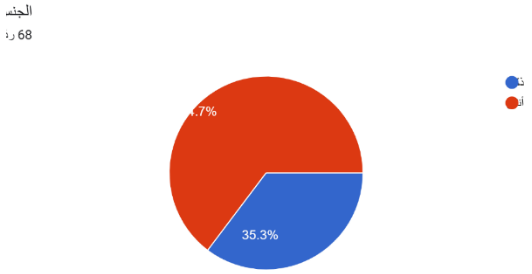
Age Category	Count	%
Under 25 years	51	77.3%
25–39 years	6	9.1%
40–59 years	8	12.1%
60 years and over	3	4.5%



interpretation: most respondents are young (students between 20 and 29 years old), so the perception mainly reflects a young academic population.

2. gender

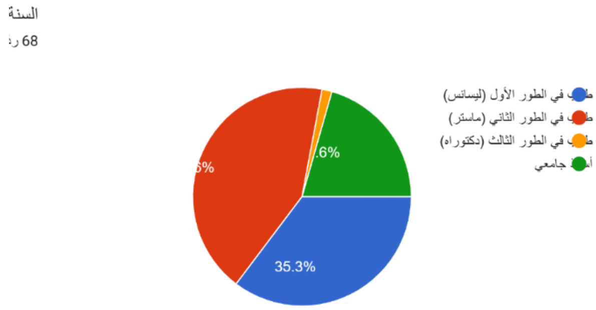
gender	number	%
female	38	64.4%
male	21	35.6%



interpretation: female respondents are the majority.

3. academic level

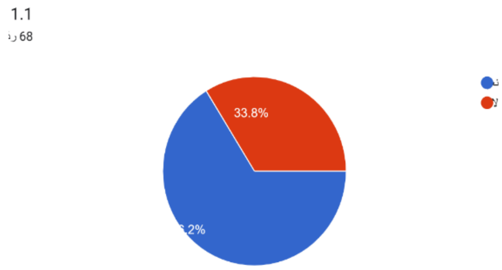
academic level	number	%
master's degree	26	44.1%
Bachelor's degree	20	33.9%
university lecturer	12	20.3%
doctorate	1	1.7%



interpretation: four out of five respondents are students in master's or bachelor's programs; there is also a group of lecturers for expert opinions.

4. knowledge of the impact of dry climate

response	number	%
yes	39	66.1%
no	20	33.9%



interpretation: two-thirds have already studied the relationship between dry climate and architectural design.

5. Knowledge or experience with shading strategies

response	number	%
yes	34	57.6%
no	25	42.4%

interpretation: More than half have knowledge or experience with shading strategies.

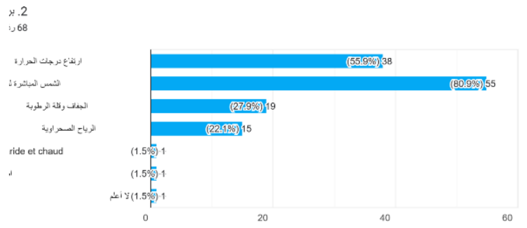
Summary and general interpretation

Most respondents are young students (aged 20-29, mainly in master's or bachelor's programs, and mostly female). two out of three respondents have studied the impact of dry climate on architecture. regarding shading, more than half consider themselves knowledgeable or experienced. there is a good representation of university lecturers, allowing a cross-perspective between students and teachers.

1. perceived challenges for shading in dry regions

Main challenges mentioned

challenges	%
- prolonged direct sunlight	47
- high temperatures	32
- dryness/lack of humidity	16
- Saharan winds	12
- lack of vegetation/other	2
- “don’t know”	1



interpretation: both students and teachers overwhelmingly identify direct solar radiation and extreme heat as the most pressing issues. lack of humidity and sparse vegetation further worsen the problem, underscoring the need for innovative shading solutions.

2. Most effective shading strategies

Most effective strategies mentioned:

strategies	%
- vegetation/planting for shade	48
- awnings, balconies, or fixed shading devices	41
- reflective roofs or paints	24
- fixed canopies (walls, overhead shading)	24
- special glazing (tinted or treated glass)	19
- other (local architectural treatments)	<3

interpretation: vegetation is the most preferred solution, followed by the use of awnings and passive architectural elements. reflective materials and special glazing are also recognized as effective.

3. Expectations for training and innovation

Expectations and wishes for training/innovation:

Expectations	%
- understanding the relationship between architecture and climate	34

- innovative methods for natural shade	32
- improving buildings’ thermal performance	31
- effective and low-cost design	30
- other (aesthetic design, curiosity)	<2

interpretation: there is strong demand for integrating climate analysis into design and for affordable, innovative, and nature-based solutions for improved thermal comfort.

4. Climate challenges in the region of residence

Main challenges cited:

challenges	%
- extreme summer heat	52
- strong winds	15
- low winter temperatures	13
- low humidity	12
- other (humidity, sandstorms, etc.)	<3

interpretation: excessive summer heat is the main challenge, followed by wind and low humidity. temperature variation between seasons is also significant.