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# Design Solutions and Architectural Treatments to Achieve Thermal Comfort in the Interior Space of the Building

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## Abstract

All countries of the world are moving to take measures to develop solutions to confront climate change, build resilience, and adapt to the inevitable effects of climate change, the growing energy crisis, and record concentrations of greenhouse gases... Here comes the role of architectural solutions, through successful designs using raw materials appropriate to the climate. It is hot in the Arab countries, especially the countries located in the desert climate region, which requires reusing some traditional architectural concepts with more modern designs, relying on technology, and using new methods of thermal insulation in order to make the building and the interior space more comfortable for the user by achieving thermal comfort. The research aims to study the architectural and design concepts and solutions in hot areas, humidify and renew the indoor air, and direct solar energy in a way that suits the nature of the climate and location in hot desert areas and encourage the concept of sustainable, environmentally friendly architecture, to rationalize energy consumption as one of the pillars on which the success of sustainable development in any country depends. Community and selection of advanced technology in a way that does not negatively affect the interior space.



***Keywords***

*Climate Change, Raw Materials, Solar energy, Technology, Thermal comfort*

## 1. Introduction

To obtain a comfortable interior space in terms of ventilation and lighting, one must rely on designs that take into account the nature of the region and its climate, especially the climate of the desert region, which is one of the main climatic regions in the Arab world, which is characterized by high temperatures, as temperatures in the summer range between 40 and 50 degrees Celsius and in the winter ranges between 10 and 20 degrees Celsius. The study is concerned with presenting the architectural methods, treatments, and successful designs of many Arab countries that follow the climate of the desert region, such as the Arabian Desert region, which includes Saudi Arabia, the Emirates, Qatar, and the Sahara Desert region, which includes Egypt. The study aims to clarify advanced architectural solutions and smart methods that are sustainable and consume less energy and at the same time have two advantages: being well-ventilated and environmentally friendly. This is done by focusing on reusing Islamic architecture in a more advanced manner and employing smart and sustainable concept.

## 2. Concepts of Climate architecture

Bioclimatic design: is the study of the impact of climatic factors on living organisms in general and humans in particular. Bioclimatic architecture: It is the architecture that stems from the nature of the region, including location, orientation, and local building materials, not only artistically and aesthetically, but also technically, with the determinants of heat, cold, and lighting. Therefore, it is considered architecture that respects nature and its resources and provides its residents with the maximum possible environmental comfort. A good integration of bioclimatic architecture must be in harmony with the site in a clear and influential way because architecture that leaves no trace is not good architecture. As for bioclimatic architecture: it is concerned with studying the relationship of architectural design and construction to climatic factors. (8)

Therefore, it has become necessary to find appropriate solutions for buildings in hot areas, in a manner compatible with the climatic conditions surrounding the building and thus protecting the internal space, in sunny areas, as is the case in most cities in the Arab world. The design strategy revolves around avoiding direct sunlight in the first place.

Adaptation to the climate: The dwelling must adapt to the climate and its various elements. The moment the building is completed, it becomes part of the environment, such as a tree or stone, and becomes exposed to the same effects of the sun, rain, or wind as anything else in the environment. If the dwelling can face climatic problems at the same time, it exploits all available climates and natural resources in order to achieve human comfort inside the dwelling, (17) so we can call the dwelling as climatically balanced.

This is done by studying the relationships between the spaces used, such as movement paths, building formation, wind direction, solar radiation, mechanical systems, and building technology. The design must also take into account the history of the region and the land so that the house becomes distinguished by its ease of use, quality of construction, and beauty of form.

The factors that make up the thermal environment inside the building can be summarized in: temperature, humidity, and air movement. However, temperature is considered the most important factor among them. However, the effect of the other two factors cannot be ignored.

## 3. Achieving thermal comfort by reusing Islamic architectural concepts

To obtain an interior space that enjoys thermal comfort and lower energy consumption, one can rely on some Islamic architectural concepts and treatments, but with a newer design. There are many successful designs in a large number of Arab countries that have succeeded in developing these design concepts.

### 3.1. Mashrabiya

The interior architecture designer can use the "mashrabiya", which is considered one of the most successful Islamic architectural solutions in dealing with openings. It helps move and draw air into the room by controlling the airflow, (12) the wood is not affected by sunlight, and it is a natural porous material made of organic fibers. The “mashrabiya” provides shade inside the dwelling without completely closing the window, and thus maintains air movement, which helps lower the temperature in the summer. It also benefits from humidity control.

The interior architecture designer can redesign the mashrabiyas to suit the development of time, as it is possible to place false windows over the glass from the outside or inside, make openings in the walls, or design wall perforations that allow a larger amount of air to pass from the outside to the classrooms. It increases natural lighting and provides privacy, but these perforations and openings in a design that suits the nature of the space, such as covering all windows with perforated shutters directly on the facade, or they can be opened when residents want a clear view while controlling light, shade, ventilation, and privacy. Semi-open wall barriers can also be used to increase the desired air volume and velocity, which helps to achieve good ventilation and air quality in the indoor space.

The mashrabiyas and the rest of the traditional Islamic architectural elements were not used as decorative elements, but they were employed by the designer as part of the design elements to emphasize the aesthetic and functional philosophy, and to emphasize the local and Arab identity with advanced modern thought. They are an architectural element that is consistent with the sustainable direction of design and can be developed technologically. Examples

come in: The context of how to employ the architectural element that performs its function in a way that suits architectural progress... as follows:

The Al Bahr Towers building in Abu Dhabi, which achieved climate adaptation in the United Arab Emirates. The Mashrabiya idea was developed, where the towers were designed with a dynamic curtain that is sensitive to the sun and reduces their thermal gain. The building is considered a smart building. They were placed two meters outside the building, semi-independently, and contained a number of large number of triangles It was wrapped with fiberglass and were programmed to respond to the movement of the sun to reduce its heat inside the building. However, in the evening, all screens are closed, and with the beginning of sunrise from the east side, they are closed from the east side, as the screens change throughout the day as a result of the movement of the sun around the building's perimeter due to sensors. This reduces the building's need for air conditioning and artificial lighting by more than 50%. (3) The example illustrates the designer's skill in applying smart technology to the Mashrabiya

Other designs include the Doha Tower in Qatar, with a height of 231 meters, where Islamic decorative elements and units inspired by the aesthetic and functional philosophy of the Mashrabiya were combined with contemporary technology. It is a cylindrical building that was covered with a group of decorative layers suspended from aluminum material with the aim of shading the building from the sun and providing natural lighting, in addition to the presence of layers. It is made of reflective glass that adds the concept of protection from the sun, and the building is illuminated in the evening. Thus, the idea of the mashrabiya combines with technology, which helps air flow and illuminate the interior space while controlling the degree of dazzle.

## 3.2 Wind shovels (malqaf)

The malqaf is a ventilator that rises above the building and has an opening corresponding to the direction of the prevailing wind blowing to capture the air passing over the building, which is usually cooler, and push it into the building. The malqaf is also useful in reducing the dust and wind that are usually carried by the winds that blow in hot regions, and it is the same idea as the wind shovel. Which extends high to catch the moving air from the prevailing winds and to provide air movement through the building in warm climate areas. (1)

The designer repurposed the barleys in the buildings of Qatar University, as well as in Masdar City in the Emirates, in order to achieve zero heat emissions. The idea of "barleys" was adopted to be an inspiration in the design of cooling systems. A report by the "Carbon" Foundation stated that consumption Energy savings in buildings that adopt these technologies reach 50%. The idea of the wind tower in Masdar City is based on the development of a model of a modern shed that contributes to saving 80% of the energy needed by the building. It must be noted that Masdar City's buildings are environmentally friendly green buildings, and from here the architectural goals are united for a clean environment, as Masdar is distinguished by. It derives its entire energy from a solar power generation station, which is the largest of its kind in the Middle East, with a production capacity of 10 megawatts, and provides a surplus of energy to the main grid of Abu Dhabi**.**

The designer's placement of the malqaf as part of the design elements is considered an appropriate development for the form of the era by finding an architectural solution that suits the place and is linked to the general culture and identity and is not linked to architectural thought only.

## 3.3. shakeshakha

One of the Islamic architectural elements used in ancient times is the "Shashakha", which is a geometric opening in the ceilings that are used to attract air to moderate the temperature and provide lighting. They come in many shapes such as domes, pyramids, regular roofs, slanted roofs, hexagonal, octagonal, and circular roofs. However, the interior architecture designer used it in a more sophisticated way that suited the interior spaces. He created openings in the ceiling to help move the air. When the hot air rises, it rises to the top and the cold air descends to the bottom, thus cooling the interior space. (1)

## 3.4. Courtyard and fountains

The courtyard is the air distributor inside the space. It is the closed or semi-closed space formed by continuous or semi-continuous walls on its four sides in the case of a quadrilateral shape or more in the case of a polygonal shape. (21) It is open to the outside air from above. In a single home, there can be more than one courtyard connected via Corridors or through some rooms. One of the most important features of the courtyard in the internal space is that it helps provide the necessary ventilation and natural lighting for the spaces. (1) The fountain is placed in the middle of the courtyard of the house, and it used to take a circular, octagonal, or hexagonal shape. The fountain is intended to give the courtyard an aesthetic appearance and mix the air with water, moisturize it, and then move it to the interior spaces. But now fountains are used in more modern forms. (10)

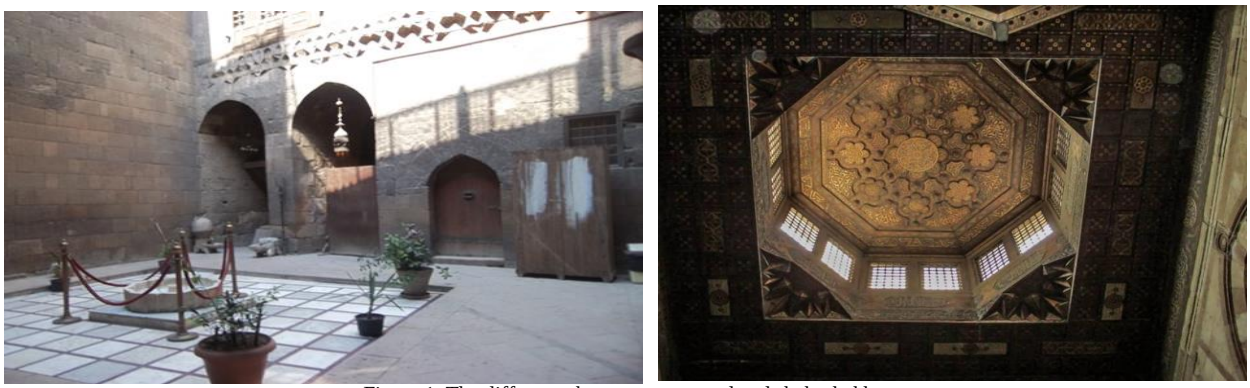

Figure 1. The difference between courtyard and shakeshakha
Source: https://slideplayer.com/slide/4329366/.

## 4. Modern architectural methods to reduce energy consumption

The field of interior architecture has witnessed a great development in information systems, which has been reflected in the interior spaces, as the user of the interior space relies on technology to perform functions within the space. Consequently, new materials and raw materials, known as smart materials, emerged that helped make successful designs and proved their efficiency in hot environments, as they consume less energy and live a long life, meaning they are sustainable.

## 4.1 Smart windows

It is important to employ smart windows within the design because they are able to control the amount of light and heat that enters through the windows by increasing or decreasing the electric field passing through the window. It also has a significant impact in reducing noise and energy consumption, and one of the technological means that smart windows rely on is liquid crystals. The suspended particle screen changes color, and the use of smart windows dims sunlight and generates electricity simultaneously. (5)

The interior architecture designer can also install solar nets directly on the glass or separately from it. They are sometimes made of woven fabric. One of their advantages is that it is easier to control the amount of blocking the window rays from the outside than traditional curtains, by changing the angle of closing them or installing motorized curtains that wrap around a fixed axis. (19) At the top of the window through an automatic motor, and it is controlled either remotely via a remote-control device via a sensitive light source or via a simple timer. It is considered economical as an integrated system as it reduces the energy needed for the air-cooling system and improves its performance. (13). It is also easy to use internal shading methods with manual control and achieve higher shading values than external ones.

## 4.2. Environmentally friendly smart lighting technologies

Smart lighting technology allows the designer flexibility in use, as it can be installed in the most difficult-to-reach places. It is energy-efficient and a long-lasting type of lighting.

### 4.2.1. LED technology

LED is considered the most smart and environmentally friendly lighting unit and achieves the quality of the interior space due to its features such as: emitting small amounts of heat during operation and maintaining a moderate temperature, reducing the risk of global warming, and does not contain toxic mercury like some types of Lighting, such as fluorescent lighting and high-intensity discharge lighting, LED lamps consume less energy to produce light, which contributes to reducing carbon emissions and greenhouse gases issued by power plants. (7)

### 4.2.2. Fiber Optics

Fibers made of pure glass or transparent plastic, long and thin, their thickness not exceeding the thickness of a hair. Many of them are gathered in bundles inside optical cables and are used to transmit optical signals over large distances. Lighting by optical fibers consists of: (light source - strands of optical fibers) - Devices and final installations of optical fibers) that transmit light over long distances without diminishing or changing its characteristics, through which the distribution of light quantities can be controlled to the required extent, accurately, and on a large scale. It can determine and direct light, the places of its fall, the quality and quantity of light emitted from it, and the ability to create special effects. Using different filters, it is easy to change the color of the lighting to different colors using color wheels placed in front of the lighting source. Its ability to reduce energy consumption enables it to withstand temperatures of up to 800 degrees Celsius, which makes it easier to collect sunlight and focus it with mirrors and lenses to insert it into the end of the fiber. (4)

### 4.2.3. Photovoltaic cells

Natural lighting can also be used in photovoltaic cells through the use of what is known as a system of cells that collect sunlight to the core of the optical fibers and from there to the interior of the building, which constitutes a saving in the energy consumed and harmony with the surrounding environment, which raises quality standards. The Bee’ah building is considered the first workplace. An integrated environmentally friendly building in Sharjah, Bee'ah Building contains many environmentally friendly elements such as dunes equipped with solar photovoltaic panels to generate solar energy while placing a central oasis in the heart of the building that will contain shaded courtyards with natural ventilation and takes into account reducing carbon emissions to a minimum.

## 4.3. Intelligent cooling and temperature reduction systems

The functions of these methods are consistent with the concepts of Islamic architecture and converge in creating a well-ventilated interior space.

### 4.3.1. Heating Ventilating and Air Conditioning and Mechanical ventilation system

HVAC systems control humidity and air flow, purify the air, and remove odor by exchanging heat between refrigerant gases, air, or water through temperature sensors for input, and flow control for output (water flow or air flow). (6) Mechanical ventilation system brings fresh air into the building and also extracts air from the room to the outside and recycles it. To provide a comfortable and healthy environmental atmosphere. Control the temperatures and humidity levels inside the building and control the temperature difference between the inside and outside air so that the inside air remains suitable and comfortable on an ongoing basis and remove fumes, heat, odors, and pollutants from inside the building.

### 4.3.2. Eco-vent intelligent system

This system, designed by experts at the Massachusetts Institute of Technology, controls the temperature of the house, and the amount of ventilation required, and saves a large amount of energy by not air-conditioning the rooms, relying on a group of sensors distributed in all corners of the dwelling. The system is based on the use of smart ventilation outlets instead of traditional outlets. A group of sensors are placed in every room of the house and the temperature is controlled via a mobile phone.

### 4.3.3. Among the modern smart methods of cooling:

Using solar ponds is the same idea as the fountain which stores solar energy and relies on the presence of vast shallow surfaces to absorb and store solar energy better than flat solar collectors with a direct absorption system, which need large tanks to store hot water, and do not operate at night. Solar ponds can absorb energy from them at night, it works efficiently during the winter as well. Developing new sun breakers that open and close automatically without the need for electrical systems. This system is an innovation as most sun breakers need motors to operate. The idea of the system was inspired by the pine plant, whose scales open and close due to moisture. A model of this system was created that works to protect from the sun's rays to provide the maximum amount of shade during the day. It can be said that solar refractors perform the same function as mashrabiyas. Among those models that have employed smart and environmentally friendly energy is King Abdullah University of Science and Technology (KAUST) in Saudi Arabia. The design of the university buildings is based on the use of natural daytime lighting to illuminate 75% of the total area of the university, with light sensors that automatically turn off electric lamps if available. Sufficient natural lighting.

### 4.3.4. Use smart indoor air purifiers

The smart function allows this indoor air purifier to independently adapt to the environment in which it is placed. Based on detected air quality and lighting conditions in rooms. If you are outside, you can check the air in the house. Connecting to the app allows you to monitor indoor air quality, check the condition of filters, receive real-time updates on air quality, and set a timer to activate the smart air purifier remotely. The strengths of the air purifier depend on not consuming electricity and the sensors' detection of pollutants in the room.

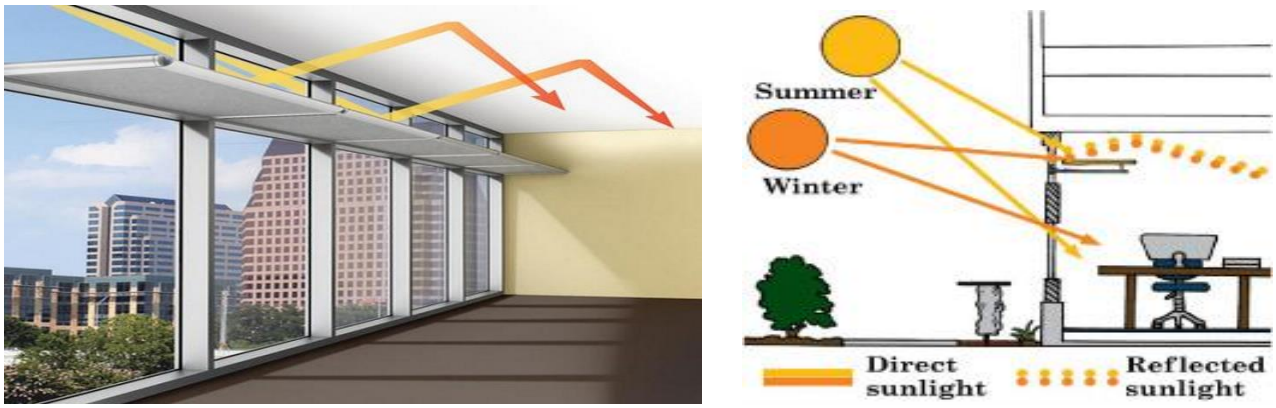


Figure 2. How solar shelves work to disperse solar rays
Source: https://www.re-thinkingthefuture.com/architectural-community/a8195-how-to-take-benefits-from-the-natural-light-when-planning/
https://www.urbanwaters.org/the-building/leed-platinum/sunny-perspective/

## 5. Design solutions that can be followed to reduce the temperature of the internal space

Some design solutions, although simple, achieve good ventilation and indoor air quality such as the following solutions:

### 5.1 Dealing with internal spaces

Bedrooms must know the direction and location of the windows, and small ventilation holes can be designed above the beds, and ventilation holes can be made at the base of the bed. In the kitchen, fans and an additional opening are placed in the ceiling of the kitchen in the case of an independent dwelling, as natural sunlight is allowed to enter even if the opening is closed. Also, when it is opened, it forms an outlet for air to enter and get rid of odors emanating from cooking. Two windows are placed, one at the top and one at the bottom of the kitchen room. When cooking, the temperature increases, and the presence of the upper window helps in evacuating the warm air to the top and then to the outside. The lower window works to bring in cool air breezes that replace the hot ones, which form an entrance for natural air. And a ventilation outlet. In the bathroom transfer air to and from the bathroom when it is closed, especially at night. Hoods and windows are also used at high altitudes. Cold air is always heavier than hot air, and this makes ventilation of the bathroom continuous. To ventilate basement rooms, heat exchangers are used: they are energy-saving equipment. Their mission is to transfer heat (cold) from exhaust air to fresh air.

Figure 3. Design solutions in furniture and doors for air circulation

Source: https://www.thefitoutpontoon.co.uk/beds-dinettes-storage/beds-mattresses/, https://bath.desigusxpro.com/en/dveri/plastikovye-dveri-dlya-vannoj-i-tualeta/

### 5.2. Windows

The interior architecture designer is interested in studying the interior space well, and the good distribution of windows is considered one of the important matters from a design perspective in terms of choosing their locations to obtain the largest amount of natural light while avoiding direct light to reduce dependence on artificial lighting and thus reduce electrical energy, which requires that it be in every room. Two windows as much as possible, distributed on two walls in order to avoid the phenomenon of blurring, or by making a window opening in the ceiling as skylights in the event that the dwelling is separate (villa) and in rooms to which light is difficult to reach, the designer may use a Solar Light tube or a Light Bandit device, and solar refractors and light shelves do the same. The task is to control direct sunlight and distribute it evenly throughout the interior space, and in order to provide good ventilation, the design solutions lie in exploiting the same design proposals, such as the presence of windows in the ceilings, or by relying on a mixed ventilation system, that is, automatic control systems for windows that can be opened and closed, such as (mashrabiyas). Automatically, which makes it easier to avoid exhaust and dust and maintain the air of the indoor space. To control heat and light alike, moving hanging curtains, electric metal blinds, solar screens, and roller screens are used. The architectural designer can also employ doors and windows made of PVC because of their ability to confront climatic conditions and also have a high ability to endure and last. Environmentally friendly material that insulates sound, light, and water.

### 5.3. Use of the plant

The plant is used in the internal space to improve the quality of the indoor air. The open wall system is used to periodize the air and prevent bad influences from the external environment. It serves as a protective cover to create

fresh air and natural light in the house to achieve the highest rates of thermal comfort and quality of natural ventilation for the internal spaces. It is also used to prevent the arrival of sunlight according to the requirements of the place. Rooftop cultivation is considered one of the applications to reduce the temperature of the building as a whole because it works to regulate the building's temperature, warming it during the winter and cooling it during the summer. It also contributes to reducing rainwater leaking from the roofs, because it works as a water-absorbing sponge, and at the same time plants benefit from this water. Green roofs are based on: reducing pollution, as they act as a filter to purify the air and reduce noise. Green roofs also have many economic benefits, as they increase the life of buildings, as they work as thermal insulators by blocking sunlight from the roofs of buildings. They also reduce the costs of air conditioning during the summer and heating during the winter. (23)

An example of this is what the Abu Dhabi City Municipality applied in its main building on Al Salam Street to increase green roofs, by planting about 1,000 different and diverse plants, which are irrigated with gray water purified from the water used in the municipal building facilities in order to beautify the spaces with environmentally friendly materials to reduce carbon emissions and improve Air quality and filtering of pollutants, reducing carbon emissions, as well as reducing the temperature in the building, and reducing energy consumption. Energy-saving LED lighting was operated through solar panels, and a water mist cooling system was operated, in addition to using mechanical ventilation technology to transform hot air into fresh cool air, meaning that green roofs are considered thermal insulation for the building.

Figure 4. The Abu Dhabi City Municipality implements a green roof project in its main building in Abu Dhabi to create a healthy work environment.
Source: https://www.dmt.gov.ae/ar-AE/adm/Media-Centre/News/28march2021-02

## 6. The relationship between bioclimatic architecture and the concept of sustainable, environmentally friendly buildings

Sustainable buildings are environmentally friendly buildings because they consume smaller amounts of energy and water by using solar panels, and the resident inside them remains healthy due to the presence of a lot of natural lighting, good ventilation, and fewer toxic paints and adhesives. One of the most important principles of sustainable buildings is energy conservation. Adapting to the climate, reducing the use of renewable resources and new materials, and applying these principles reduce the negative impact on the natural and built environment in terms of buildings and their immediate and regional surroundings. (8)

The two concepts are consistent with rationalizing the use of energy and electricity, relying more on natural energies and adapting to the climate using designs that take into account the environment, with the use of available technology to improve the health and productivity of residents. Good ventilation and indoor air quality are linked to the use of non-toxic or low-toxic materials that do not emit carcinogenic substances or chemical emissions. It leads to irritation in the body's systems during and after installation work, and the use of moisture-resistant materials that prevent the growth of pollutants in buildings. (15)

### 6.1. How to use environmentally friendly materials

Environmentally friendly furniture: Furniture made from natural cork is considered an environmentally friendly material, which is extracted from the outer bark of the oak tree, and its resource is constantly renewed. Furniture is

made from bamboo wood, as it is a renewable and fast resource, this type of wood has strength and durability, so it is used in many styles and designs of furniture. Bamboo wood is a sustainable material that can remain as it is for nearly a hundred years, as it is less affected by weather factors such as heat and humidity. Its colors range between brown, sugar, and yellow. Also, the panels made from wheat stalks are LEED-certified and use renewable natural materials, which are wheat stalks. Which are disposed of by burning, causing environmental pollution, thus helping to reduce harm to the environment. It is classified as an environmentally friendly material because it can be recycled and manufactured, and it does not negatively affect human health and the environment.

Paints are necessary to use paints that absorb less heat and use some porous materials, provided that they are used without covering them or painting them with paints that clog their pores. This will have the greatest impact on controlling the humidity level inside the building. Heat-resistant paint can also be used because of its composition, as the silicone-based dye mixture contains materials. Fillers, coloring pigments, and synthetic polymers.

Floors: Bamboo for flooring: It is a sustainable solution as a finishing material for floors and is low in cost compared to wood. It is also environmentally friendly, helps moderate the temperature of the atmosphere, is multi-colored, and is easy to form, in addition to its hardness and ability to withstand temperatures. It is resistant to moisture, as is natural cork, which is obtained from the bark of the cork oak tree. High-density compressed boards are used as flooring, while less dense boards are used as tiles for sound and thermal insulation. Materials that resist high temperatures and help moisturize the place are used also for floor tiling, such as artificial stones such as ceramic, porcelain, and marble. Environmentally friendly plastics are used, such as PVC vinyl flooring, which contains a layer of fibers with a rough texture that absorbs sound and heat. (21)

Roofing is the most important architectural element, as it reduces the temperature of the building as a whole and thus reduces the temperature of the internal space. Therefore, the designer is interested in shading the ceilings to reduce heat and develops many solutions such as: using tents, awnings, screens, reflective mirrors, and fabrics that reduce heat gain. By up to 65% in the summer on the southern facades and up to 80% on the eastern and western facades. The efficiency of the awnings depends on the permeability of the material from which they are made. (16) There must also be a distance between the awning and the facade of the building to allow air to pass through. In this case, the materials made of plastics such as PVC, plastic wood, and polyethylene, the thermal insulation rate reaches 80%, with the color being stable and not changing over the years. (22) It is worth noting that the shape of the ceilings has a major factor in dispersing the rays falling on the building, such as curved ceilings or double ceilings designed from two separate tiles with air interspersed, or inclined or tiered ceilings, (11) but if the ceiling is flat or horizontal, then here comes the role of the interior architecture designer using insulation materials. Environmentally friendly and made of plastics or roof cultivation and the use of water ponds. As for the ceilings of the interior space, suspended ceilings or dropped ceilings made of gypsum and foam can be designed. (16)

The "Khalifa Al-Tajer" Mosque is considered the first environmentally friendly mosque of its kind in the region. It was built using heat-insulating materials, and double glass coated with a metal layer that blocks the sun's heat from inside the mosque in order to reduce the energy needed to cool the air. The mosque uses solar energy to light external lighting poles to heat... Ablution water instead of using electric heaters. Smart control systems were also used for the air conditioning units so that they are turned on and off according to need, prayer times, and the number of worshippers. The mosque was also introduced to thermal insulation technology through insulating building materials for the ceilings and external walls to reduce heat transfer. It was provided with energy-saving LED lights. Energy saving instead of regular lamps, in addition to a lighting control system.

Figure 5. Cover ceilings and windows to reduce heat transfer

Figure 6. The "Khalifa Al-Tajer" Mosque

Source: https://www.climateaction.org/news/worlds_first_green_mosque_opens_in_dubai

## 7. Conclusion

The research presents an integration of different architectural concepts, where traditional architectural solutions can be repurposed in a way that is compatible with technological progress and in a way that reduces energy consumption. The use of Mashrabiya, Al-Malqaf, courtyards, and fountains are amongst the ancient Islamic architectural solutions that were developed in many Arab buildings through advanced and successful designs from a functional and aesthetic standpoint.

Using architectural solutions and processors as well as employing technology and providing successful designs and experiences in countries. Selection and modification of advanced technology in a way that saves money and energy and in a way that does not negatively affect the environment and the internal climate of the space, and reduces the heat load. Encourage the concept of environmentally friendly architecture and sustainable architecture and rationalizing building methods and energy consumption as one of the pillars upon which the success of sustainable development in any society depends.

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The authors declare that there is no competing interest.

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