Increasing the Adaptive Opportunities with passive strategies and Architectural Solutions for Healing gardens, aligned with Evidence-based design

Abstract

Evidence-based design is a methodology for identifying solutions to achieve a specific design goal that can yield a beneficial outcome. A healing garden is a general term used to describe a nature-oriented space, both inside and outside buildings, that assists in improving the mental and emotional well-being of its users. Consequently, the application of design thinking in architecture, which seeks to create opportunities for form and function, is on the rise. This approach enables the creation of structures that are not only visually striking and functional but also more sustainable, user-friendly, and reflective of their location and the people who interact with them. One type of design thinking developed by architects and utilized by people to overcome hot and cold climates is called increased adaptability. The research method in this study is applied and analytical-descriptive, qualitative in nature, and employs comparative analysis. In this study, we attempted to explain the opportunity for adaptive adaptability and provide passive strategies and architectural solutions for healing gardens through evidence-based design to enhance comfort. The aim of this research is to identify a range of passive strategies and architectural solutions for healing gardens. This study provides researchers with a systematic and comprehensive understanding of the opportunity for adaptability and can also guide designers and architects in enhancing these opportunities with passive strategies and architectural solutions for healing gardens.

Key words: Adaptive Opportunities, Passive strategies, Passive design, Healing gardens, Evidence-based design.

1.Introduction

In recent years, interdisciplinary studies in architecture, environmental psychology, and health sciences have increasingly emphasized the role of natural environments in promoting physical and mental health. A prominent example of this interaction is healing gardens, which, as purposefully designed environments, contribute to stress reduction, cognitive function enhancement, and improved user health status by providing multisensory interactions with nature (Asghari, 2020: 19). These spaces have been implemented in medical centers, public spaces, and residential environments to act as a supplement to treatment processes, facilitating the physiological and psychological mechanisms of healing. However, the effectiveness of these gardens depends on adopting evidence-based architectural design strategies and aligning them with the principles of passive architecture.

Despite the increasing growth of research in the field of the positive effects of healing gardens on human health, numerous challenges exist in achieving the optimal realization of these spaces. One of the most significant challenges is the lack of systematic integration of evidence-based architectural design strategies with passive architectural strategies. In many cases, the design of healing gardens is based on experiential approaches or aesthetic considerations, which may not fully achieve the expected functional effects. Furthermore, the lack of implementation guidelines for aligning these spaces with climatic conditions, users' physiological and psychological needs, and environmental constraints leads to functional instability and reduced efficiency of these healing environments.

A strategy approach for ideation, planning and creation that emphasises people's experience as the key focus of action is part of design thinking. It is to look forward to the future, to understand the present, and to be informed by the failures and successes of the past. Nowadays, a wide consensus has been achieved upon the importance of good architectural design and its relationship with energy consumption(Tettey et al., 2019).Global warming requires buildings to be capable of adapting to more extreme temperatures, while also reducing greenhouse gas (ghg) emissions to reduce the rate of related changes(La Roche, 2022).Passive cooling and heating strategies for architectural spaces, which was common in our architectural history are now totally forgotten. While in the past, according to the wisdom of the architects, we have the elements which are new and can be used in the contemporary architecture. But now creating a comfortable thermal atmosphere, is more dependent on the use of mechanical and electrical equipment. Using these equipment, if reasonable, require an understanding of the thermal comfort of people. The research has shown that the strengthening of the thermal resilience of residential buildings is important for different reasons, in different seasons and must be designed for such(Michael et al., 2022).Determining the internal temperature have great importance in the control of energy consumption in the buildings and careful selection of heating, cooling and ventilation systems. Besides, it gives a true perspective of the needs of comfort condition to the architect and basically determines the required type and capacity of mechanical and electrical systems to heat or cool the environment. When we can use passive strategies rather than active ones, the energy consumption in the building will be reduced. Economic aspects of these strategies in the long term will depend on the relative price of the installation and maintenance of active and passive devices. People are different which determine important factors, differences such as metabolic rate, sweating, the fat under the skin and the clothes worn. In addition, people with one type of dress, at different times of the day, have different needs of temperatures, such as during intense exercise, heavy food digestion or sleep. As a result of all these variables, it is possible that a person in a room has a completely different idea about the ideal temperature. Generally, the best thing to do is to create a condition comfortable for the most people, and let them to wear due to the weather condition fluctuations. In some situations, people may have to stay in a fixed situation for a long time, in other conditions, in living environments, each person has the freedom to sit near the fire or far from the fireplace at his house, or the sit close to the window to feel the sunlight,

while others in may prefer to sit in the shade. If designers of the buildings consider the conditions and opportunities for individual adaptations, then more people can live in these conditions. In other words, the more people have the power to control the thermal condition in the building, the more they have the opportunity of adaptation. This issue is combined with the individual opportunity such as clothing and activity in order to consume less energy in the building.Today, most of the buildings do not provide this opportunity for the users and they are surrendered by the natural conditions of the climate and building. Opening and closing the window for fresh air and ventilation is one of the situations in which people react to the condition. If the height of the window, making it difficult to access it, users do not use this approach.

2. Adaptive opportunity and passive strategies in architectural design.

Adaptation theory says that people should be active in their thermal comfort, but the question is whether this opportunity is given to them or no? Today even the design of the open kitchen, have taken the opportunity to prepare some food from people in different seasons due to weather conditions which was common for years. For more details look at the Figure1. If we assume that the temperature is on the vertical axis, in the picture, you see two parallel lines with horizontal axis between them is blue. We read this area "status quo of the architecture", the state of the comfort condition that the building provides without any change. Sine curve that the two lines are cut off, creates two stressful area, out of the parallel lines, which have large area under the curve (e.g. thermal pressure is high.) If the distance between two lines becomes more, the opportunity of adaptation increase and thermal pressure range reduces (Heidari, 2019).

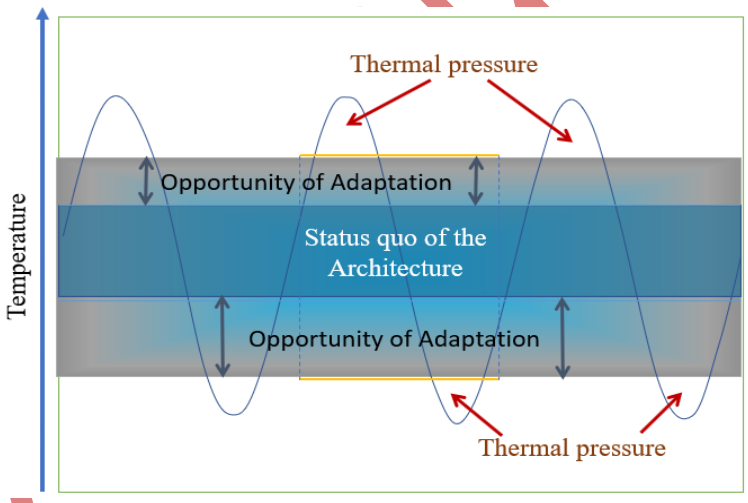


Figure 1. different conditions of the opportunity of adaptation

Finally, if the distance include minimum and maximum of the curve, we can say that the opportunity of adaptation in complete, and users can control the environmental condition. Having access to open or close the windows, moving in the room, having the ability to change the color and type of the fixed furniture, using and controlling the heat of the equipment, are all the choices of having the power of adaptation. Traditional architecture of Iran have a lot of awesome examples of having the opportunity of adaptation for the users. Yard, basement floor, garden, water and various rooms, all provide good compatibility. Thus, design of the building and its components have to provide some sort of opportunity of personal control for the users with many solutions like Passive strategy wich is not a new novel concept. Its roots go back to ancient architectural practices that were ingeniously adapted to local climates. For example, traditional buildings in hot, dry regions often had thick walls and courtyards to keep the interior cool, while structures

in temperate climates used large windows and thermal mass to capture and retain heat. In the following, a number of recent studies are discussed about passive strategies in architectural design.

3. Healing Gardens

Healing gardens, or therapeutic gardens, are nature-oriented spaces, both indoors and outdoors, with therapeutic and rehabilitative capabilities. In addition to their aesthetic functions, healing gardens contribute to the healing of mental and psychological illnesses through fostering connection, ideally preventing illnesses altogether. Initially, healing gardens were established for medical centers and hospitals, but over time, they have expanded to public spaces and private gardens. The primary goal of healing gardens in hospitals is to accelerate the recovery process. However, in public spaces, they aim to reduce the psychological pressures of daily urban life and relieve individuals from the stresses of mechanized living (Ghaderi Jouybari, 2019). The importance of landscaping and creating green spaces in human physical and mental health, especially in today's cities, is undeniable. Healing gardens are designed to create landscapes that promote mental health and heal psychological traumas. The planning of these landscapes should engage all five human senses and establish a connection with individuals (Salehi Kousalar, 2016). The concept of gardens for patients first emerged in Europe during the Middle Ages, with the establishment of medical centers for monks, featuring enclosed gardens with diverse plants for spiritual and psychological transformation. Research on the therapeutic effects of nature expanded in Western countries in the 1970s (Shafiei, 2018).

Meta-analyses show that nature-based activities such as gardening can help improve the well-being and quality of life of older adults, including those living with dementia (Sia et al., 2020), in care facilities (Barrett et al., 2019; Edwards et al., 2013). Healing gardens are nature-based interventions that have had a positive impact on human well-being (Detweiler et al., 2012). These gardens have existed since the Middle Ages when they were located adjacent to monastic hospitals to give patients a peaceful escape from the world (Jiang, 2014). Since healing gardens are described as a "plant-dominated environment designed as a refuge and place for rest" (Diehl, 2010), and engaging in meaningful activities (occupation) is a critical aspect of non-pharmacological interventions that help maintain function (Miller & Butin, 2000), healing gardens can provide a way for gardening as occupational therapy (Akindejoye, 2024).

4. Evidence-Based Design

According to the definition by Ulrich et al. (2010), evidence-based design refers to a process for creating therapeutic buildings using the best available evidence, to improve outcomes and continuously monitor design situations for future decision-making. Numerous individuals have presented different, yet aligned, definitions with Ulrich's, which is considered one of the most effective design approaches (Ahmadi, 2021).

Therefore, the evidence-based design approach is a crucial step in creating a safe and peaceful environment for patient care. In architecture, this approach is recognized for its aim to improve patients' quality of life, assist in their treatment process, enhance their health, and reduce their stress, all through the use of the best available evidence (Nematollahi, 2021). In simpler terms, this approach involves utilizing research, scientific studies, and reviews of similar cases to design new therapeutic spaces or renovate existing medical centers. This evidence-based process encompasses all stages of design, from project initiation to decision-making, planning, construction, and even post-occupancy, ensuring a clear and evidence-based process for designers and users (Mollai, 2021).

According to the aforementioned points, based on scientific findings by researchers, the design of therapeutic environments is of great importance due to its impact on the patient's clinical treatment process. This has made evidence-based design a significant and progressive trend in medical centers (Mardomi et al., 2023). Today, essential goals in constructing therapeutic environments based on evidence-based design include: reducing patient and companion stress, minimizing medical errors, increasing patient, family, and staff satisfaction, enhancing treatment effectiveness, and significantly reducing costs (Ahmadi, 2021; Mollai, 2021). Consequently, it can be said that evidence-based design is not prescriptive but rather seeks to build a foundation for increasing existing knowledge and even fostering innovation (Ahmadi, 2021).

Table1: studies related to in the last 10 years, Source: Authors

Autor(s)	Year	Title	Abstract
The passive strategies in architectural design			
Elaouzy, Y., & El Fadar, A	2022	Energy, economic and environmental benefits of integrating passive design strategies into buildings: A review	Passive design is gaining attention for its potential to reduce energy consumption, lower carbon footprints, and decrease energy costs by utilizing local climatic conditions and building characteristics. However, evaluating passive techniques solely from energy, economic, and environmental (3E) perspectives is inadequate due to the multiple influencing factors. This paper reviews the 3E potential of various passive design strategies, suggesting combinations based on building specifics and climate. Results show that while most passive strategies effectively lower energy demand and emissions when well designed, not all are economically viable, with some featuring longer payback periods. Combining multiple techniques can lead to significant energy savings (6.7–66.2%) and cost reductions (12–52%), though higher initial costs can prolong payback times. Understanding the factors impacting the 3E benefits is essential for enhancing the efficacy of passive design approaches.
Fernandez-Antolin, M. M., del Río, J. M., Costanzo, V., Nocera, F., & Gonzalez-Lezcano, R. A	2019	Passive design strategies for residential buildings in different Spanish climate zones	The Passive House (PH) concept aims to enhance energy efficiency in the building sector, particularly in residential areas where substantial energy is consumed for heating and cooling. Architects play a crucial role in implementing energy efficiency measures during the early design stages. This research focuses on optimizing energy-efficient architectural designs for residential buildings in various Spanish climate zones, utilizing Building Performance Simulation (BPS). Key findings include optimal configurations such as a North-to-South orientation, a maximum shape factor of 0.48, compliance with the prescribed U-value for walls, and a Window-to-Wall Ratio of no more than 20%. Additionally, light colors are preferred in hotter climates, while darker shades benefit colder regions. These strategies generally help meet the energy demand thresholds of the Passivhaus Standard, except in specific colder climates where additional passive design measures are necessary.

Altan, H., Hajibandeh, M., Tabet Aoul, K. A., & Deep, A	2016	Passive design	This chapter discusses passive design strategies and their benefits in building and urban design, emphasizing sustainability and human factors. Key elements include leveraging local climate characteristics during site planning, with climate and comfort as essential considerations. The chapter outlines various passive design techniques applicable across diverse climates, such as building orientation, ventilation, shading, thermal mass, insulation, and daylighting. Additionally, it highlights the integration of technologies and biophilic design for improving health and well-being. It also mentions passive solar technologies like direct solar gains, solar heating systems, and earth sheltering. Modern Building Performance Simulation (BPS) tools facilitate the evaluation of these strategies.
odriguez-Ubinas, E., Montero, C., Porteros, M., Vega, S., Navarro, I., Castillo-Cagigal, M., ... & Gutiérrez, A	2014	Passive design strategies and performance of Net Energy Plus Houses	To comply with the EU's Near to Zero Energy Buildings goals, reducing energy consumption in buildings is essential. Active systems largely drive this consumption, whereas passive design strategies enhance interior comfort and energy efficiency. This work analyzes the passive strategies used in Net Energy Plus Houses, specifically those from the Solar Decathlon Europe 2012 competition. The study compares these strategies with annual simulations and monitored data, focusing on factors like thermal properties, geometric parameters, and various passive solutions such as Thermal Energy Storage and natural ventilation. The results demonstrate the positive impact of passive design on comfort and efficiency, aiding in the achievement of Zero Energy Buildings.
Healing Garden			
Rangga, F Shaari, N Golda Yuli, N Salmarisha, D	2024	Hospital Interior Design with Healing Environment Approach	Five factors should be considered when utilizing a healing environment, including: lighting, views, social support, privacy, and comfort. Based on the results of the literature review, constructing a healthcare facility with the concept of a healing environment can aid in the patient's recovery process and enhance staff performance. Utilizing a healing environment in hospital interior design is crucial.
Kim, S.H Seo, J.B Ryu, B,Y	2024	Stress Control in Elderly through Healing Garden Activities	Healing garden activities manage stress more effectively than other stress intervention programs. Anyone can easily participate in healing garden activities without any specific skills or knowledge, and there are no spatial limitations The simplicity of enjoying space through the senses can be effective in stress management. Although this study confirmed that healing garden activities are effective in stress management among the elderly.

Agha Rashidi, M Shahcheraghi, A	2023	Designing a Health Village in Tehran with a Perceptual Science Approach and Based on the Principles of Healing Gardens	Spending extended periods in healthcare spaces often creates a sense of unease for individuals within that environment. Any effort to alleviate this feeling can positively impact the treatment process. The presence of green spaces is among the factors that play a significant role in improving people's well-being.
Taher Irani, M Ghasemi Sichani, M	2022	Designing an Educational Center with the Effect of Color on the Healing Environment to Control the Behavior of Children with Autism Spectrum Disorder (ASD) in Isfahan	A healing environment is defined as a space that can reduce tension and stress, create tranquility, restore energy, alleviate and improve health recovery, and connect with its users by aligning with the human inclination towards nature Color is one of the most important components in healing environments.
Evidence-Based Design			
Bobby Saragih, J.F	2024	Color scheme: Implementation Evidence-Based Design for Palliative Care and Hospice Building	The evidence-based design approach in the design process allows practitioners to find solutions for the relationship between humans and the environment. This comprehensive approach, which combines evidence, professional experience, and personal attention to context and situation, necessitates the implementation of a new way to improve user-centered healthcare. Although implementing this approach is very interesting, practitioners must understand that evidence-based design is not a rejection of creativity, but rather a means to improve solutions and the quality of their designs
Müller, H Rehn-Groenendijk, J	2024	Systemic evidence-based approach of health-promoting design (SEA)	The evidence-based approach transcends the personal style of designers. The determining factor is not merely what designers or architects like, but what is (a) scientifically sound and (b) validated from the user's perspective.
Nematollahi, A Zakari, M.H	2022	Designing an Oncology Clinic with an Evidence-Based Design (EBD) Approach to Reduce Patients' Stress	To address the needs and solve design problems in recent decades, a method called evidence-based design was developed for decision-making. Its mechanism and purpose are to create a bridge between research and design, or in other words, to use evidence obtained from scientific research to support the design, to make interior designs more effective and efficient. Therapeutic environments vary based on the type of people who use them and the type of services they provide.

3. Research Method

The research method used in this study is applied, and the research approach is analytical-descriptive in terms of qualitative nature and comparative analysis. The main strategy of this article is the case study method, focusing on prominent global centers. Data collection was conducted through field observations, the use of technical documents, and text analysis of related works. This study provides researchers with a systematic and comprehensive understanding of the opportunity for adaptability and can also guide designers and architects in enhancing these opportunities with passive strategies in architecture

5.strategies to achieve greater opportunity of compatibility

1.5-Shifting

In Iranian traditional architecture, Four-Season houses, are examples of strategies to adapt to climate of plateau areas, and rooms around the courtyard are used according to a certain season of the year. While this interaction also occurs based on the sunlight radiation angle, depending on the design of the architect is called winter room, summer room, basement and so on. Although this approach has been used in traditional architecture of plateau areas, but with some changes and by the use of original thinking of the design and the thermal characteristics of the materials it can be used in other climatic zones.

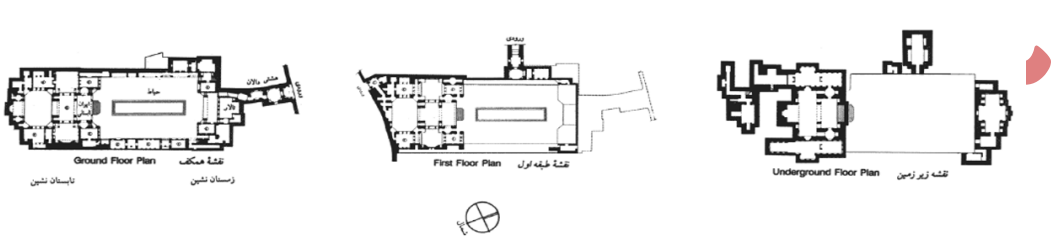
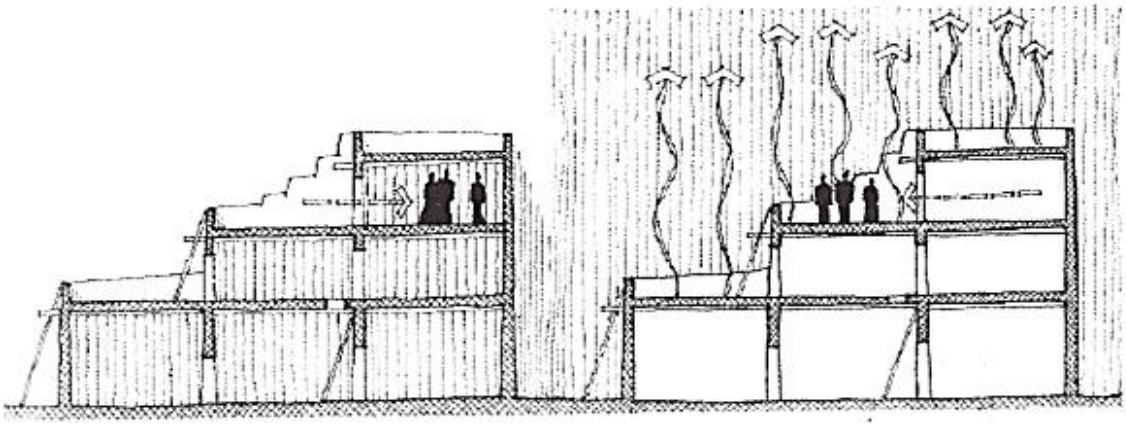


Figure 2 :Diagram of shifting strategy in the Boroujerdiha house,Kashan,Iran

We can change the point of view of moving from the northern spaces to Southern spaces into moving in vertical spaces and floors according to the used materials. Open and closed spaces can be divided so that the hot hours, cool areas can be used and for cold hours vice versa. This strategy, to keep the thermal comfort, by creating different zones, each of which appropriate for certain conditions can be merged. Because each area is set for limited conditions, the design of each part can be simpler.

In fact, we can benefit from the relationship between the thermal features, different materials and specific climatic patterns, such as thermal lag during temperature fluctuations, or the compatibility of certain conditions with social behavior, such as going from living room to the bedroom during breaks.

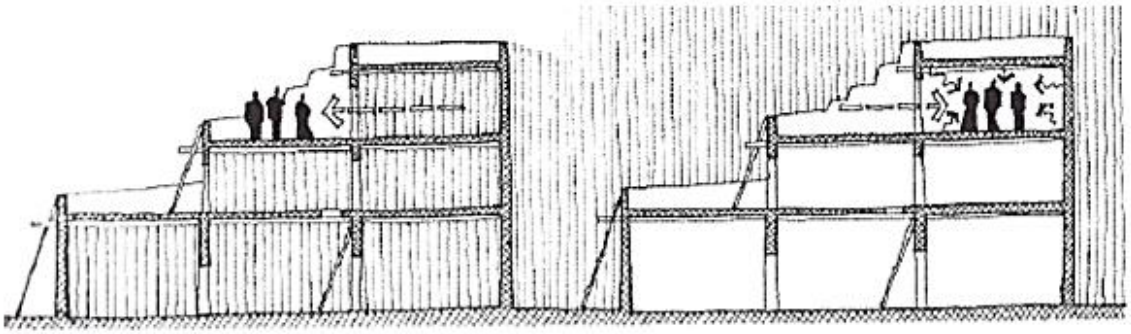
Pueblo Acoma in New Mexico, is an example of a residential building with a solution of shifting which daily use of each zone will change dramatically from season to season. The following Pictures show the efficiency of this approach. Southern terrace of the house which receives sun radiation and is a shelter against the wind in cold weather conditions is desirable. This terrace at night, transfer heat through radiation to the sky in hot weather, which is a positive feature.



Day Night

Figure 3:Diagram of shifting strategy in the Pueblo Acoma house For Warm Times

Source : Dekay.Brown(2001)

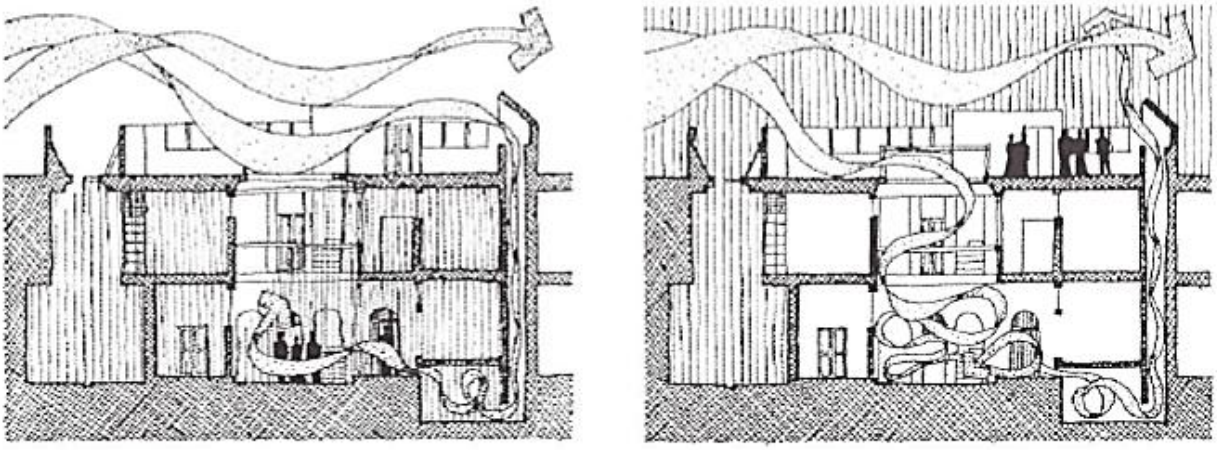


Day Night

Figure 4:Diagram of shifting strategy in the Pueblo Acoma house For Cold Times

Source : Dekay.Brown(2001)

Iraqi house, is another example which has benefited from shifting strategy. The house has a vertical zoning. Use of daily and seasonal changes in layers, courtyard and chimneys combined in the building mass, effectively mitigate high air temperatures in the summer. In hot summer days, residents live on the first floor that would cooled by the following methods: 1. Chimney openings in the direction of the prevailing wind, take air inside. 2. Cool air in the chimney due to the weight go down. 3. Air before entering the courtyard is cooled by the evaporation. 4. Walls are high enough to protect the courtyard from direct sunlight, during the day spraying water cools the air. At night, residents sleep in the open air on the roof or terrace which is cooled by the radiation to the sky. During the night, cold air of the roof penetrate into the building through the courtyard and cools the mass of the building which is heated during the hot days and is driven out through the chimney. During the short and mild winters, family live on the second floor, away from the cold floor of the courtyard. During the fall and the spring, when the floor is cold and room is warm, they use the second floor gallery to sleep and rest.



Day Night

Figure 5: diagram of shifting strategy in the Araghi house, Source : Dekay.Brown(2001)

2.5-Sunny spaces has been built in different parts of the building to benefit from daylight all day long.

Because the energy conservation and sustainability of the built environment are rising to the top of the global agenda, passive building design presents an increasingly viable alternative for the building and construction industry. Passive design strategies utilize various forms of solar energy to augment or replace fossil fuels(Vassigh et al., 2012).Sunlight, is an electromagnetic radiation emitted from the sun. These beams have different wavelengths. Solar spectrum is widely divided into three parts: ultraviolet, visible and infrared. Most of the intensity of solar radiation is in the visible light, but more than half of the solar thermal energy is related to the infrared.

When the sunlight released into the atmosphere, its intensity decreases and its spectrum based on the wavelength is absorbed, reflected or scattered in the atmosphere. Usually UV rays and all of the rays with wavelength less than 0/22 microns, through ozone the major part of infrared rays is absorbed by water vapor and CO2. Particles in the air reflect sunlight, but because it does not change the sunlight, it reaches the ground in white.

When the sun rays hit molecules and particles that are equal to or smaller than the wavelength of light, reflected light become scattered. The scattered rays lighten the parts that the sun does not shine directly to them. When particles and molecules in the air, scatter the light beams which has shorter wavelengths (blue and violet), sky looks blue. However, when there are particles larger than dust in the atmosphere, more rays of longer wavelengths which are red and yellow become dispersed in the air, the sky looks whiter. Clouds reflect plenty of sunlight to the outer space of atmosphere, but the rest of it, is released towards the Earth. This amount of radiation to the Earth's warms it naturally. Earth has a fixed rotational axis which has a 23/5's degrees with the perpendicular line of the Earth's orbit plane around the sun. Since this axis deviation make different seasons for different parts of the Earth, the Earth's temperature and climate of each region varies according to the angle of sun radiation, and this creates different seasons in each region of the earth. Because of the axis deviation, the angle of the sun radiation as well as the location of sunrise and sunset is different in different seasons.

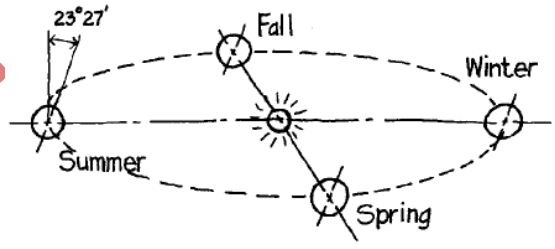


Figure 6:Sun and Seasons , Source of pic : Allen,Edward(2005)

Controlling the use of natural sunlight at different times of the day also increase the opportunity of adaptation strategies depending on the climatic conditions of the design location which can be considered. This strategy make people able to take benefit from the sun or to take refuge in the shadow depending on the comfort conditions in different seasons.

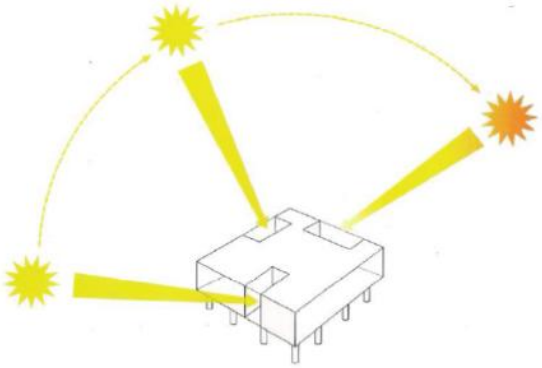


Figure 7:Creating spaces benefiting sunlight during the day, Source of pic : Duran,Sergi Costa(2011)

3.5-Taking advantage of the difference between angle of the sun radiation in winter and summer in the design.

Concerning the solar altitude can be as an approach in designing to conserve fossil fuels, so that by providing an optimal awning and deciduous trees, the entry of sun rays can be prevented in summer. If we design properly, solar radiation is more horizontal in winter and because of characteristics of deciduous trees, sun rays penetrate inside the building. As a result of this passive approach we can reduce energy consumption considerably in the building. The benefits of using solar energy includes the use of natural light, low operating costs and passive heating(Mortaheb,2014).

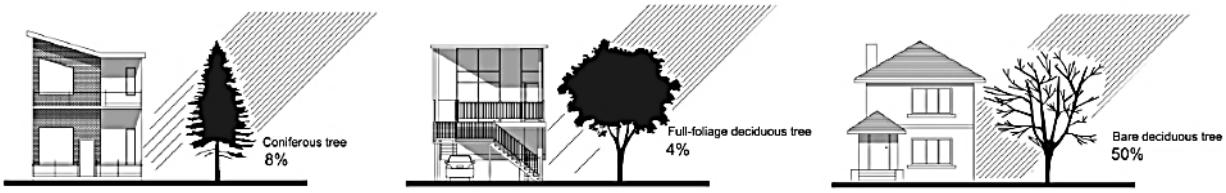


Figure 8:Design strategy for using Solar penetration through coniferous trees, full-foliage deciduous trees, and bare deciduous trees. Source of pic : Friedman, (2012)

Storing solar energy through energy storage devices and using it when you need, is a passive solar strategy. Stone storage is one of the most effective energy storage devices. Natural ventilation in summer and controlling them in winter through an appropriate design of the openings is also effective.

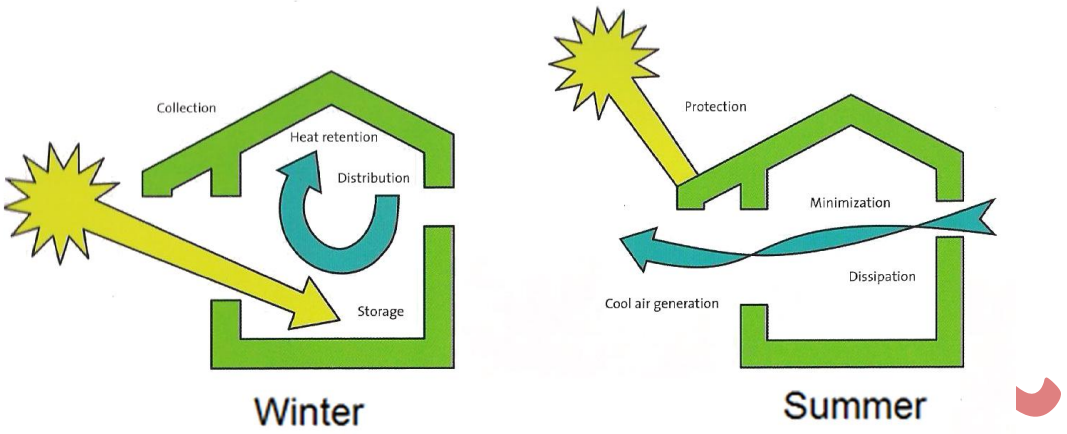


Figure 9:Design strategy for using solar energy, Source of pic : Duran,Sergi Costa(2011)

4.5-Using the solar spaces in South body of the building

Solar spaces, are kind of separate absorbing solar systems that absorb heat and store solar energy when it is needed. Combining this space with a wall that is made of a material with high density and thermal capacity, helps to increase the efficiency of the system. Two openings are built on the wall, hot air generated in the solar spaces, when is need, through convection leads to the interior, thus the place of cold air changes with hot air.

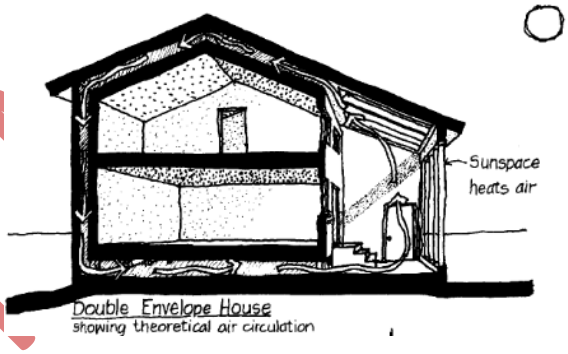


Figure 10:Solar space combined with with Double Envelope, Source of pic : Allen,Edward(2005)

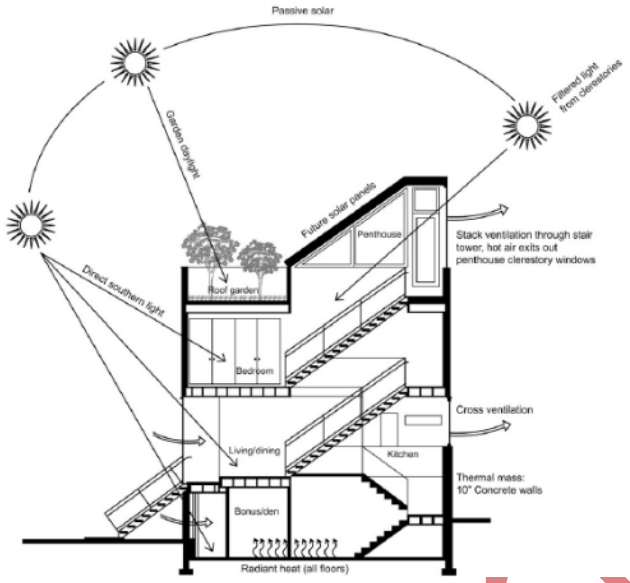


Figure 11: The project's orientation facilitates pas-sive solar gains and natural ventilation., Source of pic : Friedman, (2012)

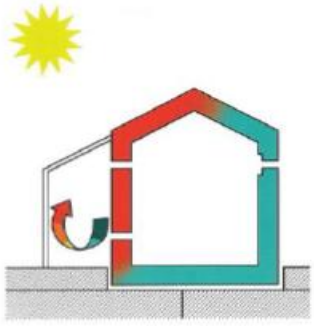


Figure 12:Solar space combined with a dense wall, Source of pic : Duran,Sergi Costa(2011)

5.5-Trombe wall

In this system, a wall with a high density and thermal capacity, is built in a distance of 10 centimeters from a window. The stored heat is guided in when is required. For example, the stored heat during the day, at night gradually is transferred to the interior. The wall can contain openings for heat transfer by convection (As shown below) or can be an integrated one without opening, and provides heat through conduction and radiation for the interior spaces.

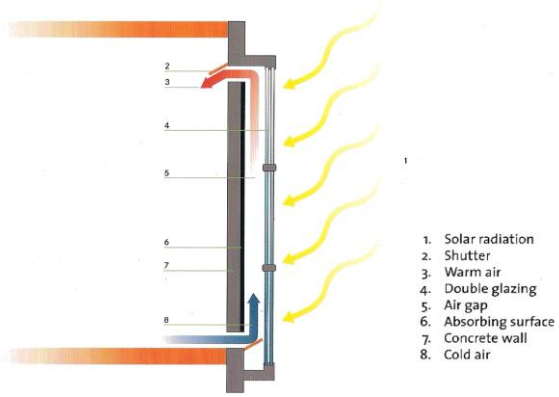


Figure 13:Diagram of a trump wall with openings, Source of pic : Duran,Sergi Costa(2011)

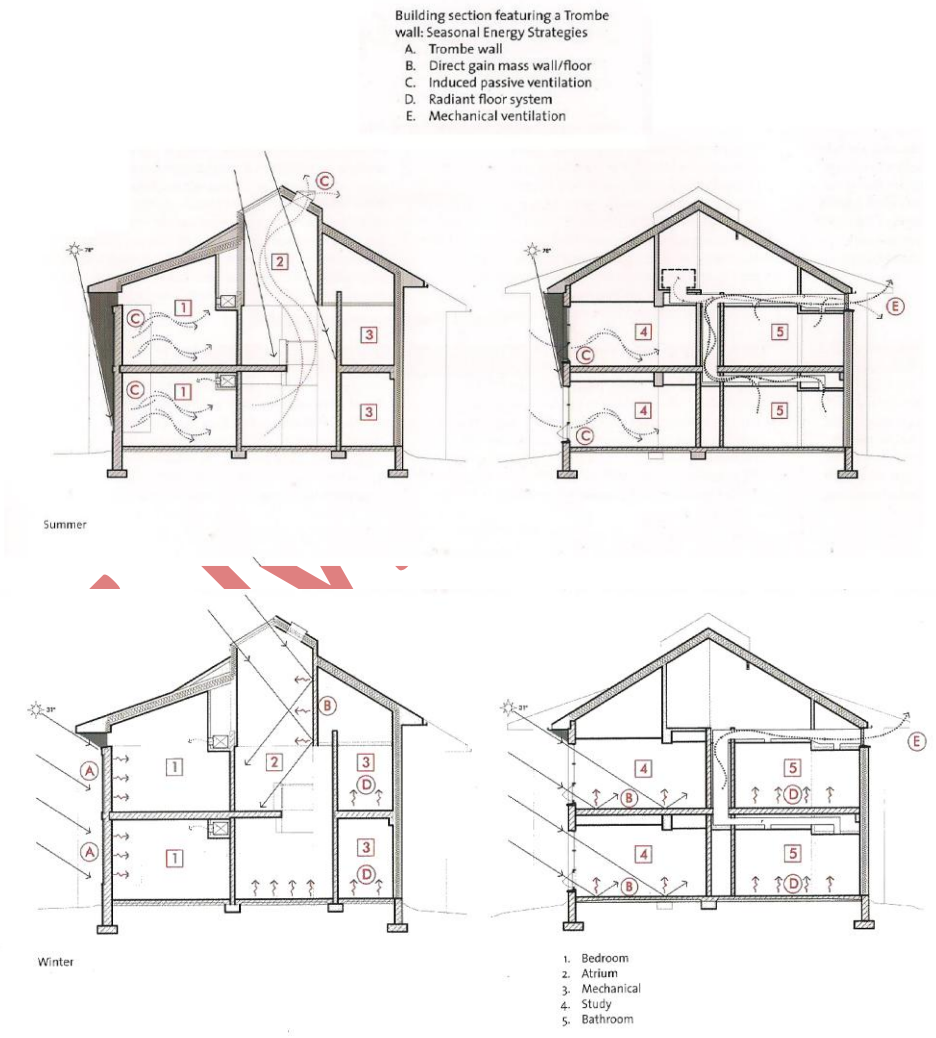


Figure 14:section of a building with a trump wall strategy- seasonal strategies for using renewable energies Source of pic : Duran,Sergi Costa(2011)

6.5-Natural ventilation system

The use of ‘proper’ ventilation measures has been recommended to decrease the risk of far-range airborne transmission(ASHRAE, 2020; Morawska et al., 2020; REHVA, 2020).The first point in natural ventilation systems is enjoying the fresh air, which residents need for breathing, evaporation of sweating and getting rid of internal heat. Designing and creating two openings in the room, can simply provide natural air movement in the space. These openings can have more capability due to the convection, in other words, architect can guide the cool air which is cooled in the shade or by passing over the water pond (by using the effect of evaporation), etc. through the lower opening into space. The air gets warm in the space, go up and go out through the upper opening, then replaced by the cool fresh air. On the other hand, since 2019 and due to the Covid-19 epidemic in closed spaces, attention to other ventilation has shown itself more. Assuming airborne transmission of virus is a route of transmission that seriously needs our attention, it is clear that the question is not only ‘What ventilation rates, and strat-egies, are required to protect building occupants against infection transmission?’, but also ‘How would it be best to ventilate for different situations’?(Bluyssen, 2022). There is a need for a new generation of ventilation systems that is able to respond to the dif-ferent cooling, heating and air quality challenges occupants may well encounter, over time (Bluyssen, 2020).

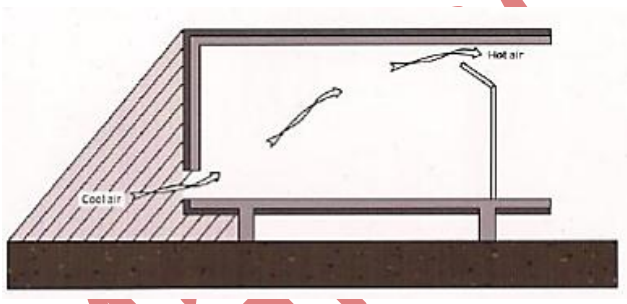


Figure 15: Natural air ventilation system, Source of pic : Duran,Sergi Costa(2011)

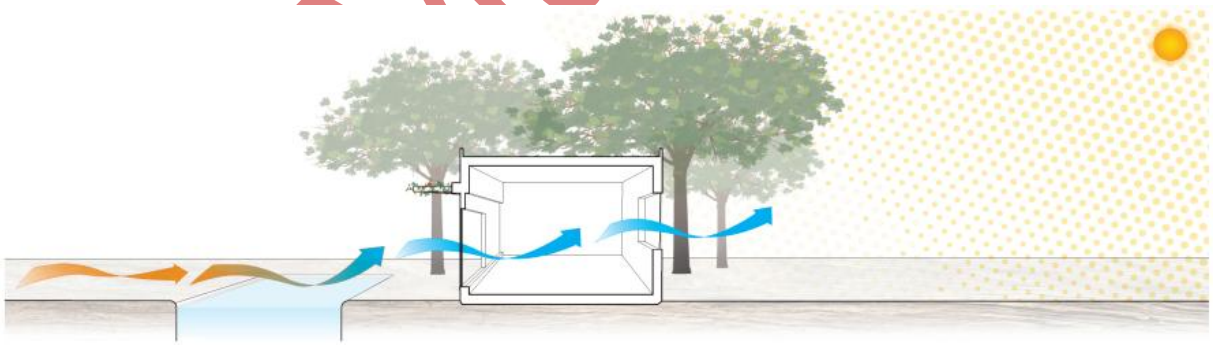


Figure 16: Design strategy for optimal use of natural ventilation

, Source of pic : Vassigh et al.(2012)

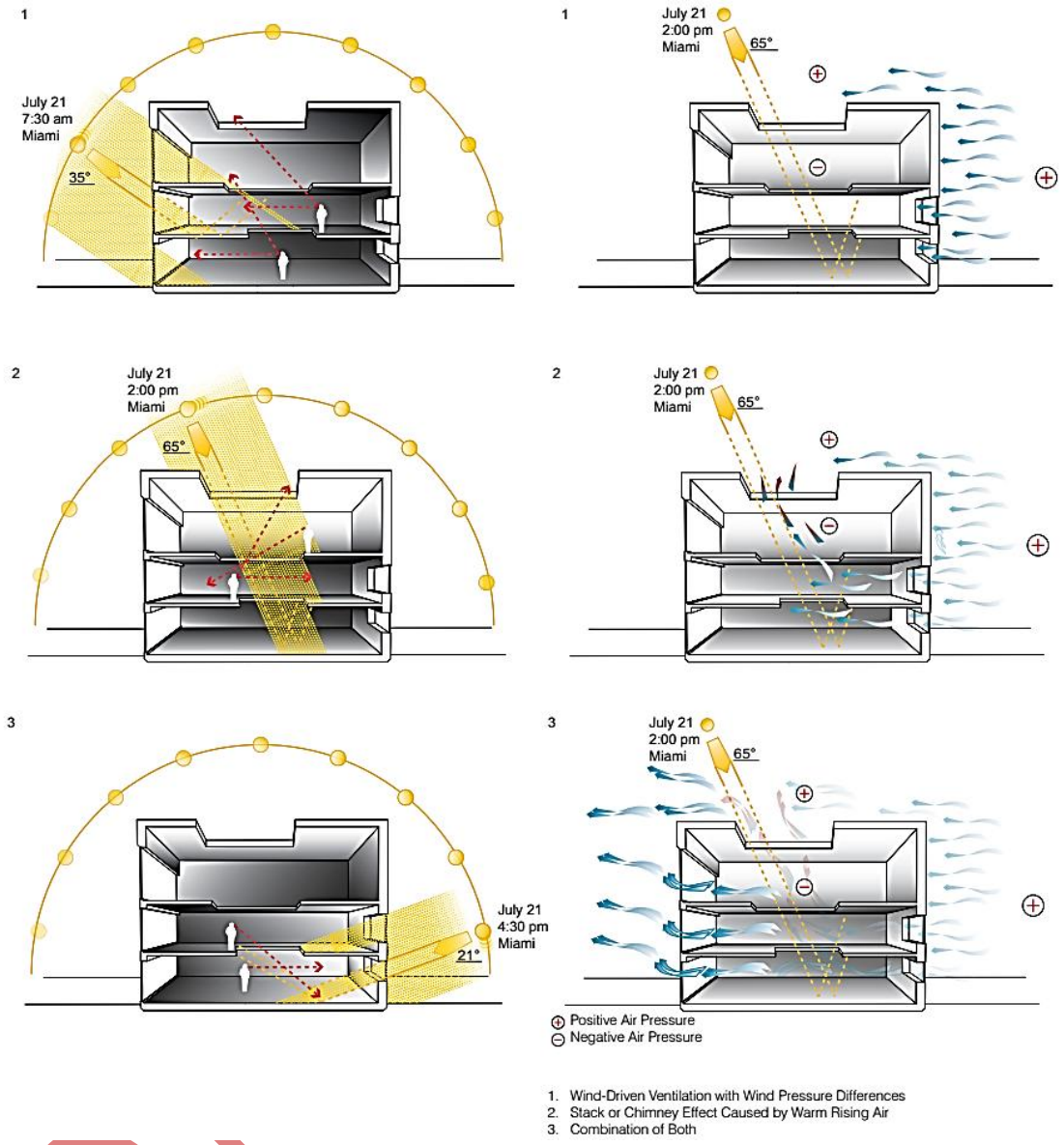


Figure 17: Natural Lighting and Passive Ventilation Strategies in a Building Based on Miami's Sun Path,

Source of pic : Vassigh et al.(2012)

7.5-Using wind-catcher as a pattern

Maximum use of renewable energy based on the climate conditions of the site, has been always important in Iranian traditional architecture; like wind-catcher which is used considerably in the central and southern parts of Iran. This wind-catcher should have a dialogue with its environment, that is, it should be windward to the desirable wind, in different shapes and heights with different functions (moving the air or making evaporation).

Figure 18:Sample of wind-catcher in Kish, Iran, Source of pic : Author(2018)

Today, due to the advances in technology and manufacturing solar collectors and photovoltaic systems, we can integrate these systems into the wind-catcher pattern and besides the benefits of them, we can have an increase in the efficiency and speed of the air movement in the wind-catchers. Evaporative cooling tower that provides cool air for the spaces, is an example of strategies with a form similar to the wind-catcher. This tower receives warm and dry air and makes it humid by a small electric pump which provide a water seep on the layers that the air goes through, therefore lowers the air temperature and cool it.

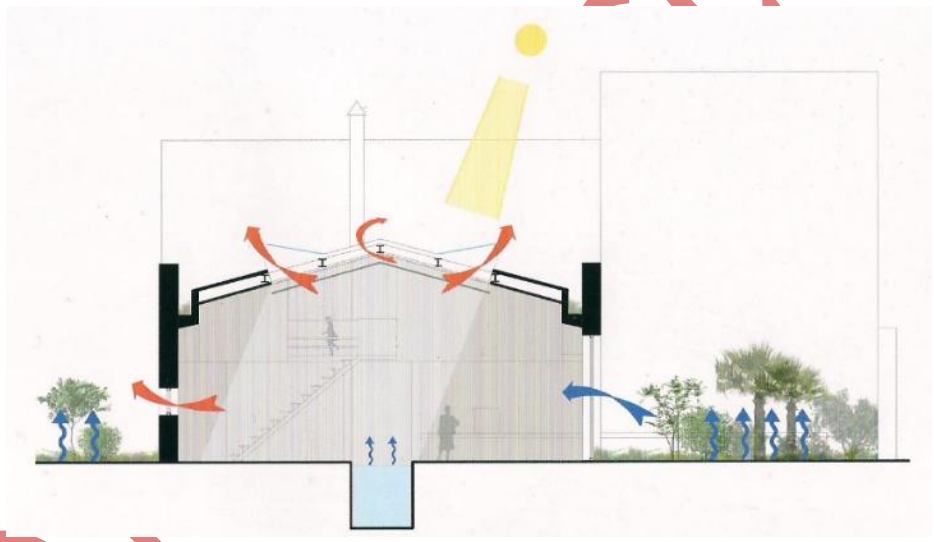


Figure 19: An example of creating cool air in the summer with trees, water pool evaporation and convection effect; the solar collector (chimney) of the attic gets warm, taking air inside increases and accelerate the upward movement of the air, Source of pic : Duran,Sergi Costa(2011)

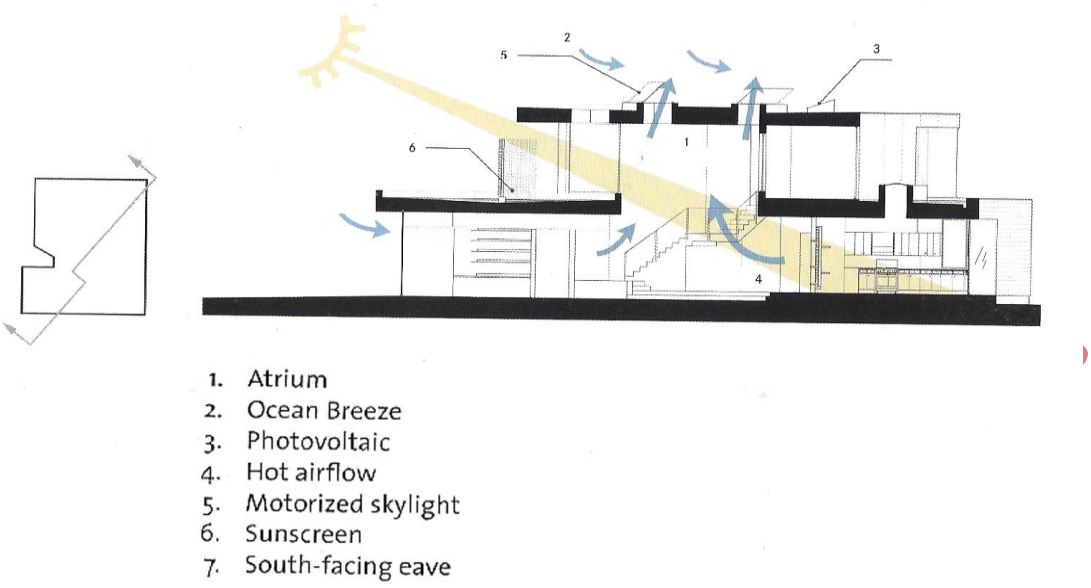


Figure 20: An example of Bioclimatic Section : Hot air evacuation by the chimney effect- a house in Santa Monica – US, Source of pic : Duran,Sergi Costa(2011)

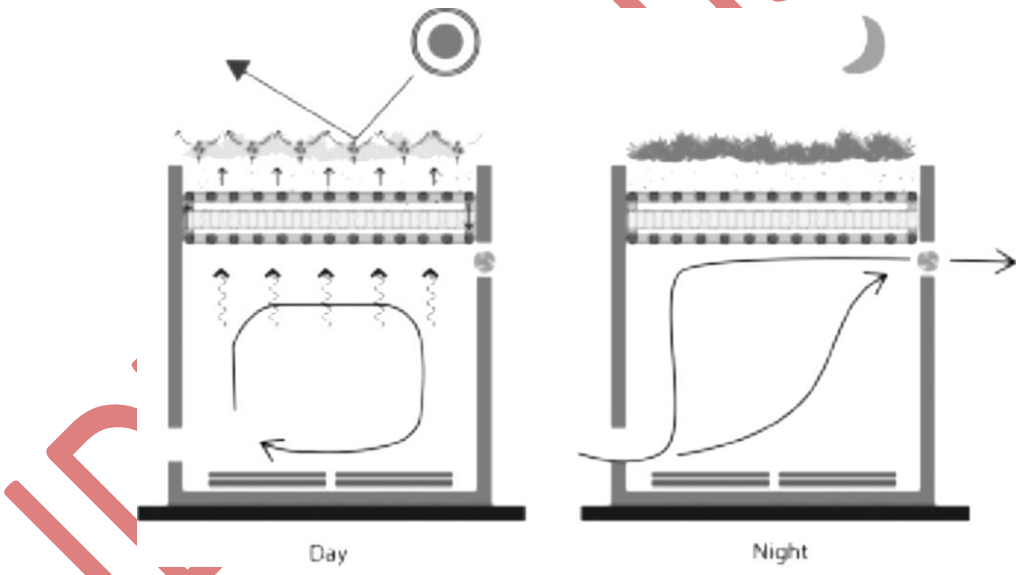


Figure 21: Living roof with evaporative/radiant evaporative system, Source of pic : La Roche, (2022)

8.5-Increasing the Adaptive Opportunities by designing kinetic facades

Designing kinetic facades make this possibility for the user to change and control the environmental conditions by optimizing the comfort conditions. This facade can respond to the difference of the solar radiation angle during the day and in different seasons, to the wind and rain. The trapped warm air acts as an insulation against the wind and rain. Besides, a kinetic façade can create visual dynamism and diversity in building design(Mortaheb,2016).

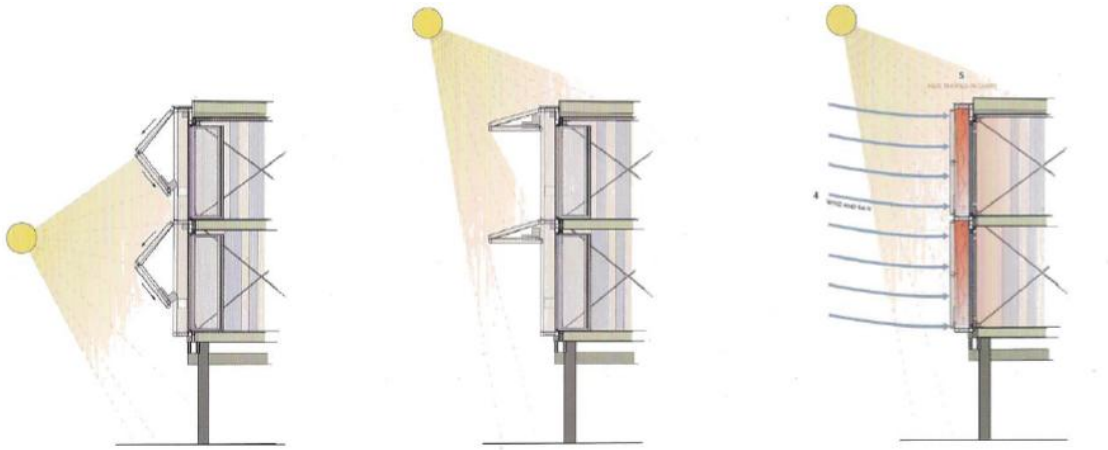


Figure 22: Diagram of the kinetic façade which acts as a shelter against sunlight,

Source of pic : Duran,Sergi Costa(2011)

9.5-Flexibility in design

In 1693, in an essay about the bilateral nature of form and program, Hortzberger wrote: To be able to create flexibility in function we must allow the built forms have different interpretations. There should be the ability to present several concepts simultaneously and without damaging the original identity, the ability to restore these concepts to the original state and that means looking for initial forms which is not only accepting the program but also let them to be free.Form and program inspire each other. The need to create personal environment that is suited to all people, make it necessary that by designing objects in a way that are interpretable provide the possibility of giving different interpretations. Flexibility in modern architecture with recent technological developments and due to the obligation of reducing energy consumption, is one of the solutions that can bring new strategies by precise and defined studies.

Flexibility in architectural design can result in multi-functionality of space and thus defining open plan and smaller spaces, which leads to the lower energy consumption and the efficient energy management, hence when a space is capable of defining two or more functions; actually, designing several rooms changes to designing one room to meet the needs of users.open plans can contribute in defining a space with small changes in level and with flexible partitioning by help multiple users to use one space. Flexibility includes many issues that can be found in all three sectors: blocks, buildings and structures. For example, designing based on the dismantling, can be a strategy to add prefabricated spaces to the building according to the user needs or to separate temporarily at any time.

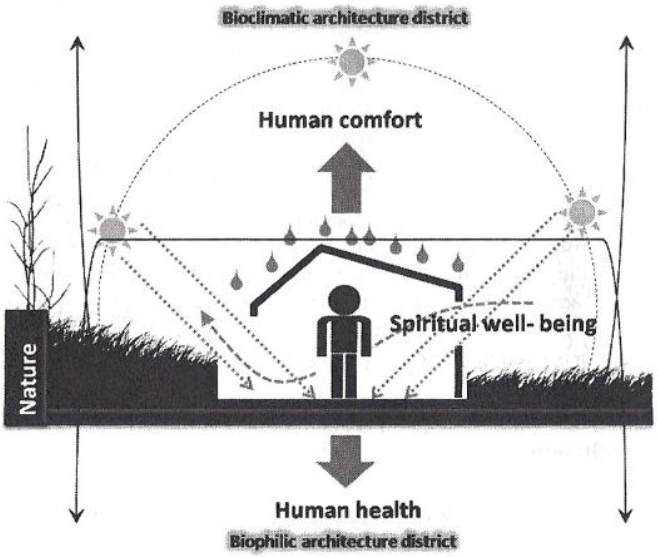


Figure 23: The Interaction Betwwen the biophilic and bioclimatic architecture concepts, Source of pic : Almusaed, Amjad(2011)

6. Architectural Solutions for Healing gardens to achieve greater opportunity of compatibility

In this research, to find architectural solutions for a healing garden through evidence-based design, after searching resources and gathering information through content analysis, the information obtained from the evidence was systematically categorized, and the most frequently repeated features related to the architecture of healing gardens were extracted from their studies.

Architectural Features of Healing Gardens in Medical Centers

1. Trees and vegetation diversity	11- Pleasant aroma (pleasant smell of plants)	21-Readability (minimizing ambiguity)
2- Presence of water	12- Communication and interaction with nature	22. Natural materials and textures (stone, wood, soil, etc.)
3. Stimulation of the senses (the five senses)	13-Horticultural therapy	23- Furniture
4- Colors	14. Spatial Diversity and Flexibility	24-Easy Routing
5- Instilling a sense of relaxation and comfort	15. Physical activity (sports, walking, etc.)	25-Inducing positive emotions
6. Natural Phonetic System (Pleasant Sounds)	16-Social support	26. The existence of a sense of control over the environment
7- Natural light (presence of sunlight and shade)	17-Fresh Air	27. Encouragement and Persuasion
8. Permeability and easy access to the enclosure	18. Presence of a sense of security	28. Creating communal spaces (for interaction with the family)
9- Perspective (view of nature from the inside)	19. Elimination of stressors in the environment	
10- Existence of spaces for solitude	20. Medicinal plants, aromatic, healing, etc.	

Figure 24: Architectural Features of Evidence-Based Healing Garden Based on researchers' studies, Source: Authors

Therefore, in continuation, according to the diagram above, the study examines and analyzes these features in the design of medical centers, focusing on the needs of visitors and their treatment methods in the recovery process, and delves into case studies.

Table 2: Introduction and Analysis of Case Studies Based on the Architectural Features of Healing Gardens Through Evidence-Based Design, Source: Authors

	Name	year	Location	Architect	picture	Analysis of Study Samples Based on Evidence-Based Healing Garden Architectural Features
1	Socso Rehabilitation Center	2014	Malasya	Arte Axie Design Group		
2	Groot Klimmendaa Rehabilitation Center	2011	The Netherlands	Architectenbureau Koen van Velsen BV		
3	Spaulding Rehabilitation Center	1995 - 2013	Boston, Massachusetts	Perkins + Will - Copley Wolff Design Group		
4	Ezra Lemarpe Rehabilitation Center	2017	Proximity to the Gaza Strip	WEINSTEIN VAADIA		
5	Basaksehir Rehabilitation Center	2016	Turkey	Pronil		
6	Basel Spinal and Brain Injury Rehabilitation Center	2002	Basel, Switzerland	Herzog & de Meuron		

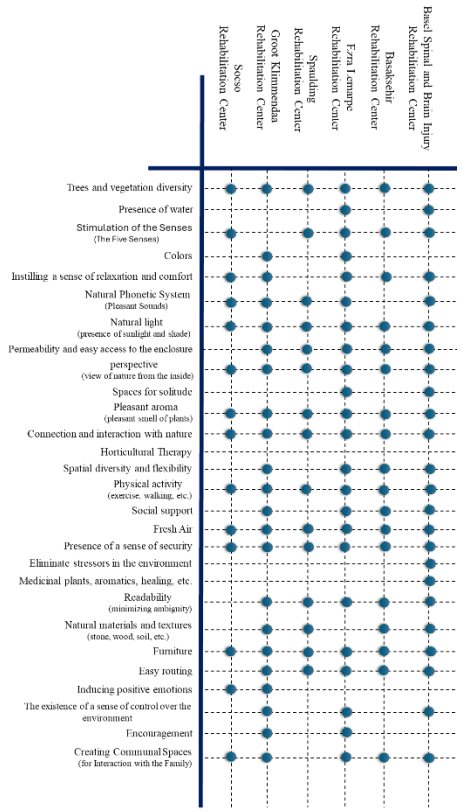


Table 3: Analysis Results of Study Samples Based on Evidence-Based Healing Garden Architectural Features, Source: Authors

The architecture of the healing garden																										
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28

Creating Communal Spaces (for Interaction with the	% 83/3
Encouragement	% 33/3
The existence of a sense of control over the	% 50
Inducing positive emotions	% 83/3
Easy routing	% 83/3
Furniture	% 100
Natural materials and textures (stone, wood, soil, etc.)	% 66/6
Readability (minimizing ambiguity)	% 83/3
Medicinal plants, aromatics, healing, etc.	% 16/6
Eliminate stressors in the environment	% 16/6
Presence of a sense of security	% 100
Fresh Air	% 100
Social support	% 66/6
Physical activity (exercise, walking, etc.)	% 100
Spatial diversity and flexibility	% 66/6
Horticultural Therapy	% 0
Connection and interaction with nature	% 100
Pleasant aroma (pleasant smell of plants)	% 100
Spaces for solitude	% 33/3
Perspective (view of nature from the inside)	% 100
Permeability and easy access to the enclosure	% 83/3
Natural light (presence of sunlight and shade)	% 100
Natural Phonetic System (Pleasant Sounds)	% 83/3
Instilling a sense of relaxation and comfort	% 83/3
Colors	% 33/3
Stimulation of the Senses (The Five Senses)	% 83/3
Presence of water	% 33/3
Trees and vegetation diversity	% 100

7.Conclusion

Healing gardens, as spaces designed to enhance the physical and mental well-being of users, require meticulous and evidence-based design. The evidence-based design approach, relying on scientific research and empirical data, facilitates the identification and implementation of the most effective architectural solutions. This approach, while considering the principles of sustainability and environmental compatibility, contributes to improving spatial quality and increasing the effectiveness of healing gardens. In this regard, the use of passive architectural strategies and innovative solutions plays a significant role in enhancing users' adaptability to environmental conditions and user needs.

Architects and designers, facing growing environmental challenges, are increasingly adopting passive design strategies as a sustainable alternative to conventional construction practices. Unlike active systems that rely on mechanical interventions, passive design harnesses natural energy flows such as sunlight, wind, and thermal mass to create energy-efficient and environmentally friendly spaces. This paper has demonstrated how simple passive design strategies can be effective, reliable, and cost-effective in ameliorating extreme indoor and outdoor temperatures. Increasing the opportunity for adaptive comfort is an approach that allows building occupants to participate in and control their comfort conditions based on their needs and decisions. Passive design strategies signify a paradigm shift in sustainable architecture, offering a harmonious blend of environmental responsibility and human-centered design. The architect should pay attention to this issue during the design process to improve comfort conditions and consider strategies to increase the opportunity for adaptive comfort, as well as consider more passive strategies and integrate renewable energies into the design. The architect can contribute to energy savings. Based on the strategies presented in this study, it can be concluded that the strategies can be simple, but these simple strategies and their combination can increase the opportunity for adaptive comfort for building occupants.

Ultimately, by integrating passive strategies and innovative architectural solutions through evidence-based design, healing gardens can be created that, while adapting to environmental conditions, contribute to the promotion of users' health and well-being.

Table 4: Summary Table of Passive Strategies in Architecture, Source: Authors

	Passive Strategies
1	Shifting
2	Sunny spaces have been built in different parts of the building to benefit from daylight all day long
3	Taking advantage of the difference between the angle of the sun radiation in winter and summer in the design
4	Using the solar spaces in the South body of the building
5	Trombe wall
6	Natural ventilation system
7	Using the wind-catcher as a pattern
8	Increasing the Adaptive Opportunities by designing kinetic facades
9	Flexibility in design

Table 5: Summary Table of Architectural Solutions in Healing Gardens, Source: Authors

	Features	Architectural Solutions
1	Trees and vegetation diversity	Extensive and diverse use of colorful flowers, plants, and various plant species in landscaping and interior spaces
2	Stimulation of the Senses (The Five Senses)	Stimulating the five senses of patients through the use of stimuli in spaces, such as fragrant flowers and plants, the presence of water, animal sounds, etc
3	Instilling a sense of relaxation and comfort	Creating safety and security in buildings through interior design informed by behavioral sciences.
4	Natural Phonetic System (Pleasant Sounds)	
5	Natural light (presence of sunlight and shade)	Utilizing natural daylight through wide and full-length windows and atriums
6	Permeability and easy access to the enclosure	Clear identification of entrances and circulation paths within the site Clear hierarchy of spatial access Prominent building entrances
7	Perspective (view of nature from the inside)	Use of wide and full-length windows
8	Pleasant aroma (pleasant smell of plants)	Cultivating Diverse and Unique Aromatic Plant Species in Outdoor and Indoor Spaces
9	Connection and interaction with nature	Widespread use of nature imagery in interior spaces Maximizing the integration of nature in interior spaces
10	Physical activity (exercise, walking, etc.)	Designing outdoor spaces dedicated to daily activities such as cooking, therapeutic gardening, group work, and more.
11	Fresh Air	Utilizing full-height and operable windows Designing atriums and central courtyards
12	Presence of a sense of security	Designing all spaces with high safety standards and tailored to user needs Designing spaces with clear visibility and user traffic control Designing security guard spaces at entrances
13	Readability (minimizing ambiguity)	Designing a clear and simple spatial hierarchy through space zoning Designing efficient and short pathways in entrances and corridors leading to spaces Designing cohesive and well-defined spaces
14	Furniture	Designing fixed and movable furniture in interior and exterior spaces for user utilization

15	Easy routing	Defining vehicular and pedestrian circulation routes within the site Identifying the shortest routes to entrances, parking areas, and site service spaces
16	Inducing positive emotions	
17	The existence of a sense of control over the environment	Enabling individual control of room lighting and temperature through windows
18	Encouragement	
19	Creating Communal Spaces (for Interaction with the Family)	Designing circular outdoor spaces for gatherings and social interaction

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