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BIOCLIMATIC CONSIDERATIONS FOR HOUSING PROTOTYPE IN DESERT ARCHITECTURE: SIWA AS CASE STUDY

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ABSTRACT

Energy consumption in residential buildings sector in Egypt is very high, in addition it is estimated to increase more due to the developments in living standards and the growth in population. The study aims to reduce energy consumption of residential buildings in hot climate conditions using Bioclimatic Design Strategies. Those design strategies include three guidelines: energy, human health and sustainability. Moreover, the study merges the Bioclimatic startegies with vernacular strategies to reduce energey comsuption and enhance occupant's thermal comfort. The study adopts a descriptive, analytical and comparitive methodology, complimented with a carried out software stimulation using ANSYS within a qualitative and qualtitative approach. This study concludes with a new design approach for bioclimatic housing units for youth Siwans that will limit energy usage, In addition that it will result as an improved architecture to the climatic environment.

KEYWORDS: Bioclimatic design strategies, Housing Prototype, Vernacular architecture, Solar Passive techniques, Energy efficiency, Thermal Comfort

1. INTRODUCTION

Electricity consumption in Egypt has been rapidly increasing and with the current growth rate of more than 7% per year, Egypt needs to double its current generation capacity by 2020 [1]. The residential and commercial sectors consumes nearly 34% of their energy, estimated at 43% of the total energy for lighting purposes [1]. Therefore, designing an energy efficient housing unit according to the bioclimatic principles will afford a sustainable environmental development in the city.

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The term ‘Bioclimatic’ is the relationship between climate and living organisms, or the study of bioclimatology [2]. Early definitions of Bioclimatic housing emphasized the overlapping fields of biology, climatology and architecture. The study aims to reduce energy consumption for residential buildings in hot-climate using Bioclamtic Design Strategies through the following objectives:

- To study the guidelines for the Bioclimatic elements applied to the design in desert architecture.
- Studying the process of Vernacular Design Strategies and solar passive techniques, to achieve the best comfort levels in interior spaces.

2. LITERTURE REVIEW

2.1 Bioclimatic Design Approach

Bioclimatic Architecture is infrequently established on Vernacular Architecture and attempts to consider traditional architecture; based on climate and culture of a place and to study the architectural and construction clarifications [2]. Vernacular architecture has experienced a slow progression through which it has gained social, cultural, religious, economic, technological and climatic information related to specific places to produce quit remarkable architectural designs. This type of architecture adjusts to the climate of the place without using additional devices that consume energy and leave an environmental impression [2]. Buildings can be designed to require lesser than the energy of today's average [3]. Climate responsive design can be equally functional to all building forms and balances therefore, this parameter is envisioned to be general, applying to low-rise detached housing construction [4]. The proposed design approaches are mainly applicable to passive considerations such as floor planning, façade design and orientation in addition to those determined by engineering clarifications such as co-generation [4].

Bioclimatic Architecture main purpose is to achieve thermal comfort for human by cooperating with the exterior climate. The design of bioclimatic employs appropriate technologies and design principles focusing on climate and environment [2-6].

According to, the appraisal of architecture throughout history, it has been approved that reaching the best interior comfort for the occupants; by succeeding the process of vernacular design strategies and solar passive technologies as shown in fig.1. Human comfort and well-being have been observed the most important constraints due to the assessments of indoor environment [2-6]. Energy efficiency theory in buildings according to the energy required to accomplish the best environmental conditions while reducing the energy consumption. The largest energy consumers in buildings are heating, ventilation and air conditioning. *"Ekici and Aksoy listed the parameters that affect building's energy requirements as follows: physical-environmental parameters and design parameters*" [2].

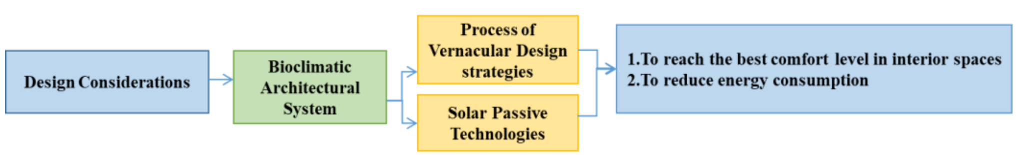


Fig. 1. Bioclimatic design considerations purpose (Researcher).

2.2 Vernacular Design Approach

The process of Vernacular Design Strategy refers to the Architectural Style that is designed based on the local needs, availability of construction materials and reflecting local traditions. Therefore, this progressive process is proposed to get back the ethics of architecture of protection against the exterior environment in agreement with minimizing the energy consumption [2]. In modern architecture, many features of the vernacular design methods can appear out of date because of the new technologies and new construction approaches [6].

The term" solar passive technology" discusses the cooling or heating procedures that submissively protect the sun's energy [5]. Although, building sustainability features; such as economic, social and environmental, are contented in the vernacular architecture [5-6]. A solar passive structure is designed for achieving pleasant indoors comfort levels; by using the solar radiation for natural daylighting and to warm up the internal spaces in winter and to block out the heat radiation in summer for cooling [6].

2.3 Bioclimatic Design Features in Vernacular Buildings in Hot Climate Zones

To study the possible bioclimatic architectural strategies, the location of the home condition must be evaluated primary [2]. Most of the residential building are not comfortable for the occupants because of its poor design conferring to the climate [7].Thus, the designing phase should focus on the constraints that are responsible for allowing thermal comfort without much dependency on energy use. Using passive and low-energy strategies in building construction to achieve environmental worth particularly on hot climate weather had become a global trend in architecture [7]. There are many benefits of passive cooling design such as better-quality of comfort, lesser value bills and little extra cost to the builder [7]. To accomplish passive cooling building is to decrease the thermal loads that might enter inside [3].Thermal loads consist of two types; the exterior loads due to the climate and internal loads due to people usages, patterns etc. Sustaining a proper zoning of different components and local ventilation can decrease the overall effect of internally generated heat loads [3].

The most important feature, for applying the bioclimatic aspects in vernacular buildings, is the building shape which it should expose the surface area to the prevailing wind. In the following Table.1 it explains the design aspect of Vernacular Architecture that exists in hot climate zone [6].

Table 1. Bioclimatic features in Vernacular buildings in warm climate zone [6].

Bioclimatic features	Bio-climatic zones
	Warm and humid
Building area (for similar family structure)	Large with open spaces
Infiltration	High
Envelop tightness	Low
Shading	Present and prominent
Windows to walls ratio	0.22
Courtyard	Present in rural houses but not in urban houses
Orientation of building plan	Rural houses are E–W direction, south facing and urban houses are not specific
Shape of building plan	U-shaped or rectangular (elongated plan)

2.4 Vernacular Architecture and Energy Efficiency

Recently, in order to achieve the energy consuming in buildings up to the maximum quantity, the energy efficiency and the building performances presents a vital role. By considering energy efficiency and passive building design, windows, windows size, and orientation of them are playing a core role in in residential buildings. As People spend more than 80 % of their lives indoors, environmental wellbeing in a workplace and living space is powerfully correlated to the satisfaction and productivity of its occupants [2]. The building temperature ranges should be established on real time experimental response of corresponding occupant's requirements [8]. Architectural style requirements, are based on the shape of built mass, orientation and form. Therefore, manages the amount of energy spent [8].

Conceiving an adequate household thermal atmosphere with the conception features, like larger ceiling height, providing of verandas substituted as buffer space between the exterior and interior environment, openings like ventilators and skylight, which can afford cross-ventilation by stack effect and the benefit of usage of local materials [8]. In view of heat gain adjusting methods would help to circumvent overheating caused by higher heat gain rates over loss. Besides, natural ventilation and thermal mass are other major features altered the thermal comfort [6]. As those features enhance the energy efficiency of the housing unit.

The ensued of vernacular architecture with the need generated the thermal comfort settings, that fact of thermal comfort accomplishment of a vernacular house proved to be more desirable than modern houses [8]. Thermal comfort is reliant on a composite of four basics: indoor temperature, outdoor temperature, and virtual humidity and clothing pattern of the people of the region [8]. To accomplish an inquiry, location climate, solar radiation and wind orientation, which all can affect the building envelope must be initially studied [2-8]. Therefore, the next section will focus on those features.

2.4.1 Disposition of building

Building orientation is the process of deciding which direction a building will be oriented to. It is important for energy consumption and helps designers take advantage of the suns free energy, which overtime, will consequently reduce the overall energy consumption of the building. To properly orient a building, it is important to understand the true position of the sun and how it will affect the building [7].The following fig.2 illustrates Siwa, chosen site for the proposal design, climatic conditions analysis [7-10].

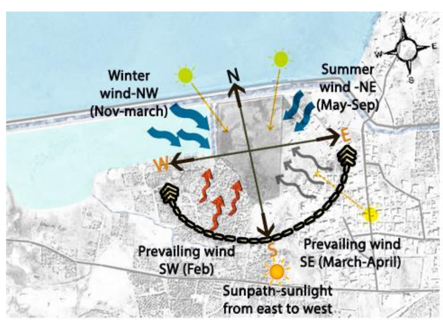


Fig. 2. Siwa selected proposal site and its climatic conditions analysis (Researcher).

The ideal house orientation is East-West and moves 20º degrees, but the most glass on the building must be facing towards the Sun. Maximizing north façade exposure for daylight harvesting and to reduce lighting, electrical loads and using shading strategies to reduce cooling loads caused by solar gain on south façades [10]. Turning long façades toward the direction of prevailing breeze to enhance the cooling effect of natural ventilation. When deciding the building orientation also take into account the location of landscape features on land plot, trees and walls, etc. which will impact on how the sun will be harnessed. The most frequently used rooms during the day are oriented in the East and the North whereas the rooms that are used mostly at night are restricted to the South and the West [7-10].

2.4.2 Landform

Site Orientation means the position of the Site with respect to the Basic directions. It is identified by the direction that the front of the Site faces. Landform signifies the topography of a site, it may be flat, swelling or sloping [3-7]. Depending on the macroclimate and season, some locations within a particular landform experience a better microclimate than others [3-7].

2.4.3 Building massing

A building that is successfully massed will use the general shape and size of the building to maximize its free energy from the sun and the wind by minimizing energy loads [11]. Passive heating, cooling, and daylighting are all important factors that are considered in massing a building during the design process. In warmer climates buildings that are designed with their biggest face exposed to the sun can cause solar heat gain.The building shape clarifies that the width of the building changes the way the building will perform [12].

2.4.4 Air movement

Living in hot climate can rapidly become uncomfortable for its inhabitants with the extreme heat gain inside the buildings. Therefore, it will be beneficial for the building structure to have effective ventilation and internal temperature below the outdoor level [7]. Natural ventilation keeps the air moving within the indoor environment and keep the occupants cooler even without the use of energy. Buildings designed to minimize cooling loads mostly through the use of natural ventilation may integrate a flexible floor plan that allows a compact shape, while allowing alterations that attain a spread out plan with greater exposure to the air [4]. When designing the orientation of the building, it is important to lay it out such that the buildings shorter axis align with prevailing winds [6]. Aligning it this way will allow for the most wind ventilation.Cross ventilation is another method used in the passive design process that uses natural wind current for building cooling. This study focuses on the vents to control the inlet air flow rate and propose new design for wind catcher as shown in fig.3

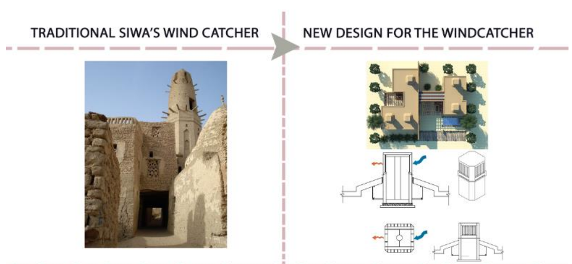


Fig. 3. Comparison between traditional Siwa's wind catcher & the new design wind catcher (Researcher).

Wind catcher contain vertical shafts with two to eight openings at the top of it to latch the draught from all directions fig.4.Wind yields pressure alterations around a stumbling block. Thus, the air velocity increases in windward area than the leeward area. For that reason, the positive pressure forms in the face of windward and negative pressure from the opposite side of the wind-catcher [10]. As shown in fig.4 that wind go in from the zone with the positive pressure and inclines to transfer to the lower pressure zone. In the case of wind-catcher lower pressure zone is located at the bottom of the wind-catcher's shaft, then fresh air enters to the house and internal hot and polluted air dissipates to the opposite side of the inlet with higher negative pressure [12].

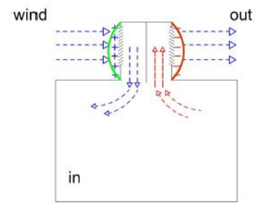


Fig. 4. Pressure zones around a wind-catcher (positive pressure zone in windward side and negative pressure zone in leeward zone) [12].

2.4.5 Internal spaces arrangements

The patio (Courtyard) is for the traditional dwelling the outdoor spaces that forms a microclimate and the most effective form of using the indoor space of house [13]. The scheme's effectiveness can be improved by contributing the place with fountain, water pools and big leaves plantations [13]. This space plays a significant part on local microclimate and helping to improve the surrounding environments. It aims to attain comfort by reducing the temperature through water evaporation while simultaneously increasing the relative humidity [14]. Although, it acts as a climate modifier by collecting cool air in night and a source of shade in daytime [6]. Thus it’s an important source for natural ventilation and enhanced air circulation. If courtyards designed properly therefore, it can lead to faster rates of heating and also enlarger the surface area of the building [7].

2.4.6 Building envelope

Building envelope consists of: roof construction detailing, walls, windows and floors which heat enters and leaves a building through them. Internal walls, doors and room arrangements affect heat distribution within a home [6]. The vernacular building envelope of this climatic zone are massive in construction. By providing thickness and tightness, these walls can be effective used to modulate the indoor temperature [6]. Envelope design is the incorporate design of building form and materials as a total system to achieve best comfort and energy savings [7]. To perform an analysis, the first areas of study are the location climate as well as the solar radiation and even the predominant wind orientation, all of which can affect the building envelope [6-7]. It can lower operating costs, improve comfort and lifestyle and minimize environmental impacts. Building envelope color can influence thermal performance and reduce maximum indoor temperatures, thus reducing the need for mechanical ventilation and cooling. For example white surfaces absorb less solar radiation than dark surfaces, thus transferring less heat to internal surfaces by conducting and to indoor air through convection [7]. The quantity of solar radiation reflected varies from 80 % in the case of white surfaces, to 20% in the case of black surfaces [4].

2.4.7 Openings

The naturally ventilated buildings take advantage of big openings, they also tend to be noisy since large openings let more noise to enter the building as well as fresh air [12]. Therefore, the location of naturally ventilated building is very important and it is reommended to avoid them in noisy areas [12]. Assuming that the structure is properly oriented with the suns alignment, proper window placement will ensure that the correct amount of sunlight is entering the building [12]. Therefore, to achieve the most natural ventilation, a building should be constructed with windows on opposite sides from each other. Siwa building's openings are recessed and not huge in structure for minimizing the heat gain.

2.4.8 Landscaping

Vegetation plays an imperative part to protect the buildings from dust, wind, and also generate a complacent outdoor space. Implanting local trees stock the water in humid leaves, or captivate water from humid air [15]. Vegetation is used association with the town's buildings and streets to diminish the sun, wind and pollution effects. Climate adopts the form and the component trees, which can help in generating the required of adjustment to weather consequence [13]. The solution with green spaces can be; high trees with thick leaves (palmers), this type of trees help in deterring the sunbeams, lower the environment air temperature of the house, change the wind direction and shadow the roof, walls, terraces, ground lowers their temperature.

2.4.9 Water bodies

Water has a moderately high concealed heat of evaporation as it absorbs a large amount of heat from the surrounding air for evaporation [10]. The cooled air can then be introduced in the building. Evaporation of water also increases the humidity level, which is mainly beneficial in hot and dry climates. Sites near seas and large lakes have less temperature variation between day and night, as well as between summer and winter as compared to native sites.Evaporative cooling can help to maintain comfort in buildings in hot and dry climate.This feature was successfully adopted in vernacular architecture. Siwa is highlighted with a huge salt lake waterfront which is taken as considerable water body element for the studies of the proposed design.

2.4.10 Building materials

The selection of sutiable materials can help avoid unwanted heat gain in warmer climates or can help store the suns heat with thermal mass in warmer climates [13]. The architecture of Siwa oasis is characterized by the use of karshif, which is unusual material made of NaCl salt crystals with impurities of clay and sand. The blocks of irregular shape taken from the salt crust that surrounds the salty lake, are cut in smaller blocks and utilized in the masonry with a mud mortar very rich in salt. Wood inserts positioned inside the wall thickness in order to boost the jointing between the external and internal parts, particularly where the walls are extensive [13].

The architecture of Siwa is unique for its use of karshif in an unusual and little studied building technique employed in the construction of the old town Shali, and of buildings of the 19th century in the oasis after Shali was being abandoned [16]. Karshif is a hardened mix of sodium and potassium chloride (75-85%) as well as quartz and calcite particles that occur at the shore of salt lakes as firm deposits as water evaporates and solutes crystallize. Irregular-shaped karshif slabs and blocks are excavated at lakeshores and engaged to construction sites, where they are accumulated into walls up to 2 meters thick [16]. A mud mortar made by hydrating tafla, a mix of clay (40-60%), gypsum (20-30%) and sodium chloride (10-30%) occurring underneath the salt crust is used to bind the karshif fragments. This mortar is quite different from usual mud mortars in that it hardens not only through drying, but also the crystallization of sodium chloride into one rigid matrix that intimately drags karshif blocks together into a sort of “monolith” [16]. Karshif architecture would be unlikely without the use of date palm trunks, which are used as beams in their houses see Fig. 10, in order to stabilize walls and, split longitudinally into half beams, to construct floors, realize architraves and projecting structures. In oasis there is only anther type of wood available which is the olive wood, but its lees rich than the palm wood and in earlier times there was not any other way to get wood from outside. In modern karshif buildings, use of palm wood seems to be supplanted by timber, or at least partially so, possibly because palm wood is a very deformable material and exhibits great vertical displacements under loads. Karshif has been hailed as being superior over modern construction materials in so far as it insulates against heat. Karshif buildings are cooler in summer and warmer in winter, thus mitigating weather extremes [16]. However, karshif walls are quite weak and intimidating cracks ensue regularly, mainly near corner edges, and under palm beams. If these remain open, occasional rains and humidity can further weaken the structural integrity of buildings. Therefore, the neglect of Shali’s karshif architecture led quickly to the destruction of the old city after its final desertion in the 1930s [16].

Siwa oasis consists of two types of wood but its utmost wealth is the date palms, which is the second important material used in housing. The logs used in the assembly of beams, floors and rarely, pillars, come from dry palms so they are lighter than habitual [17]. The palm tree wood does not have the ring-shaped structure that typically embodies the logs of trees but its trunk presents bundles of parallel fibers. Therefore, being hardly workable, it has a scarce flexion resistance and it is very deformable [17]. For this reason, the bearing distances covered by the beams of this type oscillate between 3 and 3.5 m, regardless of the length of the plant of origin. This wood is not subject to the attack of fleas, except for the red weevil that attacks the fresh palms and against which some decent results have recently been achieved, appreciations to the some Italian technologies [17].

The technical upgrade for karshif is mainly a simplified process of alteration the traditional blocks of karshif into salt squared blocks. According to this material forms as for Siwa's traditions, it is found in the surface of the salty soils and possessed after being broken into remains and condensed to slight unformed extents [17]. On the contrary, the new process attainment the exceptional grids that include the detached forms of salt blocks has been effectively retained on the shallow of Sebkah, once the structure of salt crust and the vaporization of the remains of the dissembling water occurred.

Installation of bricks with humid tilaght mortar and the passage of salt through osmosis, from the bricks to the mortar, strengthens the union between the parts. The masonry facilitates its installation, accelerates the execution process and improves the weld among the materials, improving the resistance to eventual horizontal load, thanks to the reinforcement made of bamboo canes.

As a conclusion, of the advantages achieveded by this method upgrades karshif material which has provided and respected the extensive chance of time and costs of assembly of the raw materials by the following themes;

1-High decline of time in the construction phase.

2- A considerable elimination of the waiting time for the dryness of the single wall layers.

3- A better structural strength of wall surfaces.

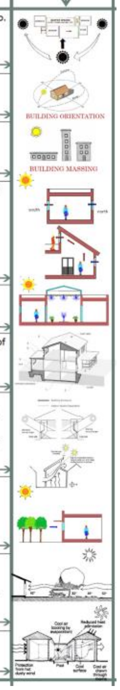
4-The wall capacity attachment is higher than the traditional method, which allow safer and longer lasting structures.

5-It allowed an obvious enhancement of the climatic and thermo hygrometric performance of the living environs.

To conclude this section, the Bioclimatic considerations for desert climate have been defined briefly in the previous section for Siwa as a case study. These ten strategies have been concluded and summarized description and diagrams in the following Table.2 to be taken in consideration for the design proposal project.

Table 2. Conclusion Table demonstrates ten design strategies with summarized description and diagrams (Researcher).

STRATEGIES	Description	DIAGRAMS
1- Disposition of building	*Building orientation, related to the sun and wind, aspect ratio. *Buildings should be orientated to minimize solar gain and maximize natural ventilation.	
2- Landform	*Space (Site planning). *Building cover the streets: creating shadows & comfortable outdoor space.	
3- Building massing (building form & open spaces)	*It is a design process to decide the shape and size of a structure. *Suppose to maximize the free energy from sun & wind by minimizing energy loads.	
4- Air movement (use of natural ventilation)	*It is important to lay out the building's shorter axis align with the prevailing winds, to allow wind ventilation. *Large surfaces should face the wind, orientating narrow surfaces limit the wind to enter. *Cross ventilation is a method used for passive cooling that uses natural wind.	
5- Internal space arrangements (courtyards or patios)	*This space plays an important role in local microclimate. *Plantations, water pools, fountains, vegetation.	
6- Building envelope.	*Envelope design: (walls, construction materials-thickness, roof construction detailing). *Any openings in the structure: windows, skylights, clerestories,	
7- Openings (size-position, protection)	*Window placement (size & orientation of building shell) to correct of sunlight to enter the building. (Dalighting &shading systems) *To achieve the most natural ventilation, a building should be constructed with windows on opposite sides for each other.	
8- Landscaping	*Vegetation is one of the most effective ways for changing microclimate for better conditions. (trees provide buffer to sun, heat , noise & air pollution) * Landscaping can be used to direct or divert the air flow beneficially.	
9- Water bodies	*Water has a moderating effect on the air temperature of microclimate, (e.g. lake) *Water evaporation has a cooling effect on the surroundings, it takes up heat from air through evaporation & causes significant cooling.	
10- Building materials	*It plays an important role in the buildings passive design. *Proper materials can help avoid unwanted heat gain in warmer climates.	



3. CASE STUDY

The selected case study is the Siwa Oasis is in the western desert of Egypt that is blessed with a dense landscape of olive and palm trees, numerous natural springs and salt lakes. Historically, Siwa was an important transit route for trade groups that merged their way through the desert from the Nile Valley in the east to the Mediterranean port of Cyrene (now in Libya) in the West [18]. The oasis, generally considered a natural vegetable system, is on the dissimilar one of the most important works of the human mind essential not only for its installation but also for its conservation inside a hostile environment like the desert [18].

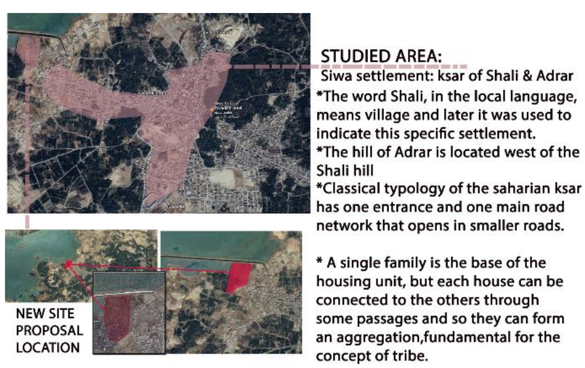


Fig. 5. Study area and new site proposal case study (Researcher).

The previous fig.5 illustrates the studied area and the new site proposal location on Google earth map, which it's location is on the Siwa Lake and it's an extension for the Siwa's settlement. According to a reported evidence in 2016 the population of Siwa to be around 28,300 persons, an extensive growth over the 8085 persons reported for 1980s and 12,500 in the 1990s. The crossroads of the occupation routes is 89%, so the Siwa's people are mixed genetic origin but culturally and demographically to a certain extent. They are of Berber origin which have closer links to nearby Libya, and a large Berber population compared to Egypt. Siwa traditional cultural indicates many aspects that are rare in Egypt, some of them replicates its ancient connections with Maghreb and the statistic that many of its citizens are of Berber origin [19].

As a result of their isolation, the Berber residents of the Oasis established a unique culture revealed in its crafts of basketry, pottery, silverwork, sewing and in its style of dress. Siwa's most detectable and famous examples of material culture were the bridal silver and the cooperative of silver decorations and beads that women bore in profusion to weddings and other rituals [20].

To assess the influences that affect the proposed management framework of cultural heritage landscape sites in Siwa, the SWOT analysis has been assembled in fig.6. The SWOT analysis offers material that is valuable in conveying into play the resources and capabilities of competitive environment. The points of analysis deliberates the strengths, weaknesses, opportunities and threats of the environmental, heritage and tourism approaches in oasis [22]. According to the SWOT studies, it debated the significant issue that Siwa face which is the local buildings were suffering from the severe setting damage due to the moist soil. However, the new building has been constructed with RC and tobe.

Point of Analysis	Strengths	Weaknesses	Opportunities	Threats
Environment	• Several magnificent salt lakes. • Fresh water springs. • Sand boards and toboggans of huge dunes. • Plants; date palm and olive, etc. • Distinct and wide-ranging collection of animal species, including at least two amphibians, mammals, reptiles, insects, soil fauna and birds. • Organic Agriculture	• Groundwater sources provide far more water than the inhabitants need. • Soil Salinization. • Desertification due to the large consumption of underground water. • The Balance of Ecosystem due to the negative change to the environment and natural heritage. • Pollution.	• Relationship between historic settlement and its surroundings natural and manmade setting. • Participation and involvement of the Siwa people in the environmental and developing programs. • Unique terrain punctuates a dramatic landscape where the Great Sand Sea converges with fresh water springs, salt lakes, lush vegetation and significant biodiversity.	• The human activities like "burning and the waste products flow from the olive factories" inhibit the vegetation diversity, performance of the plants, height, sociability life forms and phonological states. • Overgrazing was the most activities affect on vegetation diversity and floristic composition. • High temperatures during the day in summer.
Urban & Heritage	• Temple of Oracle. • Old Shali; magnificent relic at the center of Siwa's largest town. • Tomb of Alexander the great & other historical tombs. • Siwian house established of traditional building materials. • Traditional Models of windows and doors. • Variety of traditional arts and crafts.	• The urban indiscriminate sprawl of modern buildings. • The local buildings were suffering from severe settling damage due to the moist soils. • Some of the new buildings are being built in modern construction like concrete, bunt bricks; it does not fit the unique urban pattern.	• The presence of programs for developing Siwa oasis. • By putting a "Building Guideline", a good landscape image could be achieved. • Using local and traditional building materials has been appeared in hotels in the oasis and integrated patterns have been used in the layout.	• Difficulty of land reclamation due to increased consumption of groundwater. • Soil Salinization causes the difficulty of land reclamation. • The geographical isolation of the region; far away from the Nile valley. • Limited services and lack of infrastructure.
Tourism	• Historical places. • Medical tourism. • Eco-tourism. • Tourism services (Hotels, Restaurants, commercial shops, etc.)	• Cultural and Social Impediments. • Geographical Impediments. • Urban Impediments. • Regulatory Impediments. • Environmental Impediments.	• Preservation of the environment and sustainability • Emphasis to show the richness of local culture • Preservation of the architectural and urban patterns and to promote traditional building • Encourage safari	• Lack of popular participation in development. • Spatial remoteness to the oasis from the centers of urbanization in the Nile Valley. • Tourism development may adversely affect the environment.

Fig. 6. SWOT analysis of Siwa oasis [22].

3.1 Siwa housing conditions

Siwa housing conditions, urban texture and climatic conditions facing some problems that should be taken into consideration in the future [21]. The desert environment is recognized with its harsh conditions and imposed to acclimate life to these conditions. Siwa's urban texture is labelled with compactness as a technique of decreasing the aggregate of building surface exposed to the direct radiation of the sun. It requires narrow, regularly roofed and shaded streets, to avoid the heat of the sun and extreme brightness and provide ventilation channel [21].

Houses are divided into separate living spaces for summer or winter as shown in fig.7 (and day or night) to accommodate the different temperatures. Rooms and open spaces, albeit of limited size, were used in different ways in relation to the climatic conditions: the open spaces during the night in summer, while the areas under cover were the best place for spending the day, shielded against direct sunrays and naturally ventilated [20-21].

Fig. 7. The left picture shows summer living area and right one shows the winter living area [21].

Besides, traditional rules of urban planning have to be respected: the same height of the buildings, for example, which prevents one house from casting a shadow over another one; openings, constructed in a little number to control the amount of direct sunlight entering the structure. They are small and infrequent, because indirect light is preferable to direct exposure. Screening wooden elements, a sort of masharabiya, reduce the direct amount of direct lighting entering buildings and hide private spaces from unwanted curiosity from the street or from the neighborhoods as shown in fig.8 [21].

Fig. 8. Screening wooden elements and covered street in Al Qasr [21].

The traditional house of Siwa consists of two courts and the rooms surrounds them which creates a closed plan, which did not make all the house areas well ventilated. The new design approach verified that its open plan with the middle court performed much better than the traditional house, conferring a better ventilation for all zones in the house & created more pleasant atmosphere fig.9.

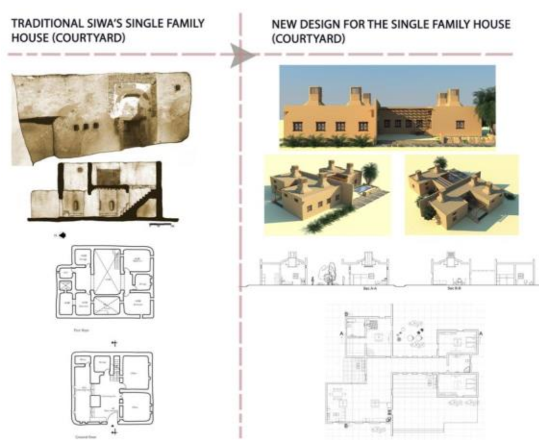


Fig. 9. Traditional Siwa house design & new plan design for single family house prototype (Researcher).

3.2 Siwa environmental & urban threats

High temperatures during the day in summer. The balance of ecosystem due to the negative change to the environment and natural heritage and pollution. The traditional Karshif buildings materials disappear, replaced by the tobe or the reinforced concrete, symbol of modernity, which are not environmental friendly and change the image & identity of Siwa as shown in fig.10.

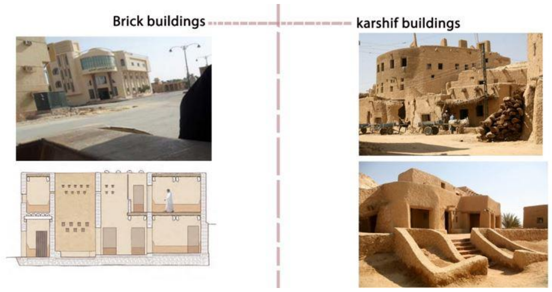


Fig. 10. The transformation of traditional Karshif building materials to modern brick building materials (Researcher).

The local buildings were suffering from severe settling damage due to the moist soils. The road network, are strongly influenced by the extreme compactness of the urban center. The richest agricultural areas are avoided in a transferring system of the housing space; even if located in the plain, it occupies areas that are not cultivated. The codes and the urban connections that have brought a sense so far to the traditional urban places disappear; they are replaced by isolated housing units, located one after the other along the main routes.

The unique compact and steady shape of the settlement and the protection from the sunlight of the houses are lost. The safety disappears and the reflection about the houses increases; these needs affect the single building and not the mass. It is not possible to clearly distinguish the presence of courtyards inside the buildings, though there is no room whose dimensions could be useful for this purpose as shown in fig.11.

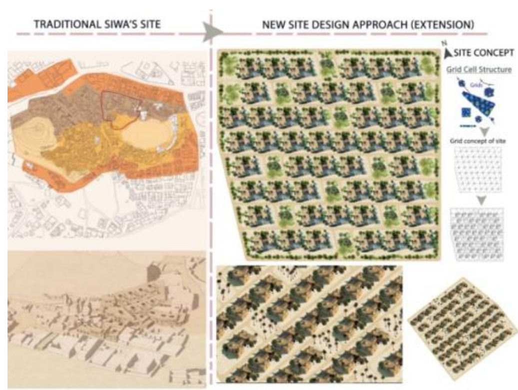


Fig. 11. Site improvement (Researcher).

4. METHODOLOGY

The study will be propose and design a new approach for bioclimatic housing units for desert climate circumstances located in Siwa, Oasis. The design will be intended, for contemporary youth Siwans, a detached single family house for 6 people. Indicating the building type is an important aspect that have an impact on the climate performance, energy consumption and thermal comfort [4].

The new design approach permitted the detached housing unit because of its feature, which contradict large envelope area and are subsequently extremely liable to solar radiation. Although, the detached housing can be the most energy challenging building category when air-conditioned. But at the same time for their greater dimensions can predict better natural ventilation [4]. The study examines preception of occupant's thermal behavior through a computer stimulation tool CDF which has been used to predict & analyze the ventilation process inside the new building design. This study encourages a new design approach by analyzing the environmental conditions around buildings to maintain ideal living conditions within the housing through minimal consumption of energy, and to achieve sustainability that has become a philosophy of the modern architecture.

5. RESULTS

Natural ventilation systems only rely on wind or stack effect as the driving forces. The wind-catcher is one of those devices which rely on wind and stack effect in the same unit. In order to evaluate the performance of the wind-catcher, the initial and boundary conditions of the CFD model. The performance of wind-catcher depends on outdoor wind velocity. ANSYS is a computer simulation tool, was used to study the indoor ventilation performance, which examined three buildings in different conditions, First a building that consists wind-catcher, Second a building without wind-catcher & Third the Siwan's traditional court house, all compared with each other in Table 3. It was concluded from the stimulation that the best building performance with the highest internal ventilation is the new design approach house that involves wind catcher. It applies the maximum wind velocity, the highest flow vector and highest contours of static pressure as shown in the comparative table fig.12.

The velocity vectors presented in the following Table 3 which discuss the highest flow vectors for each house type. According to the simulation results, the new design have a higher flow through the building including the court compared to the traditional court house in Siwa. Although by applying the wind-catcher on top of the building it will increase the ventilation indoors. Which will appraise better indoor healthier building condition and more comfortable for the occupants. In fact the new building design has substantiated and followed the design strategies to improve the indoor quality and decrease the energy consumption.

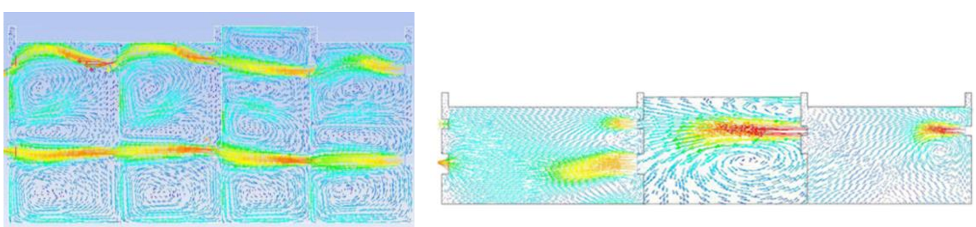
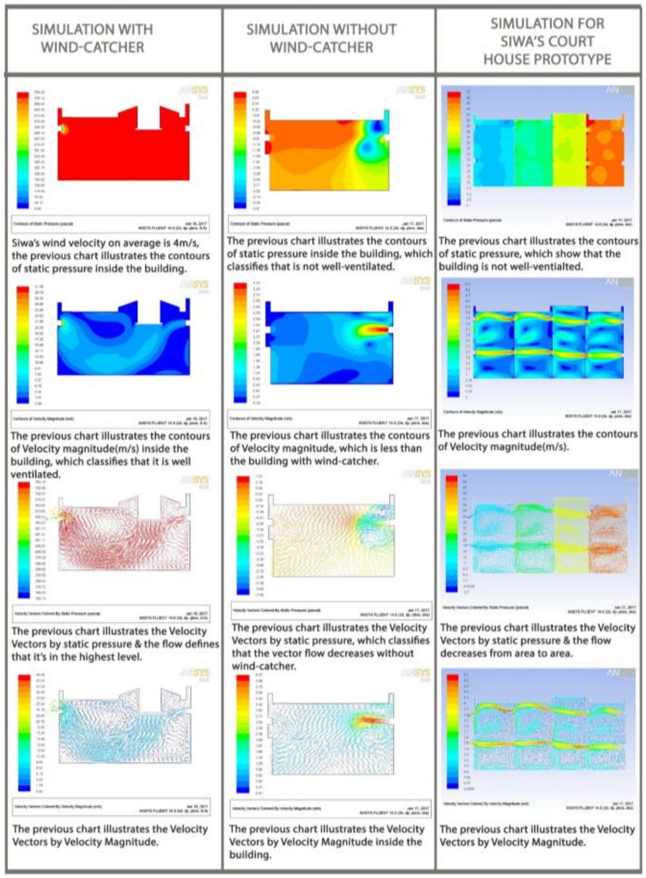


Fig. 12. Comparison results of the traditional court house and the new design house.

Table 3. Comparison chart of the Simulation (ANSYS results) between building with wind-catcher, without wind-catcher and the Siwa's' traditional court-house.



SIMULATION WITH WIND-CATCHER	SIMULATION WITHOUT WIND-CATCHER	SIMULATION FOR SIWA'S COURT HOUSE PROTOTYPE
Siwa's wind velocity on average is 4m/s, the previous chart illustrates the contours of static pressure inside the building.	The previous chart illustrates the contours of static pressure inside the building, which classifies that is not well-ventilated.	The previous chart illustrates the contours of static pressure, which show that the building is not well-ventialted.
The previous chart illustrates the contours of Velocity magnitude(m/s) inside the building, which classifies that it is well ventilated.	The previous chart illustrates the contours of Velocity magnitude, which is less than the building with wind-catcher.	The previous chart illustrates the contours of Velocity magnitude(m/s).
The previous chart illustrates the Velocity Vectors by static pressure & the flow defines that it's in the highest level.	The previous chart illustrates the Velocity Vectors by static pressure, which classifies that the vector flow decreases without wind-catcher.	The previous chart illustrates the Velocity Vectors by static pressure & the flow decreases from area to area.
The previous chart illustrates the Velocity Vectors by Velocity Magnitude.	The previous chart illustrates the Velocity Vectors by Velocity Magnitude inside the building.	The previous chart illustrates the Velocity Vectors by Velocity Magnitude.

5. CONCLUSIONS

According to the studies in the literature review and by analyzing the traditional aspects in Siwa oasis, it can be concluded First, that using the local materials is more economical than any other materials used which restore the identity and image of Siwa. Second, using natural resources and applying it appropriately on the buildings will achieve better thermal comfort for the interior spaces. Thus, the building techniques verified to be environmental friendly, more climatic response and better natural setting by using the local materials which provides a different style for the design and better tradition essence compared with the other new technologies. Therefore, adopting vernacular architecture principles and passive design strategies in the design process and construction phase will help to achieve cultural and social aspects of the local context. Third, appealing the communal in environment responsiveness programs encourages the features of the quality of life. Therefore, sustainable development project latitudes will custom the natural ventilation methods rather than the use of air conditioning.

The bioclimatic fundamentals applied to the new design approach in Siwa desert region are:

- The building form is mainly the courtyard in a continuous of the urban texture, which was the site's concept for connecting the courts of all the buildings with each other in form of grid.

- Using Siwa's local materials in order to succeed the sustainable design, creating the low-cost zero carbon building techniques, cheaper compared with the other materials and for re-establishing the image and identity of the city that has been gone in the present days.

- The windows placement in East-West direction to generate cross ventilation in interior spaces.
- The structures are built close to each other for creating solar and wind protection.
- For the environment method a new design for wind-catcher has been created and simulated, to ensure natural ventilation indoors and for attaining more energy-saving conservative alternative for climate control.
- The vegetation was locally selected and planted around the proposal site to protect it from the dust storms and also in the courts to ensure shadows and to gain the natural ventilation.

The purpose of this study was to introduce a new design approach by succeeding the vernacular architecture and passive design methods to decrease energy use and to achieve the best comfort level in interior spaces. As learnt from the inclusive sustainable improvement model prototype that can enthuse other societies and would greatly incorporate affirmative influences for the poor people.

REFERENCES

1. Dr.Anhar Hegazi, Ibrahim Yassin. Towards a more sustainable energy economy; 2013.
2. Agugliaro, G.Montoya, AndrésSabio-Ortega, García-Cruz. Review of bioclimatic architecture strategies for achieving thermal comfort. Renewable and Sustainable Energy Reviews; 2015.
3. Rajesh Sharma. Sustainable buildings in hot and dry climate of India. Rajesh Sharma Int. Journal of Engineering Research and Applications; 2016.
4. Peter St Clair. Low-energy design in the United Arab Emirates. BEDP Environment Design Guide; 2009.
5. M. H. Al Jawadi, Model of house design responsive to hot-dry climate. Journal for Housing Science; 2011.
6. Singh, Mahapatra, S.K. Atreya. Solar passive features in vernacular architecture of North-East India. Solar Energy; 2011.
7. O. K. Akande. Passive design strategies for residential buildings in a hot dry climate in Nigeria. Eco-Architecture.
8. S.S. Chandel, VandnaSharma, M.Marwah. Review of energy efficient features in vernacular architecture for improving indoor thermal comfort conditions. Renewable and Sustainable Energy Reviews; 2016.
9. E. Farjami, A. Mohamedali. Evaluating interior surfaces including finishing materials, ceiling, and their contribution to solar energy in residential buildings in Famagusta, North-Cyprus, Turkey. Renewable and Sustainable Energy Reviews; 2014.
10. Yahya Lavafpour, M. Surat. Passive Low Energy Architecture in Hot and Dry Climate. Australian Journal of Basic and Applied Sciences; 2011.
11. ISAAC A. Meir. Bioclimatic desert house: A critical view; 1998.
12. Narguess Khatami. The wind-catcher, A traditional solution for modern problem; 2009.
13. Prof. Dr. Arch. Amjad Almusaed & Dr. Ing. Asaad Almssad. Bioclimatic interpretation over vernacular houses from Historical city Basrah. Conference on Passive and Low Energy Architecture; 2016.
14. Xing Lu, PengXu, HuilongWang, TaoYang, Jinzhou. Cooling potential and applications prospects of passive radiative cooling in buildings: The current state-of-the-art. Renewable and Sustainable Energy Reviews; 2016.
15. Silvia Caccolo, Kaempf, Scartezzini. Design in the desert. A Bioclimatic project with urban energy modelling; 2013.
16. Siwa Oasis Egypt, (May 2016).
17. SIWA OASIS Actions for a sustainable development.pdf
18. Environmental quality international (EQI); 2009.
19. R.M. Ahmed. Lessons Learnt from the Vernacular Architecture of Bedouins in Siwa Oasis, Egypt; 2014.
20. Farrag, Nermin Mokhtar - Elalfy and Ayman Mahmoud. Harmonization between architectural development and heritage in Siwa oasis-Egypt. ARPN Journal of Engineering and Applied Sciences; 2016.
21. Francesca De Filippi. Traditional architecture in the Dakhleh Oasis, Egypt: space, form and building systems. The 23rd Conference on Passive and Low Energy Architecture, Geneva, Switzerland; 2006.
22. Nofal, Eslam Mahmoud Hassan Hussein. Towards management and preservation of Egyptian cultural landscape sites- case study: Siwa oasis.

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الاعتبارات المناخ-الحيوي لنموذج السكن في عمارة الصحراء: حالة دراسية سيوة

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الملخص

استهلاك الطاقة في قطاع المباني السكنية في مصر مرتفع للغاية ، بالإضافة إلى أنه من المقدر أن يزداد أكثر بسبب التطورات في مستويات المعيشة والنمو السكاني. تهدف الدراسة إلى تقليل استهلاك الطاقة للمباني السكنية في ظروف المناخ الحار باستخدام استراتيجيات تصميم المناخ الحيوي. تتضمن استراتيجيات التصميم ثلاثة مبادئ توجيهية و هي: الطاقة وصحة الإنسان والاستدامة. علاوة على ذلك ، تدمج الدراسة البدايات المناخية الحيوية مع الاستراتيجيات العامية لتقليل استخدام الطاقة وتعزيز الراحة الحرارية لمستخدمى المبنى. تتبنى الدراسة المنهج الوصفي والتحليلي والمقارنة مع التحفيز البرمجي المنفذ باستخدام ANSYS ضمن منهج نوعي و كمى. تختتم هذه الدراسة بنهج تصميم جديد للوحدات السكنية ذات المناخ الحيوي لشباب سيوة والتي ستحد من استخدام الطاقة ، بالإضافة إلى أنها ستؤدي إلى تحسين الهندسة المعمارية للبيئة المناخية.

الكلمات الدالة: استراتيجيات تصميم المناخ الحيوي ، النموذج السكنى ، العمارة المحلية ، تقنيات الطاقة الشمسية السلبية ، كفاءة الطاقة ، الراحة الحرارية

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