

Vernacular or Modern; It's All about Choosing Right Applications for Environmentally Friendly Architecture

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Abstract

In the past, passive vernacular architecture was used in the buildings so that the residents could live in a cool environment in summer and warm environment in winter. Vernacular buildings were well-adjusted to local climatic conditions with the best suitable materials. With the development of new techniques and materials; low-tech methods of vernacular architecture were regarded as backward and have been ignored by architects of modern architecture and vernacular applications were replaced by inappropriate architectural values along with their detrimental effects on the environment. Different materials and technology for a comfortable life are available today; but without passive cooling features in place, extensive use of air conditioning and energy has become inevitable for the houses to be thermally comfortable. However; high heating and cooling costs pose an economic problem for low-income people. In this qualitative study; four case studies, built in different periods of the XXth and XXIst centuries (from 1925 to 2020) were examined. Two mass houses and two detached houses in Lefkoşa were selected and examined from the viewpoint of architectural elements. The aim of this study is to analyze these houses in terms of building materials, building orientation and facade characteristics and question if importance to vernacular applications were given to these buildings during the construction in order to overcome negative effects of the hot dry climate of Lefkoşa. The results pointed out that only light building color was used in all cases as a vernacular strategy. Except the modern building from the 2000-2020 period, the other houses were oriented in the North-south direction. Reinforced concrete was used in three cases, except the Samanbahçe mass houses where 50 cm thick adobe was used in the walls. Extension of the roof was provided only in Efruz houses. Sun shading devices, which is one of the vernacular applications, was seen in the other three buildings however it was neglected only in the modern building from the 2000-2020 period.

Keywords: Vernacular architecture, modern architecture, sustainable architecture, historical texture

Yerel veya Modern; Fark Etmez, Önemli Olan Doğa Dostu Mimarlık için Doğru Uygulamaları Seçebilmektir

Özet

Geçmiş dönemlerde insanların yazın serin, kışın ise sıcak bir ortamda yaşayabilmeleri için yapılarda, yerel mimarinin pasif stratejileri kullanılmıştır. Yerel mimari ile inşa edilen binalar, kullanılan en uygun malzemelerle yerel iklim koşullarına iyi uyum sağlamıştır. Yeni teknik ve malzemelerin geliştirilmesi ile; yerel mimarinin düşük teknolojiye dayanan yöntemleri geri kalmış mimari olarak kabul edildiği için, modern mimarlar tarafından, görmezden gelinmiş ve yerel mimari stratejileri yerini, çevreye zararlı etkileri olan mimari uygulamalara bırakmıştır. Konforlu bir yaşam için günümüzde farklı materyaller ve teknoloji mevcut olmasına rağmen, pasif soğutma özellikleri olmadan, yeni evlerin termal olarak konforlu olması için yoğun klima ve enerji kullanımı kaçınılmaz hale gelmiştir. Ancak; düşük gelir düzeyine sahip insanlar, için yüksek ısınma ve soğutma giderleri ekonomik yönden problem teşkil etmektedir. Bu nitel çalışmada; yirminci ve yirmi birinci yüzyılın farklı dönemlerinde (1925- 2020'ye kadar) farklı dönemlerde inşa edilmiş dört yapı incelenmiştir. Lefkoşa'da iki toplu konut ve iki müstakil ev seçilmiş ve mimari unsurlar açısından incelenmiştir. Bu çalışmanın amacı, bu evleri malzeme, oryantasyon ve cephe özellikleri açısından karşılaştırmak ve Lefkoşa'nın sıcak kuru ikliminin olumsuz etkilerinin üstesinden gelmek için bu binaların yapımında yerel stratejilere önem verilip verilmediğini sorgulamaktır. Araştırma sonuçları; değerlendirmeye alınan tüm evlerde yerel mimari stratejisi olarak sadece açık bina renginin kullanıldığını ortaya koymuştur. 2000-2020 dönemine ait modern yapı dışında diğer konutların kuzey-güney doğrultusunda doğrultusunda konumlandırıldığı tespit edilmiştir. Duvarlarında 50 cm kalınlığında kerpiç kullanılan Samanbahçe evleri dışındaki diğer üç evde betonarme kullanılmıştır. Yerel mimari uygulaması olarak sadece Efruz evlerinde çatının uzatıldığı gözlenmiştir. Diğer üç binada gölgelik uygulaması görülmüş ancak sadece 2000-2020 döneminde yapılan modern evde yerel mimari uygulamalarından biri olan gölgelik uygulamasına rastlanamamıştır.

Anahtar Kelimeler: Yerel mimari, modern mimari, sürdürülebilir mimari, tarihi doku

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1. INTRODUCTION

Beginning from ancient times in history, human beings have always used shelters to protect themselves from wild animals, rain, storm, cold and hot weather (Pile & Gura, 2014, Abohorlu & Kurt, 2017, Nazif & Altan, 2013). People first used caves as shelters, then they began to build shelters for themselves by using local natural resources such as earth, grass, straw, bamboo, thatch and sticks.

Vernacular Architecture is a type of architecture constructed by using accessible local materials without the professional help of an architect. Modifications were made to adapt these constructions to the environment since thousands of years. Vernacular buildings are in harmony with local climate because they are made from environmentally suitable materials (Ulukavak Harputlugil & Çetintürk 2005). Vernacular buildings were placed carefully to provide natural ventilation and sustainability by using stone and adobe for the walls. On the contrary; modern architecture does not use natural materials, giving way to an unsustainable environment. It is interesting that almost 90% of all buildings in the world are thought to be vernacular.

Choosing the right materials and appropriate solutions have a direct effect on getting minimum heat during summer and losing minimum heat during winter. Recently steel structures are being used and walls are made of glass instead of stone, brick or adobe in new buildings. Reinforced concrete is mainly used in Modern architecture. From the viewpoint of sustainability; the use of reinforced concrete in North Cyprus presents some problems, like; crushing of rocks give way to dust and noise and destroy the environment (Celikag & Naimi, 2010).

With the use of new materials, architects neglected using common-sense applications such as appropriately orienting and recessing windows and including overhangs and louvers to the buildings for thermal comfort. In this situation, without passive cooling features in place, extensive use of air conditioning and energy has become inevitable for new constructions. With the increase in the usage of small air-conditioning units, people began to use more electricity in modern buildings. As a consequence, the need for energy and electricity costs increased and people with low-income levels cannot afford mechanical air conditioning payments. Furthermore, energy consumption of the buildings in Europe increased; with a rate of approximately 40% of the total consumption. For this reason the European Community wants to decrease energy use of buildings. Taking the climatic conditions into consideration, environmentally friendly architecture reduces costs of utilities and maintenance (Vellinga, 2013).

For a sustainable world in the future, modern technologies may be integrated with traditional vernacular knowledge to form an architectural perspective in the new millennium (Vellinga and Asquith, 2006).

Through the interpretation of vernacular and modern architecture from the perspective of building color, material, orientation and shading used in the constructions; this study will not only enable us to view the issue from a new perspective, but also will show the ways to make up for the insufficiency of current building materials by using the old vernacular material and applications.

2. LITERATURE REVIEW

2.1. History of housing and climate of Lefkoşa

In Cyprus cities we can see a combination of various architectural styles because Cyprus has been under the influence of different cultures from east or west civilizations throughout history. The constructions made in Lusignan and Venetian period, the Ottoman style buildings coexisting with buildings built in the British era give a mosaic character to Lefkoşa. During different historical periods; different cultures, life styles, economic conditions, developments in materials and techniques influenced the people and the design of their living environment.

Original building types of Lefkoşa were similar to the typical rural houses. The houses occupied a large area, and they were adapted to the landscape. The vernacular architecture in Cyprus changed through time in relation to the surrounding environment. In the Lusignan and Venetian times, the available space became limited and a process of land fragmentation was initiated.

Houses in Cyprus have been built according to geomorphology and the climate it would interact with. Thus the houses usually included one to three main living spaces which would be tangent to the west and north boundaries. This would ensure a south and east orientation which would be ideal for morning and daily activities. The houses were oriented in such a way that the longest facade would have the optimum orientation. The plan schemes of the houses were also formed in accordance with the climatic conditions. The rooms were arranged according to the closed and semi-open spaces. In relation to the hot climate of Cyprus, rooms were grouped around an open courtyard. As long as the degree of urbanization and the availability of the space had no restrictions, the buildings were oriented according to the climate (Philokyprou et al.2014). Importance was given to sun shading devices and cross ventilation.

In the 1920s and 1930s the new development of the urban tissue promoted the necessity of building in direct contact with the street and gradually undermined the importance of the environmental criteria. Besides the location of the building in the plot, some typological alterations had also taken place. Some limitations along main streets gave way to the evolution of the traditional courtyard house into mass houses, which were much smaller in size and had an equally small courtyard. Nevertheless, the semi-open covered spaces normally located along the south side of the building, continued to be present as part of a cultural expression of the Mediterranean way of living.

In the construction of buildings, climate has been a very important factor for human beings. In a lot of countries, many buildings are not designed suitable for the climate (Weihe, 1985). In cities having a hot and dry climate, like Lefkoşa, buildings absorb sun rays during the day and let heat go in the evening. During the design and construction of a building, the data of regional climate should be taken into consideration (Biket, 2006, Fernandes et al.2014, Michael et al, 2014). Climate affects the performance and energy consumption of buildings.

Cyprus has a Mediterranean climate; winter is mild and summer is hot and dry. Sunshine is effective for 6 -7 hours during the daytime in Cyprus. Humidity is relatively low and winds are mild in the inland. On the other hand; more humid climate is seen in the cities on the coast in summer. Temperature differs 9 -16 °C in different parts of Cyprus during the summer months. During the winter these differences are 8 to 10 °C (Abohorlu Dođramacı, & Kurt, 2017). Lefkoşa, the capital city, shows a great variance in day and night temperatures; up to 10°C (Ozay 2005, Katafygiotou & Serghides 2015).

Ventilation is needed in the summer months and September to achieve thermal comfort. Lefkoşa is in between two main mountains; Troodos in the south and west and Kyrenia Mountains in the north. As these mountains prevent wind and moisture, Lefkoşa has a hot and dry climate in summer and cool climate during winter. According to the results of bioclimatic analyses of the outdoor environment in Cyprus, the winter conditions do not appear to impose a crucial design problem for most regions of Cyprus (Katafygiotou & Serghides 2015), but in Summer, hot weather presents a real problem and cooling and ventilation is required (Oktay, 2002). Throughout July and August which are the hottest months of the summer in Cyprus. The bioclimatic charts show that shading is necessary during the day hours of July and August in order to avoid the direct solar radiation and increase of temperature in the building. Cooling may be achieved through natural ventilation, evaporative cooling and the increase of thermal mass in conjunction with night ventilation. The combination of these applications can reach impressive results because of the large daily temperature differences especially in inland areas, eg. Nicosia (Katafygiotou & Serghides 2015).

2.2. Applications related with the Mediterranean climate in vernacular architecture

Residential house design is very important for the comfort and wellbeing of the people (Akande, 2010). Several applications related with the Mediterranean climate have been used in vernacular houses (Lapithis, 2002, Fernandes et al., 2013, Philokyprou et al. 2014):

- 1- Compact form and relationship of buildings, narrow streets, and presence of *patios* decreases the number of facades to sun exposure. Buildings oriented to the south get sunlight in winter and reduce excess sunlight in summer.
- 2- Proper shading for windows such as using louvres, shutters and other sun shading projections like pergolas and covered balconies are useful when heat gains are not desired.
- 3- Decreasing window and door size and numbers reduces unwanted excess heat. Small openings towards the south allow cross ventilation and stack effect.
- 4- The existence of water elements such as fountains and pools in the environment cools air by water evaporation.
- 5- Use of vegetation and planting deciduous trees provide shade both increasing the humidity and also cooling the air until it reaches the house.
- 6- Local materials, like adobe and stone, are good material choices for the local climate. Thick materials used for thermal insulation have good heat storage capacity and the interiors remain cooler during the day and warm at night.
- 7- Light colors used for the exterior walls and roof of the building reflect extreme solar radiation.

The development in technology and environmental equilibrium are very important in adapting the vernacular design applications to modern designs. According to El Demery (2010); ‘*the aim today is to create sustainable buildings that interact and are in harmony with natural climatic conditions*’. Many architects today believe that although new technologies have been developed; there is still much to be learned from the vernacular construction methods and applications to be applied in future designs

2.3. Building envelope and building materials

Heat transfers through the roof, walls, windows and floor into a house. Heat transfer occurs through internal walls and doors in the house. These elements are named as the ‘‘building envelope’’. The envelope of traditional buildings prevents and filters negative climatic conditions. Adequate thickness of the materials in the building envelope prevents the unwanted climatic conditions to enter the building and help to improve the interior temperature. The envelope of a vernacular building does not allow excess heat and cold to enter the interiors. Stone, mud brick (adobe) have been used for the insulation of walls (Dincyurek et al.2003). Facades of buildings from Ottoman and British periods in Sarayönü region of Lefkoşa are given in Figures 1-4.



Figure 1. Stone on the ground floor wall adobe on the first floor walls of Ottoman house with bay window (Author, N.U)



Figure 2. Yellow stone house with ornaments from the British period (Author, N.U)

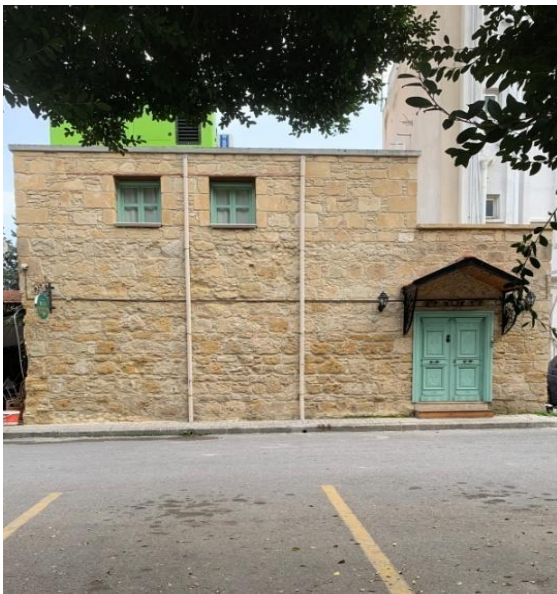


Figure 3. Ottoman period stone house with no windows on the ground floor for privacy (Author N.U)



Figure 4. The historical and contemporary elements add a special style to the buildings (Author N.U.)

Using sustainable materials makes the building stay cool inside without the need of power intensive air-conditioning (Vellinga, 2013). When mud bricks are mixed with organic material, lime or cement and sun-dried, they are called ‘adobe’. Adobe is a non-fired, economic and valuable material used for walls and floors of buildings in hot dry climates. Traditional adobe and stone interiors remain cool during the day and release warmth at night (Revuelta- Acosta et al. 2010). Another advantage is that earth and stone can be easily recycled, either by re-using old stone blocks or earth bricks as building material or returning earth to the soil to grow vegetation.

According to Jimenez-Delgado & Canas-Guerrero (2006); ‘‘fiber reinforced mud brick is a variation of adobe, made from compressed earth which consists of monolithic masonry units made with earth and straw. In this material, consolidation is achieved by mechanical means without chemical processes that change the material’s nature’’. Houses made from fiber reinforced mud brick performed better than concrete brick houses in reducing extreme indoor temperature changes during the summer and winter (Martin et al., 2010; Binici et al., 2009). Vernacular architecture includes the basic green architectural principles of energy efficiency (Philokyprou et al., 2014). On the contrary; concrete traps and holds high temperatures.

In Cyprus, generally natural materials have been used because they are easily obtained. As buildings are constructed by local people, the cost of construction is economical. By using stone and earth on the walls, minimum heat gets into the building during the hot months and minimum heat is lost during the cold months of the year. It can decrease energy consumption costs, improve interior comfort. Energy efficient constructions created according to the local climate not only save the environment but also reduce building consumption of fossil fuels. In a related study high thermal mass performed better in the Cyprus climate. Stone performed better than adobe because it has better shading and controlled natural ventilation (Nazif, & Altan, 2013).

It can be said that vernacular buildings have passive cooling systems to create thermal comfort indoors by natural ventilation. Vernacular buildings are advantageous because they are economic, they provide ventilation, thermal comfort, natural light and they are environmentally friendly. For these reasons they are considered as sustainable. In Cheung et al. (2005) study; it was reported that by using light colors on external walls, 12% saving in cooling energy consumption was found in high-rise apartments.

After the introduction of air conditioning; most architects thought that modern buildings do not need passive cooling; such as overhanging eaves, verandas, arcades and shading devices anymore and by eliminating these from the design, builders saved money. Furthermore, in modern constructions; walls were built thinner and rooms were smaller in order to save on building costs. With the increase in the usage of small air-conditioning units, people began to use more electricity in modern buildings. As a consequence, the need for energy and electricity costs increased. As thermal comfort, electricity costs, function, pleasing and healthy environment and architectural expression are all related with each other for an ideal design; these demands should be taken into consideration and applied to design. Unfortunately modern buildings made of modern materials are not effective for thermal comfort of the buildings giving way to high energy costs.

3. RESEARCH DESIGN / METHODOLOGY

In this qualitative study; vernacular and contemporary applications to overcome negative effects of hot dry climate in XXth and XXIst century residential buildings of Lefkoşa were investigated. Some criteria were taken into account in the selection of the houses included in the research.

i) The selected four cases are residential buildings, two of them were mass houses and two of them were detached houses. Two of the houses are located in the city center and the other two are chosen from newly developing neighborhoods; like Gönyeli and Yenikent.

ii) Every one of the four cases was built in different quarter periods (from 1925 to 2020). They are selected for the study to answer the below research questions:

1- What are the characteristics and construction materials of the selected houses?

2- Which applications of vernacular architecture have been applied in the selected cases to overcome the negative effects of the hot dry climate of Lefkoşa.

Examples of case studies were analyzed according to the theoretical information in the literature. The analysis included two main parts:

1. Literature review was conducted on vernacular techniques and materials used in the constructions for thermal comfort in the hot and dry climate of Lefkoşa. Four constructions from 1925-2020 were examined from the viewpoint of vernacular elements and applications in the designs, if stone or earth (adobe) were used for the walls and if there was outside or inside patio, or courtyard in the houses.

2. In this study, two mass houses and two detached houses in Lefkoşa (from 1925 to 2020 periods) were compared for the vernacular applications and materials in their constructions and their facade characteristics.

This study was conducted during the Covid-19 limitation period. For this reason, some of the data was collected from secondary sources, like research articles and theses. Because of the Covid-19 rules and limitations, face to face interviews and questionnaires could not be done.

4. CASE STUDIES: ANALYSIS OF FOUR HOUSES IN LEFKOŞA

4.1. Case 1. Samanbahçe Houses (1925 -1950 period)

During the XXth century, one and two storey houses were mostly built. Residential architecture showed some changes during the 1925-1950 period (Cogaloglu & Turkan 2019). Rooms were designed on both sides of a hall or joined the hall through a corridor. The bay windows of the Ottoman period changed and were designed as open space balconies or inner courtyards. Samanbahçe mass houses were located on the northern edge of Lefkoşa (Quriesh, 2004). They were built in the British period to solve the need for housing in the city. These houses which consist of 72 buildings were chosen because they were built by using vernacular materials, techniques and plans. The construction began in 1918 and 60 small houses were constructed in 1925 and 12 houses were constructed afterwards (Mesda, 2011). This social housing project was built for low income citizens in the walled city of Lefkoşa, in the beginning of XXth century. The land was used for growing fruits and vegetables until the end of XIXth century and as the land belonged to Şaban Pasha the area was called ‘‘Gardens of Şaban Pasha’’. Parallel roads were designed to open to a hexagonal shaped fountain with a dome at the center. Houses were planned back to back in a neat line to form rows. In this respect, Samanbahçe became the first neighborhood planned according to house plans of London.

4.1.1. Characteristics and construction materials of the houses

Houses of the 1925-1950 period are mostly single floor constructions. There are 5 rows of houses along geometric narrow roads which are parallel to Kyrenia Avenue (Fig.5, 6). They are built on stone foundations. Sun-dried earthen bricks (adobe) made of earth, gravel, clay and water and mixed with straw, grass, etc.was used for the 50 cm walls for thermal comfort in hot dry climate of Lefkoşa and a layer of gypsum plaster was applied on each side of the walls (Yıldız & Manioğlu, 2015). Traditional Cyprus marble was used on the floors. The double doors are made of wood with yellow stone frames. Doors are 1,3 m wide and 2,4 m high (Fig.7-8). The house numbers are written in Ottoman Turkish on the keystones of each house. The houses do not have columns, arches, or porches.



Figure 5. Aerial view of Samanbahçe houses (Photograph : @alpgalipcy)



Figure 6. View of Samanbahçe houses (Photograph from googlestreetview)



Figure 7. Door with lining stone and house number (Author, N.U)



Figure 8. Windows and doors of the houses and water channels on the street (Author N.U)



Figure 9: Site Plan of Samanbahce Housing from the wall of a house in the center (Author, N.U)

Windows are 1.20 m wide and 2 m high with wooden window shutters (Mesda, 2011). There is a dome shaped stone fountain for water needs in these areas, which does not work these days.

Samanbahçe area covers about 2000 square metres and each unit of building occupies 85 m² (Fig.9). Each row house measures 9.3 m in length and 3.3 m in height. The houses consist of an entrance hall, two bedrooms, kitchen, bathroom, toilet and an inner courtyard. There is one room on each side of the entrance hall. The rafters on the high ceilings of the entrance hall and two rooms are covered with woven reed mats (Fig.10, 11).



Figure 10: Entrance hall (Author, N. U)



Figure 11: Room with a high ceiling covered with woven reed mats (Author N.U)

One side of the entrance is opened to an inner courtyard with a door. The courtyard includes a kitchen, bathroom and toilet. The same plan was arranged except for four units which are located around the water fountain. Local building materials are used for these monotype constructions. Samanbahçe houses were constructed from stone and mud. Stone was used in raising the foundation of the houses. Mud brick was used in the foundation and walls. Foundations were constructed in 50 cm height with rubble stones. Walls have been coated with plaster; floorings are made of traditional marble, and roof covering materials in the interiors are reed mat.

4.2. Case 2. Efruz houses (1950-1975 period)

Cypriot architects who completed their education abroad came to the island and began to design buildings according to user specifications in the 1950 and 1975 period. Efruz houses were chosen as an example for this period because they are good examples of the transition from traditional to modern design. In the XXth century, Mediterranean modern architecture, from 1950 to 1970s, stone usage on the exterior walls and patio(outside or inside the building) were common as vernacular elements in the designs. Cypriot modernist architect Ahmet Vural Bahaeddin used these vernacular elements in Efruz houses. Efruz Mass Houses at Kumsal Quarter in Lefkoşa are also known as Müdüroğlu houses (Al-Din,2017). These houses were designed for high-income people in between the 60 and 70s of the XXth century.

4.2.1. Characteristics and construction materials of the houses

Efruz houses can be good examples of exceptional mass housing in Lefkoşa. A well-known construction company (Efruz Company), in Lefkoşa constructed the houses. The row houses have two storeys and were designed for the people with high income. The area of a house is 200 m². There is an entrance, living room, kitchen, toilet, laundry, garage, back courtyard and forecourt on the ground floor. The first floor has three bedrooms, bathroom with toilet and a corridor to transit to other spaces.

Straight and sharp lines are used in the design as a reflection of the modern age. Most of the units are oriented in the north direction. A natural stone was used on one facade. There is a large terrace in the south for the family to enjoy because terraces are very important and functional in the daily life of Cypriot people. They normally gather there to spend their evening.

Efruz houses were designed with the Modernist Bauhaus philosophy (Amen, 2017). The design has no ornament or decoration on the facades. Simple square shapes were used to compose the final form of the houses. All Efruz houses have courtyards; forecourt and backyard (Figure 12) that can be related with the 'patio' in vernacular architecture.



Figure 12: Courtyards of Efruz houses (from Salar Salah Muhy Al-Din)

Each elevation was designed according to the sun direction and windows are opened to the east while except the small windows for ventilation, the west elevations are almost closed with white plastered walls. The south and east sides allow light winds and cool the house in summer. During the summer, the sun can create overheating in Lefkoşa. The architect used long roof overhangs to prevent extreme sunlight entering the house, keeping the inside temperature lower than the outside. By using these long roof overhangs he created outdoor roof terraces (Figures 13,14).



Figure 13: Efruz houses, patio in between buildings and forecourts in front of the houses (Author, N.U).



Figure 14: The front facade, partially covered with exposed local stone (Author, N.U).

The use of local materials and vernacular techniques lost their popularity because of the popular use of reinforced concrete in the buildings (Dincyurek & Turker, 2007). In order to reflect modernism in the design, concrete was used as the main structure in Efruz houses. Some local materials and brick tiles were used on the pitched roof. White color was used as a vernacular characteristic in painting facade and envelope of the buildings (Al-Din, 2017).

4.3. Case 3: Örensel House in Gönyeli (1975-2000 period)

During the 1975-2000 period, there were economic problems in North Cyprus giving way to problems in design and construction of private houses to meet the needs of users. Thus, high rise or low rise buildings were constructed with standard plans. One storey standard house plans included a living room, kitchen, toilet and usually three bedrooms. This one storey detached house which was constructed by Sicimoğlu construction in 1997 was chosen as an example to reflect this period.

4.3.1. Characteristics and construction materials of the house

In this case, two similar buildings are joined to make a living area of 240 m²; in order to meet the requirements of its users. The total area of one house is 120 m². The ground floor has two entrances, two living rooms, two kitchens, toilets and laundries, four bedrooms two bathrooms, a semi open garage at the east facade, back courtyard and forecourt. The facade of the house is simple reflecting the standard plain characteristics of the period. The exterior walls are painted in light colors for saving cooling energy (Fig 15).

The balconies on the east and west facades are covered with pergolas to provide shade in summer. The shade under the east pergola is also used as a semi open garage for the cars. The pergola on the west facade forms a patio (Fig 16-18).

Trees are used to improve the microclimate of the house, they shade in summer on the contrary allow sun through during the cold months (Fig 15-17). Trees also reduce humidity, noise and pollution.



Figure 15: Front facade facing North (Author, N.U)



Figure 16: Back of the house facing South (Author, N.U)



Figure 17: East facade (Author, N.U)



Figure 18: West facade (Author, N.U)



Figure 19: Solar panels on the flat roof (Author, N.U)

Parallel with the standard plans of 1975-2000 period, economic building materials were used in the construction and no consideration was given to energy efficiency.

Solar panels were placed on the flat concrete roofs of the buildings for energy efficiency and decreasing the electricity bills (Fig19).

4.4. Case 4. Aksoy House in Yenikent (2000-2020 Period)

In the XXIst century constructions, single style is not used; combinations of different styles, from postmodernism and high-tech architecture are seen in the world. In North Cyprus this change has been slow, but recently contemporary design and construction details are being seen in the new projects of designers. In the 2000-2020 period, besides the developments in technology a wide range of materials have been available for building construction. Although a lot of countries have a tendency to use sustainable materials, like steel, that can be recycled; reinforced concrete is still popular in North Cyprus. As most of the residential buildings in this period were constructed from reinforced concrete; a modern semi-detached house constructed by İrfan construction in 2010 in a favorite neighborhood; Yenikent, was chosen as an example of this period.

4.4.1. Characteristics and construction materials of the house

This semi-detached house has straight and sharp lines in the design reflecting the impression of modern age. The house consists of two stories and the total area is 186.3 m². This semi-detached house shows a rectangular form with open floor plans and large glass windows on the ground floor.

Natural lighting is encouraged through large floor to ceiling windows. The architect created a simplified home from concrete with an emphasis on function. There are no ornaments or unnecessary details on the facades. The exterior walls are painted with a light color, but some parts of the walls on the first floor are painted in dark and light brown. Stone was not used as a vernacular element on the walls of the construction. On the other hand; there were courtyards (forecourt and backyard) that can be related with the 'patio' in vernacular architecture (Figures 20, 21). No measures were taken into consideration against the harmful effects of the sun in the construction. Sun shading applications or elements were not used in the windows, doors, or terraces for providing shadow in summer and the balconies are open to the sky.



Figure 20: Front facade facing East (Author, N.U)



Figure 21: Back facade facing West (Author, N.U)

Table 1: Analyses of vernacular applications related with the Mediterranean climate applied in selected cases

Vernacular Strategies	Description	Case 1 (1925 -1950) period	Case 2 (1950 -1975) period	Case 3 (1975 -2000) period	Case 4 (2000-2020) period
Building Orientation	Buildings oriented to North - South direction get maximum solar gains in winter and minimum solar gains in summer.	North- South direction	North-South direction	North-South direction	East-West direction
Sun shading projections	Proper shading for windows using louvers, blinds or shutters when heat gains are not desired.	Blinds external devices	No blinds but wide eaves projecting from the roof to cover the terrace	Louvers and two pergolas	No shading
Small openings for natural ventilation	Minimizing the size and number of openings reduces heat gains.	Very limited windows	Large windows and doors, but also small windows for ventilation	Large windows	Large windows and doors
Existence of water elements for evaporative cooling	Fountains and pools, usually placed in patios and cloisters, serve to cool air by water evaporation.	Nothing for evaporative cooling	Nothing for evaporative cooling	Nothing for evaporative cooling	Nothing for evaporative cooling
Use of plants and trees	Plants and trees are useful to provide shade and to increase air moisture helping to cool the air streams before reaching the building.	No plants or trees	hedge plants	trees on three facades	No plants or trees
Materials	The use of local materials, mainly earth and stone, is perfectly suited to local climate. Their good heat storage capacity stabilizes indoor temperature (that remain cooler during the day and warm at night).	Adobe	concrete, one facade exposed stone	concrete	concrete
Building Color	The use of light-colours for the building envelope, and especially the roof which is the most exposed to the sun, aims to reduce heat gains by reflecting solar radiation.	White color	White color, Stone	light color	light color on ground floor and dark color on first floor

5. RESULTS AND REMARKS

In this study; in order to examine and make a correlation between some applications of vernacular and modern applications; four case studies were analyzed (Table 1). The aim was to evaluate which vernacular material and applications were used in the constructions for thermal comfort.

For an environmentally friendly design; the problem is to make buildings which remain cool in summer and warm in winter. In summer, sun and heat should be prevented from entering indoors but cool breezes should be allowed to enter. On the contrary, in winter, the sun should be allowed to enter the building to keep warm and the cold winds should be kept out.

Samanbahçe mass houses were designed by using some of the vernacular technique and materials; such as inner courtyard, thick mud brick walls, high ceilings and sun shading devices on the windows. Yellow stone was used only to line the wooden doors of the mass houses.

Stone was used in one facade of Efruz mass houses and long roof overhangs were designed to prevent the sun entering the interiors in summer as vernacular elements. Louvres, pergolas and trees were used for shading in the Örensel house. On the contrary; no vernacular elements were used in modern Aksoy house.

Analysis of the four selected cases revealed that, the common vernacular applications were the use of white or light color on the facades of the houses and the courtyards. An internal courtyard was placed in Samanbahçe mass houses. The backyards and forecourts that can be associated with the patio in vernacular architecture have been included in the designs of the houses beginning from the 1950-1975 period to the present. From the viewpoint of orientation as a vernacular application; it was seen that except the Aksoy house, all the houses were oriented in the North-South direction.

Evaluation of the results also showed that only Samanbahçe mass houses had 50 cm. thick mud brick walls whereas in the other cases the thick mud brick walls were totally eliminated and concrete was used instead in the designs beginning from the 1950 period to the present. Long roof overhangs as a heat preventive vernacular application was only used in the 1950-1975 period in the Efruz houses to cover the balconies.

The use of reinforced concrete has some problems in North Cyprus because environmental destruction at stone crushing factories cause dust and noise pollution. Local materials such as adobe, yellow stone should be used in combination with new systems and materials wherever possible.

Modern steel and glass constructions need air conditioning for thermal comfort in the interiors which increase the electrical energy costs, and low income people cannot afford to pay high bills for thermal comfort. For these reasons vernacular applications are important in today's architecture. In choosing the material for the construction, the availability of the material has an important role. Stone, earth mixed with straw and bushes can be used as locally available materials and act as thermal masses in the walls or foundations of buildings (Abohorlu Doğramacı, & Kurt, 2017). They are friendly with the environment, cheap and provide better thermal conditions. Regarding the topography, the vernacular buildings do not destroy the natural land.

For an improvement in contemporary house constructions; we have to take lessons from the Vernacular architecture (Dincyurek, & Turker, 2007) and previous Ottoman and British periods and combine their applications with the new construction techniques.

Literature review on this subject showed some possible vernacular applications may be employed along with the use of modern technology. In order to achieve improvements to provide thermal comfort for the wellbeing of people in the new constructions, the following vernacular applications can be recommended for the hot dry climate of Lefkoşa:

a- Buildings should be oriented with respect to wind and sun with a good insulation of walls (40-50cm width) and roofs.

b-Small windows (preferably retreated into the facade to get less sunlight), louvers or shutters, high ceilings, thick walls, trees in the semi-open living spaces of the buildings and water have an important role on heating and cooling to reduce energy costs.

c-The walls should be painted with light colors, such as white to reflect the heat.

d- External walls can be protected by designing the roofs with broad overhanging eaves extending far beyond the line of walls.

e- Sloped roofs should be designed instead of flat reinforced concrete roofs.

f- Courtyards, verandas, balconies and terraces are very important in the residential design for Lefkoşa considering Mediterranean people spending their time outdoors.

g- Plants and trees should be added around the houses because the greenery naturally protects the environment and reduces high temperatures in summer (Philokyprou et al. 2014).

h- Energy building codes should be used for energy control. Toxic materials should be avoided (El Demery, 2010).

i- Double skin facades and technical solutions are important to improve the building envelopes in facing the climatic conditions without giving any harm to the ecosystem.

j- Low energy consumption and low maintenance utility cost should be considered in the designs.

Although vernacular structures cannot fully meet today's comfort conditions, some of their solutions can have some use in contemporary buildings for a sustainable environment for the next generations.

6. CONCLUSION

Sustainability gained importance in the XXIst century in architecture and environmental design. Although developments in technology have brought some advantages; their bad use has had disastrous consequences on the environment.

The aim of modern architects was to design light, rectangular buildings with dynamic spaces. Since the use of stone and brick is not suitable for this purpose; they turned to using concrete, steel and glass because with these materials they were able to construct modern industrial buildings containing large volumes that are light, transparent and sleek. The early 20th century style replaced the traditional architectural construction methods to modern methods. The replacement of these methods did not turn out as pleasant as it was expected. The 21st century way to solve this problem is to find out materials and techniques that will not be harmful to nature and environment.

Reduction of unnecessary levels of lighting and electricity consumption by balancing Heating Ventilation and Air Conditioning (HVAC) usage is crucial in today's world. Choosing natural ventilation, right orientation, applying light facade colors, usage of sun shades and applying extra insulation layers will make these structures more energy efficient. Usage of mud bricks, rammed earth, renewable materials are some more energy efficient ways to keep buildings cool in summers and warm in winters with low energy consumptions. In fact; vernacular architecture and sustainable design share common values in many ways.

This study contributes to show the applications and materials of vernacular architecture that can be useful and adapted to contemporary architecture in developing an environmentally friendly living environment in Lefkoşa. By knowing the general features and principles of vernacular architecture very well and following the latest technologies, architects can combine the good aspects of these two in designing new contemporary sustainable houses.

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