

# Effect of shading on thermal performance of Dormitory Building on Hot Climate

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**Abstract:** There are various architectural features of a residential buildings and commercial buildings that can influence its indoor or interior climate and electricity consumption, which due to lack good orientation and shadings elements also includes such as thermal insulation, the size of the window, glazing material, and albedo of building façade. In addition to these architectural features, shading effects (either by external objects or by the building itself) can also affect the thermal performance of a building on base on how it was working. External shading effects are mainly caused by nearby trees or buildings, which is depending on how closed the trees are with the building. Also while shading effect imposed by the building itself usually base on the layout design of the building, i.e. building shape and layout arrangement of the flats on each floor. Some flats in a building may receive a shading effect from adjacent flats located in the same building block which is normally common here in Cyprus because there roofing system normally used flat roofs which are more common. So for architects before designing a building you have to conduct the layout design of a building, a number of factors such as building regulations, (because each region has normally had its own buildings regulations like Famagusta regulation might not be the same with Nicosia) site limitations, scenic view, noise control, natural ventilation and daylight utilization will be considered. The thermal performance of a building is one of the major issues that should be taken into consideration. The objective of this study is to assess the thermal performance of buildings under the effect of adjacent shading in hot climate region. A simulation using Autodesk Revit insight and ecotect Software was carried out to identify typical layout designs of the buildings. Building energy simulations were conducted for the building blocks with different layout designs. It is found that adjacent shading effect has a great impact on the thermal performance of buildings which include both commercial buildings and residential but normally effect more on residential due to hours that we live inside. So all this thing that I had mentioned we are going to see them in this article.

**Keywords:** Shading effect, Building Energy simulation, Dormitory Building, Hot Climate Famagusta Cyprus.

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## 1. INTRODUCTION

In the previous decade the consumption of non-renewable energy source is one of the most challenging facing most people around the globe, not only here in Cyprus, when you take a look, so in other to eliminate such problem we have to minimized the used nonrenewable energy by replacing it with renewable energy. In this generation more especially in urban area buildings are one of the biggest energy consumption of electricity due to our daily activities used with electricity.so a stamped commitment can be made to preserved and ozone harming substances evacuation through modern building plan.so in buildings there are difference design which includes that can impart its indoor atmosphere and the power utilization for example thermal insulation ,used of glazed window ,coating material ,building introduction ,green house double skin façade etc. (1-5).

So in addition to these issues the building highlight the shading impact (either by outside item or by building itself) can likewise influenced the warm and outside item or by the building itself) can influence the warm and vitality execution of the building.so the outer shading impact is for the most part which is caused due to close of trees to the building.

Passive solar design strategies, as part of a larger solution to current sustainability issues in the world, demand an environmentally friendly and responsible approach in design. Therefore, the adaptive integration of PSDs into the design of buildings seeks to provide comfort and energy savings, thereby solving direct and indirect cost loads (Kats, 2003).

Famagusta is one of the fastest growing city in Northern Cyprus, due is due to benefit from locating of Eastern Mediterranean University and also by the increased in number of student's population an internationally un-recognized as of one of the developing country which has serious environmental problems. Studies have highlighted the most important environmental problems in the country as Energy problem, Lack of planning, Water pollution, and Environmental pollution, too much cost of electricity because its generate it electricity from diesel which is very expensive in descending order (Eminer et al, 2014). Sustainable Energy policies for the Mediterranean region demand the use of passive strategies for the heating and cooling requirements in the summer and winter periods, to reduce the use of non-renewable fossil fuels to power mechanized thermal comfort systems.

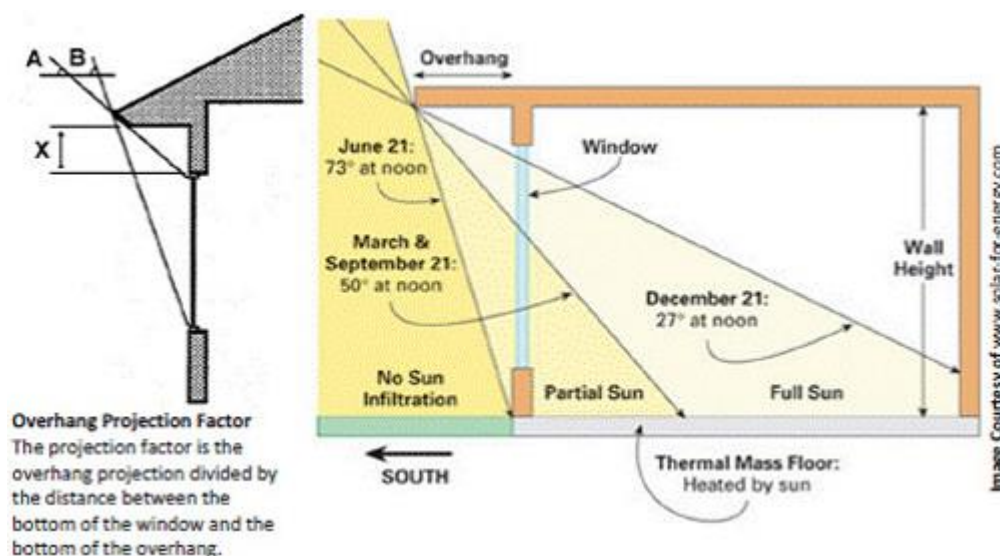
#### Aim:

- To find how the shading affect thermal comfort.
- To find out the problems that reduces the thermal comfort of the living space.
- To find out the solution of how the shading elements spouse to be in design

## 2. LITERATURE REVIEW

There are many different reasons to want to control the amount of sunlight that is admitted into a building. In warm, sunny climates excess solar gain may result in high cooling energy consumption; in cold and temperate climates winter sun entering south-facing windows can positively contribute to passive solar heating; and in nearly all climates controlling and diffusing natural illumination will improve daylighting.

Well-designed sun control and shading devices can dramatically reduce building peak heat gain and cooling requirements and improve the natural lighting quality of building interiors. Depending on the amount and location of fenestration, reductions in annual cooling energy consumption of 5% to 15% have been reported. Sun control and shading devices can also improve user visual comfort by controlling glare and reducing contrast ratios. This often leads to increased satisfaction and productivity. Shading devices offer the opportunity of differentiating one building facade from another. This can provide interest and human scale to an otherwise undistinguished design.



reference: [www.wbdg.org/resources/sun-control-and-shading-devices](http://www.wbdg.org/resources/sun-control-and-shading-devices).

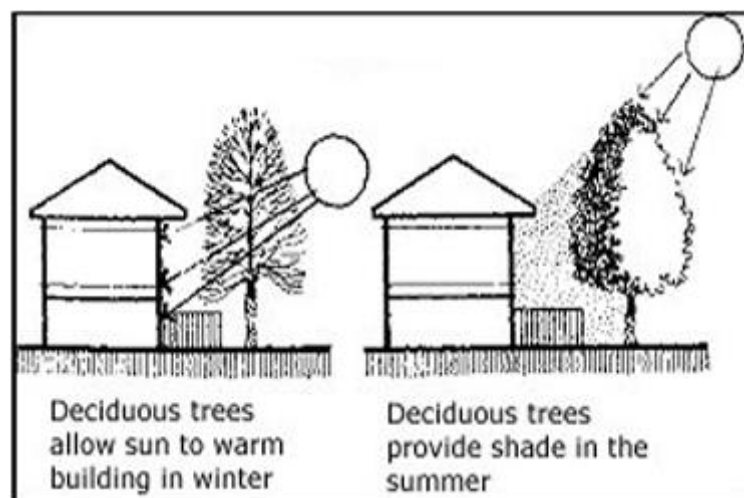
Shading devices can have a dramatic impact on building appearance. This impact can be for the better or for the worse. The earlier in the design process that shading devices are considered they more likely they are to be attractive and well-integrated in the overall architecture of a project.

In ANSI/ASHRAE/IES Standard 90.1 *Energy Efficient Design of New Buildings Except Low-Rise Residential Buildings* (on which the Federal equivalent 10 C.F.R. § 435 is based), the degree of window shading is a major consideration. Both the projection factor (PF) for exterior shading and the shading coefficient (SC) of glass must be evaluated when using the Alternate Component Packages envelope design approach.

### Designing Shading Systems

Given the wide variety of buildings and the range of climates in which they can be found, it is difficult to make sweeping generalizations about the design of shading devices. However, the following design recommendations generally hold true:

- Use fixed overhangs on south-facing glass to control direct beam solar radiation. Indirect (diffuse) radiation should be controlled by other measures, such as low-e glazing.
- To the greatest extent possible, limit the amount of east and west glass since it is harder to shade than south glass. Consider the use of landscaping to shade east and west exposures.
- Do not worry about shading north-facing glass in the continental United States latitudes since it receives very little direct solar gain. In the tropics, disregard this rule-of-thumb since the north side of a building will receive more direct solar gain. Also, in the tropics consider shading the roof even if there are no skylights since the roof is a major source of transmitted solar gain into the building.
- Remember that shading effects daylighting; consider both simultaneously. For example, a light shelf bounces natural light deeply into a room through high windows while shading lower windows.
- Do not expect interior shading devices such as Venetian blinds or vertical louvers to reduce cooling loads since the solar gain has already been admitted into the work space. However, these interior devices do offer glare control and can contribute to visual acuity and visual comfort in the work place.
- Study sun angles. An understanding of sun angles is critical to various aspects of design including determining basic building orientation, selecting shading devices, and placing Building Integrated Photovoltaic (BIPV) panels or solar collectors.
- Carefully consider the durability of shading devices. Over time, operable shading devices can require a considerable amount of maintenance and repair.
- When relying on landscape elements for shading, be sure to consider the cost of landscape maintenance and upkeep on life-cycle cost.
- Shading strategies that work well at one latitude, may be completely inappropriate for other sites at different latitudes. Be careful when applying shading ideas from one project to another



reference: greenglobes.com

Through the design history and related societies from established to grungy vernacular structures, shading has had different preferences that can be found in its applications to history (Sadler, 2005). The utilization of outside shades in structures impacts different quantifiable and perceptual execution criteria. Among these criteria are vitality utilization for warming, cooling and lighting; the sum and dispersion of sunlight; glare impact; the sentiment of 199 ICCAUA2018 Conference Proceedings, Anglo-American Publications LLC comfort and the efficiency of the building's clients. A portion of these criteria can make conflicting requests, for example, the requirement for inward sunlight enlightenment, which can diminish the requirement for counterfeit brightening however at the same time increment the warmth gain (Nielsen, Svendsen, and Jensen 2011). To decrease fake vitality necessities for accomplishing indoor warm solace, canny building development with methodology of latent sunlight based engineering is required. (Ralegaonkar and Gupta, 2010). Shading gadgets are the instruments used to lessen the episode radiation to supply thermally agreeable environment while diminishing the cooling load extensively.

That is, shading gadgets dismiss the immediate radiation and allow the diffuse component exclusively to be conceded (Duffie, 2013). Cyprus, one of the biggest islands in the Mediterranean has no oil holds and is totally subject to imported vitality from oil based commodities (AbuGrain and Alibaba, 2017). Manageability issues and environmental change as an impact of the utilization of non-renewable energy sources are at the bleeding edge of world issues. A functional 100% answer for these issues have not been grown, anyway unmistakably sustainable power source arrangements should lead the development for its compromise. Sun powered procedure structure in development expects to control the stream of characteristic vitality inside the assembled condition accordingly diminishing mineral created vitality utilization and the orderly contamination outflows while guaranteeing a superior nature of fabricated condition. An ideal shading gadget shows a framework giving greatest shading to an extraordinary period consistently (summer), while permitting greatest sunlight based radiation in winter (Bader 2013). The aggregate sun powered load comprises of three segments: immediate, diffuse and reflected radiation. To counteract aloof sun oriented warming when it isn't needed, one should dependably shade a 200 ICCAUA2018 Conference Proceedings, Anglo-American Publications LLC window from the direct sun powered part and regularly likewise from the diffuse sky and reflected parts (Shahwarzi, 2014). In the exemplary content by Victor Olgay (1963), which was reconsidered in 2015, he contends that developing structures which react to their areas through planning in light of atmosphere is a fundamental and focal piece of present day engineering. Versatile plan and use, of building fenced in areas and components looks to take care of valuable issues in a way which is bio climatically reasonable to a district.

This is accomplished by misusing the common atmosphere and client comfort factors, accordingly encouraging the change from a misleadingly created to a arranged indoor atmosphere. Appraisal of existing physio climatic conditions on a full scale and smaller scale contemplates parameters, for example, Tilt of the Earth's Axis, Altitude, Azimuth Angles, hourly and day by day lines and Sun Path. Inactive shading gadgets (PSDs) are shading components adjusted bio-climatically to suit the winning atmosphere conditions inside an area, without utilizing parts and frameworks which devour vitality produced from the utilization of non-renewable energy sources. They might be settled in position or flexible to climate changes on a day by day or regular period. In accomplishing uninvolved structure, the introduction of the shading component is similarly as critical as that of the building itself. Shading gadgets are named inward or outside, contingent upon situation.

The significance of Interior gadgets, for example, window ornaments, roller shades, Light retreats, Venetian blinds, also, screens may frequently be respected less in contrast with outside shading components, however they are frequently more affordable, and flexible which empowers them to effortlessly react to evolving necessities. Other than shading, these gadgets give various different advantages, for example, security, control, protection, and inside feel.

Around evening time, they likewise keep the "dark opening" impact made by uncovered windows (Galloway, 2004). Add up to vitality utilization is diminished when vitality utilization is lessened by the use of the even shading gadget, and lighting vitality utilization diminished by 201 ICCAUA2018 Conference Proceedings, Anglo-American Publications LLC use of lighting control. Outer shading gadgets are intended to coordinate into the building framework and oppose outer conditions. Consequently, they give vitality reserve funds by lessening warm increase because of direct daylight and by advancing glare free lighting of inside spaces. Henceforth, electrical and mechanical load are lessened, with corresponding diminishing in costs (Kim, et al 2017). Uninvolved shading gadgets adjusted to the high Mediterranean sun oriented load incorporate.

- Vertical and flat shading gadgets which might be settled profound shades, louvers, blades, blinds, egg-case and roof. Portable variations of these components incorporate screens, canopies, pivoting blades and shades, turning egg-case and outside roller shades.
- Secured semi open spaces including galleries, patios and roofed porches.
- Elite materials incorporating coating with low shading coefficients, tints and intelligent screens.
- Twofold skin exteriors.
- Massing methods, which considers the shade managed by a piece of building massed over different parts, and additionally cantilevers?
- Vegetative shading components including deciduous trees, green dividers, screen plants, hedgerows and yards.
- Shading screens which incorporate coverings, pergolas, Arbors and trellises.

Reference: ICCAUA2018 Conference Proceedings, Anglo-American Publications LLC window.

### 3. METHODOLOGY

Using Autodesk Revit Insight and Ecotect simulate the shading and the thermal comfort levels of the Pop art dormitory there by also asking some of the students who live on their suit rooms which has the shading devices while and the other students who live in standard rooms that has no shading elements in other to also have more accurate result apart from simulating with software.

In a survey to determine the thermal comfort levels of the students at the Pop art dormitory ,12 students in which 5 of them live in suit area (rooms with shading devices) while 7 who live in standard room i.e. rooms without shading devices in the dormitory randomly, who stay more than one session in the dormitory. were selected randomly to fill out the answer base on their experience of living in that area on the perception of the thermal comfort in the interior space of the building. Constant use of internal blinds as shown in fig 12 and 12.1 below suggests a high incidence of discomfiting sunlight. While 39% (n = 5) of the students indicated content with the level of shading achieved by use of blinds alone, 77% (n = 5) all of these five (5) students had stay with a North Eastern window orientation thus receiving minimal direct sunlight also with the help shading device element that they have in their rooms.

While the 93% (n = 7) of the students who lives in room without shading indicated the need for more shading for the building overall, as well as indicating that the building admits too much sunlight. 90% (n = 7) of users with offices on the South and Western facades use their blinds all day long in summer, and 93% (n = 9) believe direct sunlight is a major cause of heating inside their spaces at that time. In winter 53% (n = 13) almost all the students oriented to the East, West and South received enough sunlight to help warm their rooms naturally.

#### 3.1 Case Study:

Cyprus is located at 35° N latitude of the equator and 34° E longitude and is the third largest island in the Mediterranean Sea after Sardinia and Sicily. The city of Gazimağusa (Famagusta) is a coastal town at the Eastern part of Cyprus with 7m elevation above sea level (Ozay,2005). It is a fast-growing city bolstered economically by tourism, and immigrants occupied by the Eastern Mediterranean University (EMU). Famagusta receives an average of 5KWh/m<sup>2</sup> of solar radiation 9 hrs. daily, with July and August peaking at an of average 202.

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temperature of 36 °C and 8.1 kWh/m<sup>2</sup> radiations; in contrast, the coldest months are December and January which receives an average of 2.3kWh/m<sup>2</sup> (Shahwarzi, 2014). In assessing the adaptive use of shading devices to the region, one significant public building in Famagusta have been chosen for comparison to draw the case **The Pop Art dormitory**. The case studies were chosen because of their size, relatively contemporary design, and build, have been constructed within the decade. Additionally, the building is remarkably positioned as points of references to their locations, and are popular with regards to their functions. The building is for private dormitory building which is designed to accommodate large numbers of transient people, albeit with completely different uses. PSDs employed in the cases is Building massing and its shape, Roof eaves and overhangs, Porches/balconies, Fixed Aluminum horizontal running fins (louvers) or the shading device and Fixed in cross direction or X shape. Internally, the building utilized blind as a support to external shading systems, and also as primary devices.

### 3.2. Pop Art Dormitory



**Fig 1: Top View of Pop Art Dormitory (Image Courtesy of Google Maps, 2018)**

The Pop art Dormitory is private dormitory which is used by students as uses the dormitory is located in Famagusta in EMU south campus was commissioned in 2017 and consists of standard rooms , Suit rooms , under Ground Gym ,Library and washing area which is meant for students.

Its geometrically shaped as F shape, floor plan contains a central courtyard. Its facade is finished with a combination of Aluminum Composite Material (ACM) panels, painted in gray color. Substantial dividers of glass siding on the inside yards and outside exterior give full perspectives and concede normal light. The building sits on a large open terrace finished with marble tiles and covers approximately 2,588m<sup>2</sup> of the floor space.



**Fig 2: Showing Sunrise on Eastern Elevation (faisal saleh Minangi 2018)**

The Pop art dormitory building features a relatively uninterrupted linear facade with few pronounced mass projections and recesses on its exposed Eastern, Southern and Western elevations. Where present, projections and recesses are of insufficient depth to count as shading devices. Overhanging a porch thus suitably shading glazed walls and windows beneath it. Cantilevers were employed on the Eastern facades, admitting winter sunlight to windows beneath it and providing partial shade in the summer. Eastern windows overhung by cantilevers received further external shading treatment, but the Southern windows were not treated well with the shading devices due to its absence.



**Fig 3: Showing the X shape shading devices on the eastern Façade (Faisal Saleh Minangi Archive,2018)**



**Fig 4: Western and Northern façade of the building in which shading devices are absence (Neden Mağusa'da Pop Art Öğrenci)**

The patio spaces of the building include glass dividers advancing a light, breezy and open feel to nature. Notwithstanding, edge of episode daylight, generally low building statures and wide ranges of yard space renders building mass less compelling as a shading strategy in the spaces open to, and connecting the patio. These spaces got next to no outside shade medicines, conceding daylight openly and straightforwardly with orderly warm impacts. Therefore.

The pop art dormitory building utilizes insignificant utilization of rooftop roof, planned rather with parapet dividers reaching out as a continuation of outside dividers, and ending without eave overhangs toward any path of the building. Firmly divided X shape shading highlight on the eastern façade which fill in as Suit room (costly rooms) from the primary floor of the working to the fifth floor, along its eastern exterior to confine point of frequency sun beams.



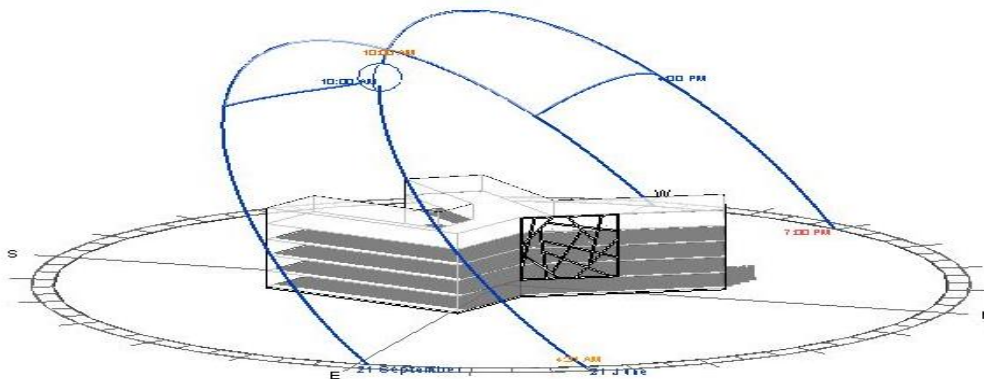
**Fig 5: Showing South Façade and north Façade (Google=Neden Mağusa'da Pop Art Öğrenci)**

From the above image as you see the entire building has same site and shape of sliding door opening which serve as windows also connecting to the balcony.

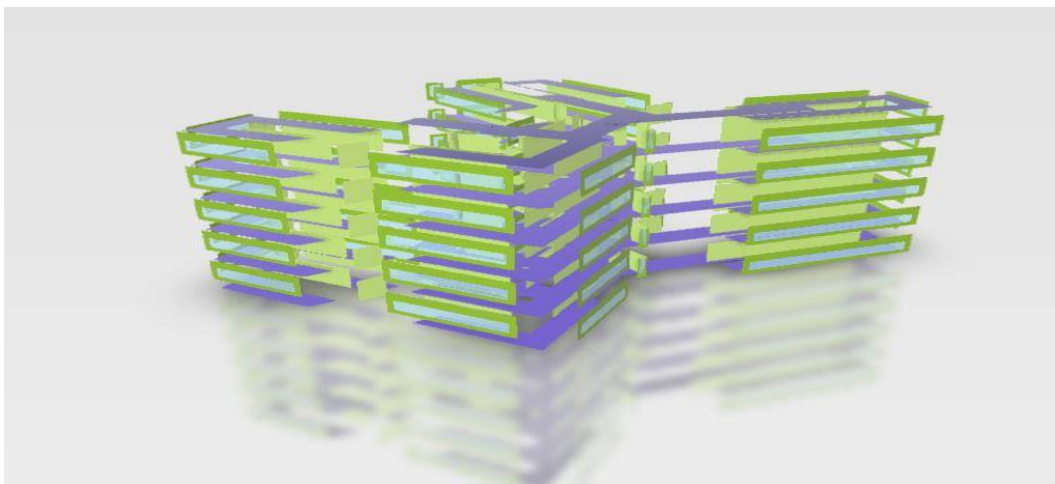
#### 4. FINDING AND DISCUSSION

Building orientation of the Pop art Building

The picture below is showing how the building is oriented and how the shadow is effecting the buildings for a one-year period of the pop art dormitory building.



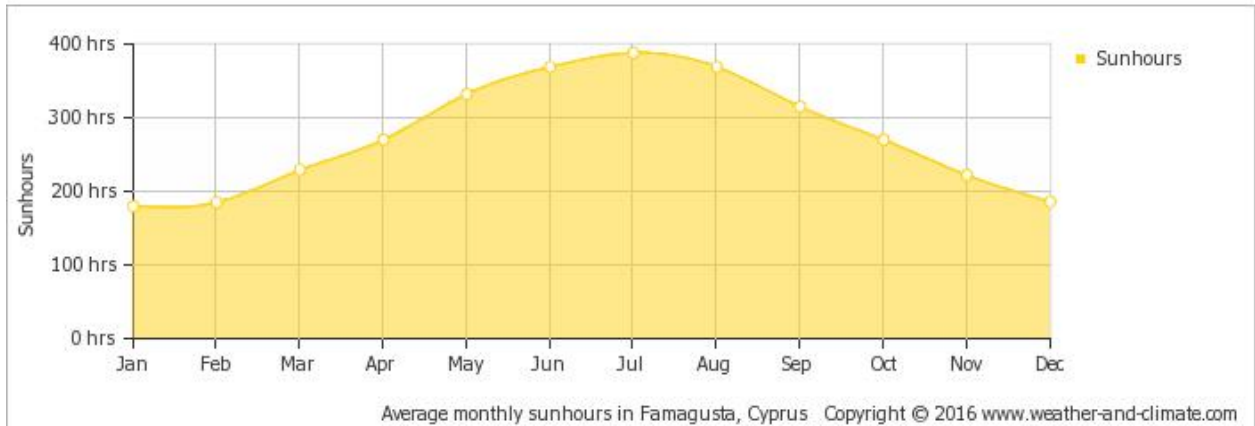
The above picture is simulate using the Autodesk Revit in other to determine the real orientation of the building because the building is actual facing directly to north or east but rather the main façade of the building is facing the north eastern part.





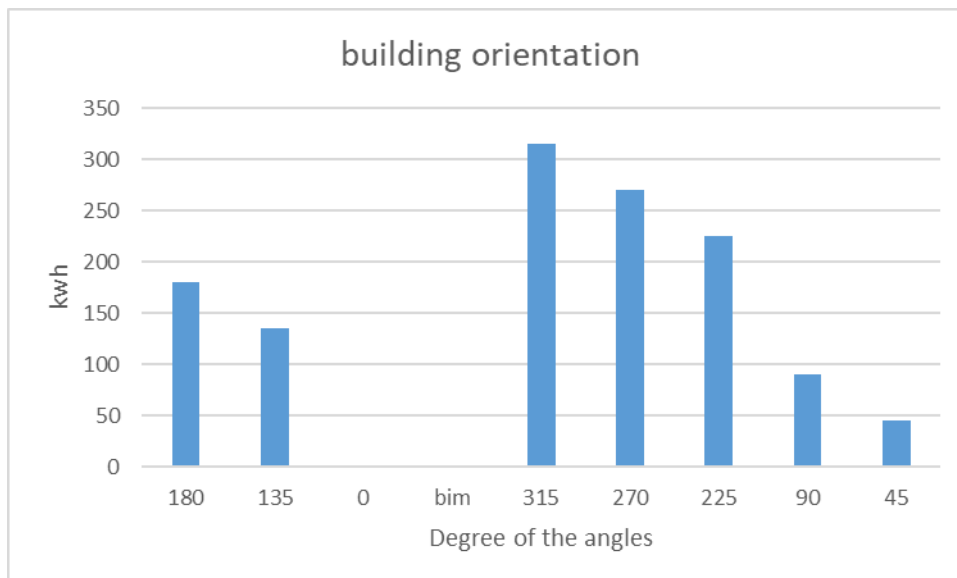
The above picture is showing the building mass using the simulation software

The climate in Cyprus is Hot region climate due to the large period of heat in the region or area which normally start from march to September as shown in the picture below,

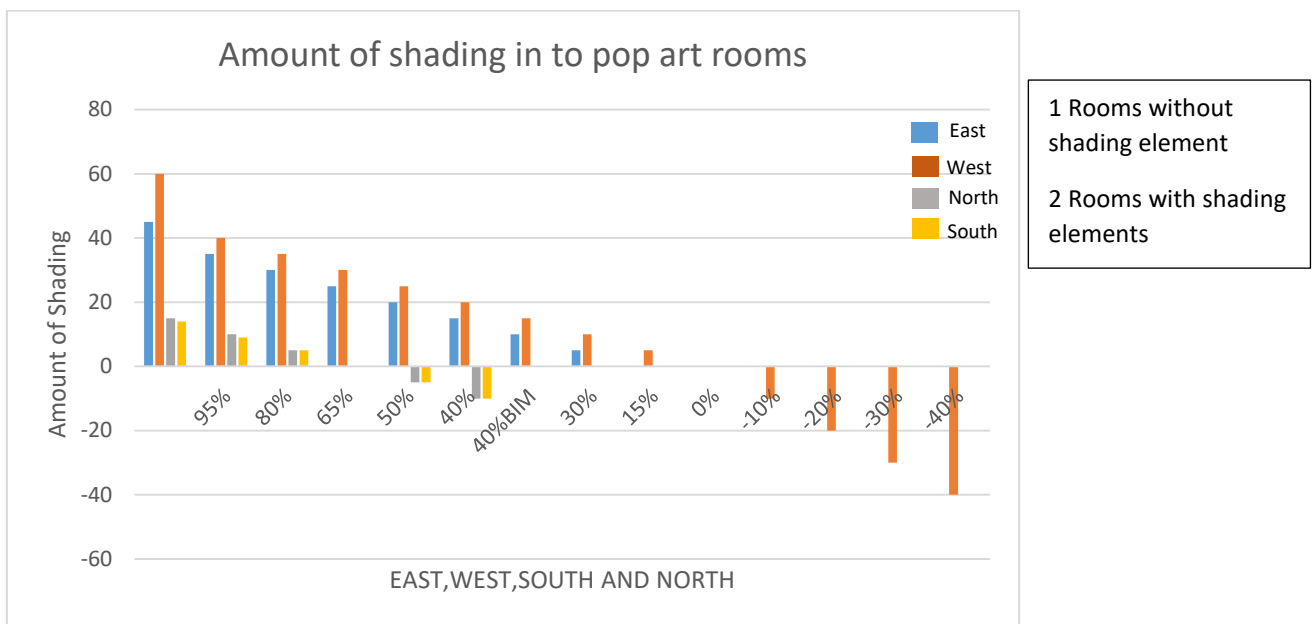


tending towards a short winter and long summer season. Because of the calm atmosphere condition in the winter months, space warming interest is exceptionally periodic. Then again, there is a long and sticky summer each year. Cooling has turned into a fundamental administration in most private pads not in any case private incorporate all the business structures too. Besides, Famagusta is a city with high populace thickness separated from Nicosia so when contrasting with different urban communities like Girne, Lefke, karkas and so on. Private structures are basically planned and developed as institutionalized one to two story building squares. Despite the fact that some private pads arrange towards the predominant breeze and regular ventilation can be utilized to upgrade the indoor warm condition amid summer days, individuals in Famagusta still will in general put their A/C units into activity because of commotion issues and poor air quality caused by traffic on close-by streets. In this manner, the present examination for the most part centers around the examination of impact of shading on the and warm solace as I said before the building cooling prerequisites over the late spring cooling months (May– October). The aftereffects of reproduction were examined so as to think about the warm execution of the which incorporates the room that impact with shading component and alternate rooms without shading components on their façade in the residence as appeared as follows,

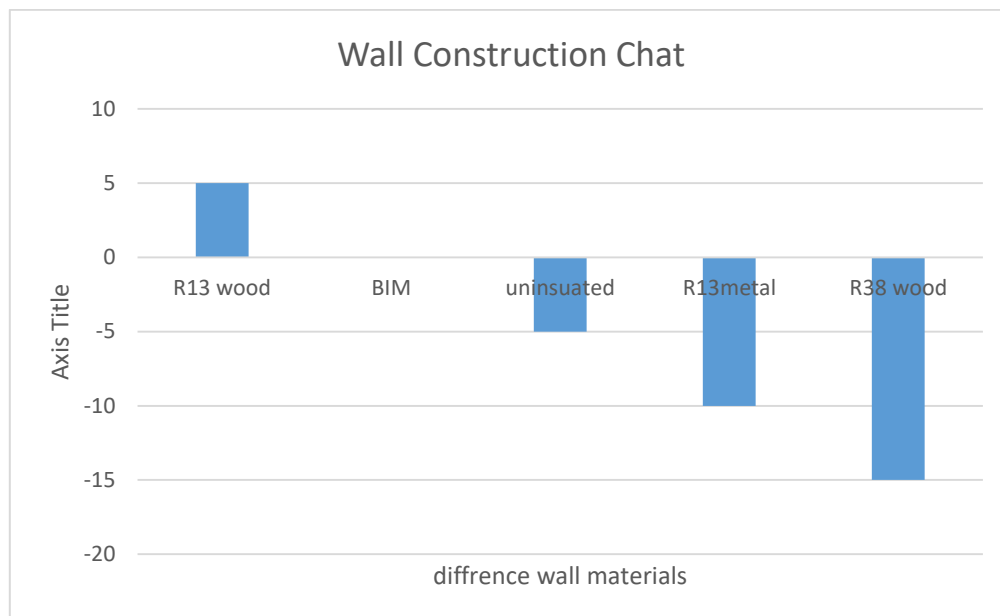
Pop Art Dormitory Building Orientation



So the above chat as showing the result after the simulating the building showing how the building it was oriented according to the degree of angles because the dormitory building form is not as regular building shapes the Pop art building form is F shape form.

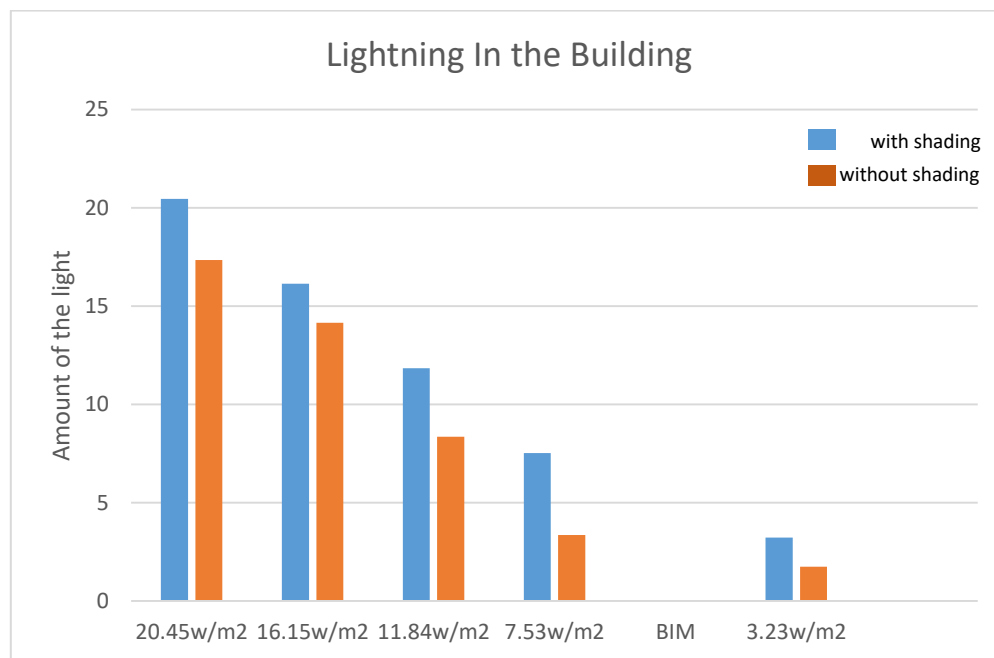


Also this chart is showing the amount of shading that the rooms have the rooms without the shading elements is the first one while the rooms with the shading elements is the second one which shows the result after the simulation of the rooms which shown room with the shading element has high rate of thermal comfort while the rooms without the shading elements has low amount of shading in which lead to low amount of thermal comfort in their rooms more especially during the summer time period.



The above chart is showing how the building will get more thermal or heat absorbing into the building when constructed with different building materials which include Wood, metal and bricks which says R13 wood will absorb more heat than the R38 wood.

And also for the lightening into the building or interior space of the building the simulation software give us some clue about the lightening into the of the building which shows the building that has shading elements and the building that has no shading elements the amount of light each rooms has below is the result that we have after the simulation of the building by comparing the two places in the building which are the one with shading elements and the one without the shading element shown below,



## 5. CONCLUSION

Giving the whole building shading components is fittingly rather just a single region from the whole working in other to limited the utilized of dynamic vitality for calling and warming in the rooms in light of the fact that the Mediterranean atmosphere of Famagusta requires bioclimatic utilization of shading gadgets to block coordinate daylight in the hot months of the year, through coated surfaces and building openings likewise with extra of shading components which is imperative. Conversely, these gadgets ought to oblige occurrence daylight in the winter to heat up spaces normally. In the two cases the effective utilization of such gadgets ought to essentially lessen the utilization of non-renewable energy source invigorated mechanical frameworks. Perception of shading gadgets on the two distinction puts in pop craftsmanship quarters contextual analysis open structures shows uninvolved plan mindfulness, as utilized in their shading frameworks, basically utilizing massing methods remotely, and in addition customizable blinds inside. Be that as it may, client view of warm solace levels completed in a study of the structures recommends constrained achievement.

Notwithstanding the effect on the warm execution of the pop workmanship residence, it is normal that the sun based shading impact of contiguous pads will acquire a decrease of sunlight got, prompting higher vitality utilization from the electric lighting framework in the territory that has less shading gadgets. In any case, such an expansion in vitality utilization won't be considerable since it is a typical practice that electric lights in the quarters are normally exchanged on after the late night in Famagusta Cyprus. Amid the daytime, most local exercises don't require electric lighting, with the exception of perusing a book in the inside zone of a lounge or a dozing territory. The finish of this paper is for the most part drawn dependent on the view purpose of the warm execution of structures. As referenced above, there are different components to be considered in the structure of a building. The consequences of this examination can give draftsmen and building originators extra data for the format plan of a building. As an on-going examination venture, further investigation will be done to explore the effect of the adjoining shading impact on the visual execution and common ventilation of private structures.

This assessment is upheld by perception of insufficient quantitative utilization of utilized shading gadgets. In the suit rooms some portion of the building, remotely settled aluminum shading component set Venetian blinds were utilized as the essential methods for latently shading the building. covering under 20% of windows and coated surfaces, and showing predominant thought for its stylish esteem. It very well may be reasoned that the PSDs connected to these structures are more nonexclusive than versatile, as highlights which are normal for detached cooling methods in the Mediterranean have not been utilized adequately. Further research is required to expand on a module for versatile inactive frameworks, and the discoveries from this examination will be utilized as reference information for the structure of ideal shading gadgets reasonable toward the North Cyprus areas.

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