YAŞAR UNIVERSITY
GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES

MASTER’S THESIS

USING COMPUTER ANALYSIS FOR CALCULATING ENERGY EFFICIENCY AND IMPLEMENTING SHADING DEVICE FOR GLASS FACADE OF A HIGH RISE BUILDING IN IZMIR

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ABSTRACT

USING COMPUTER ANALYSIS FOR CALCULATING ENERGY EFFICIENCY AND IMPLEMENTING SHADING DEVICE FOR GLASS FACADE OF A HIGH RISE BUILDING IN IZMIR

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Building sustainable architecture in an efficiency state considering the energy utilization in sustainable architecture. Energy efficiency is a matter of utilization of natural resources, in a way of energy saving. The research on energy efficiency depicts that, the most modern buildings are highly insulated and airtight. Even so, these qualities lead to significant increase of over-heating. The energy consumed for heating, lighting and cooling in the buildings all around the world has reached excessive levels. Solving these requirements artificially, leads to an unsustainable building while the cost of electrical energy is constantly increasing. Climatic conditions determine the amount of energy needed to create a comfortable living space in the buildings in a specific area. In that case shading devices as an architectural element become crucial, considering the reduction of energy consumption. It is a fact that glazing is the soft spot in a building’s overall thermal performance and a major source of heat loss. However, glazing is always the initial consideration of the designing process. Nevertheless, shading should be the first option to be considered. Shading contributes to insulation of a building’s transparent envelope. Shading devices on a building facade are a crucial design strategy as they control the waste of natural resources. Shading devices are also used for aesthetical purposes aside from the main goal of their creation. External or internal shading, overhangs, light shelves etc. are important shading devices that increase the energy performance in buildings. The purpose of this study is to analyze energy efficiency of a high-rise building with glass façade using computer programs, to implement a shading device, and to review the differences between current and implemented state in the view of energy efficiency besides thermal comfort. Rhino software and plugins of Grasshopper LADYBUG HONEYBEE were used. Whereas, the manipulated variable is the types of shading device used. The study represents the importance of the shading device considering the overall energy performance of high-rise office building located in İzmir Turkey. In this study, it was emphasized that daylight and energy efficiency should be taken into consideration besides external appearance at the early design stages of the building.

Key Words: shading devices, energy efficiency, sustainable, high-rise buildings, control of daylight

ÖZ

ENERJİ ETKİNLİĞİ HESAPLANMASI İÇİN BİLGİSAYAR ANALİZLERİNİN KULLANILMASI VE İZMİR'DEKİ BİR YÜKSEK YAPININ CAM CEPHESİ İÇİN GÖLGELEME ELEMANI UYGULAMASI

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Sürdürülebilir mimaride enerji kullanımını göz önünde bulundurarak verimli mimariyi sürdürülebilir bir binada inşa eder. Enerji verimliliği, doğal kaynakların, enerji tasarrufu amacıyla kullanılması konusudur. Enerji verimliliği üzerine yapılan araştırmalar, çoğu modern yapının oldukça yalıtımlı ve hava geçirmez olduğunu göstermektedir. Bu, bu durumda bile, bu nitelikler aşırı ısınmanın belirgin şekilde artmasına neden olur. Tüm dünyadaki binalarda ısıtma, aydınlatma ve soğutma için harcanan enerji aşırı seviyelere ulaşmıştır. Bu gereksinimlerin yapay olarak çözülmesi, elektrik enerjisinin maliyeti sürekli olarak artarken sürdürülemez bir binaya yol açmaktadır. İklimsel koşullar, belli bir bölgedeki binalarda rahat bir yaşam alanı yaratmak için gereken enerji miktarını belirler. Bu durumda, mimari bir eleman olarak gölgelendirme aygıtları, enerji tüketiminin azalması göz önüne alındığında, önemli bir rol oynamaktadır. Camların binanın genel termal performansındaki yumuşak nokta ve ana ısı kaybı kaynağı olduğu bir gerçektir. Bununla birlikte, cam tasarımı her zaman tasarım sürecinin ilk düşüncesidir. Bununla birlikte, ilk önce gölgeleme düşünülmelidir. Gölgelendirme, bir binanın şeffaf zarfı yalıtmaya yardımcı olur. Bir bina cephesinde gölgelendirme cihazları, doğal kaynakların israfını kontrol ettikleri için çok önemli bir tasarım stratejisidir. Gölgelendirme cihazları, estetik amaçlı olarak, yaratılmasının asıl amacının yanı sıra kullanılmaktadır. Dış veya iç gölgeleme, çıkıntılar, ışık rafları vb. Binalarda enerji performansını artıran önemli gölgelendirme aygıtlarıdır. Bu çalışmanın amacı, bilgisayar programı kullanarak cam cepheli yüksek katlı bir binanın enerji verimliliğini analiz etmek ve bir gölgelendirme cihazı uygulamak ve ısıl konforun yanı sıra enerji verimliliği açısından mevcut ve uygulanan durum arasındaki farkları incelemektir. Grasshopper LADYBUG HONEYBEE Rhino yazılımı ve eklentileri kullanılmaktadır. Oysa manipüle edilen değişken kullanılan gölgelendirme aygıtı tipleridir. Çalışma İzmir'de bulunan yüksek katlı ofis binasının genel enerji performansını göz önünde bulundurarak gölgeleme cihazının önemini göstermektedir. Bu çalışmada, binanın erken tasarım aşamalarında dış görünümün yanı sıra aydınlanma ve enerji verimliliğinin de göz önünde bulundurulması gerektiğini vurgulamaktadır.

Anahtar Kelimeler: gölgeleme cihazları, enerji verimliliği, sürdürülebilir, yüksek binalar, gün ışığının kontrolü

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I would like to express my enduring love to my parents, who are always supportive, loving, and caring to me in every possible way in my life.

Gizem Yavuzarslan

İzmir, 2019

TEXT OF OATH

I declare and honestly confirm that my study, titled "USING COMPUTER ANALYSIS FOR CALCULATING ENERGY EFFICIENCY AND IMPLEMENTING SHADING DEVICE FOR GLASS FACADE OF A HIGH RISE BUILDING IN IZMIR" presented as a Master of Science Thesis, has been written without applying to any assistance inconsistent with scientific ethics and traditions. I declare, to the best of my knowledge and belief, that all content and ideas drawn directly or indirectly from external sources are indicated in the text and listed in the list of references.

Yavuzarslan, Gizem

Signature

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January 21, 2019

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SYMBOLS AND ABBREVIATIONS

ABBREVIATIONS:

W	Watt
m	Meter
K	Kelvin
s	Second
EPW	EnergyPlus Weather Data
IDD	Input Data Dictionary
IDF	Input Data File
X_n	Shading Control Parameters
Y_n	Performance Objectives
CSV	Coma-Separated Values
HDR	High Dynamic Range
lx	Lux
°C	Celsius degree
T	Temperature Objective
L	Illuminance Objectives
T_{in}	Temperature Inside
N	Number of Observation
approx.	Approximately

SYMBOLS:

Δ	Difference
%	Percentage
∑	Summation
C^0	Centigrade Degree

CHAPTER 1
INTRODUCTION

1.1. BACKGROUND

Gölgeleme elemanı tasarımının temel ilkesi iç ortamlarda görsel ve ısısal konfor sağlayarak enerji verimliliği elde etmektir (Bellia, Marino, Minichiello, & Pedace, 2014) .

Renewable energy sources and energy efficiency are the most effective and lasting solutions to air pollution, climate change and energy crises. (Omer & reviews, 2008). One of the important factors determining the energy efficiency of a building is the façade of that building. (Sadineni, Madala, Boehm, & reviews, 2011). The highly efficient envelope system of a building is expected to perform a highly efficient regulation of air leaking, heat insulation and solar energy gain. However, the envelope itself is not enough to perform highly energy efficient regulation. There are other factors like size of the openings and glazing, the indoor quality, natural lighting and other similar factors. The effect of solar radiation on the building and on the human body both visually affects the energy and visually (De Carli, De Giuli, & Zecchin, 2008). The shading elements applied to the façade in the structure determine the daylight levels as well as the annual solar energy gain of the building (Dubois & Department of Building Science, 1997). For this reason, shading elements help reducing the energy required for HVAC and comfortable lighting within office hours during the day.

Sustainable architecture makes the maximum use of daylight a necessity. It is important to include usage of daylight within design process for providing energy-saving and efficient use of natural energy resources. It is obviously impossible to ignore the benefits of the sun obviously. Today, it became inevitable for people to benefit from solar energy. However, it is not enough to handle the sun only for energy requirement, since it is going to be a new form of civilization. Because the sun is not an energy resource solely. It is the source of life itself and all the life forms developing according to this source are valuable. These values should be healthy, modern and sustainable architectural structures (Koçu & Dereli, 2012).

1.2. STATEMENT OF THE PROBLEM

The building's first goal is to shelter the occupants against the negative outdoor conditions like cold and hot weather, wind, rain etc. The first thing required to be considered during the design of the building is the fact that the structure ought to create a comfortable living space. The amount of light is especially important for office workers. In particular, as for the office workers living in the Mediterranean the climate directly affects the internal comfort level. Controlling the air circulation would directly affect the indoor space quality.

Glazing in a structure is one of the main sources of energy loss and consequently excessive energy consumption. Glazing properties have large effect on lighting, and heat transfer and energy loss. Thermal and visual comforts are directly influenced by the characteristics of the glazing (da Silva, Leal, Andersen, & Buildings, 2012).

There are several factors to be considered while analyzing the energy loss of a building. For example, the orientation of a building is important because the direction of a facade is also a decision of, how much a building gets sun light and radiation. Consequently, effecting the heat flow and thermal comfort of a building. The second factor to be considered is the climate condition. A critical feature because; the climate of an environment is the main reason of the loss gaining thermal energy. However, in an air condition where building is located in a hot or cold climate, the size, and the amount of the glazing determines the loss and the gain amount of the heat. Moreover, the type and the value of the glass are also important, while designing the process. On the other hand, besides the glazing features, the building's structural aspects play an important role. After all, the weight of live load and dead load is also considered as a crucial factor.

“Buildings offer enormous scope for energy savings and perhaps the most widely understood ways of increasing energy efficiency are in the home and workplace.” (Grynning, 2015).

By adjusting the heat gain from solar radiation, glazed facades can help to provide energy balance during the whole year. On the other hand, glass facade buildings cause an increase in demand for cooling in hot climates such as Izmir (Eskin, Türkmen, & Buildings, 2008).

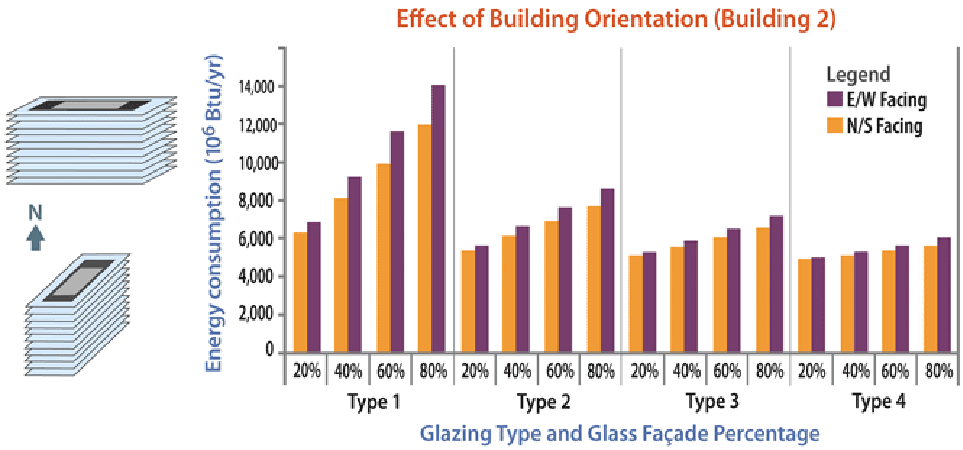

Figure 1. Glass Facade Energy Loss Chart According to Orientation (Grynning, 2015)

- In current state, does this office have capability of providing human comfort and why is human comfort essential?
- In hot and humid climates, is it possible to build a shading device for an office room in high-rise building with glass façade so that human comfort increases with respect to previous state?

In terms of enlightenment, the shading elements control the light of day to prevent glare. At the same time, shading elements play an important role in energy conservation and cooling. One of the savings strategies is the use of a shading element suitable for the façade orientation of the building. In this study, the preferred shading element is fixed to the glass façade and a holistic design is applied to the direction of the facade considering the integrity of the structure. The actual data collected from the building were analyzed using Ladybug and Honeybee modules in Grasshopper plugin.

For importing EPW file Ladybug is used in Grasshopper. It also allows designers to make changes instantly during design stage and makes analysis and calculations easier. By providing visualization of 3D model, it helps architects and analysts to view their works. Validated energy and daylighting simulation software, for example EnergyPlus, Radiance and Daysim, are used by designers thanks to Grasshopper (Roudsari, Pak, & Smith, 2013).

Table 1
Comparison of the existing environmental analysis tools for Rhino/Grasshopper

PROCESSES		ANALYSIS TOOLS				
		Ladybug	Heliotrope	Geco	Gerilla	Diva-for-Rhino
Climate Analysis	Analysis	✓				
	Visualization	✓	✓**			
Massing/Orientation Study		✓		✓		✓
Daylighting Study		✓		✓		✓
Energy Modeling		✓			✓	✓*

* Limited to one thermal zone
** Only daily sun path diagram

Figure 2. Some of the simulation tools and their capabilities for analysis

1.3. RESEARCH AIMS

The purpose of this thesis is to analyze the energy loss due to needs of current building in Izmir, Turkey, based upon the envelope of the building. In addition, to come up with a solution for this specific problem of transparent facade.

Since last century, glazed facades with aluminum mullions have become very popular, on those tall buildings dispread through the sky. Holding them as grand as possible, with reflection of the cities on the face. Huge glass facades of skyscrapers have known for its sumptuous feature. Although glass facades have approached to be beautiful on the appearance, it is not it is only function and not only features to become the choice of the designers.

It is self-evident that glass facades are lighter than those bulk facades made of concrete solely. Glass facades reduce the weight with light metal called aluminum, moreover accepts more sun light comparing small windows attached on concrete facades. Aluminum glass facades have many more advantages for sure, however has a disadvantage of gaining more solar heat considering the direct light into the indoor space, in hot climate or in the summer time and loses heat during the cold weather because of the enormous size of the glazing types.

Research aims to find a solution to this energy reduction with shading devices. It is important to decide what type of shading device can be used according to façade of building. For the high-rise office building in İzmir; In view of the conditions, the improvement design for the thermal and visual problems experienced by the office workers during the working hours was examined. The shading element designed according to the direction of the facade was analyzed for energy efficiency and thermal comfort and compared before and after the design. The aim is to answer the questions like:

- Can design of shading device, which is appropriate to glass façade in high-rise building, be performed?
- How the type of shading device affects the reduction of the energy loss?

1.4. METHODOLOGY OF RESEARCH

The main reason of this research is to analyze the energy reduction through glass facade and solving this very problem by designing a shading device to a facade of a building in Izmir Turkey. The research applies various ways in order to analyze the achievement of the concept of shading device. The recommendation of the utilization of horizontal static external shading device is investigated through computational software. Computational design of shading device is conducted specifically for the high-rise office building, in order to compare the formerly energy reduction of the glazed facade without shading device.

Computational tools were used in order to investigate the performance of shading devices. The reason was to quantify the potential performance. The computational software used to create and analyze as well is Rhinoceros with the plug-ins Grasshopper, solid modelling software that aided to create a visual algorithms (McNeel, 2015). In addition, Ladybug Analysis tool, a plug-in of Grasshopper, was used as analysis tool and simulation. Ladybug handles weather data operations like importing to Rhino/Grasshopper environment and prepares for analysis by drawing sun path, radiation rose etc., Honeybee provides connection between simulation software and Rhino/Grasshopper and data streaming between them in both direction. (Roudsari et al., 2013).

1.5. SCOPE AND LIMITATIONS

The aim of the analysis is to compare the building's energy use before shading and after shading device implementation and investigation of the effect of shading element design on glass facade structures. The aim is to achieve maximum benefit of daylight and minimum energy consumption besides providing the comfort of occupants indoor. Simulation engines and modeling software was utilized as a computational aid to analyze the performance of shading devices from the perspective of solar control and comfort.

Static horizontal and vertical external shading device has been examined with control parameters. Static shading's control parameters are optimized on an annual basis. In order to drive an annual inference, all of the weather conditions also have to be considered in daylight hours. Other variables important for the study have also been contemplated. The orientation of the facade was chosen to be south and east, in order to implement the horizontal and vertical shading devices to be investigated. For the analysis, other variable has an important effect on energy performance, which was mentioned before. The glass type is one of the significant variables that need to be considered. Since the building was already constructed, the shading device cannot be examined as design of initial process. However, because both horizontal and vertical shadings have different effects, considering the parameters like, depth, offset, and rotation. The analysis is made accordingly.

In the previous sections, it was mentioned several factors that need a serious consideration in the case of investigation of energy loss of a building. They were; size and amount of glazing or openings, live load and dead load of materials, and structural aspects, glazing types (taking account of U value, color of material, and so on), climate situation of the environment which the building was located.

1.6. OUTLINE OF THE THESIS

The research is constructed in this paper on 6 chapters. Introduction part is the first chapter, which was given merely solid summary of the whole research. The second chapter includes the background and the literature review of the research topic. At first, historical background of the glazed facade is explained and the energy flow of its correspondingly. The implementation for the design process to prevent the energy consumption is inspected and comes to an end solution of shading devices.

The third chapter is about the computational methodology of this study, which explains in detail how the modelling and simulation process was conducted with the specified software tools of Grasshopper, which is a plug-in of Rhinoceros. After the simulation and modelling process, the analysis and the investigation results are explained through charts and tables. The third chapter explains the process of creation and simulation of recommended solution, which is a horizontal shading device, in a comprehensive way.

The fourth chapter is where the discussion between proposed shading device and facade without shading device was occurred. The comparison between the old condition of the facade and the energy-reducing solution-shading device was made in this section. It will be extensively expressed the distinctness of two situations. Moreover, performance of the simulated shading device will be discussed.

The final chapters are where the conclusion of the research will be expressed in the form of summary.

CHAPTER 2
BACKGROUND AND LITERATURE REVIEW

The chapter overviews the previous studies conducted about energy usage in buildings and improvement methods from architectural viewpoint as well as, focuses on the inadequacy of the buildings in terms of shading and energy efficiency.

First, relation between buildings and energy with regard to efficiency was discussed to provide preliminary information why solar energy should be considered while designing buildings.

Second, increasing population in cities and its consequences was touched upon. Reasons to construct high buildings and development of cities were discussed with architectural aspects. Energy usage in high-rise buildings for lighting, heating and cooling, elevators etc. was considered in order to find out how much energy consumed for services. Case studies were examined to understand solution for the energy consumption problems better.

In the third title, glass facade and its influence on energy were discussed and methods used for saving energy in glass facades were investigated. Since high-rise buildings are aesthetically pleasing, the glass facade is generally preferred, but the aesthetic is kept in the foreground during the design phase and the energy losses at the front are ignored. The global energy crisis, the depletion of fossil fuels in the near future, and the environmental pollution caused by them have led people to use renewable energy resources and energy more effectively. Some architects have just begun to consider energy efficiency in their designs.

In the next section, the importance and impact of the shading elements in the architectural field and in the energy field are mentioned. Shading elements can be considered as the hat of a building. It prevents the sun's excess radiation and allows the amount of daylight required to be transferred to the interior environment. They can be divided into several different types according to their usage and places of use, but they all have the same task. Shading devices mounted externally have more efficacy than inner shading elements since they prevent the sun's rays from coming to the façade, but they affect the field of view since they do not move. Although the inner shading elements do not block the sunlight as effectively as the outer shading elements, it is possible to move them as they are on the inside.

High structures primarily require shading devices for cooling systems. Since high structures consume more energy than other sectors, it is appropriate to provide some of this energy from renewable sources. The main purpose of the shading devices in high buildings is to create a warm environment in the winter while creating a cool environment in the summer. When the shading devices in high buildings are designed efficiently, they provide the optimum thermal balance in the interior.

While designing the shading devices, the climate of region, the positioning of the building, the facade design of the building and the thermal properties of the materials used in the building and the light properties are taken into consideration during the design phase. In order to control the calculation method used in mathematical calculations and simulations, it will be appropriate to collect field data. When designing shading devices, the building should be considered as a whole with the surrounding environment.

Designing an effective shading device for any high structure with mathematical calculation requires ignoring many important factors to simplify the calculation. Nowadays, computer programs have made it possible to simplify the creation of such complex simulations and to consider more variables. Today, using computer software is the only option to estimate the energy demands, thermal and visual comfort fast and accurately. Some of the most commonly used programs are Radiance, EnergyPlus, Therm, DIVA-for-Rhinoceros. EnergyPlus has no user-friendly interface and uses text files to generate energy analysis and thermal load simulations. Usually it is used in conjunction with visual design programs. Radiance makes lighting simulations and visualizes results so that designs can be easily interpreted. Term is used extensively to simulate heat transfer analysis and energy efficiency of building components such as doors, windows, walls, roofs. It uses the finite element method for two dimensional heat transfer analysis.

2.1. HUMAN COMFORT IN OFFICE UNITS

Boundaries and population of developing cities are continuously expanding. In the first decades of the 20th century, less than 15% of the total number of people living in the world populated in urban areas. At the present, over 50% reside in urban areas and it is estimated that by 2100, urban residents will represent 80% of the world population. The use of global energy patterns are changed by increasing urbanization of the world and the cities are placed in the center of the discussion about easing climate change and sustainable improvement (Alves, Machado, de Souza, de Wilde, & Buildings, 2018). Accordingly, the quality expectations of people in buildings have also increased and benefits like thermal comfort, lighting, and air conditioning have come to the forefront.

This is the case concerning the buildings having large glazing areas creating high cooling loads due to radiation coming from sun. Places with hot and arid climate characteristics have more cooling energy consumption as they are more exposed to solar radiation. What is important is that the structure creates comfort conditions in terms of the desired energy. By monitoring of heating, air conditioning, ventilation, heat recovery systems etc., improving buildings energy efficiency and decrease in building energy consumption are becoming significant increasingly because of global energy crisis and carbon emission. For this reason, evaluation on building energy efficiency and energy conservation are essential (Wang et al., 2016). The situations of reduction of conventional energy reinforce the demand of sustainable buildings to be designed in the first place, in order to construct energy conscious buildings. Shading strategies in a building provide indoor comfort without energy use. Excessive energy consumption not only affects the comfort of indoor occupants, it also a main reason for global warming. Because energy is mostly derived from fossil sources that emit the greenhouse gas and in conclusion results in a cause of global warming. As designers, we should develop renewable energy sources and reduce the total energy consumption of the building as a solution to the energy sources that negatively affect the environment.

Reducing the energy consumption of a building is crucial. It must be understood that it is a very fast and cheap way of decreasing the energy consumption. Factors affecting the conservation of energy in buildings; layout and orientation, suitable shape, heat insulation and high thermal capacity and resistant building materials, landscaping, shading designs for orientation, exterior coverings vice versa. Keeping the heat away from the building is the most effective method to cool the building and save energy at first Shading is the most important passive cooling system at this point (Malarvannan, Sivasubramanian, Sivasankar, Jeganathan, & Balakumari, 2015).

High-rise buildings can be used as various purposes. These are offices, hotels, and residences and can be diversified with many different combinations. Especially in regions with high population, such high structures are needed more. The majority of the world population prefers urban areas. This majority is expected to rise by 60% in 2030 (Saroglou, Meir, Theodosiou, Givoni, & Buildings, 2017). Factors such as migration from rural areas to city centers, rapid increase in population and developing industry have revealed the necessity of high buildings in many cities of the world. Considering the increasing number of high-rise structures built worldwide, it is seen that it is worth more research and experience. (Niu & buildings, 2004). They have many advantages in terms of providing various comfortable services, which consume more energy. Usually at developing countries, this energy consumption is ignored at design stage of buildings but when energy efficiency is considered it can be noticed enormous amount of wasted usable energy emerges. In the construction of a high-rise building in a busy settlement, economic disadvantage comes first. Average cost required to build a high building is 40% more than the amount required for an ordinary building. However, considering the floor area efficiency, it is seen that this increase is less than the increase in the normal structure (Laustsen, 2008).

Because elevator systems, stairs, structural elements take up more space, the net area in the same floor area becomes less. As a result, space between one-fifth and one-fourth of the floor area is occupied by these systems. In addition, operating costs in high buildings are much higher than in normal structures (Del Percio & J., 2004). Elevator systems in high buildings are very energy consuming systems due to their high operation speed (Campbell, 2003). Moreover, high-rise buildings have many obligations around service areas like heating, cooling, and many others.

Internal conditions are not the only effect of energy consumption. There are also external factors, which makes energy consumption increase. The location of a building, materials used on the construction are also important in addition to the floor number of high-rise building (Ng, 2009), (Simmonds, 2015).

Rapid economic developments in many Southeast Asian countries and China have increased the need for high-rise buildings. Hong Kong is one of the best examples of these cities. Almost all of the population here lives in high-rise buildings (Bojic, Yik, Sat, & Buildings, 2001). In summer, homeowners need air conditioning systems to provide thermal comfort in their homes. In the 1990s, air conditioning ownership increased to 90% in just 4 years. With this in mind, it can be seen that a significant reduction in the emission of greenhouse gases polluting nature can be achieved by using shading devices in such structures. Although such design studies were not taken into consideration by local designers at first, these criteria were taken into consideration in the following designs (Cheung, Fuller, Luther, & buildings, 2005).

Large volumes of high buildings and increased energy consumption compared to low-rise structures have revealed the necessity of measuring the energy used in these structures. At this stage, it is important to examine three basic criteria: the factors near the building and the orientation of the building; the structure of the environment is highly effective in maintaining the thermal equilibrium between internal and external climatic conditions. The basic materials used in the construction of the building also play an important role in providing the interior comfort.

2.1.1. AN EXAMPLE STUDY ON ENERGY EFFICIENCY IN HIGH RISE OFFICE BUILDINGS

A study of daylighting performance named "Simulation-Assisted Daylight Performance Analysis in a High-Rise Office Building in Singapore" written by Szu-cheng Chien under the supervision of King Jet Tseng will be examined (CHIEN & TSENG, 2013). The author would like to conduct daylight performance simulations for two offices located in Singapore in order to examine the condition of the offices by using simulation programs.

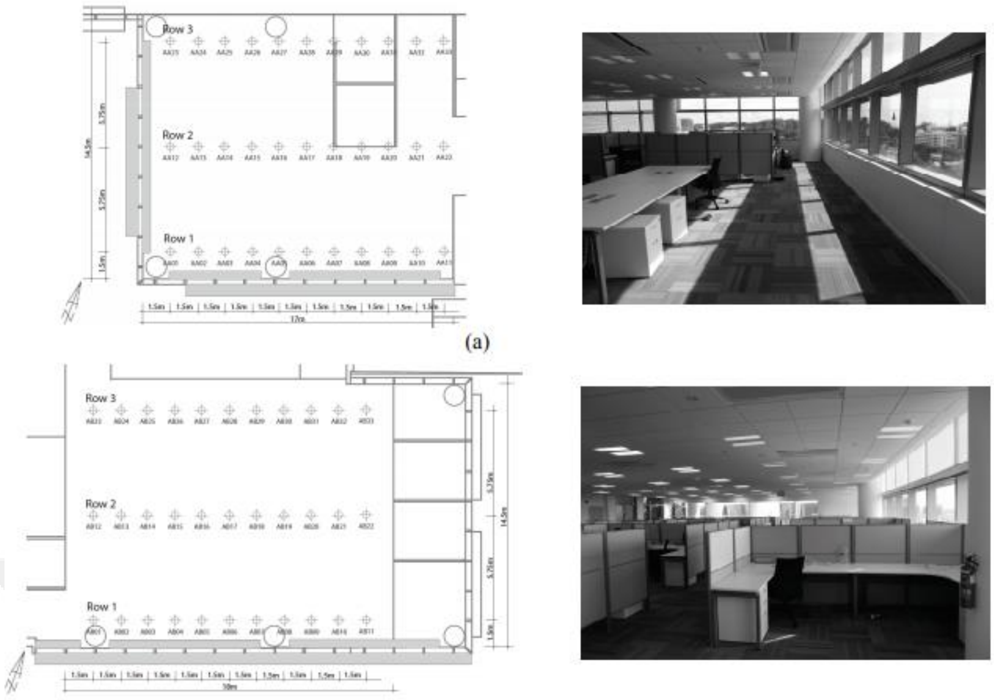

Figure 3. Sensor points on plan (office AA and AB)

Approach

Sample modelled two offices (marked as AA and AB for simplicity) at level 11 in CREATE Building and environment around the building using Google SketchUp and exported the model to Ecotect and DAYSIM simulation programs. In order to obtain the daylight performance distributions, he deployed three bunches of sensors measuring illuminance in 50cm intervals in each direction at 80cm height from the floor.

Thus, six rows of illuminance sensor points (i.e. AA01-11, AA12-22, AA23-33, AB01-11, AB12-22, AB23-33) were considered in relation to the distance from south-west perimeter (see Figure 2). Thereby, artificial illuminance is considered closed. However, as the base case study, no shading devices were assumed at current stage. The requirements (involving properties) and effects of the shading devices and interior furniture will be studied in the future stage.

For simulations, he used Singapore (Climate: Hot and Humid - Global Position: 1.22°N, 103.59°E) weather file downloaded from EnergyPlus website, with the ASHRAE International Weather for Energy Calculations (IWEC). The IWEC files, which were used, consist eighteen-year-data. It includes solar radiation and illuminance data estimated on an-hour-basis from earth-sun geometry.

This example study is based on Ecotect (environmental analysis tool from Autodesk) and DAYSIM (RADIANCE-based daylight simulation tool) completely. DAYSIM uses daylight coefficients to run daylight simulations under all sky conditions in. Assumptions in this study for these two offices are listed below:

- During daylight hours, occupants leave three times for 30 minutes in the morning and in the afternoon and for 1 hour in the midday.
- Occupants need minimum 500lx illumination level so that they can perform their tasks adequately.

Discussion

Carried out daylight performance analysis for office AA and office AB by using Ecotect and DAYSIM simulation tools, obtained large amount of data, and then analyzed them in order to interpret performances of these offices. DAcon, DAmax and UDI were used for conducting dynamic daylight analysis.

Daylight Quantity

DAcon more than 60% shows that an office AA and AB receives sufficient daylight through the year. However, some sensor points show continuous daylight autonomies under 40% on an annual basis meaning that occupants perform their tasks under poor daylight performance inner sides of offices. Additional lighting may require in these areas.

Daylight Quality

The results show that the edge areas of both offices receive excessive daylight. In particular, the UDI100-2000 and UDI>2000 values are markedly bright. These values indicate that glare and thermal disturbance may occur in the surrounding areas with overheating. Shading devices (light shelves, shutters, and blinds) should be used to significantly eliminate or direct sunlight to eliminate glare problems and provide thermal comfort for the occupants. Additional electrical lighting control should be considered to meet the complexity of dynamic visual performance.

This study has achieved preliminary results in a systematic approach to formulating, analyzing, and simulating daily lighting performance for a high-rise building in Singapore. The ongoing study includes long-term data collection related to indoor lighting, discomfort glare, temperature, and use of electric lighting energy, usage forms, and sky lighting.

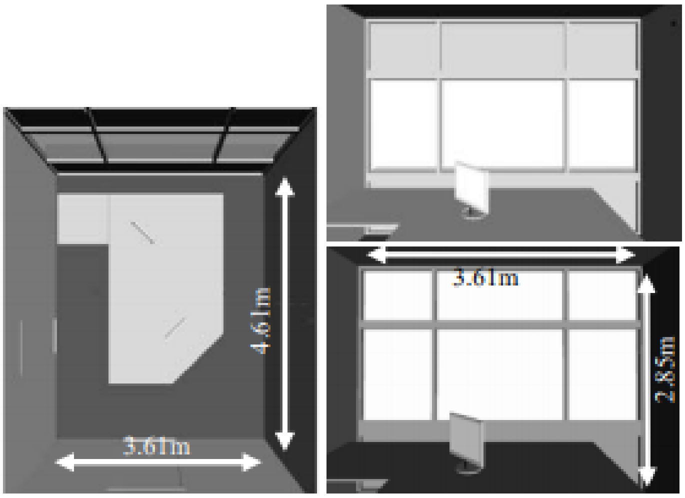

Figure 4. View from inside offices and dimensions, width and height

A study titled "DYNAMIC DAYLIGHT GLARE EVALUATION" conducted and written by Jan Wienold for dynamic calculation of glare by using different methods based on Daylight Glare Probability (DGP), was examined below in order to understand better how glare is simulated (Wienold, 2009).

Approach

The author used three different calculation methods to calculate and evaluate glare and used RADIANCE - DAYSIM as software. He chose an exemplary model of the test rooms at Fraunhofer ISE, Frankfurt (Germany) for dynamic glare investigation and modelled two different facades: band facade and fully glazed facade.

Illuminance measurements were taken for the study; distance between facade and measurement points is 130cm while for glare investigation distance between window and viewpoint is 160cm at 120cm height. Shading models for the example office, he used two different shading systems for simulations and took material values from spectral measurements of the blinds.

Shading cases:

Case one is that the offices are examined without shading applied for whole year and were considered as fully glazed with parapet.

Case 2 is that roller shading with fabric was used as shading device. The shading properties of roller blind: total and direct transmission are 0, 04 and 0, 01 respectively while total reflectance is 0, 42.

Case 3 is that as shading device, venetian blinds with 8cm blades was used. This device has reflectance factor 0, 52, and attached from outside to the façade. He used Perez All Weather Sky model for analysis.

Using RADIANCE program, 300 x 300-pixel resolution image file is analyzed for every hour. Because of this analysis, the glare values in the image were examined. This analysis takes a long time because there are many points that need to be established in the studied environment. Two methods are used for DGP calculation: the first is a simplified method and the second is an improved method. This method of analysis can be used to measure the performance of different fronts and to compare the improvements to be made on the front.

An another study named "Energy-efficient envelope design for high-rise residential buildings in Malaysia (2012)" was conducted by Nedhal Al-Tamimi and Sharifah Fairuz Syed Fadzil in order to investigate the effects of four design strategies - size of window, thermal insulation, glazing type and external shading devices on energy loads with respect to both annual and peak cooling in Malaysia (Climate: Hot and Humid, Global Location: 5.35◦N , 100.30◦E), (Al-Tamimi & Fadzil, 2012).

Approach

They have evaluated energy efficient strategies on the cooling energy demand for the main bedroom (marked as R1 in picture above) in a high-rise residential building named "The View" (twin towers). The residential scheme consists of two towers (A and B) each 29-story high with three units on each floor. The two towers are connected by a sky-bridge at the 14h floor and both towers have 164 units. The floor area of each unit is approximately $184m^2$. Annual cooling and peak load of the cooling system were selected as variables. The HVAC system for the base case model (R1) is assumed that it is typical window-mounted direct expansion airconditioner. The set point of the air-conditioning system was 26◦C to diminish the start-up cooling load. In their research, the heat gain from lighting system as the room is assumed to be for sleeping mostly. The heat gain for each person is $40W/m^2$.

Egg-crate shading device type with four different widths was selected for analysis. They used Ecotect computer program in order to simulate energy performance of the building.

About base case:

It was assumed that two persons occupied the base case.

Assumed that from 10pm to 7am from Monday to Friday and 11pm to 9am, air-condition is fully operating.

Thermal comfort temperature limits are 18 C^0 and 26C^0.

Discussion

Shading device reduces solar heat gain and provides reduction besides delay in total heat flow. The results obtained from analysis show that the longer shading device has better shading performance for whole year both for cooling and for heating. They acquired that with a shading length of 30cm, efficiency of shading device was minimum. When they used shading length of 60cm, decrease in cooling load was doubled with respect to previous length. This length was also limit in economical view because efficiency started to stagnate. Annual load for cooling with shading length 90cm is 2,47% and with shading length 120cm is 2,56%.

They used Ecotect software in order to analyses the thermal conditions of a residential building under Malaysia' tropical climate and showed importance of energy-awareness especially for high-rise residential buildings.

2.2. OBSERVATIONS FOR HIGH RISE OFFICE BUILDING BY THE ASPECT OF GLASS FACADE

The iconic skyscrapers that form our skylines represent a large sector of buildings that is in need of improvements in energy efficiency (Kibert, 2016). The curtain wall facades in high-rise buildings provide a powerful aesthetic, but when not designed properly, the facade can be a major weakness in terms of energy efficiency (Ali & Armstrong, 2008) .

The pursuit of energy efficient façades has remained the trend since the 1970s, and has grown significantly in the last decade. Rising fuel prices and further fossil fuel depletion along with the increasing concern over climate change and carbon emissions have caused architects, engineers, and researchers to focus on energy efficiency measures. Passive heating and cooling strategies, daylight utilization, and integrated energy generation are a few of the approaches that have been explored. Façade design receives much more attention than ever now that the correlation between energy consumption and façade design is evident. The façade design is a core determinant for occupant comfort, heating and cooling loads, and artificial lighting requirements. Some architects have begun to incorporate thermal mass into the façade, others have concentrated on harnessing the full potential of daylight, and others still are developing new concepts such as the double-skin façade to provide natural ventilation for the space (DuMez, 2017) .

The modern skyscraper has reached heights that were only achievable through the curtain wall system. Not only are curtain walls lighter than the first generation of high-rise façades, but they also streamline the construction process. Systems can be assembled onsite, or they can be fabricated elsewhere, brought to the site, and installed as panel systems. Curtain walls can be anchored to the building in a variety of ways. The fastening approach is often selected based on the aesthetic goals of the architects and desired construction characteristics. Curtain wall systems enable architects to design the tallest buildings in the world, and allow for timely construction.

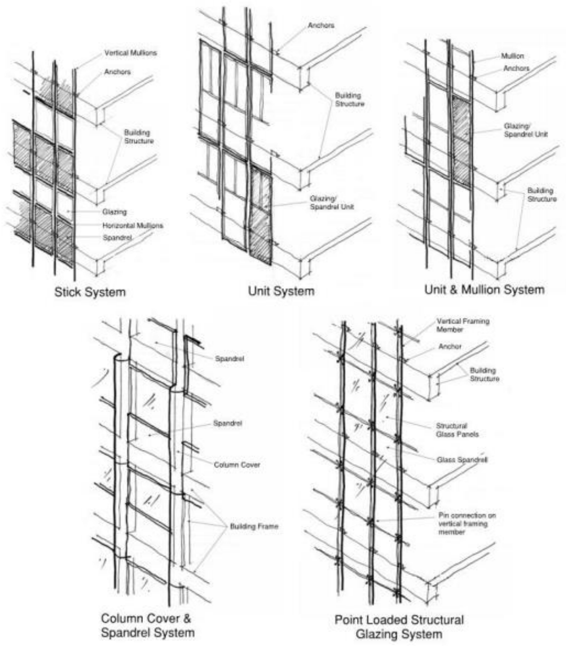

Figure 5. Curtain wall system types (DuMez, 2017)

Another benefit to curtain walls is the flexibility of building shape and material selection. Curtain wall systems allow for a wide range of window-to-wall ratios. Opaque materials on the façade can be any combination of masonry, metal, or even opaque glass sections. The glazing on highrise façades can take many forms as well. The growing concern for energy efficiency in buildings has led to many developments in available glazing products and strategies. Current highrise buildings display the evolution of glazing strategies in the different glass tinting, reflectivity, coatings, and fillings utilized throughout the last century of highrise design (DuMez, 2017).

The possibilities available with curtain walls are endless, and architects are continuing to produce designs that push the limits of shape and visual aesthetics. However, a crucial decision for each curtain wall design is the glazing characteristics. Because glazing typically occupies a large percentage of the highrise facade, it can have a drastic impact on the occupant comfort, energy consumption, safety, and aesthetic qualities of the building (Menzies, Wherrett, & Buildings, 2005). Glazing impacts the heating load, cooling load, and electrical lighting load of the space. Most glazings attempt to incorporate one or two of the following goals: control solar gain in cooling conditions, reduce heat loss in heating conditions, and increase and/or redirect visible transmission in daylighting conditions. The original skyscrapers utilized simple, singe-pane windows. In the mid-20th century, it became popular to have tinted and reflective glazing to achieve a certain aesthetic. During the energy crisis in the 1970s, it became evident that the poor thermal and radiation properties of the windows used in highrise buildings were a large energy sink (Bahaj, James, Jentsch, & Buildings, 2008).

Today, the United States constitutes 5% of the world's population, yet US citizens account for nearly 80,000 kWh per person per annum; UK citizens consume 45,800 kWh each year, compared to an average of 36,400kWh per capita for Europe. For various window types, several analysis have been conducted in order to predict cost and efficiency in terms of energy. (Reinhart, Mardaljevic, & Rogers, 2006), presented a study in 1998, in which the energy performances and life cycle costs of the smart window, a double-glazing unit in which one pane consists of a highperformance heat- reflective glass and the other is coated with a low-emissivity (low-e) coating, were compared with the performance of double-glazing units composed of clear, low-e, and reflective glasses, respectively. Energy performances and atmospheric pollutant levels were calculated for the window alternatives in a twenty-story building model. They found that the smart windows met the technical and economic targets set, thus making these units a viable long-term investment for high-rise commercial buildings (Maçka & YASAR, 2011).

(Favoino, Fiorito, Cannavale, Ranzi, & Overend, 2016), investigated the effect of reversible windows on the energy performance of a building. The investigated window was a double-glazing unit, where one layer is absortive glass and the other is clear glass. This study was realized for four cities representing a Mediterranean climate, and the energy performance of a room 3x4 m in size without heatingcooling was calculated. In conclusion, double-glazed window systems produced from an absorbent and transparent glass panel can decrease their annual energy demand; the suction chamber faces the outside during the heating season and the outside during cooling (Yaşar, Kalfa, & management, 2012).

Considering the developments in technology and industry, population growth, energy and increasing construction costs, it is seen that the production to consumption ratio has degraded drastically worldwide. In Turkey, where 66% of the total energy demand was imported in 2000, it is suggested that in 2010 and 2020, 73% and 77% of the total energy used, will be imported, respectively. In addition to the effects of the economy of country, energy efficiency in Turkey is considered to be of primary importance due to environmental issues like warming, pollution, and increasing energy costs (Bilgen et al., 2008). Measures to reduce the heating and cooling loads of a building and the use of passive sytems are important in energy efficient house design. As a result, technical engineers, architects and building authorities should find methods to reduce energy consumption in homes.

Nowadays, it is important to determine the window performances according to the needs of the building.. Care should be taken in the design and implementation of glass for energy efficiency and less energy consumption of the building. According to energy statistics, energy consumption in the residential sector constitutes 30% of total energy consumption in Turkey. Factors such as light permeability, thermal properties, the purpose of the building, the condition of the windows, the climate in the region are important for energy design. The designers should know these criteria and the design should be done accordingly. The heat conservation performance of any given glass depends on the heat transmittance coefficient (U-value,W/m^2K). A low U-value corresponds to high heat conservation performance. The solar heat gain coefficient (SHGC) is significant in determining the solar control performance of a glass. A low SHGC represents a high solar control performance. . Using the best windows solutions in commerce, as for example a quadruple pane, very low-E, Krypton filled, the glass U-value will be around 0.6 - 0.7 W/m^2K (Jones, 2016). Although new technologies concerning the windows are improving the glass parameters, it is impossible to reach the same U-values of an opaque surface. The losses through caused by the envelope transmittance in a building with 100% glazing will always be many times higher than in a building with traditional walls. Because a modern standard brick well-insulated wall, instead, with a good thickness can easily achieve U-value up to 0.1 W/m^2K. Reasons why building completely covered by glass are criticized are the first at all, the U-value issues.

The second problem is the enormous amount of surface covered by glass in a skyscraper. Since the glass is opaque at the infrared radiation, the sunlight transmitted by the glass can create a sort of greenhouse effect inside the building. This effect could be positive in winter, or in climate in which heating is required, but devastating in warmer climate because the cooling loads can increase of more than one time the value they would have in a traditional building. This is because in winter the high windows U-value requires high heating loads, while in summer the high solar gain implies an high cooling load.

The third problem is glare. Certainly it is advantageous that facade is covered with glass because it allows not only natural daylight but also eliminates the border oroutside inside feeling for occupants. The exposure to natural light stimulates the production of vitamine D, which is connected to the human immune system and influences the circadian rhythm. Then, human vision under daylight conditions is normally better than under artificial light, as it enables us to see colours and perspective more clearly. All human beings have a physiological and behavioral pattern of changes. With the Enlightenment, the time directly affects the function. If the correct calculation is not applied, it causes many health problems in the human body in case of excessive light exposure inside and outside (Aries, Veitch, & Newsham, 2010).

The energy requirement of a building constructed using a curtain wall is known to be higher than the buildings with normal facades. Developments in glass production improve the thermal and light properties of the glass and improve the energy performance of glass facades. Energy performance in curtain-walled buildings can be improved by using techniques such as insulated mullion, improved cooling strategies, and suitable façade systems.(Haase & Amato, 2006), (Park et al., 2014), (Dussault, Gosselin, & Galstian, 2012).

The u-value in windows can be a good choice to reduce the energy required for heating, but the same does not apply to cooling. On an annual basis, the amount of energy required for cooling increases with the high u-value in the windows. The low u-value reduces the temperature rise in the interior and prevents the heat stored in the stored windows. The U-value has important effects on heat properties.

Solar Heat Gain Coefficient(SHGC) is another important factor for saving energy in glass facade. SHGC is calculated as the ratio between the transmitted and the total incoming solar radiation on the windows. Low SHGC values have a great impact on the cooling demand (Lee, Jung, Park, Lee, & Yoon, 2013). Thus in cooling dominated climate, the choice of the windows has to be focused on SHGC, and cooling strategies are compulsory (Attia, Gratia, De Herde, Hensen, & buildings, 2012).

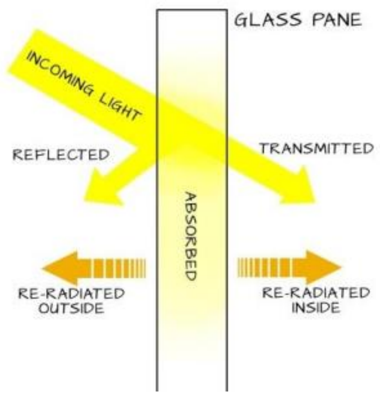

Figure 6. Scheme of how the glass reacts with incoming light

Besides the U-value, the solar heat gain coefficient is an important feature of the window. This affects the solar heat gain coefficient and the light transmittance coefficient. Although there is no linear connection between these two parameters, the SHGC increases and the VT decrease. According to the method of manufacturing the window, this effect varies. The SHGC / VT ratio has a significant impact on the need for cooling. Because, depending on this ratio, the need for cooling decreases while the heating requirement decreases or vice versa (Lechner, 2014). The energy and sunlight efficiency of the glass is determined by the ratio τ1 / g. this ratio should not be less than 1, values greater than 1.55 are considered very effective (Bodart, De Herde, & Buildings, 2002).

Many studies confirm that the best solution for overheating issue is a shading system. In fact, many original solutions have been proposed, as (Erell et al., 2004) proposed an intelligent glazing shading system, in which a natural air ventilation prevents summer overheating in warm climates. Other articles pointed out the total need of a shading system in warm and hot climates and how it can reduce the global annual energy demand. In a study (Erell et al., 2004), in which the influence of a shading system in a building in warm climate was investigated, the analyses showed how the Mediterranean climates are the ones that strongly need a shading system to increase the performance of the buildings. In fact, in cold dominated and hot dominated climates, the variables, such as the air temperature and the solar radiation, don't change dramatically. Thus, a design that follows the needs of the buildings for the whole year is allowed.

In (Bellia et al., 2014), it is investigated the amount of potential Energy savings in a stand-alone office building in three different Italian climates. The use of shading

elements directly affects the energy usage for heating, cooling, lighting systems. The result showed that the solar shading system decreases the global annual energy demand in warmer climate. For instance, the annual global energy savings in Palermo are around 20% while only 8% in Milan (Scanferla, 2017).
Conventional glazed facades increase the risk of unsatisfactory thermal comfort near the façade and cause more glare problems in the building. Buildings with glass façade are more sensitive to design or manufacturing defects. Shading is an alternative way to face the solar radiation incoming through the high fenestration surface. A good balance between SHGC and shading needs to be done, to enables a good daylight incoming trying to keep low the value of solar gain.

2.3. TYPES OF SHADING DEVICES

The shading element in architecture is an important element. Shading elements in different periods of architecture; overhang, light shelf, awning etc. It is used in many kinds of visual dimensions and shapes. Frank Lloyd Wright, in particular, used the "aesthetic explanation" in terms of shading strategies and the energy effect of it. In the sense of "sun shading", he proposed the use of "brise-soleil" as a static shading in the architecture of Le Corbusier (Shrestha, 2016).
The shading element is simply a barrier to solar radiation from the structure. Enlightenment provides a significant effect on the performance of the building. It can be considered as the hat of the building shell. The shading element, which is an important strategy to ensure the comfort of air conditioning, also creates different levels of design approach to cooling the structure (Harish, Kumar, & Reviews, 2016). The application of shading throughout the history and the transition between cultures is evident.
For example, rainfall is intense in hot and humid areas with different architecture. In order to be able to overcome it, the roofs of the structure were applied in different directions. Most of the time, it is possible to protect from direct sunlight and the rainfall on the wall (Singh, Mahapatra, & Atreya, 2011).
Static shading elements are classified according to the location of the structure both internally and externally. Many different studies have shading elements; projections, internal shading elements (light shelf, etc.), external shade shades are known to affect energy consumption in various climate types in terms of cost. In hot climatic zones, external shading elements are more effective because they reduce the cooling load of

the structure (Al Dakheel & Tabet Aoul, 2017).

2.3.1. STATIC SHADING DEVICES

Overhangs

Overhang in architecture is the building elements that protect the building against daylight and rainy weather. These systems are designed to direct daylight to the interior, increase visual comfort, provide control of the wedge, and reduce heating-cooling loads. The overhang can be designed as a flat horizontal panel, but this panel captures hot air and carries wind and snow loads. To overcome this problem, it can be used as a horizontal overhang louver. This design makes air movement possible and reduces snow, wind loads. It decreases the horizontal louvers overhang length in the vertical plane and prevents a certain part of the field of view.

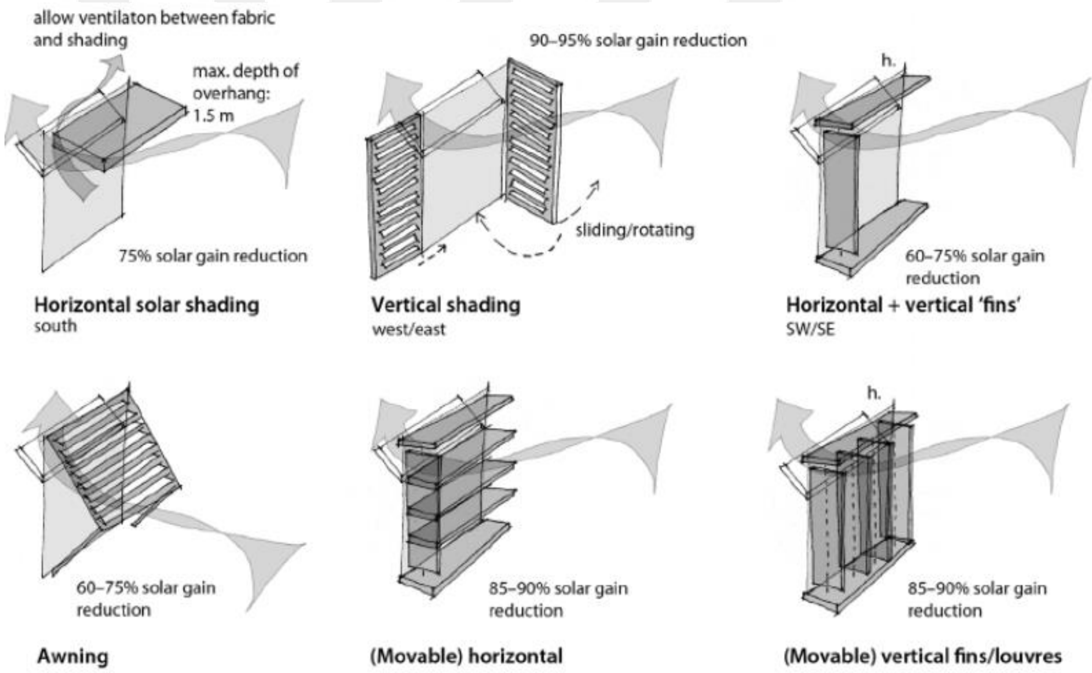

Figure 7. Types of shading devices

Horizontal

Horizontal louvers help to shade a window during hot summer months as well as let daylight in the winter through window to warm building. Horizontal shading devices are usually in the form of canopy, long patients, moving horizontal louvre blades. Their performance is measured by vertical shadow angle. A horizontal shadow device for equator facing facade is effective because of the higher angles around noon that would be easily blocked with a smaller surface area.

“Light shelves are horizontal fins mounted to the inside of the window framing, usually 80inches above the floor to comply with building codes and accessibility requirements.” (Shrestha, 2016).

Light shelves act as a shading device as well, moderating the intensity of daylight at the perimeter of the building so that it is more balanced with reflected light deeper in the space in a deep plan. Thus, the effect of a light shelf is an increased daylight zone. The top surface is usually covered with a prismatic aluminum film or painted with a light color to increase reflectivity.

Vertical

Vertical Shading Devices include louvre blades, projecting side fins in 45 degree a vertical position. They are used on western and eastern sides of buildings effectively and useful for shading north faces from summer sunlight early and late hours of the day. Their performance is determined by the horizontal shadow angle (delta). Spacing’s are also important, as protection will be at its least when the sun is parallel to the device’s angle. These devices cover the glazing and typically provide shading for one direction (Givoni, 1998).

Egg-Crate

Egg-crate shading devices are combinations of vertical and horizontal devices forming an egg-crate shape. They are usually designed like grill blocks or decorative grids. Performance is determined by both the horizontal and vertical shadow angles delta and epsilon. Although egg-crate can be successful in hotter climates as it requires less depth, egg-crate types can be problematic because they obstruct view (Levengood, 2017).

2.3.2. MOVABLE SHADING DEVICES

Venetian Blinds

In order to adjust the amount of daylight passing through the glazing to the interior, venetian blinds are used widely. A typical venetian blind is consists of several long horizontal or vertical slats made from wood, plastic or metal which are held together by cords that run through the blind slats. They can be maneuvered with either a manual or remote control so as to set the most suitable formation and are effective on providing privacy, visual and thermal comfort. Calculating or simulating of their shading properties can be compelling because of discrete structure (Galasiu, Atif, & MacDonald, 2004) .

Vertical Blinds

With contrast to horizontal (venetian) blinds, vertical blinds are less likely to collect dust because of standing vertically. They can be operated faster and easier due to horizontal operation movement. Vertical blinds are also more suitable than venetian blinds for doors. Stationary vertical blinds are hung in the doorways of some homes and businesses which generally leave the door open. They can be made of various materials such as PVC, fabric, faux wood materials, wood (Galasiu et al., 2004).

Roller Shades

In offices and residential buildings, roller shades are popular for adjusting daylight and controlling glare. Automated controlled types have great performance effect on energy savings (Tzempelikos, Shen, & Environment, 2013).

2.3.3. OTHER SHADING DEVICES

Awnings and Canopies

An awning is a secondary covering mounted to the exterior wall of a building. Typically, they are constructed of vinyl-laminated polyester fabric from acrylic, cotton, or polyester yarn or firmly stretched on a lightweight structure made of aluminum, iron or steel. The configuration of this structure is something of a truss, space frame, or planar frame. Aluminum understructure with aluminum sheeting construction is also common. In snowy regions, aluminum awnings are preferred due to snow load. An awning becomes a canopy with additional columns that used frequently at the entrance of hotels or restaurants (Gómez-Muñoz & Porta-Gándara, 2004).

Deciduous Plants

Windows and roofs can lead absorbance of solar heat and cause increase in cooling costs. Landscaping elements can help reduce this solar heat gain. Cool air settles near the ground and temperature near trees is lower than other areas. Deciduous trees with high, spreading leaves and branches can be planted to the south of buildings to provide maximum summertime shading. Lower trees are more appropriate at west side because daylight angle decreases afternoon. In cold climates, they are should not be planted as branches of trees will block some of daylight in winter (Krishan, 2001).

2.4. SHADING SYSTEMS IN HIGH RISE OFFICE BUILDINGS

High-rise buildings commonly require shading devices to reduce the amount of power needed for cooling. Excessive upward trust buildings are actually uncovered to sunlight, it is far important to have the ability to manipulate the amount of daylight admitted into a building, moreover controlling, and diffusing herbal illumination will enhance daylights. The usages of solar manage and shading devices is a vital element of many energy-green building techniques. The principle purpose of introducing shading gadgets in high-rise buildings is to create relaxed inner surroundings that are cool in the summer time and warm in the winter (Asman, 2017).

High rise buildings consume more energy than any other sector, 76% of building energy comes from fossil fuel, high rise buildings located in the tropics that lack shading devices tend to have a high risk of increase in cooling loads, and consequently heating up the indoor environment. Furthermore, the introduction of shading devices and reflected glazed façade tend to reduce high load of cooling down the building (Yang, Yan, & Lam, 2014).

Efficiently designed solar manage and shading devices can dramatically lessen building peak warmness gain and cooling necessities and improve the herbal lighting quality of constructing interiors. Depending on the quantity and area of fenestration, discounts in annual cooling electricity intake of 5% to 15% had been reported (Utpariya & Mishra). Sun manipulates and shading gadgets can enhance user visual comfort by controlling glare and lowering comparison ratios. This regularly leads to accelerated delight and productiveness. Shading devices offer the possibility of differentiating one constructing facade from another façade. The aim of putting shading devices in a building is to maintain a comfortable indoor temperature.it reduces heat gain and Improves the natural lighting quality of building interiors.

The solar geometry explains that the publicity of each facade to the sun is specific, and varies through orientation. each façade calls for distinctive technique of shading the north elevation (in the northern hemisphere) does no longer require shading because except in the summer time months within the morning and night-time, no solar penetration takes place. Whilst solar shading devices are set up, it might of vain. It is far pleasant to restrict as a whole lot as feasible fenestration on the north elevation as there will be little or no solar warmth benefit and lots direct warmth loss from this facet. If fenestration is needed for day lighting fixtures, then it is important to pick a green glazing assembly to lessen strength transfer. The south elevation permits for the perfect control of sun strength. Shading devices are generally designed as horizontal projections above the windows; the length of the projection is decided as a geometric function of the height of the window and the attitude of elevation of the solar at sun noon. Such shading devices may be designed to absolutely get rid of sun penetration in the summer time and allow for complete solar penetration throughout the winter whilst such is favored for passive heat benefit.

2.5. CALCULATION AND DESIGN CRITERIA OF SHADING DEVICES

Different types of shading elements play a major role in reducing energy consumption for air conditioning. The design and implementation of the climate in various climatic zones is important for the protection of building energy. In this study, the shading element chosen according to the building structure and the orientation of the façade is the calculation of the comfort of the design by solar radiation (Harvey, 2009).

Considering the effect in summer and winter months, it is important that the office should have a comfortable interior environment in terms of air conditioning and enlightenment (Chen, Ji, & Xu, 2012).

The performance requirements of the building shell, taking into account human comfort and energy consumption, have been the primary factor. The compliance of the structure with the objectives depends on the measurement of performance. The classification of different alternatives is to examine what needs to be the target between a few values defined as values. Testing the values according to the criteria ensures that the performance can be optimized (Beijing, Harbin, Shanghai, Guangzhou, and Kunming) .

In the calculation of the energy consumption of the building, it is possible to determine the internal environment values and compare the data with the computer programs used. The calculation of the energy consumption of the building by means of simulation program and its gain and loss are examined.

Figure 8. Outline of energy saving calculation

The energy consumption effects of different building types can be different in the same area and in the same shade. The different construction features of public buildings, shops, and special structures lead to this phenomenon. As for store structures, a better energy-saving effect with better thermal properties than public buildings was achieved by using external shading and energy efficiency glass due to the large proportion of the window (70%) to the wall. In contrast, due to the large heating load in winter, exhaust air heat recovery can be a significant energy saving technology in office buildings, while the impact on store buildings is not significant.

Table 1 Analysis types and information about units, duration, and purpose

TYPE OF ANALYSIS	GLARE	ENERGY	ILLUMINANCE	GRID BASED
PERIOD	MOMENT	ANNUAL	ANNUAL	MOMENT
UNIT	cd/m^2	kWh/sqm	LUX + (%)	LUX
PURPOSE	LIGHT	THERMAL	LIGHT	LIGHT

In a study, energy and natural lighting analyzes were conducted based on the simulation method for the offices facing the outside of the building (Rijal et al., 2007) . The effects of different types of facade design alternatives (surface area of the glass, shading and light control elements) on the energy and natural lighting performances of office buildings in the early design phase were examined. In another application, the historical development of the facade designs of the buildings according to the natural lighting efficiency was examined and the effect of the most recent facade technologies on the natural luminous performance of the building was examined. Various lighting examined (Binol, 2008), systems, the most appropriate natural lighting system should be selected to meet the requirements of the building, otherwise overheating of space and glare problems (visual comfort problems) has announced that occurred.

2.6. BASIC OF SIMULATION TECHIQUES AND BENEFITS OF COMPUTER

It is possible to examine the energy and lighting performance of the modeling with the use of computer in advance. Generally, these decisions are compared with the design decisions made previously and the design is compared with the validity. It requires less detailed data to be able to calculate sunrays by computer.

The thermal performance of a structure has a complex effect between the environment, mechanics, and the internal loads acting on them. The biggest effect; It is the difference between the hours and seasons. Using computer simulations at the preliminary design stage; that the structure should be used according to the need to be determined as well as the cost of energy to be considered approximately. Thanks to this, a suitable design can be developed for the study. In the decision phase, facade orientations can be evaluated in terms of heat and lighting.

Computer simulations, purpose-appropriate design heat, light, cost, material etc. The convenience to test the diversity is provided.

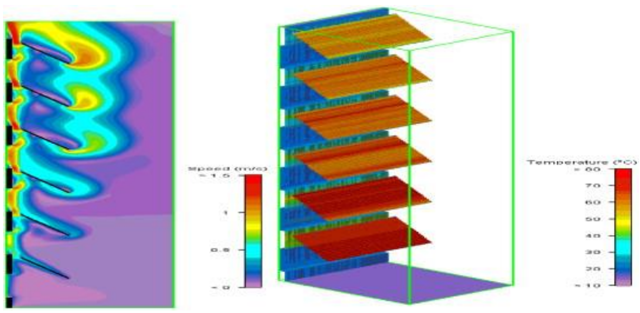

Figure 9. Example of horizontal shading simulation

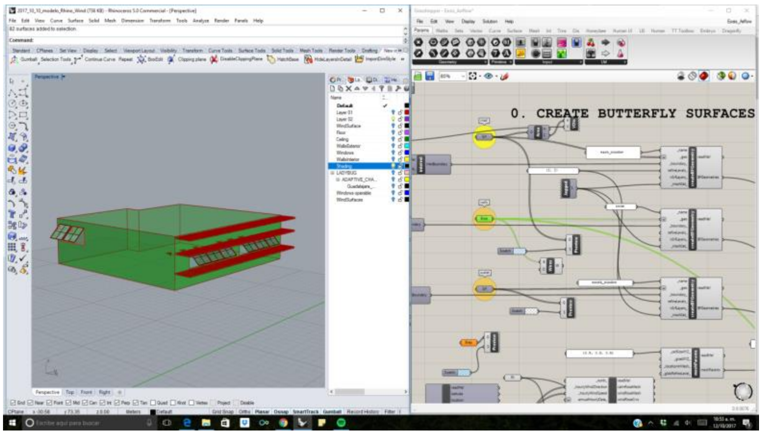

Figure 10. Example of horizontal shading simulation (Grassopper Model)

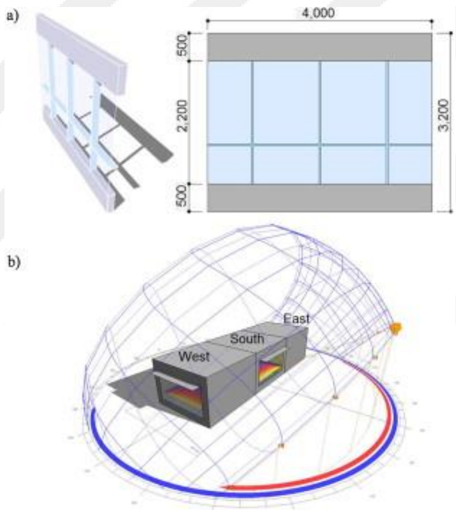

Figure 11. Shading devices according to orientation of building and analysis view

Today and all the structures that have been made in advance affect our future. The responsibility for this is great and all the structures that will be made after those affect all aspects of sustainable architecture and environment. It affects not only architects, but also engineers, regional planning and structural engineers.

It can be simulated in different computer programs in order to evaluate the performance of glazed facade systems for many office buildings and other structures. The Eko- Facade Tool, by IEA-IEREB-ANNEX 44, is an example of glass facade simulation performances such as the TM35-Environmental program CIBSE. BSim, EnergyPlus, EcoTect, ESP-r are the programs for energy performance analysis

(Loonen, Trčka, Cóstola, Hensen, & reviews, 2013).

Today, it is seen that the development of simulation programs has gained value for the future. Static and kinetic details of the shading element designs are simplified with the help of simulation program. The concept of "net zero energy building" has contributed to the energy performance of buildings. Through the simulation program developed, thermal and visual comfort, natural ventilation, daylight values have made real life predictable (Marszal et al., 2011).

DOE-2 and BLAST have proven their validity in many places and have the opportunity of easy use in many projects. EnergyPlus is important to have many numerical data together and to be able to evaluate hundreds of parameters. It is thought that the design concept is looking at the design concept from the field of engineering. For the last few years, while the studies that have been initiated towards integrated design with three-dimensional modeling programs such as Design Builder, Sketch-Up have been successful, the loaded data entry required for detailed analysis pushes the designer who has to assume a lot of information at the beginning of the design. It is important for an architect to evaluate the performance of carbon and energy consumption. The aim of this course is to examine the benefits of thermal comfort, natural ventilation, and shading. Optimizing solutions, daylight, airflow, energy, cost effect has an effect on human comfort (Harish et al., 2016).

ECOTECT is developed as a response to the question of how the nature of the early stages of design and the results of an analysis for it can be used to optimize the environmental impacts after initial design evaluation and developed in the context of research on how to simplify the complex processes in a way that can be used by the designer. The results of ECOTECT are approximate. It is sufficient for a program that performs an evaluation in a process fed by continuous returns such as the design itself, which is not yet finalized in the early stages of design, and that it can provide comparative evaluation rather than full and accurate values after a analysis program. The feature of the program is that it can work with AutoCAD. Can provide data output for detailed analysis programs (Roberts & Marsh, 2001).

DIVA-for-Rhino is a Rhinoceros plug-in developed first at Harvard University and used for energy modeling. Along with many types of analyzes, it also provides rendered images of the results (Kirimtat, Koyunbaba, Chatzikonstantinou, Sariyildiz, & Reviews, 2016).

RADIANCE was developed in in the Environmental Energy Technologies Division of Lawrence Berkeley National Laboratory in order to simulate the daylighting and prodives visual outputs to the designer. From architectures to engineers, all the designers use it for many purposes in design stage. The software uses GUI for modeling the work and so as to simulate the case, it uses space-geometry (Cho, Yoo, Kim, & Buildings, 2014).

The thermal simulation program, which performs the analysis of energy flow and environmental control systems, is ESP-r. It helps with the energy requirements and environmental conditions of climate, user interaction, design parameters, control systems. ESP-r primary interface, which consists of a series of programs, is the project management application. ESP-r, project management that supports the features of design problems, has functions to assist with design features and changes to be made with the help of performance indicators (Rodríguez et al., 2013).

CHAPTER 3
METHODOLOGY

Although energy efficiency studies have gained importance in our country in 2000s, energy expenditures have not been reduced due to the lack of awareness of the energy conservation of the users and the inadequacy of relevant standards and regulations in terms of implementation and content (Watson, Boudreau, & Chen, 2010). Increasing the population and increasing the comfort requirements in parallel with technological developments cause the energy requirement to increase. A significant portion is spent in buildings to ensure the comfort requirements in Turkey's energy; energy efficiency in buildings is a major problem (Shaikh et al., 2014). For this reason, heating, cooling energy expenditures and optimum daylight usage are firstly used to provide thermal comfort conditions in buildings (Baker & Steemers, 2003). In order to reduce heating, cooling energy expenditures and use the most suitable daylight in the design and usage processes of buildings;

- At the design stage; to make the right decisions regarding the values of the design criteria, which can provide the best daylight with minimal energy consumption and climatic comfort,
- During use; assessing whether buildings show the desired performance in terms of climatic comfort and renewing decisions on intervening design criteria

The variables can be classified as follows:

- Location of the building; It is a design parameter which is effective in preventing slope, location, vegetation and direction of the local part, climate control and preventing air pollution.
- The location of the building compared to other buildings; it is one of the most

important design parameters that can control the effects of external climate elements such as solar radiation and wind on design.

- The dimensions of the building and the form factor; It is one of the most important parameters that affect the dimensions of the building in horizontal and vertical directions and the surface area of the shell element surrounding the building and thus the amount of heat passing through the shell element and the change of the indoor air temperature. Design and renovation work to reduce the energy requirements of buildings in Turkey are becoming increasingly important. At the same time, it allows both human health and air pollution to be prevented by minimizing energy expenditure and using appropriate daylight.

Therefore, in this study, the parameters affecting the enlightenment and energy consumption for a high-rise office building were examined. With the results obtained, the selection criteria were introduced in order to consume less energy and obtain the appropriate daylight. In line with the analysis, the most suitable alternatives for saving energy consumption for an office building were determined. As the basic parameters, building location (sun effect), shading and daylight lighting as well as operating conditions (comfort temperatures) are examined. Many alternatives of each parameter were compared with each other. In this direction, the most suitable alternatives have been determined in order to minimize the energy and to provide the appropriate illumination condition. The most appropriate alternative results were introduced to the facade. However, it has provided significant savings in energy consumption.

The flow of design processes is summarized in Figure 12.

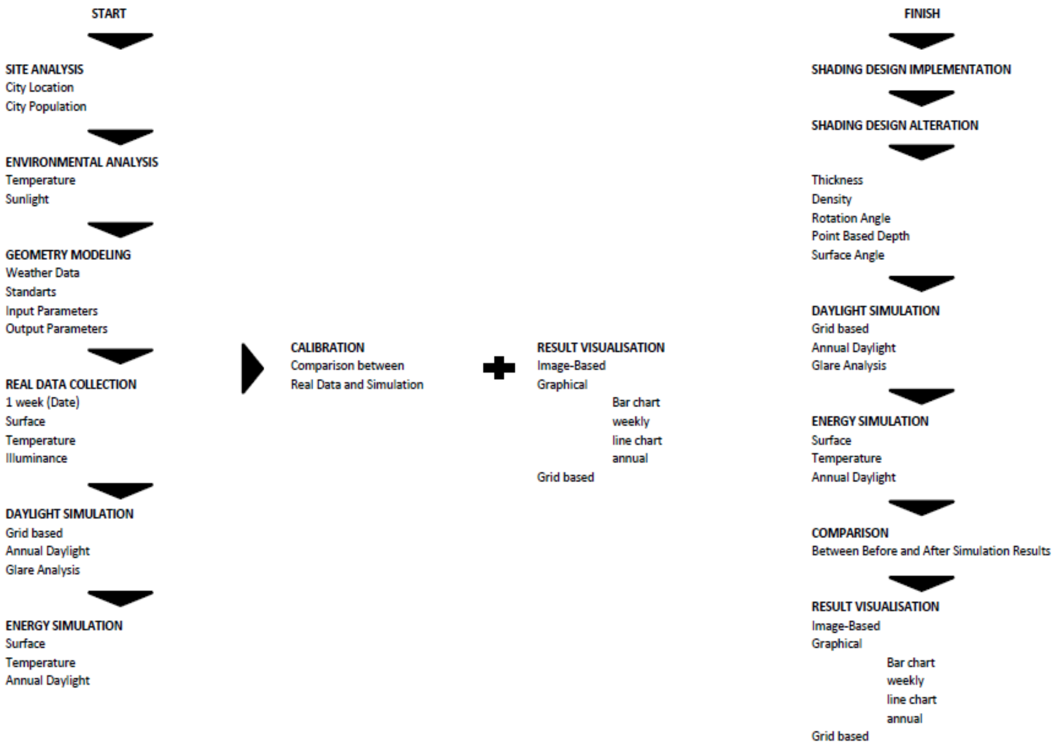

Figure 12. The flow of design process

In general term, the research method is an inquiry strategy that extends from the assumptions to the research design and from the underlying hypotheses to the data. (Myers, 2013). Despite different classifications, research methods are the mostly used qualitative and quantitative.

While the data obtained in the studies carried out by using qualitative techniques is considered as a definitive judiciary in accordance with the rules of scientific research and systematically, the number of guiding and enlighten studies on how the 'data analysis' progressing is quite limited (Yin, 2006).

It was used for estimation, precision analysis and understanding of complex, real simulation metamodeling systems. Because there are many input parameters in many simulation models, it is great interest to respond to a series of questions limited by the metamodeling, to know the most significant additions in a metamodeling with a limited modeling context (Kleijnen, 2005).

3.1. GEOMETRY DESCRIPTION

After the design phase, the evaluation of the natural lighting performances of the existing buildings started to be used for the correction of the deficiencies in the visual comfort conditions, if any, or for the use in the subsequent designs. According to the mentioned reasons, Izmir high-rise building was chosen as the research area. The purpose of this study is to examine the design elements related to natural lighting that is widely used in office building and to evaluate the performance of energy and proper daylight in the offices that need to provide visual comfort conditions.

Figure 13. View of high-rise buildings

The building that is the subject of the study is the office building where the construction completed. The structure is located on the southeast of Izmir, 26'52''N - 10'46''E. The building has an area of approximately 920 m^2 and consists of 47 floors and 3 basement floors. Convex is a structure and consists of different types of offices. The office wing is 47 floors in total and 214 m in height.

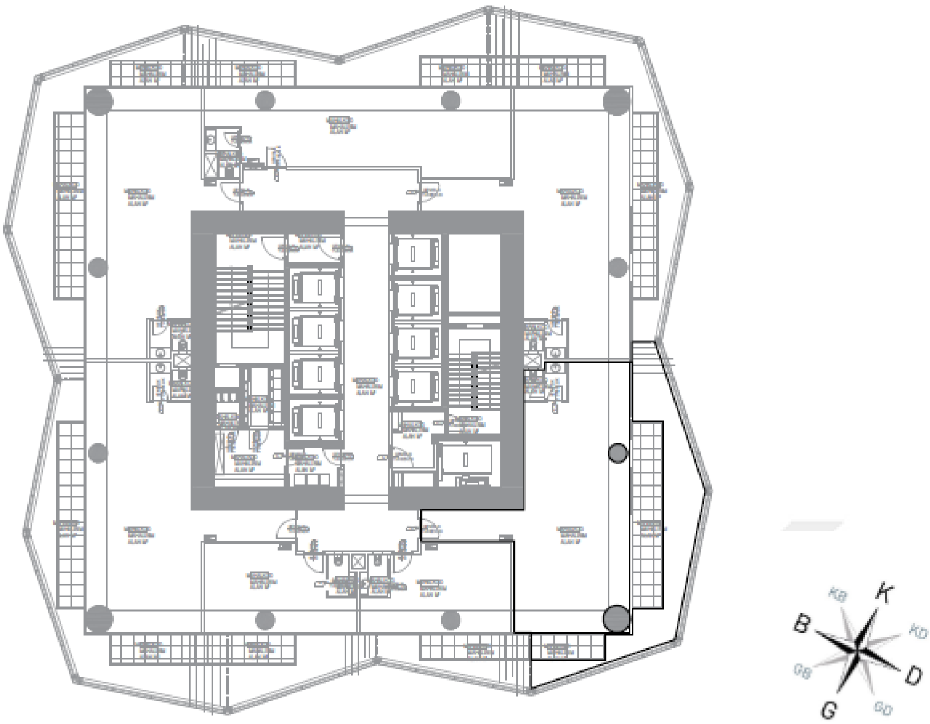

Figure 14. Plan of studied office

Figure 15. Field pictures from different points

Figure 16. Field pictures from different points

Type 4 open office located on the 5th floor of the office building on the 5th floor was discussed. The inner dimensions are 8.85 x 15.31 m, 3.80 m high, net usage area 174.55 m^2, 7.64 m on the south facade, 7.64 m on the south façade, 7.64 m on the east facade and an office with a total window opening of 91.68 m^2 .

3.2. CLIMATIC CONDITION IN IZMIR

Considering the climate information at the beginning of the design phase, emphasizes the importance of sustainability. Considering climate and facade data, design thinking will support sustainable architecture to respond to human comfort needs. Turkey located in the 36°and 42° N latitude, and has a typical Mediterranean climate. Solar energy potential in Turkey is very high. The average annual solar radiation is 3.6 kWh / m^2 (Sözen, Arcaklioğlu, Özalp, & Management, 2004). The condition of a climate can be characterized in terms of degrees and days. In many cities, different climatic conditions affect lighting and thermal requirements. (Dağsöz & Bayraktar, 1995). TS 825 standard rules of thermal insulation in buildings are used in the calculation of energy needs in Turkey. The date, time, and the usual daylight in a particular location of the sun and sky indicate the availability in daylight. Design climate, latitude, and facade orientation of the building is very important (Alrubaih et al., 2013). Solar, horizontal, and vertical surfaces are very important in determining the energy needs of buildings. In recent years, rapidly progressing high-rise buildings are more effective when the vertical surfaces of the two surfaces are compared (see Figure 16).

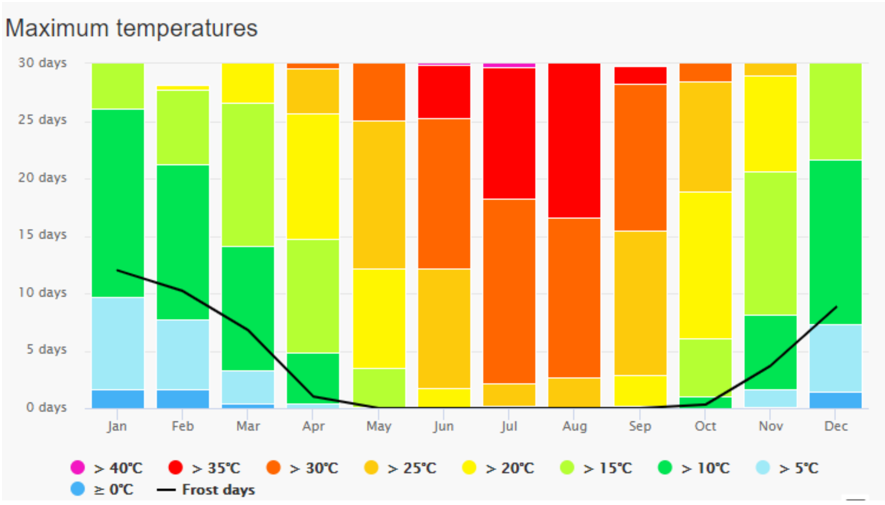

Figure 17. Annual maximum temperature levels in Izmir

While the average solar radiation in the northern districts of Izmir is 1500 kWh/m^2-year, in the southern districts such as Kiraz, Ödemis, Tire, Bayındır and Kemalpasa, the average reaches to 1800 kWh / m^2-year. The climate in İzmir is hot and humid. In July temperature is highest while in January is the lowest in the whole year. Total number of day in a year which temperature is below zero, is about 10 degree and more than 100 days the temperature is higher than 30 degree. The weather is very rarely snowy. The annual precipitation changes 700mm to 1200mm. In summer seasons, wind blows from sea to shore and provides cooling slightly. Hot summer days brings coolness to Izmir. The main basis of daylight based on annual meteorology is climate. It changes the brightness and brightness depending on the light and brightness. The design and material properties of geometry are taken into account together with the local climate condition. Climate data is obtained from measurements recorded in the field for years to be downloaded and used from the Internet (Mardaljevic, Andersen, Roy, & Christoffersen, 2011). For simulations, EnergyPlus weather file which can be downloaded from EnergyPlus website, (*.EPW) is used. Dataset was derived from weather data collection between the years of 1982 and 1988. Global location coordinates of studied building is 38°30’ N and 27°1’E (GMT+3).

3.3. GEOMETRY MODELING

An office model shown in Figure 18 is the beginning of the simplified simulation study of this research. For the comfort of office workers, we recommend shading design and control method. Acknowledgments to this method, the use of natural lighting in terms of energy and lighting in terms of office users visually and thermal comfort can be increased.

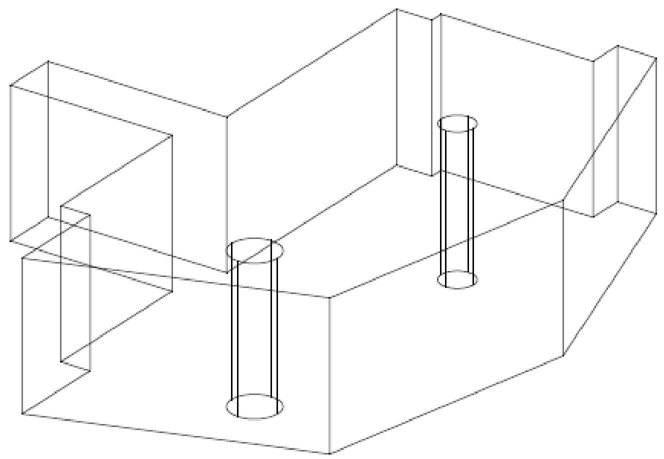

Figure 18. Axonometric view of office 54

The scenario focuses on the parametric design of a single office model of a high structure with a complete glass façade in Izmir. The convex-shaped office building is 4.00 m high. It has 15 double-glazing glass; size of each glass is 1.40 * 4.00 m. Shading devices are architectural elements that are mounted inside or outside of the building, providing heating / cooling, lighting and comfort of view aesthetically. The shades provide energy control by building the aforementioned architectural integrity by controlling the amount of daylight entering the building. For a building in the northern hemisphere, sunlight is effective on the south, east, and west, where shading devices are needed. When the movements of the sun are observed in the year, horizontal shading elements are more effective on the south side because sunlight comes from the right angle to the earth. On the west and east facades, vertical or angled shading elements should be used because, daylight is expected to be vertical according to opening between shading devices.

Table 2 Decision variable used in the current work

Input Parameters	Data Type	Explanation of Parameter	Range	Unit
X_1	Categorical	Change Direction of Shading	[0-1]	-
X_2	Continuous	Number of Shading	[0-10]	-
X_3	Continuous	Rotation of Shading	[0-45]	Degree
X_4	Continuous	Depth of Shading	[0,1-0,3]	Meter
X_5	Continuous	Local intervention point 01	-	-
X_6	Continuous	Local intervention point 01	-	-
X_7	Continuous	Local intervention point 01	-	-
X_8	Continuous	Local intervention point 01	-	-
X_9	Continuous	Local intervention point 01	-	-
X_{10}	Continuous	Local intervention point 01	-	-

The shading device, which is considered to use in the building, is adjacent to the glass façade (Table 2). Parameters (x_1 to x_{10}) listed in the table, define design criteria's. While choosing shading device, the daylight level in the working hours was considered. Because light rays' coming from the sun is perpendicular on the south side of the building, it was thought that using horizontal shading devices and light shelves on this façade are expedient. On the eastern side, the diagonal shading devices are used when the sun's rays are perpendicular to the plane of the façade. The parameter x_2 indicates number of shading devices per story in vertical plane. In spite of the fact that, the shading effect is proportional to x_2 value, it should be considered that choosing improper value for this parameter could cause to decrease in beneficial amount of daylight and discomfort in visual aspects. In this study, it is restricted between 1 to 10 pieces per story. The next parameter x_3 is angle between shading devices and horizontal plane on the south and east façades. Using greater value than 45 degree, both it would not functional and it would pretty limit the visual connection between outdoor and occupants in the office. The heat gain, which occurs by transition of sunrays from the façade, can be decreased by increasing depth - meaning parameter x_4 here - of the shading devices, x_4 that affects the shading is changes between 0.2 and 0.6 m While determining this parameter, taking advantage of the solar heating effect in winter seasons should be considered and static stability should be taken into account due to cantilever structure of shading devices. The parameters from x_5 to x_{10} correspond to the convex structure of the building and determine the compatibility of the shading elements to the façade.

3.4. INPUT FILES & DATA DICTIONARY

The aim of this study is to provide the relationship between the shading design to the façade and the effect of daylight performance on minimum energy and maximizing daylight on office workers.

- The input data dictionary, (IDD) in short, is an ASCII encoded plain text file that contains list of all the possible EnergyPlus objects and specifications related to energy simulations. It is equivalent to keyword file for DOE-2.
- The input data file (has IDF extension) is file type using ASCII character format that includes data describing the building information and HVAC system structure to be simulated. With EnergyPlus installation, various sample file come together. Additionally, a spreadsheet file “ExampleFiles.xls” holds columnar explanations of each file’s features.
- Radiance image format (typically ".pic") is the basis for one of the standard HDR (High Dynamic Range image) image formats (".hdr"), supported by most HDR image editors including Adobe PhotoShop (eg: PhotoShop CS2, 2006). 4 bytes are allocated in memory and 3 bytes for RGB information and 1 bytes for exponent. The pixel data may be stored uncompressed or using a straight forward run length-encoding scheme. A Radiance image file contains

of three units: a header, resolution string, followed by the pixel data (Reinhard et al., 2010).

- Simulation programs use the EPW, EnergyPlus weather file, which contains information about hourly and sub-hourly weather data. The fully information about the data format can be found in the Auxiliary Programs Document. It is also described neatly in the Input Output Reference document (Bueno Unzeta, 2010).
- CSV is a plain text file that uses delimiter character (generally comma) in order to separate containing data. EP-Launch and EnergyPlus automatically generates post-processed standard output (eso) and, meter output (mtr) files into columnar csv (comma-separated variable) files. These files are ready to be read by spreadsheet programs (such as Excel™).

EnergyPlus uses its own built-in library named 'ASHRAE_2005_HOF_Materials' according to construction materials based on ASHRAE standards. This material library is used by all the construction material organizations. Besides, there is another specification, which classifies the materials according to light, medium and heavy construction. At this point, all the materials are arranged in terms of thermal mass, thermal resistance features and thickness. For the building to examine in this study, Mediterranean climate type was used. For digital model, material properties in the building were chosen for heavy construction. The material, which is taken into account, is listed in table below (see Table 3).

Table 3 U-values of construction materials which is taken into Account in analysis

Building Elements	Material description	Material Properties (W/m2K)
Ceiling	Glass	0,625
Floor	Concrete	0,625
Wall	Bricks (13.5 cm)	0,550
Glass	Double Glazing	1,300

Table 4 Properties of glazing used in studied building

Light Transmittance	50%
Light Reflectance	18%
Direct Energy Transmittance	22%
UV Transmittance	0%

All the building elements in the office have been formed to arrange light and thermal features in the model. From the Table 3 construction, layers can be looked into. There are no mass materials having thermal properties like density, conductivity, etc. By controlling thermal transmittance value, just u-value can be modified.

3.5. RANDOM SAMPLING

The complexity of the nature of design problems and the application of new technical methods in the present day make the analytical solution impossible. The number of rapidly increasing integrated systems and advancing technology affect the structure of the problem. In simulation models, it is easier to observe the interaction between variables. However, it requires intensive computer use (Spall, 2005). A test method can be used to test hypotheses and to determine confidence intervals. The values that are sampled with the statistical values of the set can be compared. From this, the sampled distribution does not need to be re-determined for the observed data values. The distribution belongs to the test statistics generated by a particular model regarding the occurrence of observed data. The confidence intervals of the data generated from the model can be based on the predicted variation of the observed parameter (Howell, 1998).

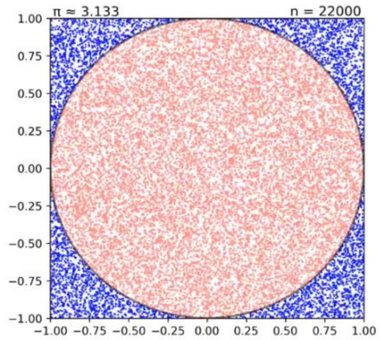

Figure 19. Monte Carlo (Random Simulation)

In Monte Carlo simulation, some researchers have recommended that sampling be used only in the techniques of variance reduction. Today's usage is the selection of random values in probability distributions. The simple tool for determining the testing in the Monte Carlo method is between 0-1 and uses uniform distribution numbers.

3.6. SIMULATION EXECUTION

Nowadays, there are a number of technical computer programs to assist architects and designers about daylight and energy technology. These programs, operating systems, can be used to achieve interior comfort in terms of digital connections and standards. It examines several programs in this field comparatively. It is used by combining more than one simulation motor due to detailed and complexity of the investigated parameters. Rhinoceros (2018) is modeling software used to create models. By adapting the program with the visual programming tool Grasshopper (2018), it is possible to control the geometry in order to analyze it according to the environmental parameters. The model is widely used to make parametric experiments on material types. For use in this project, Honeybee and Ladybug (Lima, Kos, & Paraizo, 2016) is the environment in which a number of add-ons are used. Furthermore, the Grasshopper directly connects to Rhino, which means that every geometry iteration triggered by the Grasshopper immediately affects the 3D model developed in the interface of the previous program. Grasshopper is a Honeybee and Ladybug plug-in that allows you to perform many environmental analyzes such as daylight levels, user comfort, and shadow range. Approved engines such as EnergyPlus, Radiance, OpenStudio and DAYSIM can be used to operate them. If used before the design can be taken against the effects that may come after. It can also be used to document certification systems. Rhinoceros 3D, an industrial-purposed CAD/CAM software running on most mainstream OSes, has a visual programming environment named Grasshopper3D developed by (Rutten & Associates, 2007) and based on Python scripting language in order to make models, analysis, drawings, automations etc. There are two important plug-ins for Grasshopper3D called HoneyBee and LadyBug. They help architects, designers, and engineers to assess the environmental performance of buildings. While LadyBug allows to import standard weather data (i.e. *.EPW files) to analyze and draw diagrams sun-path, wind-rose, HoneyBee provides a wide variety of free computer applications supporting environmental design and connects validated simulation programs like Radiance, EnergyPlus, Therm, OpenStudio to Grasshopper3d environment (Joo et al., 2012). Since EPW files must be imported and EnergyPlus surface results must be read by LB, they are used together usually. In this thesis, a high-rise building was analyzed with this plug-ins to obtain data about its energy and visual performance and to test effects of shading device in this view.

3.6.1. REAL DATA COLLECTION

The application was carried out for 7 days period (7x24 = 168 hours) with a climatic data of 7 August 2017 - 14 August 2017 in İzmir province. The TESTO 545 illuminance level meter is used to measure the solar radiation intensity. The glass facade was measured in a high structure and the solar radiation from the office facing two main directions in the south and east. 168-hour measurements were recorded with a data logger at 10-minute intervals. Solar radiation measurements in the horizontal plane from Turkey, General Directorate of State Meteorological Service (DMI) serves some universities and research institutions. Turkey's possible to reach the horizontal plane of the solar radiation values for many of the settlements (Dağsöz & Bayraktar, 1995), (see Figure 20).

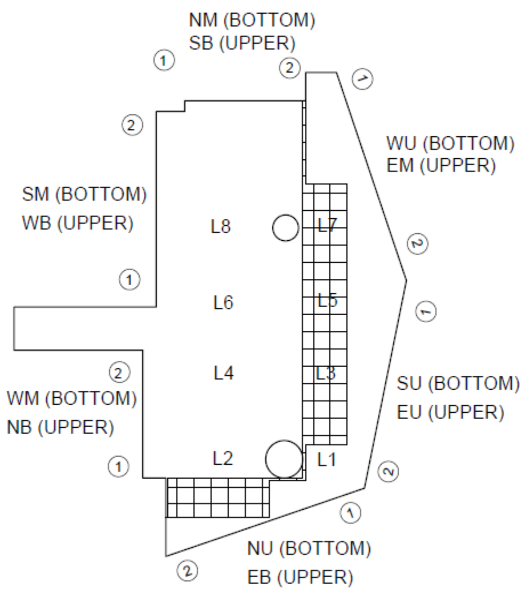

Figure 20. Sensor deployment in the field (plan view)

Figure 21. Placement of temperature sensors (office view)

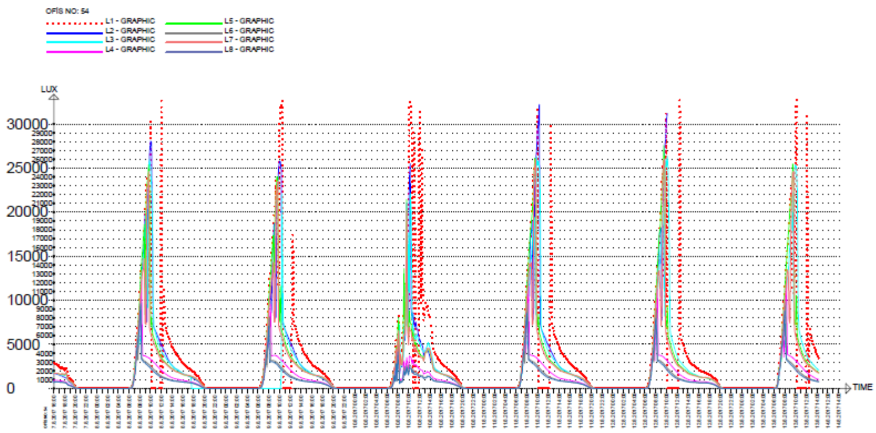

Figure 22. Comparative chart of measured daylight levels $L_1 \ldots L_8$

Table 5 Temperature and daylight measurements from the field study

DATE	TIME	EU	EM	EB	SU	SM	SB	WU	WM	WB	NU	NM	NB	1EDIUI	L1	L2	L3	L4	L5	L6	L7	L8
07.08.2017	09:00	43,0	40,4	-	43,1	33,4	34,7	40,2	35,5	33,1	40,4	35,8	35,1	36,2	22370	19847	17896	3978	8478	3254	7412	2998
07.08.2017	12:00	43,2	40,4	-	43,6	33,8	35,9	39,7	36,6	34,2	46,7	35,7	36,3	36,4	32887	5007	4467	2204	3745	1623	3384	1387
07.08.2017	15:00	39,9	38,8	-	39,9	33,8	35,9	38,4	36,4	34,1	41,4	36,1	36,5	36,0	3803	2124	2345	1158	2101	838	1978	835
08.08.2017	09:00	42,8	40,2	-	42,8	33,1	34,5	39,9	35,3	33,0	40,1	35,8	34,8	35,9	20370	19720	17742	3717	8380	3091	7393	2916
08.08.2017	12:00	43,1	39,9	-	43,3	33,7	35,6	39,5	36,3	33,9	46,5	35,7	36,0	36,2	32639	4958	4250	2058	3520	1421	3284	1270
08.08.2017	15:00	39,6	38,6	-	39,5	33,7	35,8	38,1	36,3	33,9	41,3	35,7	36,3	35,9	3742	2098	2130	1057	1902	827	1868	798
09.08.2017	09:00	42,2	39,7	-	42,2	33,4	34,7	39,5	35,7	33,3	39,7	35,8	35,1	36,1	19643	18717	17541	3757	13141	3137	7526	2946
09.08.2017	12:00	43,1	39,9	-	43,4	33,9	35,8	39,6	36,5	34,0	46,1	35,9	36,3	36,4	-	5224	4632	2111	3684	1451	3393	1300
09.08.2017	15:00	39,7	38,7	-	39,6	34,0	36,0	38,2	36,5	34,1	41,1	35,9	36,5	36,0	3656	2040	2118	1039	1880	819	1831	788
10.08.2017	09:00	35,2	34,5	-	35,2	32,6	33,9	34,3	34,4	32,6	34,6	33,8	34,4	34,0	8227	4050	3124	1482	4997	1148	4154	1220
10.08.2017	12:00	41,9	38,9	-	42,0	33,9	35,1	38,7	36,0	34,0	45,2	35,2	35,7	36,1	28890	5564	5283	2193	4020	1523	3728	1372
10.08.2017	15:00	40,3	39,5	-	40,1	34,2	36,0	39,1	36,6	34,4	41,6	35,9	36,5	36,4	3886	2143	2185	1081	1980	848	1932	815
11.08.2017	09:00	44,4	41,3	-	44,3	34,6	35,8	41,3	36,8	34,5	41,7	37,1	36,1	37,5	20089	18945	16430	3724	19861	3084	7196	2886
11.08.2017	12:00	45,2	41,4	-	45,3	35,0	37,1	41,1	37,7	35,2	48,8	37,1	37,5	37,7	-	4934	4217	2027	3427	1382	3136	1232
11.08.2017	15:00	40,9	39,5	-	40,7	35,0	37,3	39,2	37,8	35,1	42,3	37,2	37,8	37,3	3657	2037	2091	1036	1887	814	1834	787
12.08.2017	09:00	44,9	42,0	-	44,9	35,0	36,4	41,9	37,3	34,9	42,1	37,6	36,7	38,0	20641	18232	16559	3716	20743	3056	7093	2867
12.08.2017	12:00	46,3	42,2	-	46,2	35,6	37,7	41,9	38,4	35,8	50,3	37,8	38,2	38,3	-	4354	3666	1844	2943	1250	2679	1108
12.08.2017	15:00	41,3	39,9	-	40,9	35,4	37,8	39,5	38,2	35,6	43,1	37,7	38,3	37,8	2653	1580	1664	882	1547	713	1483	692
13.08.2017	09:00	45,2	42,0	-	45,1	35,3	36,5	42,0	37,4	35,2	42,4	37,7	36,8	38,3	20217	11582	16460	3697	20427	3028	7397	2820
13.08.2017	12:00	46,6	42,7	-	46,5	35,8	37,7	42,3	38,5	36,0	50,9	37,8	38,3	38,6	-	4495	3852	1891	3067	1283	2854	1138
13.08.2017	15:00	41,6	40,1	-	41,3	35,7	38,0	39,7	38,4	35,9	43,4	37,9	38,5	38,1	2828	1654	1768	922	1596	743	1557	716
14.08.2017	09:00	44,8	34,7	-	43,0	32,8	34,8	41,3	37,0	34,9	42,0	37,4	36,2	37,9	20507	12382	16250	3752	20352	2989	7345	2798
14.08.2017	12:00	46,0	39,1	-	43,3	34,1	35,9	41,2	37,8	35,5	49,0	37,5	37,6	38,1	32550	4697	3435	1642	3014	1124	2675	1089
14.08.2017	15:00	39,9	39,7	-	39,9	34,4	36,1	39,4	38,1	35,6	42,4	37,6	37,9	37,7	3125	1580	1634	825	1498	704	1489	689

DAYLIGHT OBJECTIVE

Useful Daylight Illuminance also known as UDI, is a modified version of Daylight Autonomy conceived by Mardaljevic and Nabil in 2005. This measurement collects hourly data for the lighting properties of an environment and divides them into three parts. Just 100-2000lx range is accepted in these criteria and other ranges (less than 100 and more than 2000lx) are not useful (Nabil, Mardaljevic, & Technology, 2005). UDI is much more realistic analysis with respect to previous approaches because, it uses changing sun and sky conditions and includes whole year. UDI indicates both daylight level that is not enough and sunlight level causing excessive heat gain. The value in range of 100-2000 lux is desired to be high because, the values out of this range are not suitable and do not appropriate for illumination. Recommended light level for offices is 300 lux (Cantin, Dubois, & Technology, 2011).

$$min\left(EUI, \frac{1}{UDI}\right)$$

$$UDI(Pt_1) = \frac{1}{n}\sum\nolimits_{j=1}^{n} H\left(P_{t_1}, j\right) \times 100$$

$$H(X) = \begin{cases} 1, if\ 100 \leq x\ \leq 2000 \\ 0, otherwise \end{cases}$$

Glare is the situation when light rays from a light source in the field of view or a bright surface are at a level that can prevent the sight of a person in the environment. If the glare is at a level that completely blocks the sight of the eye, it is called 'disability glare'. Disability glare is a feeling of discomfort or even pain caused by excessive light sources (Bullough & Hickcox, 2012).

ENERGY OBJECTIVE

Energy use intensity according to the ASHARE 105-2007 standard, the main approach used to measure energy performance in buildings. Energy demand for a building is indicated by energy per unit area (kWh/m^2) thus, energy usage can be observed. A factor affects EUI such as climate, HVAC system, building type, LEED certification, and occupancy. Simply calculating the amount of energy consumption for each process does not take into account the size of the building, the structure, or the type of use. The Energy Use Intensity (EUI) indicator uses tools to synchronize the method of comparing energy consumption with different building types and to evaluate the total energy saving alternatives.

$$EUI = \frac{Annual\ Building\ Energy\ Demand\ (kWh)}{Building\ Area\ (m^2)}$$

3.6.2. EVALUTION OF REAL DATA

The factors that determine how effective lighting is in an environment are the amount of light in the environment, light quality, shading. These factors should be handled and designed separately depending on where the light is needed. The Lighting Standards also provide the solution for abundance of other concerns related to design, installation, installation and minimum energy requirements, as well as efficiency, durability, cost and maintenance in different locations (Banos et al., 2011).

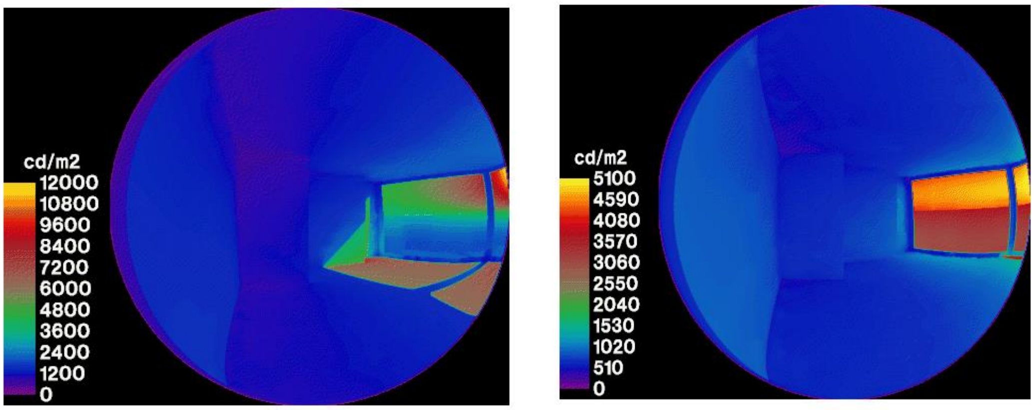

Figure 23. 5th floor 54 in the office building (Glare-fish eye)

In this study, it was evaluated between the dates of 7.08.2017 and 14.08.2017 at 9.00 in the morning, noon at 12.00 and 15.00 in the evening at the 5th floor 54 in the Mistral Office building. As shown in Figure 23 Intolerable glare in office buildings is a common phenomenon. Many studies on this problem have been done and this problem has been tried to be prevented in the design phase. In Figure 23 above, glare indices and comfort daylight were reviewed and the design recommendation was made for the shading element.

3.7. APPLICABILITY

The shading device that examined in this study can be constructed by well-known facade techniques and with common materials like aluminum composite panels for covering, aluminum alloy profiles for supporting structure. A flanged u profile shown in Figure 24 is horizontally mounted to bearing system of glass façade in order to use as base for shading device. This provides structural strength and integrity.

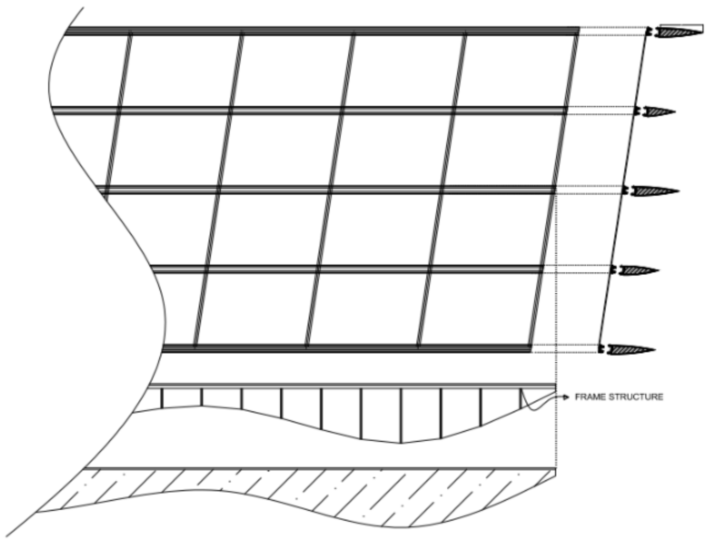

Figure 24. Front view and cross sections of shading devices

A frame, shown in Figure 24, can be built to form the shape of shading device. Using sheets of aluminum by equal intervals according to shading device will provide a smooth shape. About 50 cm intervals is enough for this purpose however, if we would like smoother surface, shorter intervals can be used as in the figure. Once frame is constructed, aluminum composite panels that are available in various patterns and colors by using screws cover it. In the junction of panels, appropriate sealant mastic should be applied so that water from rain or snow is not able to infiltrate. This finished shading device now can be attached to its base by bolts (see Figure 25). This production cycle continues until all shading devices are completed.

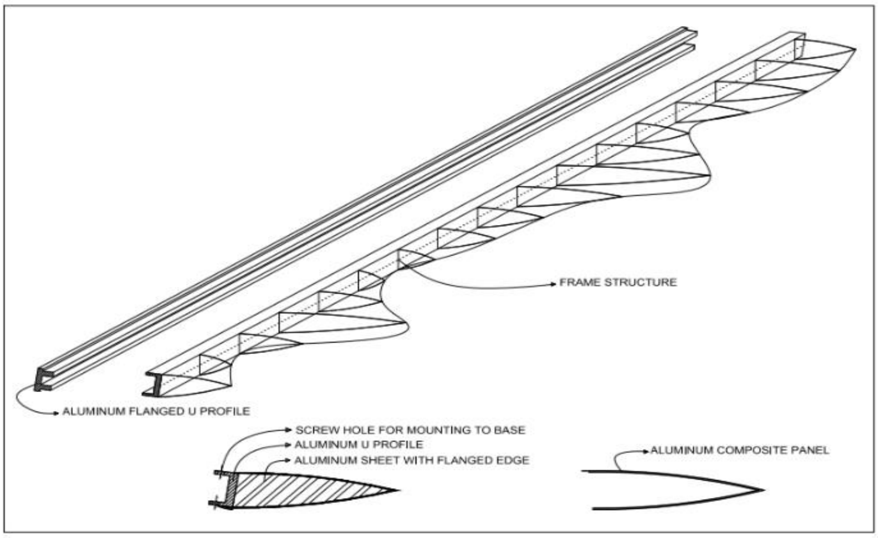

Figure 25. Construction details of external shading devices(frame and section details)

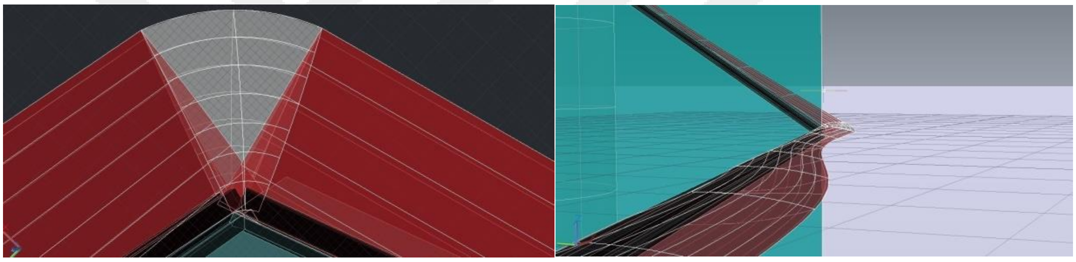

Figure 26. Visualization of shading device and connection of two ends

Since, shading on the two side of the adjacent façade is not coplanar, this end sections should be connected to each other with appropriate part shaped like transition curve appropriate to geometry at these points. Extra care should be paid for sealing.

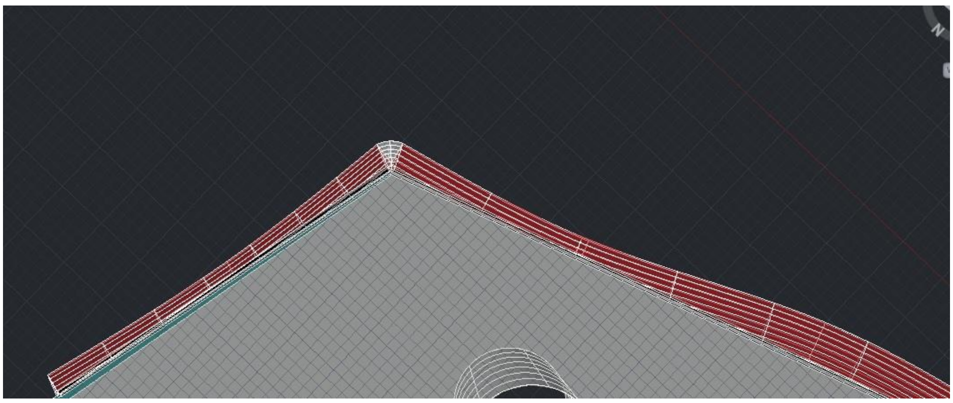

Figure 27. Visualization of shading device and connection of two ends

3.8. CONCLUSION OF METHODOLOGY

This section describes the design of the workplace. It is the esthetic importance of the high buildings, which is the reason for the creation of the design. Thermal environment satisfaction is a mental process that also indicates the satisfaction provided by thermal comfort. A biological entity should not be forgotten. This causes a decrease in the performance of man; where the environment cannot provide satisfaction. Ensuring the health and comfort of individuals is to increase the efficiency in production. Another effect; sustainability refers to careful and careful use of nature and natural resources to allow future generations to be transferred. It was used in the study because of the structure of the problems related to the evaluation criteria. The creation of real data has led to the sequencing of alternatives. The inclusion of the objective part in a holistic and simultaneous solution is the most important contribution to the solution. The fact that the actual data is present in the stages of creating and implementing the model makes the analysis more realistic. The introductory part of this study and chapter 2, the aim of the problem, what has been done before and the methods that are affected are explained; in the third chapter, there are details about the model developed, design stages; the findings and results of the application are given in section 4.

CHAPTER 4
RESULTS

This section also describes the results of the procedures described in section 3. In section 1, an overview of the formation of the model's design process data collection. Section 2 shows the data that will help the model and which will be exemplary of the process. Factors affecting the model described in next section 3; İzmir climate, actual data, and the performance of the proposed design model are summarized. The most recent section is a comparison of the improvement of the proposed shading design for the façade of the high-rise office. The results of the proposed design are summarized.

4.1. COMPARISON OF RESULTS

Chapter 4 presents the effects of the proposed shading element design of the modeled office. The effects of parameters on daylight and energy performance, as described in the previous sections of the study, were investigated. The design of the facade shading element was compared with the actual data by considering the İzmir climate and environment. Considering that the daily working hours are between 09.00 in the morning and 18.00 in the evening, 2817 working hours have been taken into consideration in a year. As shown in Figure 28, the data of daylight illumination values and thermal comfort were obtained because of the calculations of the simulation program without the shading element with the support of real data.

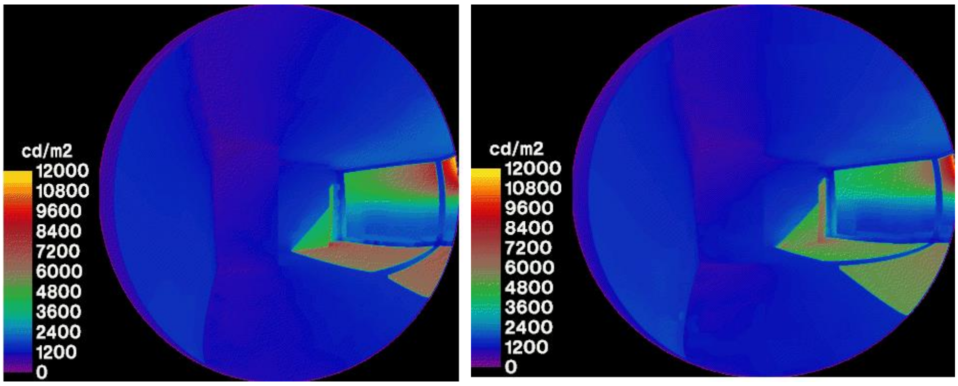

Figure 28. The highest weekly and annually values (before)

The limit values should not exceed 16-19 in an office, depending on the work done in order not to disturb the user. The measurements were evaluated daily and weekly between 09.00 in the morning and 12.00 in the noon and 15.00 in the afternoon. In the measurement taken as a week, the highest glare value was found to be 0.46 at 9.00 in the morning of 14 August. In the measurements taken throughout the year, the highest glare value was found as 0.47 in September at 9.00. The glare value of the glass facade, which provides daylight illumination between occupancy hours, is high (see Figure 29 and Figure 30).

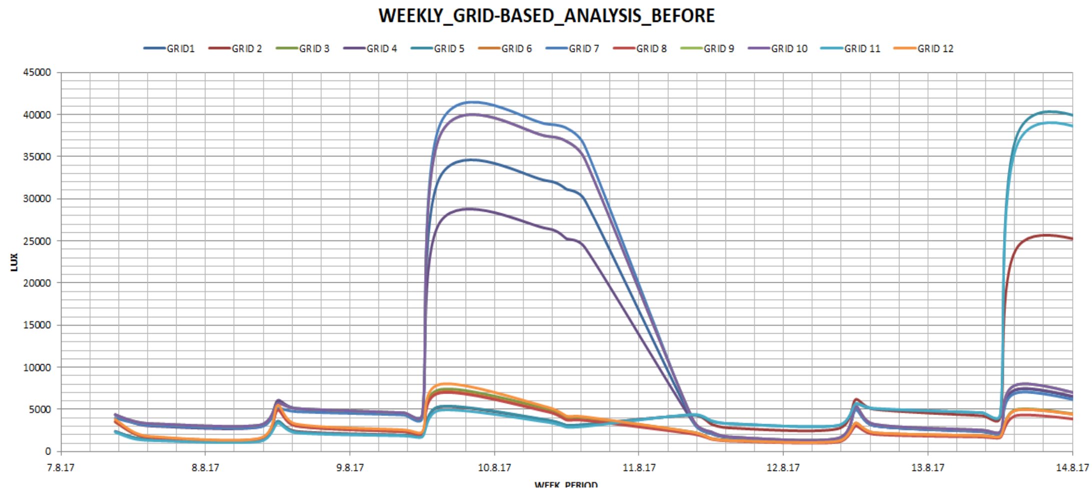

Figure 29. Weekly daylight levels within the analysis grid

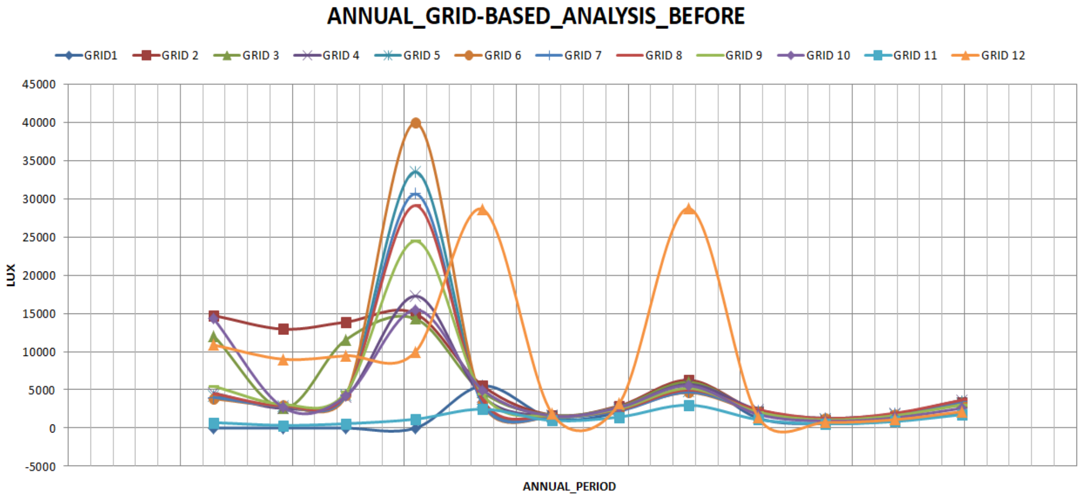

Figure 30. Annual daylight levels within the analysis grid

The above graph shows the lighting values of the office examined at different times and at different times. 12 test points were used as 3x4 in the simulations. When the data in the graph and figure are analyzed, it is observed that the values of the simulations performed in the office in a week were Grid 7, which is close to the glass facade, 38898 lux at 15.00 on 9 August, Grid 9 at 11.00 pm at 9.00 on August 12. The daylight values specified in the standards are minimum 300 lux in offices. On an annual basis; grid 6 is calculated as 40385 lux at 15.00 in June, while grid 11 was seen as 356 lux at 9:00 am in November. When these values are examined, the evidence obtained from the architectural and engineering point of view is affected negatively in terms of thermal and visual and comfort. Thermal comfort is a mental condition that expresses satisfaction with the thermal environment. Existing comfort standards such as ASHRAE 55-2010, ISO 7730: 2005 are designed to ensure the thermal acceptability of indoor environments (Taleghani, Tenpierik, Kurvers, Van Den Dobbelsteen, & Reviews, 2013). Satisfaction with indoor climate evaluates real thermal conditions in a particular context. In this respect, the shading element design for the façade in glass facades is presented.

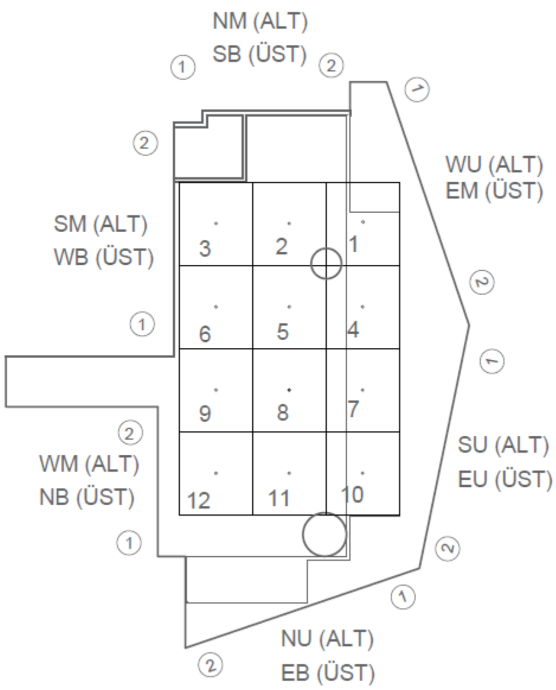

Figure 31. 12 points (grid based analysis)

Table 6 Before UDI (Annual Daylight)

UDI _LESS _100	UDI _100 _2000	UDI _MORE _2000
%53	%21	%25

As shown in Table 5, the total heating and cooling consumption before shading implementation are given. When the actual temperature data are analyzed, excessive energy consumption is observed in order to provide thermal comfort. The temperature for August is above 50 C^0 at noon. As a result, the annual energy consumption of the HVAC system is calculated as 26448 kWh. While the energy consumed for cooling throughout the year was found to be 20057 kWh, the energy consumed for heating was 6391 kWh. This difference is observed to be three times the annual cooling energy of the sample office floor. The energy consumption of the room is 152 kWh/ m^2/year.

In open office plans, the UDI value is very difficult to be between 100 and 2000 lux. In this study, the annual UDI 100-2000 value is around 20% while UDI_Less_100 is

53% and UDI_More_2000 is 25%. Therefore, when the daylight value increases, the energy consumption is affected by the total thermal as seen from the data.

4.2. SIMULATION METHODOLOGY

Because of the decrease in our energy resources and the increase of high buildings today, the works of the buildings in terms of energy and enlightenment in the front architecture have increased. To reduce energy requirements in terms of cooling and heating of buildings in Turkey has also become an important condition. The structure of the study was directed equally in four directions as required. In this study, by considering a limited number of alternatives, the effect of different orientations on illumination and total thermal is investigated by changing the design of the shading element to the façade. In order to reach general results; the effect of physiological and physiological analysis of human alternatives on the reduction of enlightenment and energy expenditure has been investigated. Monte Carlo simulation (Random data generation) has obtained 1000 different results. They produced multiple alternatives and evaluated their best. Architects and designers have used advanced modeling programs by simply reducing the calculation method. The front architectural design helps to take into account the structure and the conditions to be found within it.

4.2.1. IMPACT OF VARIABLES

The alternative is derived from the shading element 10 designed for the façade. Four depth variables (Local intervention) were tested at different values between 0.1 and 0.25 in the design of the shading element where the measurements were made. Depth (depth of shading) is kept constant and Local intervention is different.

In the proposed shading element design, the south and east facade varied in number when exposed to excessive daylight. Since the floor height is 4m, the frequency of the shading element is more than seven. Approximately 50 to 65 cm of shading element range is observed. In order to decrease the frequency of the shading element, the depth must be higher than the output.

For the angle made by the shading element to the façade, values ranging from 0 to 45 degrees were tried.

Table 7 Extreme values for variables and their regarding consequences

	Depth of Shading (Meter)	Number of Shading (Piece)	Shading Rotation (Degree)	Local Inter_XY_01	Local Inter_XY_02	Heating Load (kWh)	Cooling Load (kWh)
Minimum	0,10	1	0	0,00	0,00	36,53	141,10
Maximum	0,30	10	45	1,00	1,00	31,46	156,91
Medium	0,20	6	22	0,5	0,5	32,19	142,00

The table above shows the limit values of variables and corresponding heating and cooling loads. This value is just for having an idea for the effect of limit values.

Table 8 Rather good thermal load values after shading devices appliance

Alternatives #Number	Heating Load	Cooling Load	Total Thermal Load
1	33,56	140,53	174,10
2	36,27	139,04	175,31
3	35,91	139,81	175,72
4	28,00	158,18	186,18
5	29,78	158,43	188,21
6	30,16	158,07	188,23
7	33,77	138,64	172,41
8	29,18	145,85	175,03
9	27,55	168,30	195,84
10	24,85	190,09	214,94

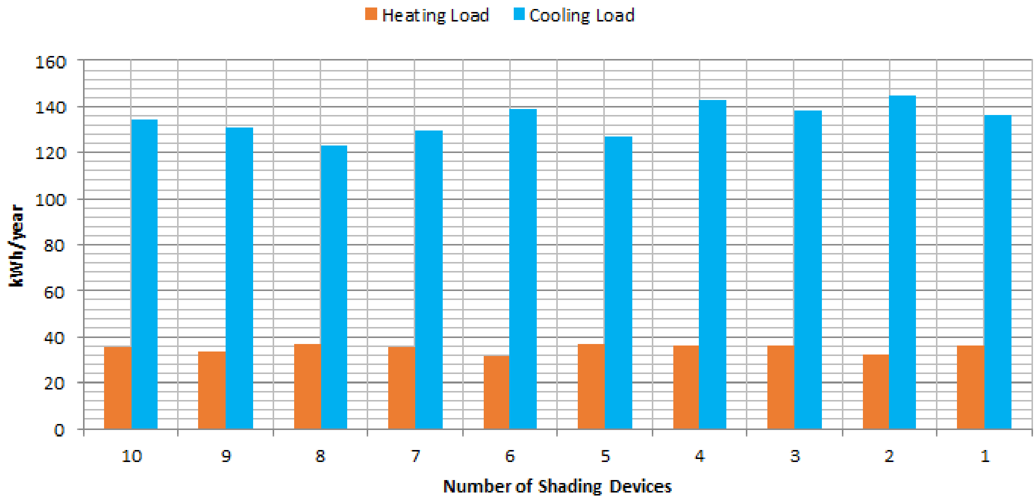

Figure 32. Comparison between annual cooling and heating loads

Table 9 After UDI (Annual Daylight)

UDI _LESS _100	UDI _100 _2000	UDI _MORE _2000
%55,33	%43,17	%1,5

The annual energy consumption of the HVAC system is calculated more effectively with the simulation shading element design. When the energy spent for cooling throughout the year is examined, it is seen that the amount spent for heating is more. This difference is observed to be three times the annual cooling energy of the sample office floor.

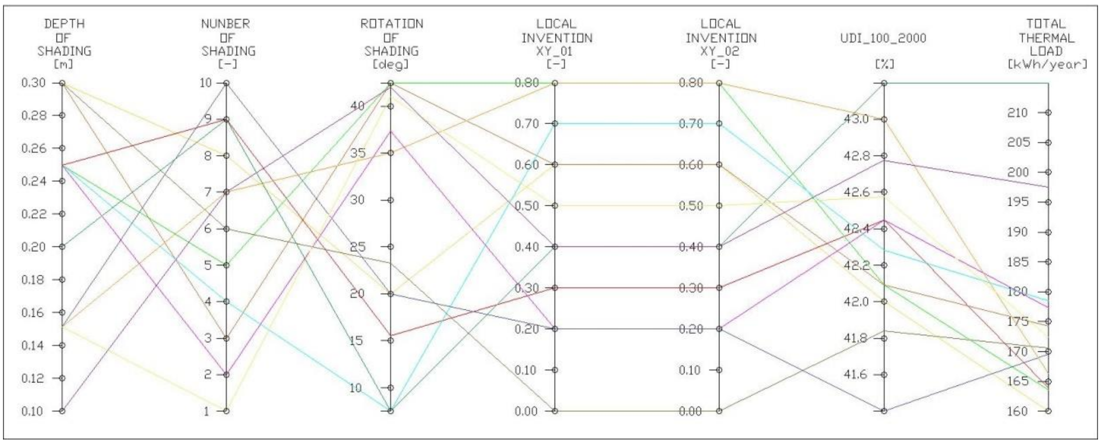

Figure 33. Parallel plot for selected alternatives that provides good effectiveness

Many factors determine the effectiveness of shading devices such as depth of shading, rotation angle, shape, distance between shading devices etc. However, these factors do not affect all the results (i.e. glare, daylighting, total thermal load) in the same way. Thus, optimal values should be determined to avoid imbalance due to unproportioned relation between. The implementation of the shading design has improved UDI 100-2000 and DGP values. 50% better results were obtained with the shading design of the office as a case study. (see Fig 34.)

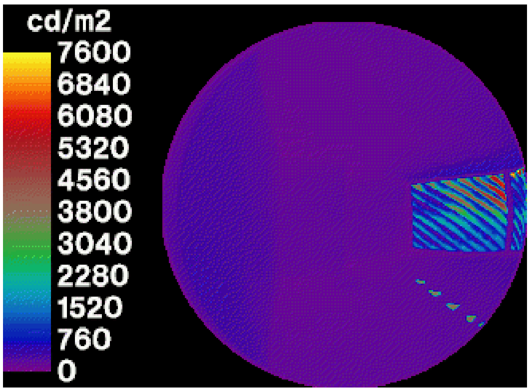

Figure 34. The annual values for office 54 after shading device implementation

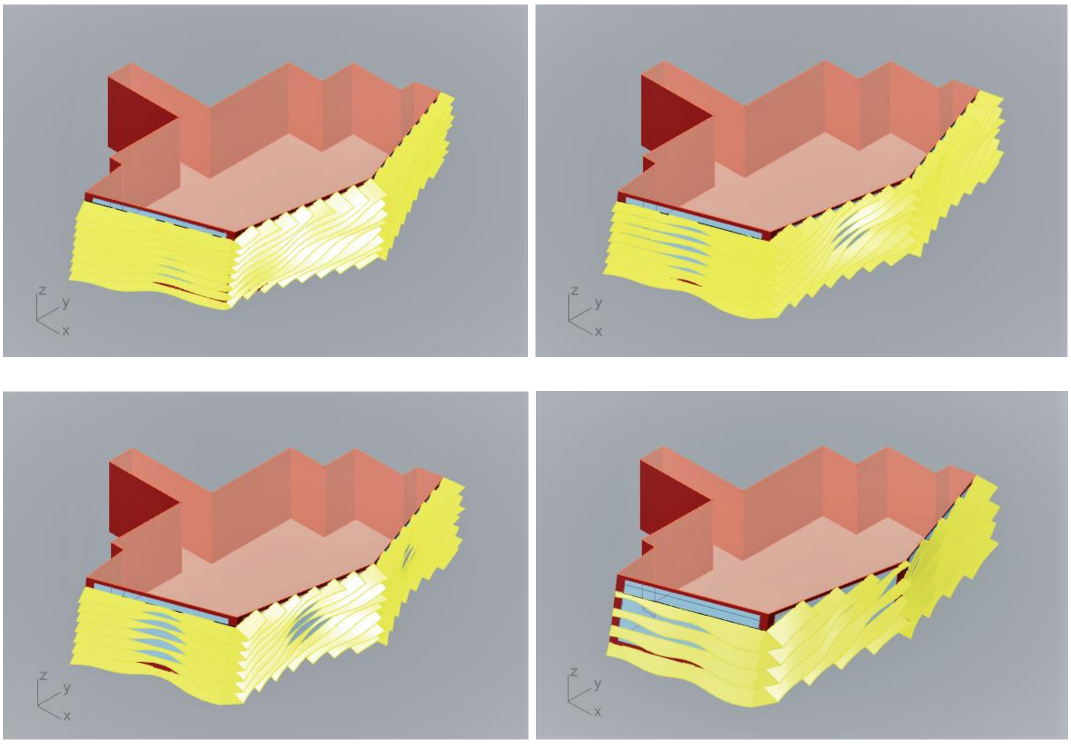

Figure 35. Design views with different values of decision variables

When designing the shading element, different alternatives can be analyzed comparatively and the most appropriate approaches for the criteria can be evaluated. Each decision variable of the shading design has a different effect on the total energy and UDI value of the building.

Additionally, for the same result, several alternatives can be found as solution and this is important in the view of visually of the building. For example, No 11 and No 12 alternatives gives almost the same results for both UDI_100-2000 and total thermal load. On the other hand, when these two alternatives are compared, it's seen that for No 11 rotation is 20 degree, number of shading for one floor is 8, depth of shading is 0,3 m and for No 12 rotation is more than 40 degree, number of shading for one floor is 5, depth of shading is 0,25 m in other words, two the same results with different values of variables.

4.2.2. EFFECT OF GLASS PROPERTIES

Table 10 Properties of different glazing types

PRODUCT		DAYLIGHT EN 410				SOLAR ENERGY EN 410					U-VALUE W/m^2K	
NAME	CODE	VISUAL TRANSMITTANCE	EXTERNAL REFLECTION %	INTERNAL REFLECTION %	COLOR FIDELITY %	DIRECT TRANSMITTANCE	EXTERNAL REFLECTION %	COOLING %	Solar Heat Gain Coefficient %	SHADING COEFFICIENT	DRY AIR	ARGON
GLAZING 1	NEUTRAL 70/37	69	15	17	95	34	37	29	36	0,42	1,3	1,0
GLAZING 2	NEUTRAL 50/27	49	16	19	89	23	32	45	26	0,30	1,3	1,1
GLAZING 3	FUME 31/28	31	9	19	94	23	14	64	28	0,31	1,3	1,1
GLAZING 4	DEEP BLUE 26/19	26	17	34	74	14	15	71	19	0,22	1,3	1,1

In the building studied, since the glass facade is applied without ventilation, the greenhouse effect occurs in the summer months. The properties of the glasses used in such facades should be able to reduce this effect. In the selection of glass in high buildings, negativities should be avoided by considering such features. Gas filled glazing in curtain walls creates a thermal insulation between the interior and exterior space, and reduces effect of outdoor temperature significantly on room temperature. Thus, the amount of energy consumed on cooling in regions such as the İzmir climate is higher than the amount of energy consumed for heating. The insulation of air is less than that of argon gas. For this reason, all U-values and total energy consumption are affected. In addition to the applied glass type, four different argon filled glass type alternatives were calculated.

Table 11 Effects of different glazing types on daylight performance

Alternatives Number #	UDI _LESS _100	UDI _100 _2000	UDI _MORE _2000
GLAZING 1 (DRY AIR)	56,17	42,08	1,92
GLAZING 1 (ARGON)	56,25	42,92	0,92
GLAZING 2 (DRY AIR)	56,33	42,33	1,33
GLAZING 2 (ARGON)	56,00	43,00	1,08
GLAZING 3 (DRY AIR)	56,33	42,33	1,33
GLAZING 3 (ARGON)	56,33	42,33	1,33
GLAZING 4 (DRY AIR)	56,00	43,00	1,08
GLAZING 4 (ARGON)	59,83	38,58	1,58

Table 12 Effects of different glazing types on thermal load

Alternatives #Number	Cooling Load	Heating Load	Total Thermal Load
GLAZING 1 (DRY AIR)	117,81	27,29	145,09
GLAZING 1 (ARGON)	117,81	27,29	145,09
GLAZING 2 (DRY AIR)	121,24	26,47	147,70
GLAZING 2 (ARGON)	121,24	26,47	147,70
GLAZING 3 (DRY AIR)	105,93	30,92	136,85
GLAZING 3 (ARGON)	105,93	30,92	136,85
GLAZING 4 (DRY AIR)	132,47	23,98	156,45
GLAZING 4 (ARGON)	132,47	23,98	156,45

CHAPTER 5
CONCLUSION

Because of the research in line with all these mentioned issues, today as technology and urbanization increase, the high structures are preferred because of its impressive structure. This is due to the increase in land values, social and environmental factors.

Although glass facades are preferred in high buildings, the calculation related to the lighting, heating, and cooling energy of the building are not taken into consideration enough.

In the early architectural design stage of high-rise projects, study should be done in a cooperative manner taking into consideration all the conditions of the workers from different disciplines. Because the design of the early architectural design is quite complicated, it also requires effective use of computer programs at this stage.

The application of the shading device on the glass facades will provide a significant amount of energy savings, especially in the summer months as the need for cooling increases. In addition to energy saving, the aim of the design is to ensure that office occupants work more efficiently throughout the day.

In this study, energy and enlightenment of high buildings with glass façade and the effect of daylight were mentioned. The disadvantages of a complete glass structure while considering the aesthetic appearance; it has been observed that the cooling load increases with increasing light level. In this case, the building's total energy load increases, so the carbon emission of the building increases.

The light levels and temperature values of the office 54 located in the high-rise office building which is facing the south and the east direction, were measured. Measurements were taken in August, particularly because it is the hottest period in Izmir.

The study examined the comparison of shading element performance with real data and enlightenment and energy. It was a parametric calculation of multiple alternatives to experience this problem. In the first stage, weekly and annual evaluations were made actual data taken on weekly basis. In the second stage, 1000 different results were produced throughout the year for the shading element suitable for the façade. The effect of different variables of the designed shading element was obtained. The design of the multi-alternatives to İzmir climate and structure was obtained. The realization of real data in terms of progress has enabled us to use the time efficiently in the formation of a wider and more comprehensive design. Importantly, the glass façade in Izmir is the first study of the design problem by calculating confined daylight and thermal energy in terms of design of the shading element to a high structure. This study used the designed shading element to compare the performance to the façade and demonstrate its applicability. It is assumed that the shading element will show a better performance effect. In order to evaluate the design, multiple alternatives were created using weekly, annual, and specific time zones. To compare the difference between the shading elements, actual data was required.

At the end of the study, 1000 results obtained with the shading element applied to the façade were discussed. In this way, the amount of energy spent on heating and cooling loads in a high structure is foreseen. Using the variable values of these 10 results, 80 different results were examined considering the argon and air-filled characteristics of four different glass types. Because of the investigation, argon filled glass type was found to be more effective. According to the calculations, except for the type of glass applied in the building, examination of different types of glass did not significantly affect the value of enlightenment rate. When the argon-filled glass type was used in the glass façade system, the total energy consumption decreased by 20.6% according to the type of air-filled glass. With this study, which will be guiding at the early design stage of structures in Izmir, estimating energy efficiency will be practical.

In future studies, the shading should be examined separately between the variables and the targets thereof. However, it can be developed kinetically to the shading element design. In addition, actual data can be taken for long time.

CHAPTER 6
DISCUSSION

Initially, the current research, the glass facade of the high office building in the current climate in a place like Izmir climate by taking into account the real value of the enlightenment

and energy performance based on the goal was addressed. We achieved this goal by integrating the process of shading element design that is applicable to the façade. Prior to the application, the actual data received at the site provided with a one-week leave were evaluated during the daylight hours. The values of the test were done without shading, and the results of multiple alternatives were tested at 9.00 in the month of the year, 12.00 in the afternoon and 15.00 in the afternoon. Based on real data, the study created a phase to explore the design for the façade and provide the appropriate design for the proposed design. The development of the study stems from the designs applied at the preliminary design stages without evaluating the aspects of the facade and the environment. In addition, the Mistral Office building located in Izmir is presented with officially calculated levels of enlightenment and energy. In the design process, it is of great importance to investigate the high buildings of our day. Besides, it also makes the approach strong to design calculations in a parametric way. As an approach, the shading element, which is designed to be appropriate to the façade, designed in terms of architectural aesthetics and energy, has been formed in detail from the literature.

The results provide different data when compared to actual data and the effect of the shading element in terms of enlightenment, temperature, and energy. The problem should be tried with more alternatives considering today's energy performance. Future studies can be designed and evaluated in terms of temperature, illumination, and energy in a kinetic way by considering human comfort.

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