Post-Occupancy Evaluation of Facade Design and Performance in Terms of User Satisfaction for Architecture Office Building, EMU

Ömer Anıl Sürme

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Approval of the Institute of Graduate Studies and Research

Assoc. Prof. Dr. Ali Hakan Ulusoy
Acting Director

I certify that this thesis satisfies all the requirements as a thesis for the degree of Master of Science in Architecture.

Prof. Dr. Resmiye Alpar Atun
Chair, Department of Architecture

We certify that we have read this thesis and that in our opinion it is fully adequate in scope and quality as a thesis for the degree of Master of Science in Architecture.

Assoc. Prof. Dr. S. Müjdem Vural
Supervisor

Examining Committee

1. Assoc. Prof. Dr. S. Müjdem Vural

2. Asst. Prof. Dr. Polat Hançer

3. Asst. Prof. Dr. Ehsan Reza

ABSTRACT

The building construction industry is developing significantly and the development is decreasing the design and construction time. The necessity of achieving user satisfaction and feedbacks became more important compared to history. One of the most important parts of the building is a facade. The design and performance of the facade have an important effect to achieve user satisfaction at an indoor environment. Facade can play a big role in balancing different aspects of indoor environment quality such as view to outdoor, privacy level, air quality, thermal comfort, and natural lighting. Facades that designed according to contextual features can promise for achieving high satisfaction and comfort for building occupants. Consequently, it is important to take into account in designing facade and developing according to occupant's needs.

In order to understand the user satisfaction and collect feedbacks, post-occupancy evaluation (POE) method is developed. It is an essential method to evaluate the design success of the building and the performance after an occupancy. The different type of POE is applied to several buildings to examine various parts of the building in terms of user satisfaction but there are few numbers of POE that applied to examine facade design and performance for user satisfaction.

This study focused on evaluation of facade design and performance of the selected office building by POE. The indicative POE method applied with questionnaire and observations of users and author. The study evaluated the facade of Architecture Office Building in EMU Campus, Famagusta, North Cyprus. The results were discussed and possible solutions for the case and recommendations for future projects are provided.

Keywords: Office Building, Facade Design, Facade Performance, User Satisfaction, Post Occupancy Evaluation.

ÖZ

Yapı inşaat sektörü önemli ölçüde gelişiyor ve bu gelişmeler, tasarım ve yapım süresini kısaltıyor. Kullanıcı memnuniyeti ve geri bildirimleri elde etmenin gerekliliği, geçmişe oranla daha önemli hale geldi. Yapının en önemli bölümlerinden biri cephedir. Cephe tasarımı ve performansı, iç mekanlarda kullanıcı memnuniyetini sağlamakta büyük bir role sahiptir. Dış cephe; gizlilik seviyesi, hava kalitesi, termal konfor ve doğal aydınlatma gibi iç mekan çevre kalitesinin farklı yönlerini dengelemede büyük bir role sahiptir. Çevresel faktörlerin göz önüne alınması ile tasarlanan cepheler, bina kullanıcıları için yüksek memnuniyet ve rahatlık sağlamak için umut verebilir. Sonuç olarak, cephe tasarım süreci, kullanıcı memnuniyeti ve ihtiyacını dikkate alarak tasarlanmalı ve inşa edilmelidir.

Kullanıcı memnuniyetini anlamak ve geri bildirim toplamak için, kullanım sonrası değerlendirme (KSD) yöntemi geliştirilmiştir. Binanın tasarım başarısını ve kullanım sonrası performansı değerlendirmek için önemli bir yöntemdir. Binanın çeşitli kısımlarını kullanıcı memnuniyeti açısından incelemek için, çeşitli binalara farklı KSD türleri uygulanmıştır, fakat kullanıcı memnuniyeti icin cephe tasarımı ve performansı ile ilgili uygulanan az sayıda KSD örneği vardır.

Bu çalışma, seçilen ofis binasının cephe tasarımını ve performansını Belirleyici Düzeyde KSD yöntemi ile değerlendirmeye odaklanmıştır. Kullanıcı anketi ve gözlem yöntemleri ile bilgiler toplanmıştır. Çalışma, , DAÜ Kampüsü, Gazimağusa, Kuzey Kıbrıs'ta yer alan Mimarlik Fakültesi Ofis Binası'nı ele almıştır. Sonuçlar değerlendirilip, bina için olası çözümler ve gelecekteki projeler için öneriler sağlanmıştır.

Anahtar Kelimeler: Ofis Binası, Cephe Tasarımı, Cephe Performansı, Kullanıcı Memnuniyeti, Kullanım Sonrası Değerlendirme.

DEDICATION

To My Family

Metin Sürme & Nuran Akın Sürme,

Yağmur Anıl Sürme

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PREFACE

"I believe that the way people live
can be directed a little by architecture."
(Tadao Ando)

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LIST OF SYMBOLS AND ABBREVIATIONS

(%)	Percent
24/7	24 hours a day, 7 days a week
ASHRAE	The American Society of Heating, Refrigerating and Air Conditioning Engineers
HEFCE	Higher Education Funding Council for England
HVAC	Heating, Ventilation, and Air Conditioning
LEED	Leadership in Energy and Environmental Design
POE	Post Occupancy Evaluation
SPSS	Statistical Package for the Social Sciences

Chapter 1

INTRODUCTION

1.1 Significance of the Study

Building facades are acting as a face of buildings and they are the public skin of architecture. It is the exterior face of a building that provides comfortable enclosure (Knaack et al., 2007). It can be called as the most important piece of building's image that shapes the building identity. In other words, building facades are the physical evidence for the aesthetic evolution of the city and also effective aspects of architectural transformation (Elshahed, 2007).

Facade technology can play a big role in balancing different aspects of indoor environment quality such as view to outdoor, privacy level, air quality, thermal comfort, and natural lighting (Schumacher et al, 2010). Facades that designed according to contextual features can promise for achieving high satisfaction and comfort for building occupants. Consequently, it is important to take into account in designing facade and developing according to occupant needs. User satisfaction and interaction are the two main factors that cannot be neglected when developing facade design and constructing according to the project (Cole and Brown, 2009). Quick developments in design technology, within innovative facade systems, have given numerous possibilities for architects and engineers for achieving high levels of building energy performance without considering as no importance to their general stylish appearance. Even so, design of building (together with building skin design)

and user satisfaction and interaction with the indoor space, are sometimes considered as detached aspects of the building procurement process. One of the consequence is that some new buildings are finally charged with performing poorly in meeting user needs and environmental performance, as opposed to desires (Anderson, 2015). Consequently, the necessity to check the performance in practice of new building parts and innovative design strategies, considering also users' satisfaction, is increasingly encouraged (Cole and Brown, 2009).

Post-occupancy evaluation (POE) is a process of systematically assessing the performance of buildings from the point of the view of the people who control and inhabit them. POEs have the potential to lead to a better understanding of how feedback loops in the building design process can be completed in order to enhance continuous improvement in building design and construction and support occupant's satisfaction towards the built environment. POEs permit featuring, in addition to other things, the interaction between various environmental factors, the building design, and the user's general satisfaction, encompassing physical and psychological aspects (Anderson, 2015).

In this respect, the user's feedbacks takes an important role during the design process. POE is a great method to collect user's thoughts-observations to transferring to the next projects design process and even creating possible solutions for renovation. Especially, facade design and its performance is the key part of the building that effects user's comfort at indoor space. As a result of this, the importance of user's feedbacks with POE method and its benefits for facade design is underlined and analyzed for better design solutions in this research and the study is supported with a case study.

1.2 Problem Statement

Considering the overview of literature, user needs changes according to personality, culture and contextual factors of the working environment. There may not be defined clear standards for supporting the design of building facades in terms of user satisfaction, and there are many kinds of research are going on for it to find the better interaction between facade design and users of the building in order to achieve high user satisfaction. In general, evaluating the users feedbacks about design is a useful way to understand needs of people in a space. There are previously done examples of this kind of evaluations but they are not mainly focusing or used often on facade design and its performance. Facade design can be improved with the help of user satisfaction evaluation in order to achieve maximum thermal comfort for a better working environment at indoor space. The application of these evaluations will be better to increase for facade as well. Otherwise, lack of knowledge may limit the development of facade design for the next generations of our world.

1.3 Aim and Objectives of Research

This study aims to evaluate a user's comfort and satisfaction levels and perceived productivity in relation to facade design of office building. The objective is to identify possible relationships between the facade design characteristics within its performance, and the overall satisfaction with the work environment of users in terms of facade design and performance factor. In order to achieve the aim of the research, a post-occupancy evaluation(POE) for user satisfaction was carried out in a selected building (case study).

Following actions will be carried out for the evaluation;

- Collecting data for classification of selected building's facade and finding proper standards of facade design for achieving high user's satisfaction in their working environment and setting the limitation of a building.
- Setting up and conducting the questionnaire and doing observation in a building.
- Data analysis and recommendations for finding better design approaches and possible solutions for problems in the facade design of the case study and recommendations for next projects.

1.4 Research Scope and Limitation

The limitation of this research is to make Post-Occupancy Evaluation on user`s comfort and satisfaction levels and perceived productivity in relation to facade design and its performance in the Office Building of the Faculty of Architecture at Eastern Mediterranean University, Famagusta, North Cyprus. Since the case study building is located in a mediterranean area, the study will be focused on facade design and its performance in mediterranean areas within thermal comfort factors.

In order to know how the facade performs well for achieving better results regarding user satisfaction, firstly, it is essential to analyze the literature and discuss the design characteristics of facades through the user's observations and feedbacks. Finally, the possible solutions for the case study building and recommendations for the next projects will be discussed.

1.5 Research Methodology

The methodology of the research is which was used in the previous literature is the combination of theoretical issues with empirical assessment in collecting data. In the theoretical part, data will be entirely collected from books, articles, scientific journals and previous researches regarding the specific topic. After the data collection process, evaluation of the data took place to find out the building's facade design problems in office buildings where the hot climate conditions exist. The POE questionnaires was carried out with staff who work in Office Building of Faculty of Architecture. The criteria for the selection of the case study is to be evaluated in terms of its function, location, a number of users and as well as working units (offices) through facade design features. Obtained background data from the theoretical part will be used for evaluating the case study through questionnaire and observation. Statistical Package for the Social Sciences (SPSS), is used for analyzing the questionnaire results and these results are added as a graphs into case study chapter.

1.6 Structure of the Thesis

This study contains five chapters; the first chapter presents, the significance of the study, problem statement, aim and objectives of research, research scope and limitation, research methodology and structure of the thesis.

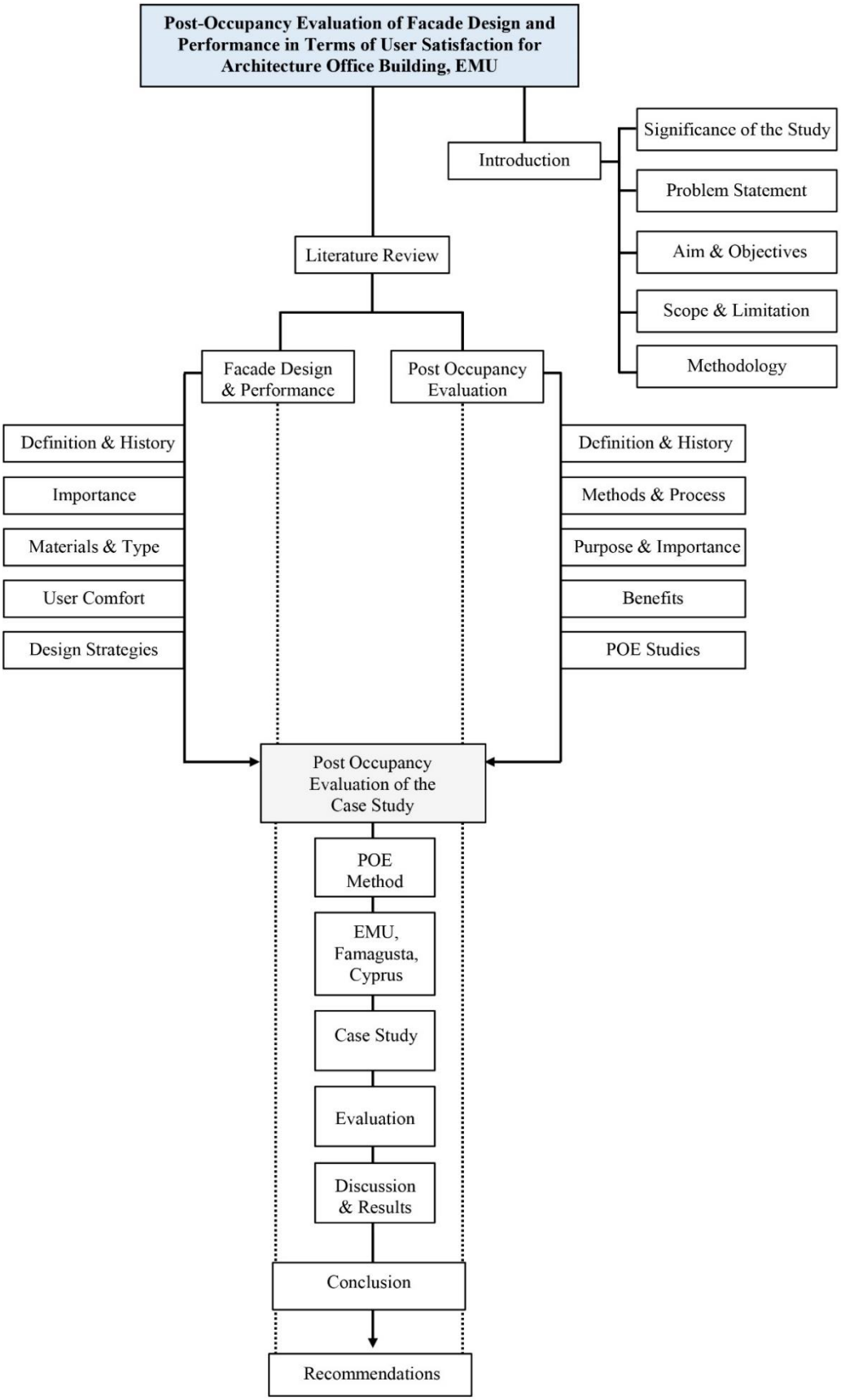
In the second chapter, the literature review that is related to the selected subject was gathered, and a general view was given to understand facade design and performance in buildings with regard to user satisfaction and thermal comfort. Underlining some factors which affect the thermal comfort in a building, also facade design strategies are explained.

The third chapter, giving deep information about Post Occupancy Evaluation Method and previously done related case studies as an example.

In the fourth chapter, Office Building of Faculty of Architecture as the case study was evaluated regarding its facade design and its performance in terms of user satisfaction by POE method. The results are discussed and recommendations are given.

The fifth chapter is a conclusion, summarizing the findings in the literature review and the evaluation result. The achieved data furthermore suggest some solutions for the case, future researches and next facade design projects within user satisfaction.

Table 1: Structure of the Thesis



Chapter 2

FACADE DESIGN AND PERFORMANCE

This chapter is allocated to the definition and history of facade and facade types. The section also explains the importance of facade design on buildings, effects of the facade types and thermal comfort factors on users.

2.1 Definition and History of Facade

It is necessary to explain the facade's history to analyze its functionality and importance in a building. Firstly, explaining the meaning of a term is better before going to the deep description. The originality of term is from Italian language called "Faccia" which means face. The word also used for describing the outdoor sides of buildings in general, but it is not only the front side (UrL 1). There are many ongoing researches that analyzing building facade and envelope where various terms are defined the exterior parts of a building. The building facade is a surface that protects the interior space which conditioned thermally, from an outdoor environment (Kelbaugh, 1990).

The history of building facade is important to be mentioned firstly, for describing the details of a facade design. The facade is a part of the building which can't exist without it. In history, buildings constructed with light and simple materials where people can find in nature. This has effects on the facade design as well.

Functionality was the first step to take into before form and style. By the time, innovation of materials created a different look to the buildings and facade design introduced in architecture. Within this journey of developments and innovations, it can be easily observed that facade design is very important in our modern era. The below pictures shows various examples from history (Figure 1).

Figure 1: Different Facade Materials in History
(UrL 2)

2.2 Importance of Facade Design

Facade takes an important part for aesthetic and performance of a building. It cannot be separated from the rest of the building components. The role of facade design is important for constructors, clients, firms and all users in a manner of presentation. A buildings' image and the way of an organization representing the professionalism and the effort that spent it on achieving good values. Facade must be done in the right way to prevent natural forces such as high-low temperature, strong winds, and gravity on a building. Temperature is created by outdoor (high-low temperature, strong winds, and solar radiation) and indoor factors such as building's user activities and mechanical heating and ventilation systems. These forces should be resisted in order to achieve indoor comfort for users. Another role of the facade is protection, from unclear situations when security and privacy have taken a big priority in the century.

It is an important need to be specialized in the design process and elements of facades to have high varieties in terms of functionality. This is the reason why facade design and climate conditions took a important part during the planning time, and as well as facade performance (Billow, 2012).

2.3 Materials and Types of Facade

Facade design and their construction of the modern world are the achievements of developments in an industry and design process, it can be related to the history as well like earlier houses. Natural local materials such as wood and stone were the main elements of the wall construction when the facade was simply done with very small openings on the wall and roof. By the developments, a function of openings took a new role such as natural lighting. An innovation of glass material in a building construction, people started to use the glass to fill the openings. An advantage of the material discovered because it helps users to see out and let the light to get in. During the time, window technology improved and different type of windows such as box type, double glazing type which increased the thermal comfort within two glass and air gap between the frame, started to be used (Figure 2). Now the glass is ordinary material for the building facade (Oesterle et al, 2001).

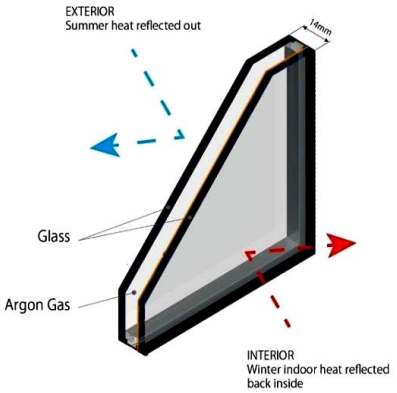


Figure 2: Double Glazed Window
(Knaack et al., 2007)

The effect is different in winter and in summer, but the person who seats close to the window will be more uncomfortable in both season. The window surface temperature is high compared to rest of the indoor space surfaces in the summer season and oppositely, the window surface is colder than other surfaces in indoor space during the winter season.

Facade should be designed in a way to answer the standards and cannot be done without considering the climate conditions. The conditions changes in different regions but insulation is important to protect users from high-low temperature (heat and airflow), natural light, all types of radiation, noise, non-privacy conditions and safety. The complexity of facade design increased with innovations and developments. The result of these innovations is very different from before. Kinetic, Intelligent, Smart, Moveable and Responsive Facade are the new terms in facade technology. All these facade types are done to have high user satisfaction in terms of thermal comfort at indoor space (Knaack et al., 2007).

Natural ventilation, noise cancellation, high benefits of natural lighting and sunlight control are main factors to apply the double skin facade system on a building. A double skin facade system is becoming more popular and increasing the performance of a building within the application of modern technology.

2.3.1 Double Skin Facade and Types

The office buildings are one of the most important spaces where user's comfort must be considered carefully within the less energy consumption such as using mechanical cooling and heating system. Designers prefer to use double skin facades for office buildings which can have a high level of natural light. Simply, the system is a combination of two glass surface that is placed at outside and inside of a building. It works as envelope and two glass surfaces are filled with an air gap also known as air space. The glass which placed outside is strong to have durability for natural forces and, the glass which is inside working as insulation material. The gap between them can be according to design and as well as requirement. This gap must be ventilated for keeping the air temperature at a comfort level. A ventilation can be mechanically or even naturally. The working process is simple, air should be heated during the winter season and, in the summer season, air should be cooled by the ventilation system. Applying this process will keep the air temperature in comfort level for users but if the air is not ventilated (during summer) in minimum requirements then heat will increase and indoor space will be overheated (Harris, 2006). The efficiency of the system is mainly depending on these aspects;

- Insulation Type
- Orientation, Form and Location of Building
- The Proportion of Glass to Solid Elements
- Level of Opaque on Glass
- Building Function and Usage
- Design of Shading Devices
- Solar Systems (Active–Passive)

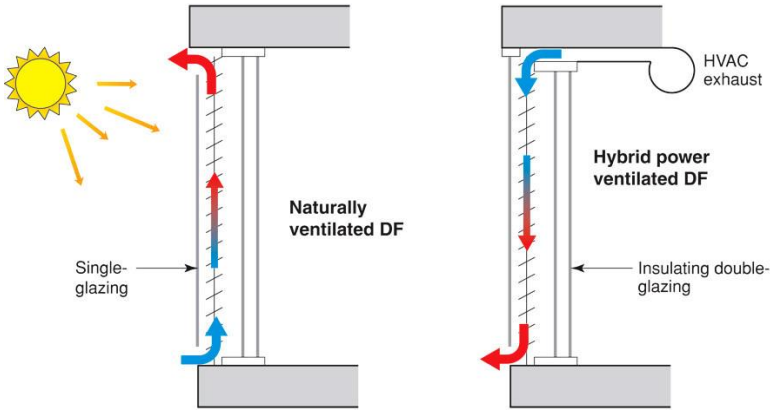


Figure 3: Diagram of Double Skin Facade Working Process
(Straube, 2007)

The system can be applied to all facades or even only on facade according to the needs of the design. These needs can be a direction of the strong wind, a height of the elevation, noise level, and economic reasons. “Double Skin Facade” as a term is divided to different sub-categories such as the design of geometry, preferred glass type, a direction of air move but all these sub-categories are collected under four main categories in a double skin facade system. These are Box-Window Facade, Shaft Box Facade, Corridor Type Facade and Multi-Storey Facade (Straube, 2007).

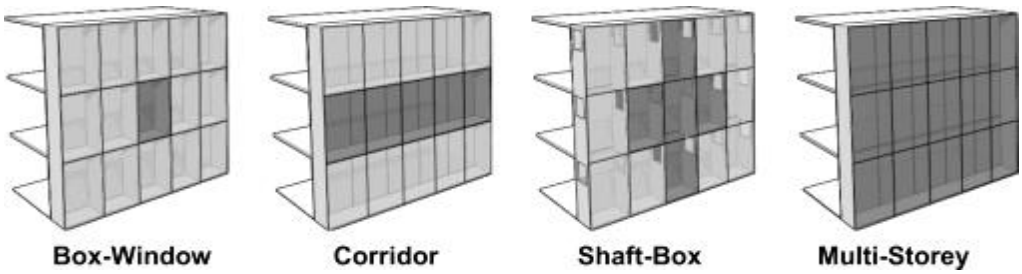


Figure 4: The Four Types of Double Skin Facade
(Straube, 2007)

2.3.1.1 Box Window Facade

The concept of a system is similar to box window but there are facade components for high story buildings. The windows which placed inside are openable for natural ventilation. It opens to air space that is between two layers of the system. The outside facade has openings as well and, it works for having fresh air and exhausting the current one in the gap. There are elements as dividers help to reduce noise from outdoor and between floors. In 1999, architect Kolhoff H designed Mercedes-Benz Office Building in Germany with using box window facade system (Knaack et al., 2007).

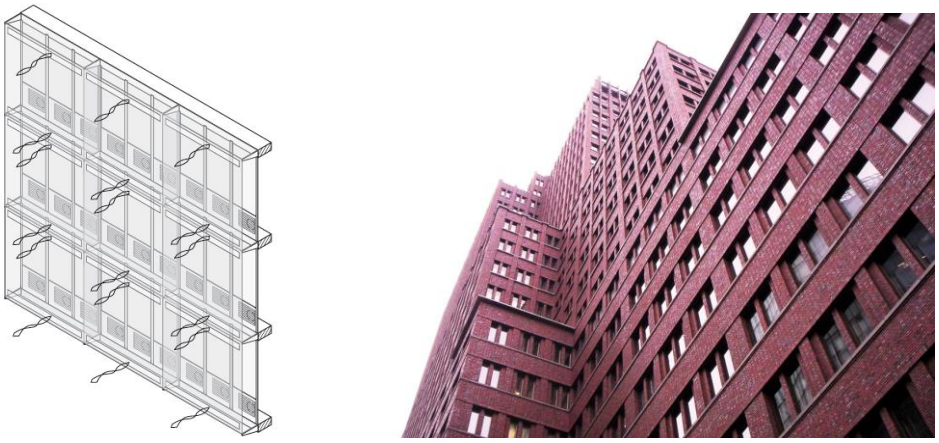


Figure 5: Box Window Facade and Mercedes-Benz Office Building (Knaack et al., 2007)

2.3.1.2 Shaft Box Window Facade

The application principle is coming from box window facade. There is a shaft which goes through many floors in a building. Each vertical shafts are attached to box windows on each floor. The air in a window is exhausted with stack effect to these shafts and it moves until the top. This can be done by the mechanical system as well but because of the need for high power and cost, it is uneconomical (Oesterle et al, 2001). Small openings are placed on the outer skin to have sound insulation which is standard. Buildings with shaft box window facade are generally located in thunderous areas where noise insulation should be considered at indoor space (Harris, 2006).

Figure 6: Shaft Box Window Facade
(Schulze, Eicker, 2013)

2.3.1.3 Corridor Type Facade

The system has a wide gap called corridor between two layers of the facade. It is repeating at each floor and separation is done by horizontal elements. Small openings are located at ceiling and slab, hot air intake and exhausting cool air is done by the openings (Knaack et al., 2007). Generally, designers prefer to use corridor type facade in public buildings which are in need of good ventilation and noise cancellation. Early examples of the system had timber elements, now it is common to use more economical materials such as aluminum.

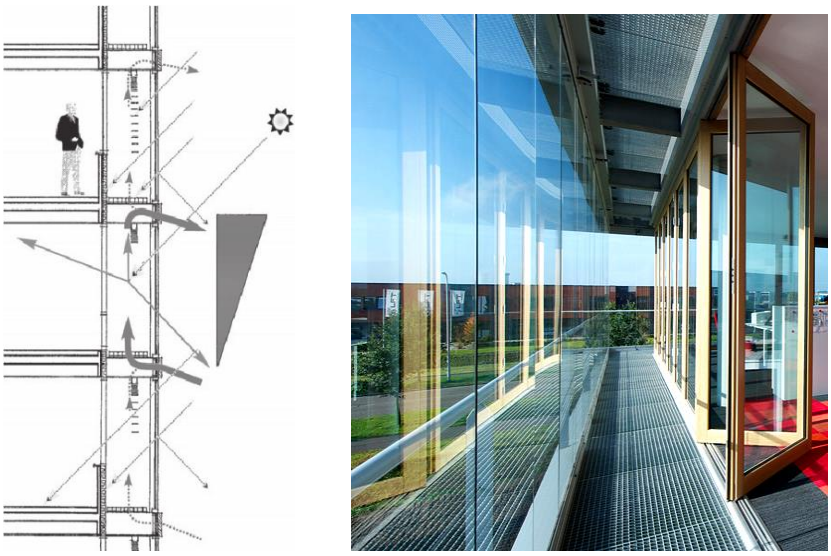


Figure 7: Corridor Type Facade
(UrL 3)

2.3.1.4 Multi Story Type Facade

The space at the middle is connected in a horizontal and vertical way with many rooms and, a cavity is not divided. The cavity (air gap) is extending to all over the building skin. The system has openings at roof and ground level for ventilation. Occupants have interaction with the system such as closing the openings when they need to heat the building and also cancellation the outdoor noise. Generally, multi-story facade system is used for building with less number of floors. The mechanical system is needs to ventilate the spaced behind facade, and common air-duct is used later.

In order to get maximum performance of the system, a chimney can be connected to the facade system. This will accelerate the air move from a cavity and indoor spaces and just the opposite way (Schulze, Eicker, 2013).

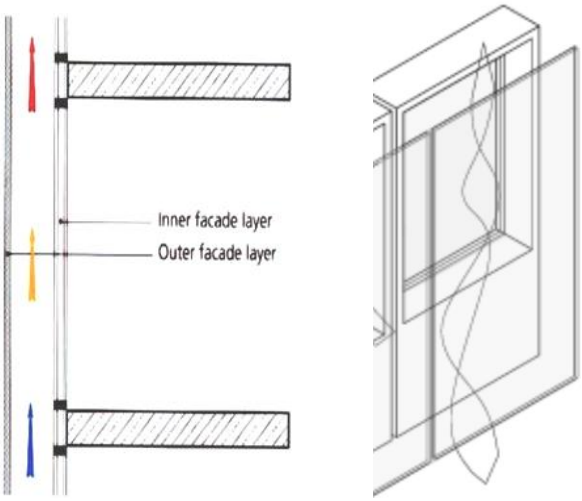


Figure 8: Multi Storey Facade
(Oesterle et al, 2001)

Double skin facade has many advantages but also some disadvantages. The advantages of the double skin facade system;

- Quality of ventilation
- Less depending on mechanical ventilation systems
- Creating a thermal comfort at indoor
- Noise cancellation
- An aesthetical appearance of a building
- High visual connection with outdoor

Disadvantages of the double skin facade system;

- Protection of fire problem
- Loss of space such as wide air gap in corridor facade type
- Sound insulation problem – in a case of wrong application or use of wrong materials
- Indoor heating – in case of not enough air circulation or non-ventilated application

2.4 User Comfort and Satisfaction

Users's comfort in a building depends on the numerous controls on different conditions that are assembled among them and their indoor spaces (Nicol and Humphreys, 2002). The comfort zone as a term is defined as indicating of the right atmosphere in physical, physiological and mental estimations. In another definition, the comfort zone of users is the physical, physiological or mental capacity to control the different conditions in a given environment.

In a building, there are many factors that effect the users's comfort. One of the research says that the design characteristics of buildings, the personal characteristics of users, and outdoor climate conditions shows a great effect on comfort quality related to the primary conditions of indoor area as thermal, visual, and acoustic, especially in indoor spaces (Nicol and Humphreys, 2002).

In general, these factors are classified under three main areas. According to the reviewed literatures, these factors are; thermal factors, pointing the temperature appeals in physical and personal spheres; visual factors, acoustic factor, consisting of sound waves at the environment around them.

2.4.1 Thermal Comfort

The definition of thermal comfort is defined by The American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE); it is the reactions of users which appears for a low and high temperature in a space. In another definition, thermal comfort is defined as current response of user's mind in a relation with environmental thermal conditions. The response can change from one to another user because it is depending on perception and user experience which can be different at the same space (ASHRAE, 2004). Thermal comfort cannot answer to each user needs, because of this, ASHRAE organization standards are answering most of the people's needs for achieving thermally comfort buildings. In general, four main factors (air movement, mean radiant temperature, humidity, and temperature of the air) effecting to thermal comfort as physical factors, and three personal factors (body activity, metabolism, clothes). There are many other factors as well; age, gender, an adaptation of user, and current season of the year.

Each factor can be checked separately and occupants' body will react to these factors as one. If the design of a building can balance the factors, the level of comfort will be fine for users.

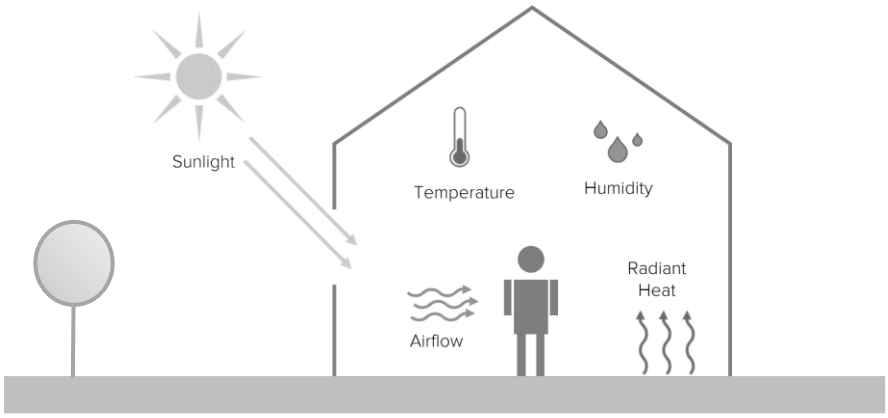


Figure 9: Physical Factors of Thermal Comfort
(Diagram drawn by the author, 2018)

The physical factors can be seen in all climatic zones but the values for thermal comfort will change in different climate zones. In winter and summer seasons, indoor thermal comfort conditions are not different for occupants' comfort but it may change in a day. Human body temperature is low at morning and high at afternoon. As a result of this, it is not possible to keep the values same for each occupant but average must be applied to achieve user satisfaction. A temperature in comfort values and enough ventilation is necessary subjects in office buildings to have high productive, healthy and thermally comforted occupants.

The requirements of successfully designed and achieving thermal comfort are worries of designers and as well as users. It is easy to understand that a person who is sitting for a long time need a higher temperature compared to the one in an activity at indoor space.

The coldness causes non-comfortable indoor space, and some health problems such as pain in muscles, headache, loss of attention and trembling. All these problems will decrease the satisfaction of users (Aksamija, 2013).

In the summer season, high level of solar heat gain will affect the occupants' comfort at indoor space, therefore this problem must be thought as an important reason to have thermal comfort circumstances with well-enough air circulation in spaces. Three problems should be considered as main effects which decrease the thermal comfort in countries with hot climate type. These are; high heat gains during summer season, high heat loss during the winter season, and high-relative level of humidity (Nicol, Humphreys, & Roaf, 2012).

The use of energy is high in buildings where they are located in hot climate areas. In order to provide a thermal comfort, used energy will have cause an uneconomical situation because the mechanical systems will always try to prevent against the effects.

2.4.2 Visual Comfort

There is not just one totally accepted explanation of visual comfort. There are various definitions developed based on the factors that are focused on. In general, visual comfort is specially aimed to be defined as a condition, which is revealed depended on various factors such as the amount, direction and degree of the light as well as the balance of contrasts, the absence and existence of glare and the temperature of applied color in a space. Since the visual comfort is the consequence of different complex but integrated factors that work together in many ways, different environmental contexts involve with different factors (Lemon, 2015). Actually, these factors are not stable. They all appear in different forms or taking role according to the distinctive characteristics of environments.

2.4.3 Acoustic Comfort

The sound can be defined as the vibrated pieces in waves that can be spread towards to different directions in environment by leaving a pattern of density. In different definition, the sound can be illuminated as the energy that is accomplished by pressured waves into the space with the aid of pressure of the air in the natural environment. Since, the sound is one of the important factors effecting to the comfort quality for the users. It holds an integrated relationship with the other comfort factors (thermal and visual conditions) for improving the comfort quality of indoor environment as well (GSA, 2012). Significantly, the users could indicate a unsatisfaction in terms of sound depended on the amount of noise at outside or spaces, or the quality of sound control at indoor area etc. In such a context, the effect of sound on users' comfort experience is indented to be understood.

2.4.4 Indoor Air Quality

According to ASHRAE standards, the air quality of indoor spaces should be accepted by a minimum 80% of building users (ASHRAE, 2007). It shoul not contain any detrimental element. Indoor air quality is an important factor for users' health and part of a sustainable design Low air quality may contain a high level of carbon dioxide, bacteria, and air pollutants. All these can cause health problems and reduce user satisfaction in a building. The air quality based on the mechanical ventilation system, materials used in space, facade design and occupants' activities (Vural, 2011).

Facade should let fresh air to come into building with proper and controlled systems. Mechanical ventilation should be maintained and cleaned regularly. Sustainable materials should be preferred and applied carefully.

2.5 Design Strategies for User Satisfaction

Generally, warm air goes up to take a place of cool air, this movement creates a wind. This movement can be changed to a design solution to increase the level of air quality and comfort at indoor, which can decrease the use of mechanical energy. The strategy is called “Natural Ventilation”, and it is depending on natural wind. Indoor spaces always have an air transfer with outdoor, this caused by a different level of temperature and wind among inside and outside of a building skin. Passive natural cooling creates power through the use of outdoor air move, cooling it and ventilating the indoor space, with no use of any mechanically powered structure. These cooling types are generally applied to the design of modern buildings, and even for old buildings which have designed by same guidelines. Buildings should have designed in a way to get winds when a temperature is high and affecting occupants’ comfort in hot climates areas (Nicol, Humphreys, & Roaf, 2012).

Building’s windows can be controlled by users for having fresh air into space, this is simply can be adjusted by opening and closing the openable part of a window frame. Ventilation should not cause a non-comfortable time and design is important to give an advantage of good air quality with ventilation process which can be controlled by users. For designers, depending on a mechanical system is an easy solution but to use natural ventilation is an important issue in hot climate areas. The conservation of energy is possible by natural ventilation, the wind will help to decrease the temperature on facade and this will help to mechanical systems to work less. The level of humidity can be decreased by vaporization, and outdoor air will be cooler then it will have transferred to indoor for increasing the air quality. This process is a well-known solution to decrease humidity and temperature in areas with hot climate. Passive Stack

Effect and Cross Ventilation design strategies are important to be considered to achieve thermal comfort.

Facades have two main roles; they are the most important parts of the building which protects indoor spaces outdoor environment, and their second role is a presentation of a building to the environment. It is called the buildings' image. Well-designed facades are not only the walls which work as barriers, but they are also holding a responsibility to give occupants a comfortable space. As a result, facades should be designed carefully to respond to external factors and decrease the cost of mechanical systems (Aksamija, 2013).

2.5.1 Building Orientation

Building orientation is important to have advantages of natural factors at a maximum level, and disadvantages in minimum level. A south facade of the building should be protected from high heat gain with proper design solutions.

When solar heat gain for passive heating is an important factor, some other considerations include noise, day-lighting, protection from prevailing winds, having breezes for ventilation, shading for overheating and glare, views, privacy, indoor/outdoor flow, users' preferences, and planning restrictions. Where passive cooling is more important than passive heating, the building should be oriented to have an advantage of prevailing breezes.

Orientation, location, and layout should be considered from the first step of the design process – ideally, from the time the site is being selected. Once a building has been completed, it is difficult and expensive to re-orient later (UrL 4).

2.5.2 Building Height

In order to use natural wind movement, building height should be considered and the direction of the building should be faced in a direction of the right wind to achieve naturally ventilated spaces in terms of needs and design (Fordham, 2001).

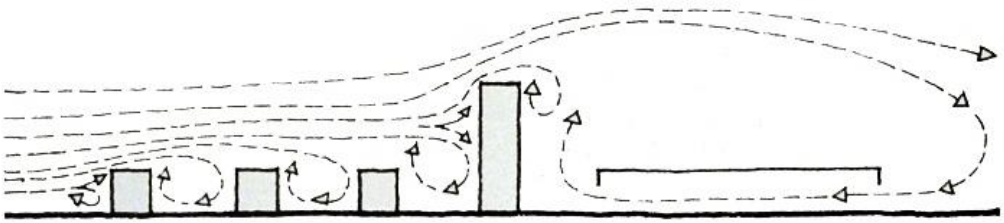


Figure 10: Diagram of Buildings Height and Wind Relation
(Modified from Fordham, 2001)

2.5.3 Building Form and Natural Shading

Plan organization and form-mass of the building have held important places while designing in a hot climate. Building form should be considered from the first step of the design process in order to decrease energy consumption in terms of achieving thermal comfort. Having trees on site should be used carefully, benefits of natural shading has more advantages than using shading elements on a facade. Selected case study, has surrounded by large trees. The trees working as a barrier for wind and sunlight and reducing the energy consumption of a building. Locating the trees on right places can help to achieve around %50 of less energy consumption (Fordham, 2001). There is an example of how trees can be placed in a hot climate (Figure 11).

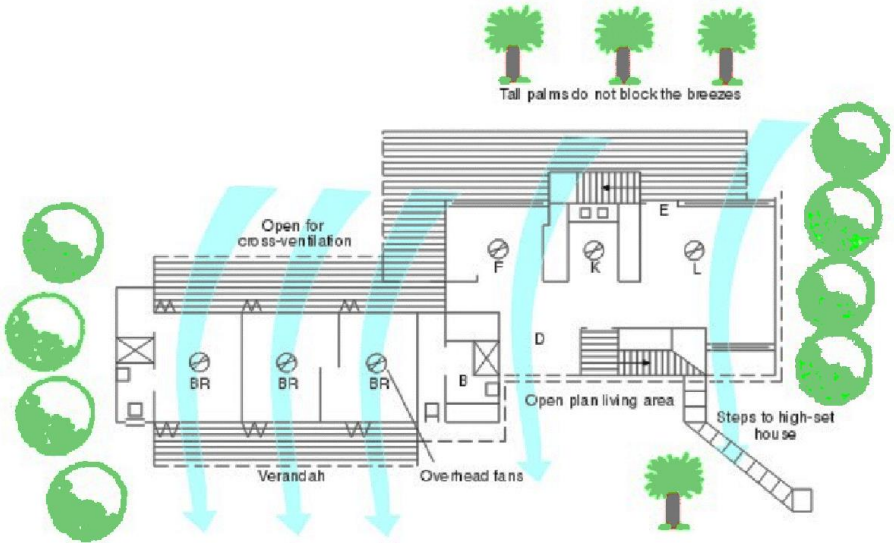


Figure 11: Example of Building Plan in Hot Climate
(Modified from UrL 4)

2.5.4 Consideration of the Wind

It is one of the most important factors that influences thermal comfort. The wind control cannot be forgotten during a design process. An effect of the wind is directly on building skin and decreases the temperature on the surface. Wind direction and potential harms must be evaluated while designing our buildings. Because of the selected case study is located in Famagusta, North Cyprus, it is better to explain an effect of wind in hot climate area.

During the day, land is collecting the solar energy and temperature is getting higher compared to the sea. The heat transferred to air on the land, this reducing the density in the air. Therefore, wind moves from sea to land direction and this movement is replacing the hot air with colder one (Nicol, Humphreys, & Roaf, 2012).

During the night, land is losing the energy and temperature decreasing and but a temperature of the sea stays higher compared to the land. As a result of this, because

of the low density in air, the air on the sea moves up and cold air moves to the sea as a continuous circulation. Therefore, wind moves from land to sea direction (Nicol, Humphreys, & Roaf, 2012).

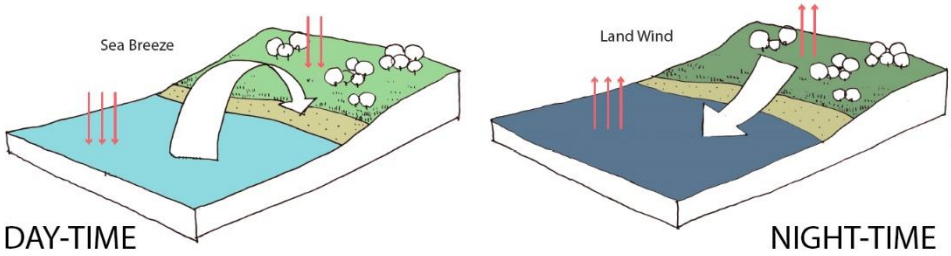


Figure 12: Coastal Winds in Day & Night Time
(Modified from UrL 4)

2.5.5 Openings

Among all the facade components, windows take an important role for thermal comfort. The window and wall ratio in between is important, the facade with more windows tends to affect the users' thermal comfort compare to the ones with low windows to wall ratio. The effect will be higher as much as occupants' seats near to the window. In a seated position, an occupant who seats near to the window tends to be more uncomfortable compared to the one who seats away from the window. The acceptable windows to wall ratio should be depended on building floor plan (design, space relations, orientation) and user profile. A low ratio is needed for south oriented buildings where users prefer to seat near to the window. In office buildings facade ratio should not be more than 40% and less than 25%, this is an ideal ratio where users prefer to seat close to a window (Aksamija, 2013). The windows ratio cannot be totally depended on designer, the regulations and standards are affecting as well.

Facades may create unwanted air move in two type; one of them is a movement of air caused by cold window surface and another one is air movement from the gaps of the outer skin of a building. The effect of air movement can be reduced by proper design and materials of glazing for the openings.

Generally, architects and engineers have some solutions for windows to achieve a high level of thermal comfort for building's users. These are;

- Calculating the right ratio of window to wall, which can change according to the building. For example; sometimes it is a good option to apply more openings and transparency to have more natural light, and sometimes it must be done oppositely to have good insulated indoor space.
- Manufacturing the windows frame as much as tight against to air movement by filling all gaps on the exterior surface.
- Glazing material strategy for applying the one has high performance in terms of heat gain and insulation.

2.5.6 Passive Stack Ventilation

The roof or high level of a building has openings to transfer hot air outside, this based on an idea of the warmed air will move to the up direction by itself. Following the transfer of hot air, a fresh air will be moved in from openings that located on facades. This will be done by benefits of stack effect and power of the wind. Having chimney or opening on top of a gallery(void) in design is a good solution to achieve passive stack ventilation. It can be controlled by users whenever is needed.

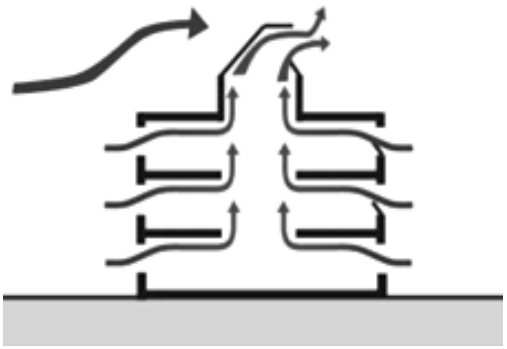


Figure 13: Stack Effect in Building
(Diagram drawn by the author, 2018)

2.5.7 Cross Ventilation

Space should have openings to outside on two facades as a minimum to achieve cross ventilation. A fresh air will pass through space and will renew the air inside. This can be described as using the power of wind from one direction to another. Designers prefer to locate small openings to get wind and larger ones to transfer out.

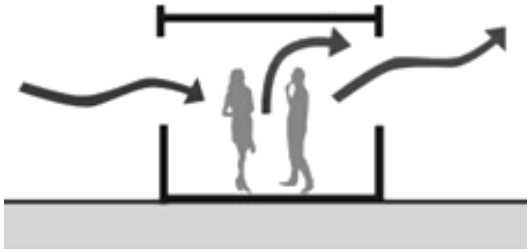


Figure 14: Cross Ventilation in Room
(Diagram drawn by the author, 2018)

2.5.8 Daylighting and Glare

Natural lighting is an important factor to be considered for low energy consumption. It is helping users to do not depend on artificial lights during the daytime. Artificial lighting elements create heat as well, but using natural lighting strategy will reduce the used power by a mechanical cooling system. Studies are good examples to explain the advantages of day-light; these advantages are not limited by only energy factors. They are also good for occupants' psychology by giving a positive effect, with the help of

positivity, satisfied and more productive occupants can be observed in buildings. Especially, in office buildings, the benefits of natural lighting are higher. In terms of being healthy, productive and with the help of these benefits; occupants will be less absent at their work. In another research has shown that well-designed educational buildings will help occupants to be more successful in their academic life and missing the classes will be more much less (Edwards and Torcellini, 2002).

Architects should pay attention to the need for a natural lighting design with different factors. The aim of the natural lighting design will be better to be integrated with a view to outdoor, level of privacy, energy consumption and other factors. Building form and facade design are two main trumps on designer's hand to achieve natural lighting with the control of environmental conditions.

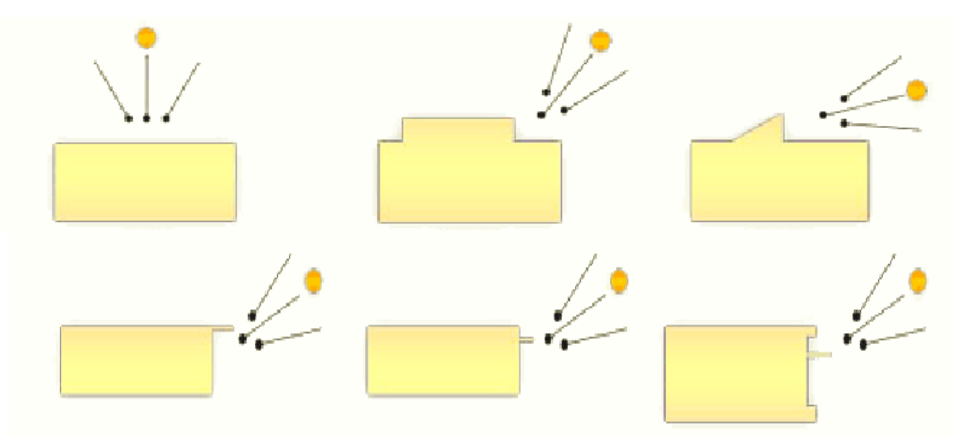


Figure 15: Daylighting Strategies
(Modified from Edwards and Torcellini, 2002)

The glare can have some effects on the users and these are classified in two. The first one is glare disability, this happens during the light interfere with the visual tasks because of the visibility reduction. The second one is the glare discomfort, which the light- effect is not necessarily interfere the visual performance but the light received

by the eyes is considered higher than the normal standards which produce a long-term consequence (Edwards and Torcellini, 2002). In order to control the glare effect; a size of windows, translucent glass material and controlling the natural light are some factors to be considered.

2.5.9 Shading Element

Shading is required both during the overheated time and even when conditions are comfortable. The reason for that if a solar gain is permitted during comfortable periods the excess heat thus gained can cause hot discomfort. Thus the lower limit of comfort is used to establish when shading should start. There are four steps to follow during the design of shading devices; Step 1 is to understand when shading is needed, what hours of the day and which days of the year. This can be understood by studying the underheated and overheated periods. Step 2 is the position of the sun at the times when shading is needed must be established. This is generally achieved with the aid of a sun-path diagram. Step 3 is the dimensions and proportions of the shading device that will provide shading during the period earlier defined is found. This is achieved with the aid of a shadow angle protractor. Step 4 is the selection of prefabricated devices or the design of new ones (Lechner, 2015). The design of shading devices takes not only the required geometry into consideration but also aesthetic and structural factors.

According to the steps above, a shading device can be selected from three main types of shading devices. These are;

- Vertical Shading Devices is consist of pilasters, louver blades or projecting fins in a vertical position. Their performance is measured by the horizontal shadow angle. They are generally preferred for east and west elevations.

- Horizontal Shading Devices are usually in the form of canopies, long verandas, movable horizontal louvers or overhangs. They are best suited for south and north elevations. Their performance is measured by the vertical shadow angle.
- Egg Crate Devices are combinations of vertical and horizontal devices. They are usually in the form of grill blocks or decorative screens. Their performance is determined by both the horizontal and vertical shadow angles (Lechner, 2015).

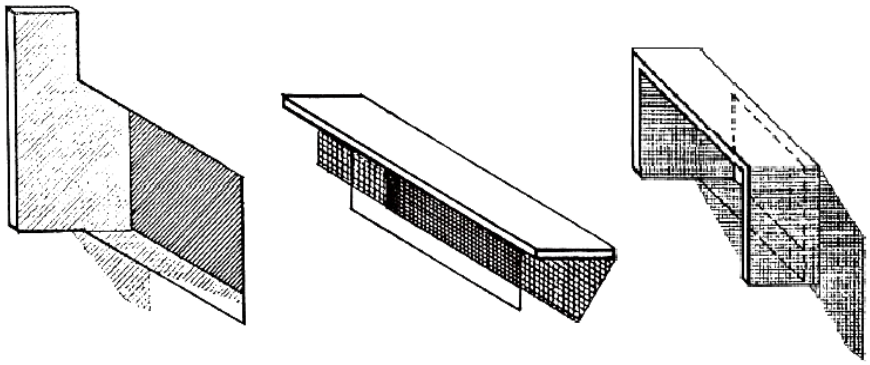


Figure 16: Shading Device Types
(Lechner, 2015)

Chapter 3

POST OCCUPANCY EVALUATION

3.1 Definition and History of Post Occupancy Evaluation

Post Occupancy Evaluation (POE) is the technique of assessing buildings within an organized and proper system after they have been built and used for a certain time. POE concentrate on building users and as well as their needs and therefore they give insights into the consequences of earlier design decisions and the resulting building performance. The information forms a base for making better buildings in the future.

Users informally evaluate aspects of building performance in everyday life. For example; in an office environment, it can be possible to hear the going on conservation from the next office room. In such a case, noise insulation and performance of acoustic will be evaluated in users' mind. Temperature, lighting type, furniture and overall quality of the offices are also discussed by occupants. All these evaluations are based on occupants' experiences and observation from various spaces (Preiser, Edward and Harvey, 1988).

There are many scholarly study which investigating the POE with the intention to analyze the contextual conundrums which have develop the culture of POE in last years. Analyzing the history of POE is important to understand the status of the topic with regards to worries in architecture, explaining a little tenuous relation.

In addition to the historical classification of the POE studies, the scope and the size of the project are carried out by (Preiser, Edward and Harvey, 1988) as follows:

- 1960s, Structural arrangements, Studies covering psychological elements,
- 1970s, The studies covering the sociological elements in the built environment, systematic-multi-method POE studies,
- 1980s, Organizational change, research on building diagnosis, POE applications in public and private sectors.

The POE method was first developed in the world between 1960-70 in the field of examined physical environment and human behavior (Bechtel and Churchman, 2002). The first important studies of POE were aimed at the observation of problems that were thought to belong to some of the structured environment in the 1960s, such as mental hospitals and prisons. In these researches, it was important to evaluate the health, safety, security and psychological effects of the environment on the user (Zeisel, 1995).

According to Cooper (2001), the basis of the POE studies was based on research on human behavior of interdisciplinary professional associations on the physical environment, which was formed by different professional groups. For example; founded in the United States in the 1960s, the Association for Environmental Design Research is an important organization that has underlined the emergence of the relationship between human behavior and design of a building.

In the 1980s, the POE was now clearly understood and its methods were discussed. During this period, with use of some terms; the language of the POE was settled and the network of relations between the practitioners and researchers was shaped, and

POE was used in buildings with large scale and even in multi-user environments besides only the buildings with one function. Therefore, it can be said that in the 1980s POE achieved important steps in the field of concepts, methods, strategies and practices. Compared to the earlier periods, the term “user data” changed to be called “values” in this period and this also change the content of method. The previously thought values have become the basic and concrete information that will work as literature for the designer before thinking the user's needs and client’s wish list (Preiser, 1994). In the 1990s, the POE approached developed and became the combination of technical, functional and user needs assessments. Therefore, from the 1980s to the 1990s, the POE began to add larger applications step by step.

POE studies, in both short and long time planning; has taken an important role in the design process, usage, and maintenance of the environment as well (Preiser, 1994). In recent years, building performance evaluation and occupant satisfaction assessment have become as routine in POE studies (Preiser and Vischer, 2005). However, even though POE is so informative and necessary, even professional firms cannot perform POE with enough number of projects.

The emergence of POE and the publication of evaluation studies are supported by those who support a serious design process of building in the field of architectural profession. These works have brought the next step to the idea of design needs and patterns in building design process. It was underlined that occupant needs should be evaluated in design projects. All these works have been the earlier studies for POE. First important studies on the historical development of POE are shown below (Table 2).

Table 2: Milestones in the Development of POE (Modified from Presier, Harvey and Edward, 1988)

YEAR	RESEARCHER	FUNCTION OF BUILDING THAT POE IS APPLIED	CONTRIBUTION
1967	Van Der Ryn and Silverstein	Dormitory	Environmental analysis concepts and methods
1969	Preiser	Dormitory	Correlation of subjective and objective performance measures
1971	Field	Hospital	Multimethod approach to data collection
1972	Markus and Others	Any Function	Cost based building performance evaluation model
1974	Becker	Social Housing	Cross sectional, comparative approach to data collection and analysis
1975	Francescato and Others	Social Housing	Evaluation models of resident satisfaction
1975	General Services Administration	Office	Office systems performance standards
1976	Army Corps of Engineers	Military Building	Design guide series with updatable, state of the art criteria
1976	Rabinowitz	School	Comprehensive full scale evaluation of technical functional factors
1979	Public Works Canada	Governmental	POE incorporated into project delivery system
1980	Daish and Others	Military Building	POE as routine staff activity in government building process
1981	Marans and Spreckelmeyer	Office	Evaluation model linking perceptual and objective attributes
1982	Parshall and Pena	Any Function	Simplified and standardized evaluation methodology
1983	Orbit I.	Office	Office research linking buildings and information technology
1984	Brill and Others	Office	Linking worker productivity and office design
1985	White	Any Function	Linking programming and POE in graduate architectural education
1986	Kantrowitz and Others	Arch. School	POE analysis of entire building process and documentation
1986	Preiser and Pugh	Any Function	POE process model and levels of effort

More than 50,000 POE studies were done until the earlier of the 2000s (Bechtel and Churchman, 2002). Especially in the government buildings of US and Canada, efforts were made to include POE's studies in the production phase. In the 1980s, POE programs were developed for many government sections.

For example, in the United States; US General Services Administration, US Department of State, US Department of Commerce, US Postal Service, In Canada; such as Public Works Canada institutions gave support. In the USA in the 2000s, it is observed that POE studies are generally carried out by academicians and design students in universities as theoretical and pragmatic (Preiser, 2001).

Although Post Occupancy Evaluation studies provide endless benefits for designers and customers, POE is not a routine design-project phase, because of cost, required time and designer or client never wish to see their mistakes to be appear in their project.

3.2 Methods and Process of Post Occupancy Evaluation

A building can be assessed in different time intervals with organized way, it is based on the function and size of the building, the objectives of the owner and the levels of work for POE. According to the previously done studies and experiences of POE, the method shaped under the three section. As defined by Preiser; there are 3 levels of effort for POE: indicative, investigative and diagnostic. Each of these is composed of three phases: planning, conducting and applying;

- **Indicative POE**

  Indicative POE, "Quick walkthrough evaluations involving structured interviews with key personnel, group meetings with end users as well as inspections" (Preiser, 1995). In this method, four data collection methods can be seen, these are analyzing of documents, walkthrough evaluation, questions, and selected interviews.

- **Investigative POE**

Investigative POE, more deep analyzes, utilizing interviews and questionnaires, generally evaluate a number of buildings of the same or similar type. Photo/Video records and measurements are preferred for data collection (Preiser, 1995).

- **Diagnostic POE**

Diagnostic POE is the most advanced method among all methods. It requires a high level of work and time about months or even years to finalize it. Combination of different data collection is combined with this method. These are observations, measurements, questionnaires, longitudinal and cross section evaluation, and photo/video recording. According to Preiser, in this method "high validity and generalizability of data collected. . . that has the potential of being transformed into guidelines" (Preiser, 1995).

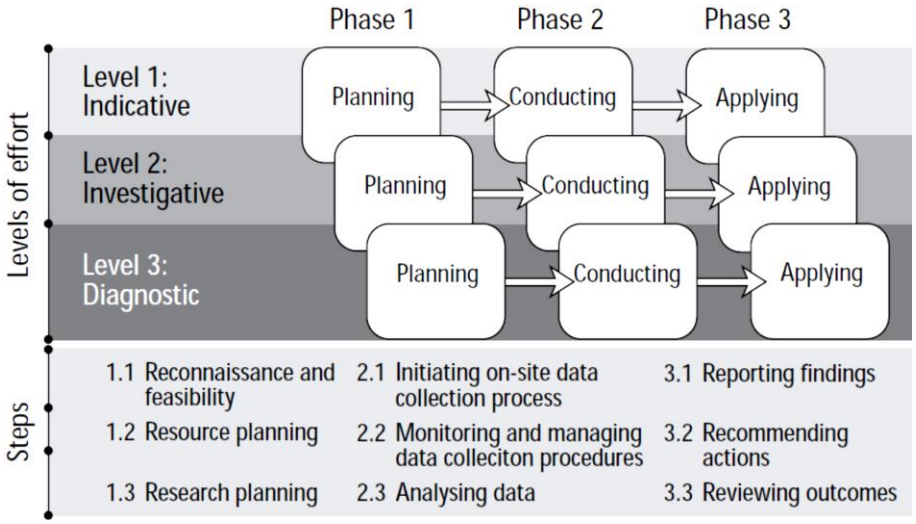


Figure 17: POE Methods
(Preiser, Edward and Harvey, 1988)

The most well-known and used method is "Indicative POE" because it requires a less time and the data collection can be done during the site visit and findings can be reported in a few days.

Data collection is the most important side of a POE for achieving a successful evaluation. In the POE of US Postal Service, there are several data collection techniques, in which most of them are similar methods used in other evaluations; presite visit, user interviews, clerk interviews, touring interview, space-use observations, physical environment checklist, assessment of details and systems, photographic/video documentation, questionnaire. In order to achieve high benefit from POE, it is important to use methods and reporting their findings with an understading of the context of the organization being researched. Within these methods, many techniques can be implemented, such as; standardized questionnaires, interviews, observations, physical monitoring (Jaunzens, Hadi and Graves, 2001).

According to (Jaunzens et al., 2001), the list of modern evaluations in today, that can be possible by POE methods that based on requirements;

- Building performing according to design decisions
- User satisfaction with building
- Sick building syndrome
- Impacts on the productivity of users
- Level of building functional support to users
- Management problems

As they are listed above, there are many tests that can be evaluated by POE, even organizations which wish to apply POE can also develop new test standards. There are some other well-known methods of POE as well. Table 3 highlights these methods, within a framework of methods (format taken) and criteria (broad areas covered) used in evaluations, in which the areas of performance has been classified under headings

derived by the LEAF (Learning from Evaluation and Applying Systematic Feedback) project. In the table, what is to be understood by 'product' is "how well the building achieves the pre-defined specification of fitness for purpose", 'performance' is "how well the building supports the organization's goals and user expectations", and 'process' is "the performance of the team, which includes the client, measured against the ability to meet client expectations. All these methods and test can create different techniques (Jaunzens, Hadi and Graves, 2001).

Table 3: Different POE Method Samples (Jaunzens, Hadi, and Graves, 2001)

Method Title	Format taken	Broad Areas covered
Overall liking score **PERFORMANCE** **PRODUCT**	• Staff questionnaire	Impact of office design on productivity: • satisfaction with environmental systems performance • satisfaction with provision of facilities Benchmarked against originators' internal data set.
PROBE **PERFORMANCE** **PRODUCT**	• Staff questionnaire • Managers' questionnaire • Energy use assessment • Environmental systems performance review • Study of original design intent	Performance of the building against the original design brief: • energy use • satisfaction with environmental systems performance and functionality • satisfaction with provision of facilities Benchmarked against developers' internal data set, ECON 19 energy benchmarks, and original design intent.
BRE Project Building Appraisal **PERFORMANCE** **PRODUCT** **PROCESS**	• Questionnaire administered to members of the design and construction team on ongoing basis over project.	Feedback for use in future projects: • feedback on success of the briefing process • feedback on success of the design process • feedback on success of the construction process • feedback on success of the construction product
BRE / DEGW NEW project **PERFORMANCE** **PRODUCT**	• Staff questionnaire • Business Managers' questionnaire • Facilities Managers' questionnaire • Physical monitoring • Focus group • Observational studies	Match between workplace design and organisational requirements: • satisfaction with design, performance, and functionality of environmental systems • satisfaction with provision of facilities and support for business functions • monitoring of environmental systems performance
OPI Toolkit **PERFORMANCE** **PRODUCT**	• Staff questionnaire	Impact of office design on productivity: • satisfaction with performance of environmental systems • satisfaction with provision of facilities and support for business functions
A questionnaire for studies of sick building syndrome **PERFORMANCE** **PRODUCT**	• Staff questionnaire	Likely incidence of sick building syndrome: • medical symptoms • satisfaction with performance of environmental systems and indoor environment Benchmarked against developer's national database.

According to Higher Education Funding Council for England, the process of POE is divided into 7 steps (HEFCE, 2006);

- **Identifying a strategy**

  In this step, listing the evaluation needs and possible sides of the evaluation, also making an appointment for participants should be done.

- **Deciding on an approach**

  In the second step, an identifying of what kind of factors should be pointed out from the evaluation and who will make it; internally or external consultant. In order to find the proper approach, objectives, fast or deep analyze, time availability, need of a new method or existing one and when to use the findings are important to be considered while deciding for an approach.

- **Brief**

  The third step is a concise statement setting out the aim of the POE and way of achievement. The time, who will make, who can be involved, problem areas, method, where to apply and focus groups are explained and defined.

- **Planning**

  The fourth step is a selection of approaches according to needs. The time for starting an evaluation, preparation of questionnaires, scheduling a time for meeting with people, meeting places and time agreement for collecting the questionnaires back.

- **Carry out the evaluation**

  In this step, giving and collecting back the questionnaires, meetings, and observation will be finalized. The end of data collection and quick analyzing of information will be processed during this step of the process.

- **Preparation of reports for findings and result**

  The sixth step, identifying to whom is the data to be addressed and making the structure of a report. Preparation of reports according to the aim of evaluation and audiences(if there are different).

- **Recommendation-Action in response to the evaluation**

  In the last step, information and achieved results should be used for the solution of the current project and transferred to the next projects. Publication of the evaluation is a valuable way to share the data and it should be accessible for who may need it (HEFCE, 2006).

3.3 Purpose and Importance of Post Occupancy Evaluation

POE supports us for not repeating the same mistakes many times because of having less information which is users' feedback. Generally, POE is suggested for providing a method of collecting and spreading valuable data to all people who involved in the project as a designer, contractor, user and etc. The information is important for a building life-cycle, but here are also some particular parts of the data that giving benefits to specific people (Preiser, 1995).

There are many designers think that end of the construction of a building is the last moment of their participation in the project. However, a designer should not step back from the care of the projects when they hand over the building. Actually, important learnings and feedbacks of design can be achieved after the handover stage. There should be some questions in mind to evaluate their own projects. An occupant satisfaction and building performance are two main factors to think about it.

The quantitative and qualitative data collection of these factors can be gathered by POE (Rouse, 2003). Importance of POE is to give answers to designers' questions in a life cycle of projects, and these answers will work as main elements for next projects, also will give a solution to renew some parts of the building which cause user unsatisfaction and decreasing the performance of the existing project. Collection of all these evaluation results will create a knowledge to understand comfort factors of occupants. Each POE will create a specific piece of information, and by doing these evaluations regularly, the pieces will come together to create a coherent knowledge.

Therefore, it is very important to have not just a client or occupant mostly contributed in the design process before construction of a building, but also the designer involved with the experience of occupant after a building is completed – a stage where designers are generally forgotten. In practice, the feedbacks achieved from post-occupancy evaluation on a project can then be utilized to come up with change for that specific project and to transfers the information to future projects in these ways;

- Intervention design: modifying some parts of the building that can be changed easily to increase user satisfaction - aim for short-term.
- Renovation design: when renewing the building, more suitable space, materials, systems and facade of the building should be preferred - aim for medium-term.
- Future building design: preventing problems that cannot be solved as present in future projects - aim for long-term (Rouse, 2003).

Therefore, to summarize, POE can be conducted, as the different studies have recommended, for many reasons and purposes(aim), but the overarching concept of the aim of POE is to simplify the collecting of data and feedbacks that can be utilized to develop the procurement of buildings to the benefit of all the stakeholders who contributed in a project (Rouse, 2003).

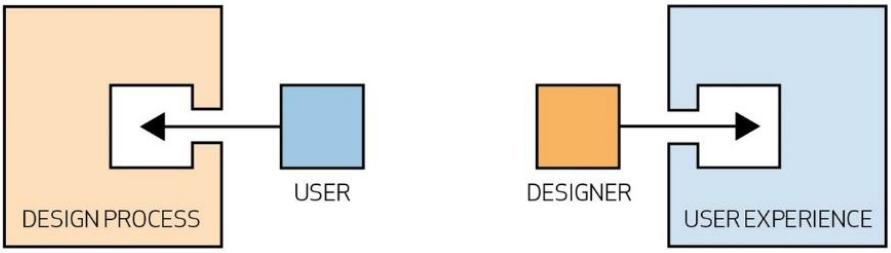


Figure 18: User and Designer Relation
(Modified from UrL 5)

3.4 Benefits of Post Occupancy Evaluation

Based on the client's objectives within the required time difference, there is a short, medium and long term of benefits in POE (Preiser, Edward and Harvey, 1988). These feedbacks are used as a literature for further design solutions to improve user satisfaction. The benefits;

- **Short-Term Benefits**

- Finding the problems and giving solutions
- Building management based on occupants' values
- Feedbacks for space usage to improve the performance of the building
- Feedbacks for decision making
- Response to needs of occupants

■ **Medium-Term Benefits**

- Finding solutions to reduce cost of construction process by building life cycle
- Accountability for a performance of the building by architects and clients
- Finding ways of new uses for spaces

■ **Long-Term Benefits**

- Improvements in building performance for a long time
- Improvement of the design quality and standards
- Strategically review

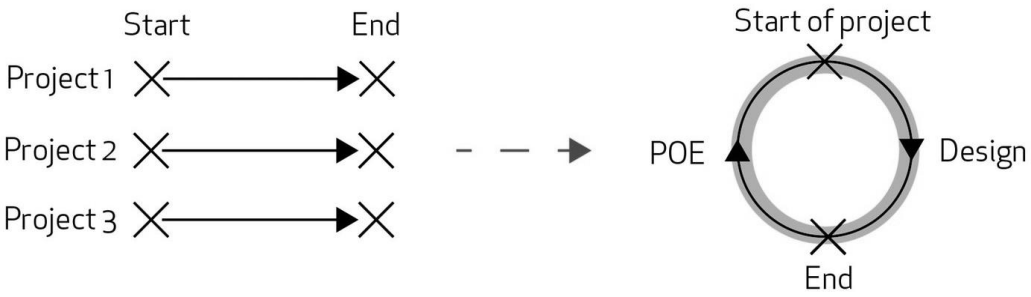


Figure 19: Working Method of POE Benefits on Project
(Modified from UrL 5)

The benefits of POE are very important for building performance factors seeking for technical sides, but it has not yet matured enough in its theme in terms of socio-cultural, aesthetical and environmental context criteria. For this reason, adding the missing criteria into POE is a must to be not faced with design features that is not enough, to have success in next project designs, to be able to cope with complex building design such as re-used or sustainable buildings, and provide reliable data, in the sense of both technical and nontechnical terms (Rouse, 2003).

3.5 Post Occupancy Evaluation Studies

According to the literature and thesis topic, it will be better to analyze some previously done relevance Post-Occupancy Evaluation of buildings, buildings' facades and other parts of the building in terms of user satisfaction with different methods of POE. The evaluations are from different parts of the world and they can be categorized into two groups; office and other type of buildings.

3.5.1 Evaluation of Office Buildings in Terms of Various Factors by POE

İlknur T. Doğrusoy discussed the importance of openings for office buildings within natural lighting, thermal comfort, view to the outside, natural ventilation, exterior with visual and privacy issues. In the study, the questionnaire method was used and applied to 45 users with investigative POE method. The research aimed to compare the offices with windows and offices without windows for buildings located in Turkey. According to the study, it was understood that the office which has openings, the working productivity is higher. External visual bonding and horizontal banding in terms of providing view and dressing the most adequate seen window types (Doğrusoy, 2002).

Becker, Gield, Gaylın and Sayer tested the user satisfaction with closed and open plan types in an academic building with academicians and students. The POE indicative questionnaire applied for a group of 100 people, 31 of the employees were selected for open-private office, 36 closed private office and 33 closed - shared office users. In the research, acoustic, level of concentration and effect of space on discussion with students for projects were analyzed. It is perceived that open offices contain more adverse conditions than closed private and closed shared offices (Becker, Gield, Gaylın, Sayer, 1983).

Gonzalez, Fernandez and Cameselle in their research, user satisfaction, working environment, and buildings were empirically tested as one concept via indicative POE method. Temperature, noise, and air quality were evaluated in the study. The questionnaire applied to 52 users. As a result of the research, it was found that noise and temperature in the office were more important than air quality (Gonzales, Fernendez, Cameselle, 1997).

Farrenkopf and Roth researched environmental behaviors such a space, settlement, human research, aesthetics, privacy, sound, ventilation, heating, lighting tools, furniture, windows, and landscapes. The diagnostic POE method applied to the building in a university, the priority of the actions in the offices was asked to 65 users, and performance tests were applied. It was found that preparation for a class was higher than the others with 19%, communication with other academicians and some paperwork were in second place. In the analysis conducted in the context of the offices within the existing university structure when a ranking of satisfaction is made; settlement, privacy, volume, ventilation, furniture, lighting, window and landscape and aesthetic form was found to be a ranking (Farrenkopf, Roth, 1980).

3.5.2 Evaluation of Buildings in Terms of Facade Performance by POE

Perkins Eastman in 2018, evaluated the natural lighting performance of Dunbar High School in the United States vie indicative POE. Within the completing a POE, something very interesting appeared: While the building was designed to meet user satisfaction targets, in actuality, space was considered slightly over-lit by building occupants. They took this important information to their next school project, Perkins Eastman decreased the window sizes and added an internal light shelf to increase daylight distribution while minimizing glare. In Perkin Eastman's POE for the new

project, 80% of the school staff feedback was positive and they were satisfied with the glare and visual comfort in the new school as compared to old swing spaces (UrL 6).

Figure 20: Perkins Eastman School Project
(UrL 6)

In another noteworthy diagnostic POE study in 2018, HGA Architects visited their Los Angeles Harbor College, design for the 3 stories, around 74,000 sq ft complex using about 44% less energy than base line models and producing about 26% of its own electricity by using solar photovoltaic panels. HGA's POE, evaluated the project's performance in terms of general user satisfaction, thermal comfort, acoustic quality, air quality, and lighting. Based on positive user feedback from applied questionnaire, HGA is using this project as a experience to be consider for the next projects, especially for educational buildings (UrL 7).

Figure 21: Los Angeles Harbor College
(UrL 7)

In different diagnostic POE in 2018, Intermountain Healthcare brought in Building Envelope Commissioning expertise for its Utah Valley Clinic to both assist with the design and construction of the building enclosure and to make sure, POE, that the building facade systems are designed, constructed, and perform according to the client's project requirements. At the Intermountain Healthcare Utah Valley Clinic, a building energy commissioner was brought in to make sure that the building facade was performing as planned. They completed site reviews, witnessing of testing to confirm the performance has been achieved, as well as assisting with some one off details on-site during the construction time. Including a Building Envelope Commissioning expertise as an integral part of the project was instrumental, as it was a critical process in achieving the project's high-performance requirements as well as playing the main role in increasing the durability of the facade while decreasing risks of future facade performance issues (UrL, 7).

Figure 22: Utah Valley Clinic
(UrL 7)

Chapter 4

POST-OCCUPANCY EVALUATION OF FACADE DESIGN AND PERFORMANCE FOR CASE STUDY

Office; is the name that given to work space. In this space, the individual operating tasks are performed in order to provide a business, service, and administration. The office building can consist of rooms of several square meters, or one common area. There are four types of layout for offices; open plan, private offices, cubicle, and hybrid solutions. In universities, the office buildings are servicing for academicians and administrative employees. In such buildings, offices are separated for individuals. This type is called private offices but buildings can have common spaces such as meeting, seminar, studying and archive rooms.

According to the importance of the working environment and user satisfaction in office buildings, evaluation of selected case study will be taken a place in this chapter of the thesis. The case study is Office Building of Faculty of Architecture at Eastern Mediterranean University. The evaluation will be based on facade design and its performance in terms of user satisfaction in the o and post-occupancy evaluation questionnaire for users and observation method are selected to be applied in the building. In order to collect information and data for the research, selected building "case study" has been defined as a research tool.

4.1 Post Occupancy Evaluation Method of the Case Study

An indicative method of POE was selected due to time and resources. The method adopted for evaluation of the case. It is a qualitative study with building and location characteristic research, questionnaire for users, short interviews and observations of an author as a former employee in the building. The permission letter is received from the ethics committee of the University and the questionnaire was distributed to 44 members of faculty staff in a week. The staff had been informed about the purpose of the research, risk, and procedure with an attachment of letter of information-voluntary participation. The majority completed the questionnaire in a short time and out of the 44 given, 40 questionnaires were returned as completed within the letter of information-voluntary participation with signature. The questionnaire consists of 25 questions regarding the user's point of view about the effect of facade design and its performance in terms of thermal comfort in a working environment. The collected data from questionnaires were analyzed with SPSS program. The SPSS is a computer program for statistical analysis.

4.2 EMU, Famagusta, Cyprus and Climate

The largest and the only governmental university of the country is Eastern Mediterranean University. The university is founded in 1979. The university has 141 programs offering undergraduate and postgraduate degrees, as well as a research infrastructure. The language of programs are in Turkish and English. Currently, it has 12 faculties and among them, one of the largest faculty is Faculty of Architecture. It is located in Famagusta city.

Famagusta, also known as Gazimağusa, is a city on the east coast Cyprus. The city was considered as one of the most glorious cities on the island in the old times, with

the port being referred to as a hub for the transportation of both passengers and goods to and from Cyprus. The island is surrounded by three continents: Africa, Europe, and Asia (Figure 23). Cyprus is close to Southern Europe, and Northern Africa, and has had lengthy periods of mainly Greek and intermittent Anatolian, Levantine, Byzantine, Turkish and Western Europe influence.

Figure 23: Location of Cyprus
(Google Earth, 2018)

The city has a mediterranean climate and during summer, the humidity is over 60% and cold weather with rain during winter (Alibaba & Ozdeniz, 2011). Very hot during the daytime in summer and mild winter days are the reflection of this climate. According to the given climate graphic; the minimum temperature is 5.8 centigrade in January, and the maximum temperature is 36 centigrade in July.

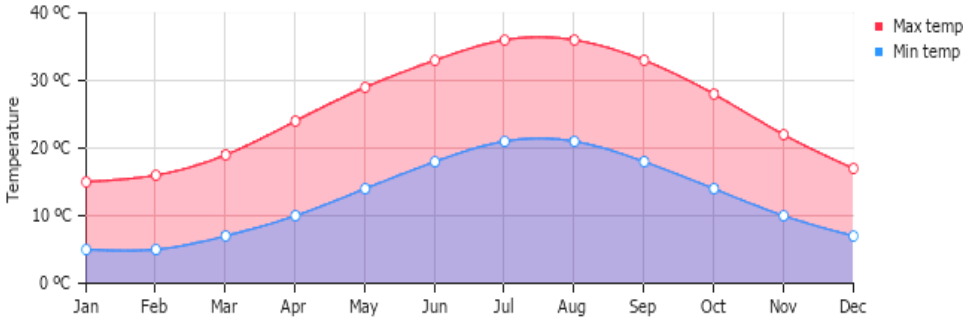


Figure 24: Climate Graphic of Famagusta City
(UrL 8)

4.3 Case Study, Faculty of Architecture Office Building in EMU

Faculty of Architecture is located in the north-east of the campus (Figure 25). The faculty is consist of 2 clustered type of studio building, 1 three-story studio building named as colored building, 1 computer lab building and 1 office building for academic staff and administration facilities. The office building is the case study of the thesis. It is located at the center of faculty area. The building has three stories and a rectangular plan layout with 2280-meter square. There are individual offices for academicians and administrative staff, seminar rooms, meeting room, research area, small kitchens, storage etc. Basically, the spaces are divided with central long corridors and 4 entrances which serves to users from garden and car park side of a building.

Figure 25: Location of Faculty of Architecture in EMU Campus
(Modified from Google Earth, 2018)

There are 64 individual offices aligned on two facades (north-east and south-west) from 12-meter square to 40-meter square according to re-drawn plan through the given original plans by the administrative staff of Faculty (Appendix D). The building is open between 7.30 to 19.00 according to university regulations but faculty members have access to use the building for their office works during 24/7.

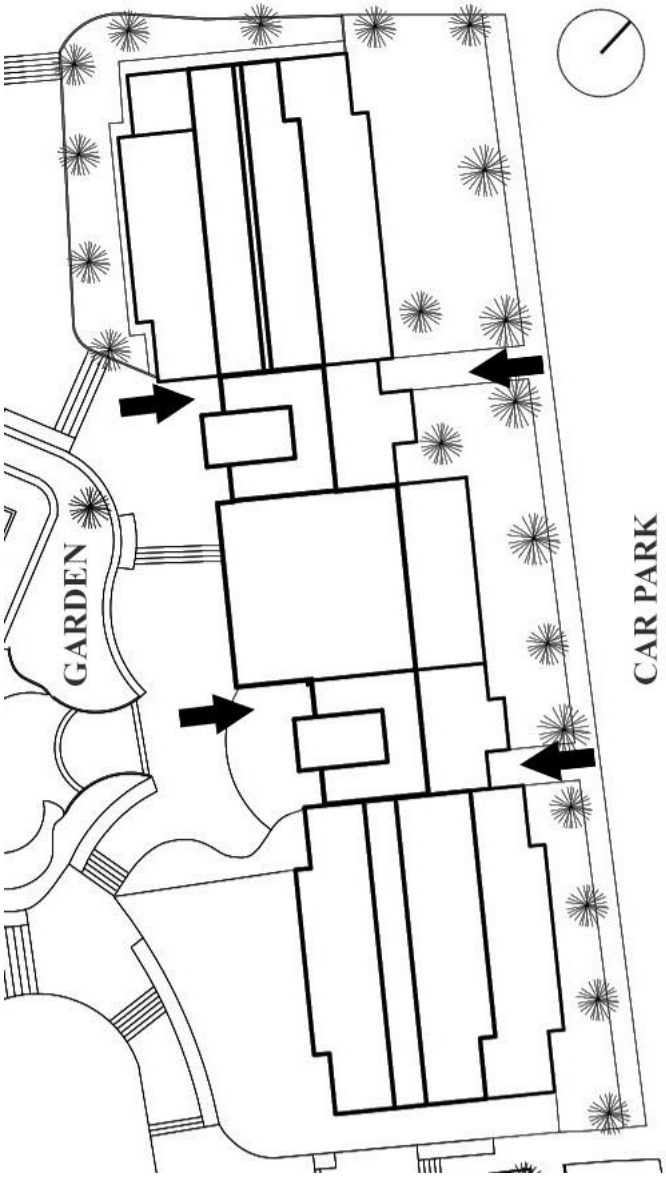


Figure 26: Site Plan of the Office Building
(Drawn by author, 2018)

4.3.1 Facade Design of the Case Study

The facade design is simple with box window and it has some movements such as different types of openings, roof angles within the floors and front-back shifted parts according to plan. Trees are planted around the building (Figure 26 & 27).

Figure 27: South-West Elevation of the Office Building
(Taken by author, 2018)

20-centimeter brick, 2 centimeters of lime plaster and paint for exterior surface used for the construction of facade. On the facade; 11 different sizes of windows with 2 types of material and 2 different sizes of doors are placed, and walls painted with 3 different colors according to the observation of author. In the long elevations, offices, meeting room and toilets openings with building entrances are placed. In the short elevations offices, corridors and seminar room openings are placed. There is no any type of shading element or integrated facade system which can increase thermal comfort within the less use of a mechanical cooling&heating system. A similarity of facade design for each elevation of the building can be understood from the following figures (Figure 27 & 28).

The chair offices of departments of the faculty are located at edge of the building which have openings to south-west and south-east directions. Offices are defined with grey color on the facade (Figure 28).

Figure 28: South-East Elevation of the Office Building
(Taken by author, 2018)

The building secondary entrances and large trees are located at north-east facade (car park side). These trees provide a natural shading. Dean office of the faculty, corridor and one semimar room openings are located on north-west elevation as well (Figure 29).

Figure 29: North-East & North-West Elevations of the Office Building
(Taken by author, 2018)

4.3.2 Effects of Facade Design to Indoor Space of the Case Study

The result of the facade design of the building and differences between south-east and north-east directions to the indoor environment such as the amount of natural lighting can be perceived from the images below (Figure 30 & 31).

Figure 30: Office and Corridor Located on North-East Side
(Taken by author, 2018)

Figure 31: Natural Lighting from South-West Direction for Circulation Areas
(Taken by author, 2018)

Cooling and heating system is dated from 1990's and maintenance is hard to make it because of the lack of finding proper pieces and parts for this type of units. During the winter, users always prefer to keep the heating system on and during summer cooling system is working during a day. The building depended on HVAC system for thermal comfort. Acoustic and noise comfort is another issue to be considered in office buildings. Academic staffs are using their offices for scientific researches as well as

for faculty works which need a good concentration to be productive and have better works. All these factors are asked to users in a questionnaire, the results will be discussed one by one to understand the importance of feedbacks for providing better recommendations and solutions.

4.4 Post-Occupancy Evaluation of the Case Study

In this part, questionnaire results will be discussed and problems will be underlined. The possible recommendations and solutions will be according to this analysis. The questionnaire cover page consists of thesis title, researcher information and aim of the study is briefly explained (Appendix B). The questionnaire has three parts;

In the first one, personal information such as gender, age, educational level, office location in the building, working time during the day and week are asked.

In the second part, overall quality, usage of HVAC system, air quality, facade design details, windows design (usage, size, place), stylistic attributes of facade and view to outdoor within privacy are asked in the format of choosing answer from 1 to 5 (1-Very Unsatisfactory, 2-Unsatisfactory, 3-Neutral, 4-Satisfactory, 5-Very Satisfactory).

In the end, the place provided for additional feedbacks for the ones who prefer to write more about their thoughts and observations about facade design and its performance (Appendix B). These feedbacks will be mentioned in the thesis to improve research data and underline the importance of users feedbacks.

According to the literature and previously evaluated POE studies, answers and feedbacks of users are shown by graphics and results are discussed below. The data is transferred to the graphics, and then the data obtained according to user status and

arithmetic the average is transferred to the graphics and suggestions are presented. All the answers of questions that are asked in user survey will be analyzed in order.

4.4.1 User Review of the Office Building

Before starting to analyze other feedbacks, it is better to understand the user profile of the office building. Age, gender, educational level, and health problem questions are asked at the beginning of the given questionnaire. As it is mentioned at beginning of the case study, 40 users of the building are involved in the research. These people are professors, research assistants, and administrative staff.

Surprisingly, the result of the gender questions shows that participants are divided by female and male equally. 20 female and 20 male are involved (Figure 32). This can be a good opportunity to receive feedback from both genders in an equal number.

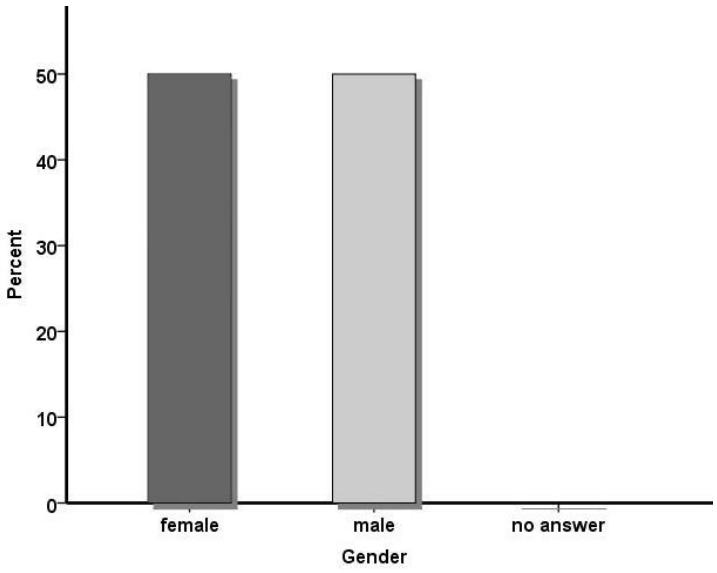


Figure 32: User's Gender Question

According to health problem question; 17% of users have replied as “YES” while 83% replied as “NO” for having health problem. The need of thermal comfort and well-ventilated space is important for human health. Working environment with low thermal comfort can cause more health problems such as pain in muscles, headache, cold, loss of attention and tremble (Figure 33).

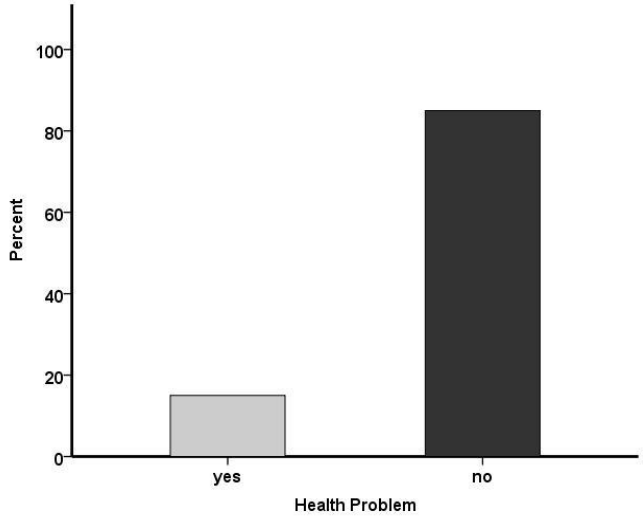


Figure 33: User’s Health Problem Question

Since it is an office building in a university, the educational level result is shown as it was expected. Academicians, research assistants and administrators are a member of Faculty of Architecture who are in the same field of thesis research field. A result of the questionnaire will be very effective depended on knowledge, experience, and observation of participants. Ph.D. is taking the place with 65%, participants with master education are 33% and 2% for an undergraduate level who works as a student assistant in the building (Figure 34).

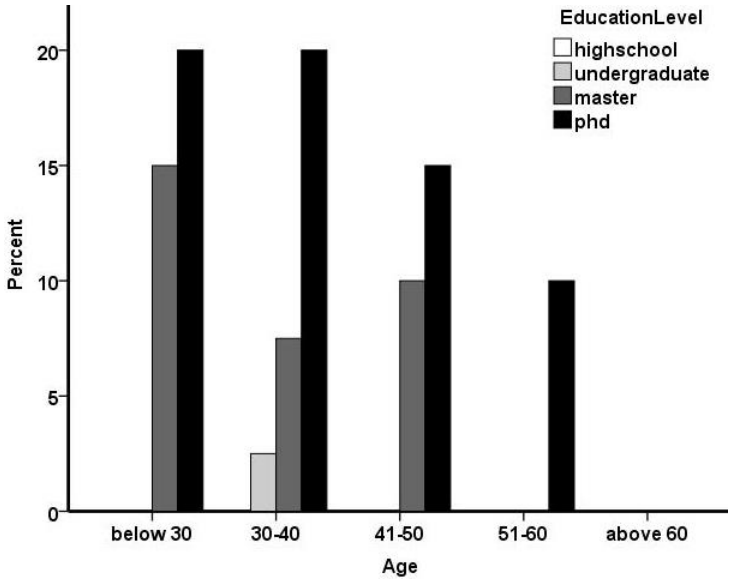


Figure 34: User's Educational Level and Age Question

The working time of users is shown in the graphics below. Graphics are divided according to questions; working year, working days in a week and working hour in a day. According to the first graphic; 37% of the users worked more than 6 years, 31% is 3 to 6 years, 28% is 1 to 3 years and 4% of users worked less than 1 year in the building (Figure 35).

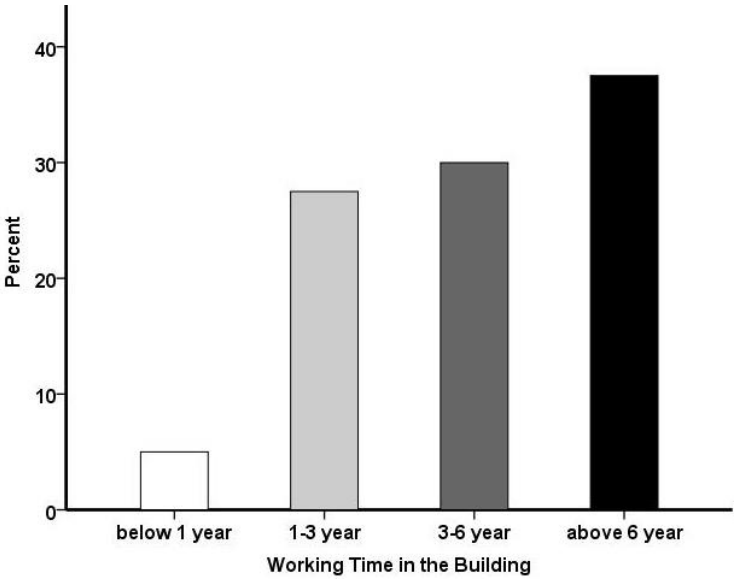


Figure 35: Question of Working Year in the Building

According to Figure 36; 70% of users answered for working days question with 3 to 5 days, 20% answered above 5 days (using the offices for studying at the weekend as it was mentioned at the beginning of case), and the remain answered as 1 to 3 days which is 10%. There is no user who answered as below 1 day.

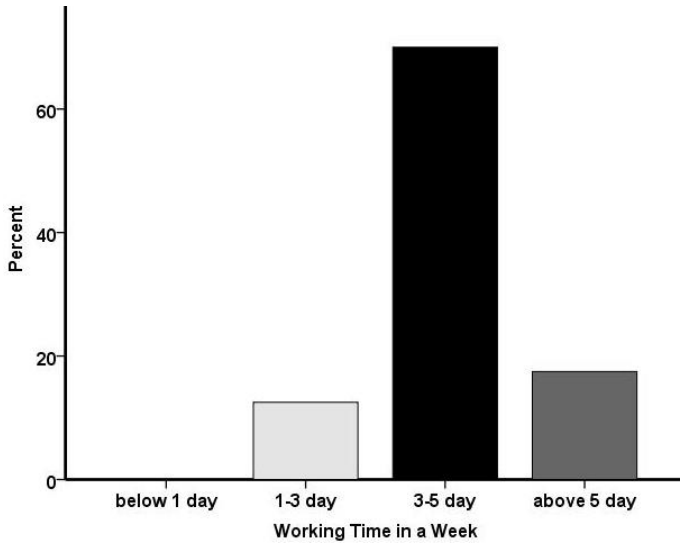


Figure 36: Question of Working Days in a Week

In Figure 37, 50% is 4 to 8 hours, 38% is 1 to 4 hour, and 12% is above 8 hours. There is no user who answered as below 1 hour working time in the day at the office.

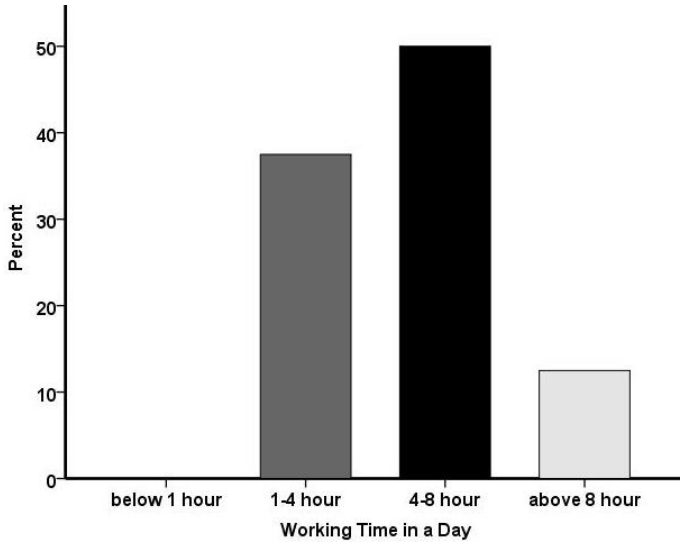


Figure 37: Question of Time Spent in a Day

4.4.2 Evaluation of General Facade Design

In the following graphics, questions about facade design are asked and answers are analyzed in the format of choosing an answer from 1 to 5 (1-Very Unsatisfactory, 2-Unsatisfactory, 3-Neutral, 4-Satisfactory, 5-Very Satisfactory).

In Figure 38, overall thoughts about the quality of facade design of the office building question is shown. 40% is very unsatisfactory, 28% is unsatisfactory, 30% is replied as neutral, 2% is satisfactory and there is no answer as very satisfactory.

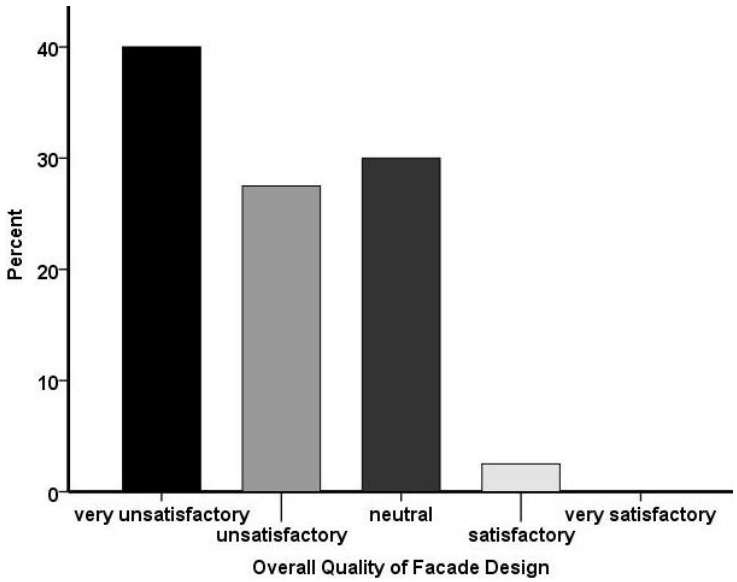


Figure 38: Question of Overall Quality of Facade Design

In Figure 39, overall thoughts about the stylistic attributes of a facade of the office building question is shown. 27% is very unsatisfactory, 38% is unsatisfactory, 35% is replied as neutral, 2% is satisfactory and there is no answer as very satisfactory.

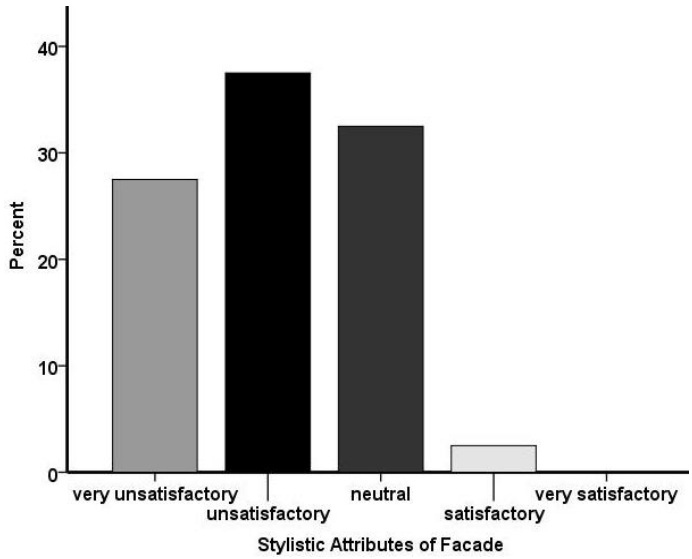


Figure 39: Question of Stylistic Attributes of Facade

In Figure 40, thoughts about the facade relation with outdoor and privacy level question is shown. 18% is very unsatisfactory, 15% is unsatisfactory, 25% is replied as neutral, 40% is satisfactory and 2% is very satisfactory.

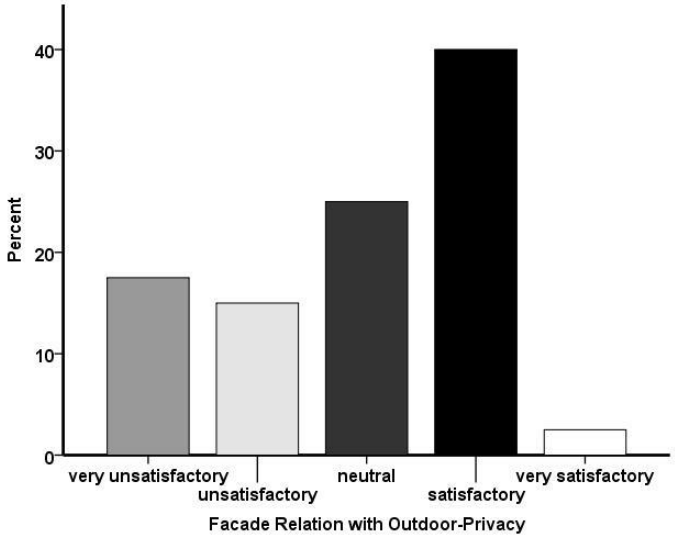


Figure 40: Question of Facade Relation with Outdoor in Terms of Privacy

4.4.3 Evaluation of Office Design

In Figure 41, the result of users office location in the building shown in terms of floor and facade direction. The graphic showing the location of all the participant's office room in a total calculation.

On the ground floor, 20% of the office rooms are located on the north-east side while 15% on the south-east. On the first floor, the result is the same for both facades and it is 23%. On the second floor, 7% is north-east and 12% is south-east. In a total, 50% is north-east and 50% is south-east facade oriented. This result is the second to be equal after the result of "gender question".

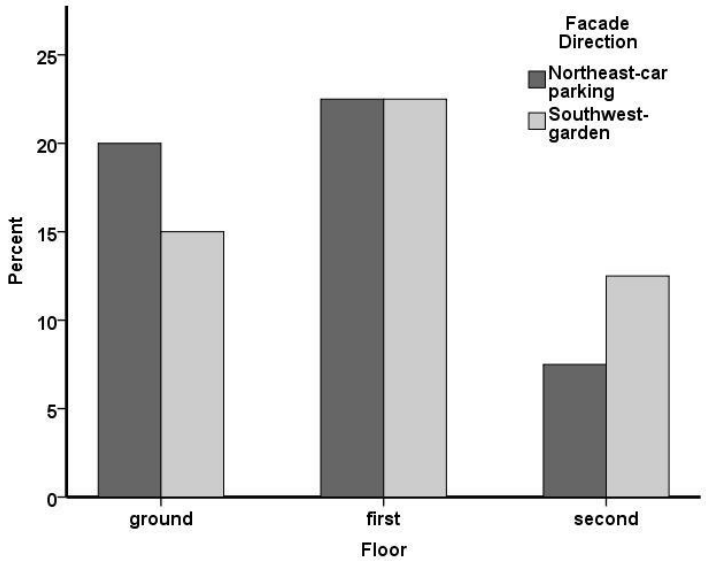


Figure 41:Question of User's Office Location in the Building

The following figure is showing the type of office rooms in terms number of people in a space. 45% of the users are occupying the room alone while 55% sharing with other/others (Figure 42).

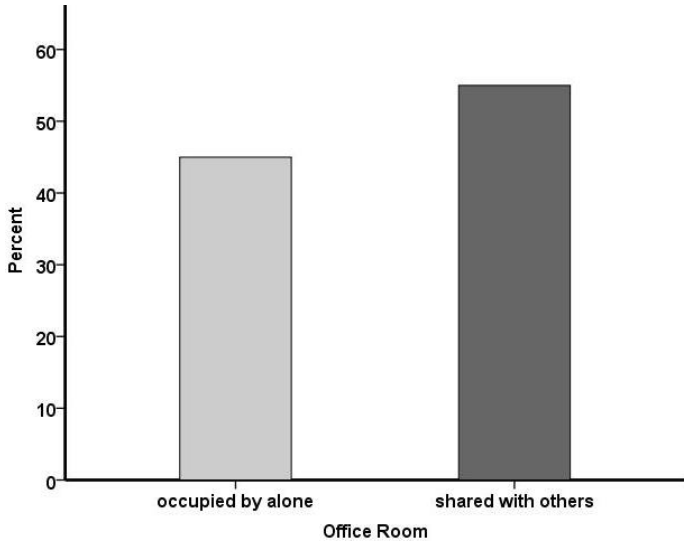


Figure 42: Question of Type of Office Room

In Figure 43, thoughts about the facade relation with outdoor and privacy level question is shown. 18% is very unsatisfactory, 15% is unsatisfactory, 25% is replied as neutral, 40% is satisfactory and 2% is very satisfactory.

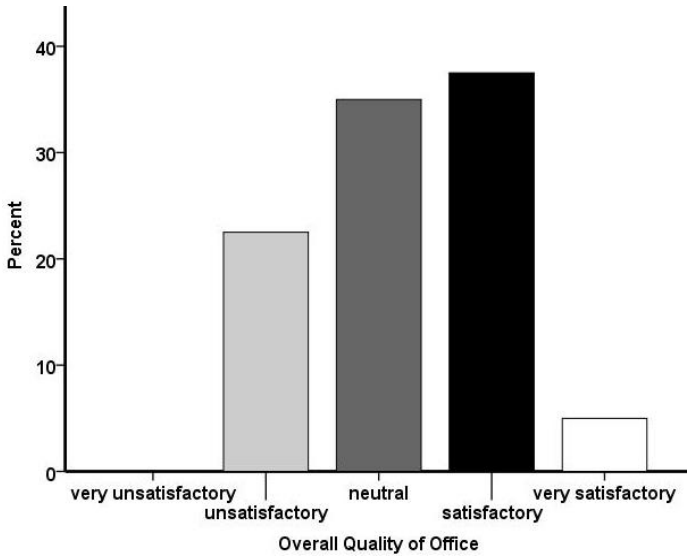


Figure 43: Question of Overall Quality of Office Room

4.4.4 Evaluation of Window Design

In the following graphics, user thoughts on usage, design, size, and place of windows on facades are shown. The following figure shows that 62% of partipants are satisfied with the usage of windows and while 38% not satisfied. Additionally, the reason of choosing not satisfied with the usage of window is explained by some participants;

- According to the participant 6, resaon explained as “Having mosquitos, too hot, too much noise from outside.”
- According to Participant 18: “There is always a wind in winter coming from the sea direction during daytime. So, windows can not be kept open for long time.”
- The participant 19 explained as “Opening direction, detailing and quality have big problems.”
- The participant 24 claimed about functionality of the window, “It is not functional at all.”
- The participant 34 is mentioned the problem as “No view.”
- The participant 35 explain the reason as “The way of opening in terms of direction.”

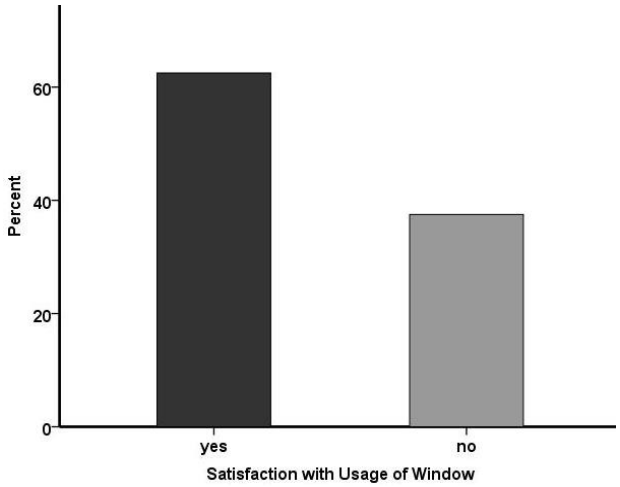


Figure 44: Question of Usage of Windows

In Figure 45, thoughts about the windows design question is shown. 25% is very unsatisfactory, 30% is unsatisfactory, 35% is replied as neutral, 10% is satisfactory and there is no answer as very satisfactory.

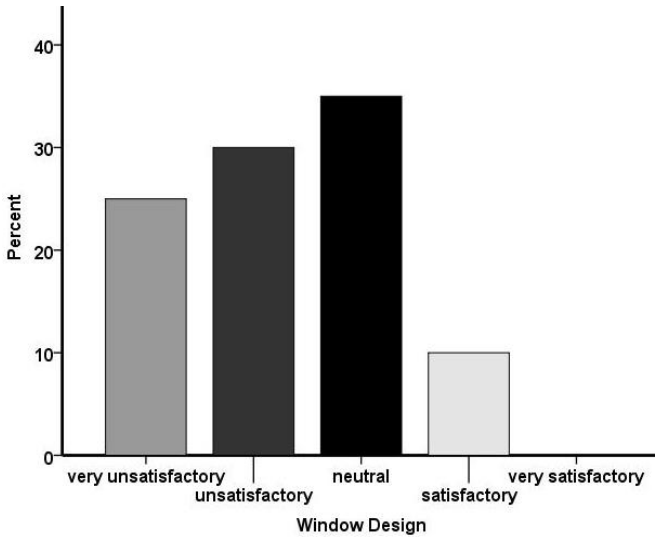


Figure 45: Question of Windows Design

In Figure 46, thoughts about the windows place question is shown. 8% is very unsatisfactory, 10% is unsatisfactory, 45% is replied as neutral, 37% is satisfactory and there is no answer as very satisfactory.

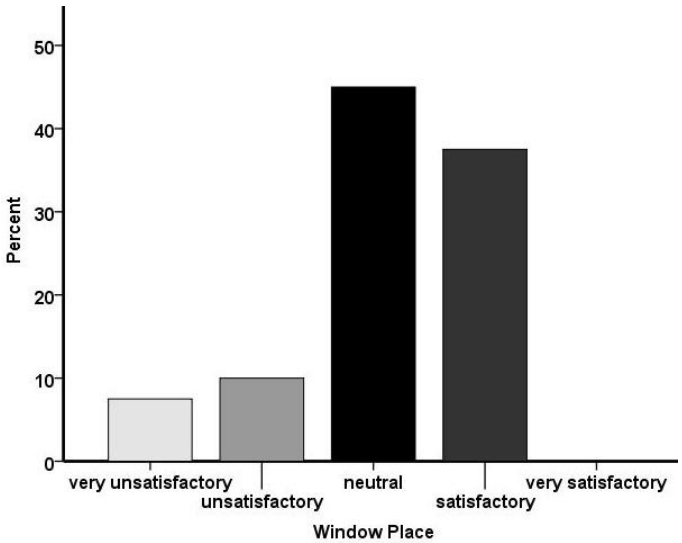


Figure 46: Question of Windows Place

The following Figure shows the thoughts about the satisfaction with the size of windows question. 12% is very unsatisfactory, 18% is unsatisfactory, 30% is replied as neutral, 35% is satisfactory and 2% is very satisfactory. (Figure 47).

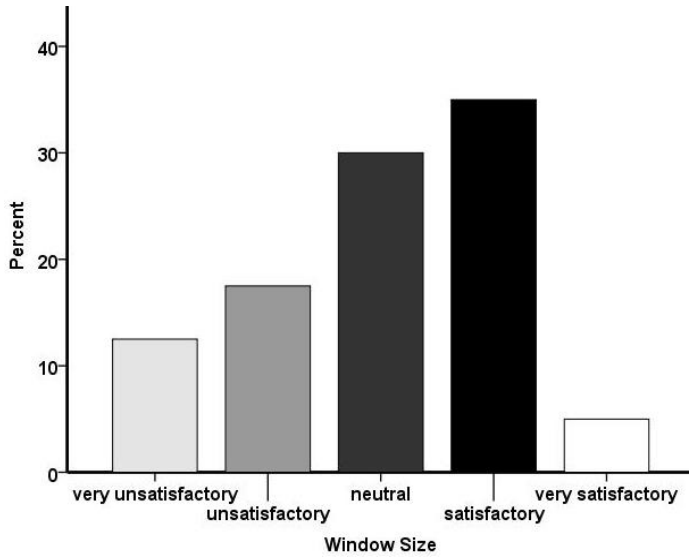


Figure 47: Question of Windows Size

4.4.5 Evaluation of Indoor Temperature and Use of HVAC

In the following graphics, questions about satisfaction with indoor temperature during the summer and winter are asked according to two different conditions to understand the differences between HVAC system ON-OFF status in both seasons with fixed temperature setting. The indoor temperature can be the most important factor for thermal comfort to be considered for users. The answers are analyzed in the format of choosing an answer from 1 to 5 (1-Very Unsatisfactory, 2-Unsatisfactory, 3-Neutral, 4-Satisfactory, 5-Very Satisfactory).

In Figure 48, satisfaction with the Indoor Temperature in Summer with Mechanical Cooling System is ON of the office building question is shown. 10% is very

unsatisfactory, 23% is unsatisfactory, 12% is replied as neutral, 40% is satisfactory and 15% is very satisfactory.

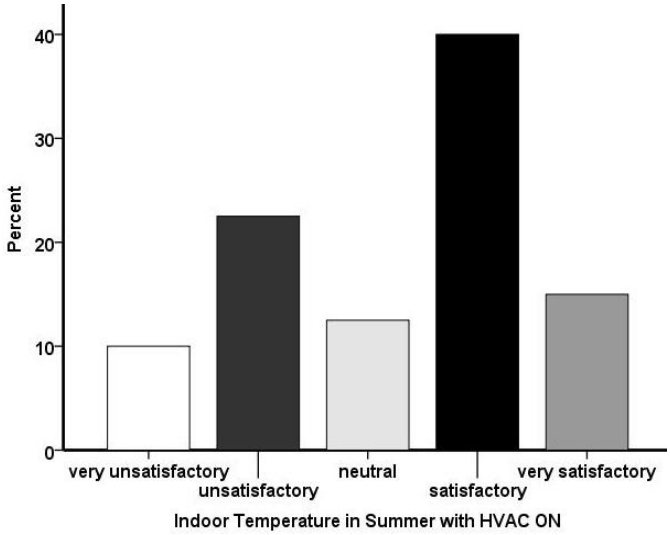


Figure 48: Question of Indoor Temperature in Summer with HVAC-ON

According to the Figure 49, 64% of users are answered as very unsatisfactory, 30% unsatisfactory, and 2% for each neutral, satisfactory and very satisfactory answers with the Indoor Temperature in Summer with Mechanical Cooling System is OFF.

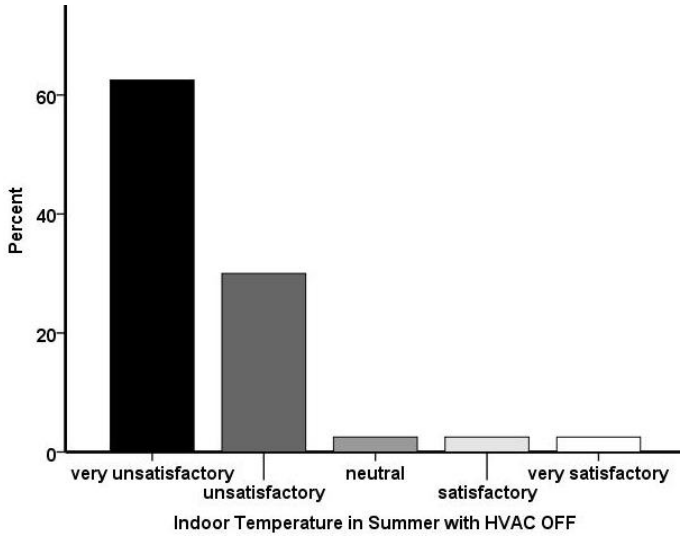


Figure 49: Question of Indoor Temperature in Summer with HVAC-OFF

According to the Figure 50, there is no any users who answered as very unsatisfactory but 32% unsatisfactory, 20% for neutral, 32% satisfactory and 16% very satisfied with the Indoor Temperature in Winter with Mechanical Cooling System is ON.

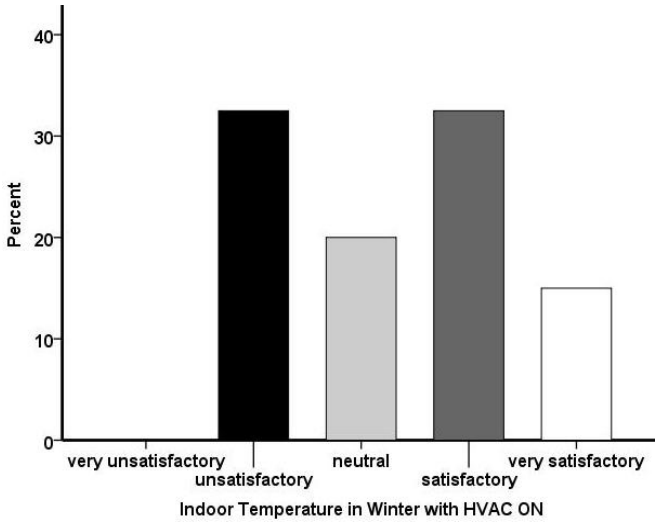


Figure 50: Question of Indoor Temperature in Winter with HVAC-ON

In the Figure 51, a question asked for satisfaction with the Indoor Temperature in Winter with Mechanical Cooling System is OFF. 48% of users are answered as very unsatisfactory, 22% unsatisfactory, 10% for neutral, 16% satisfactory and 4% very satisfactory.

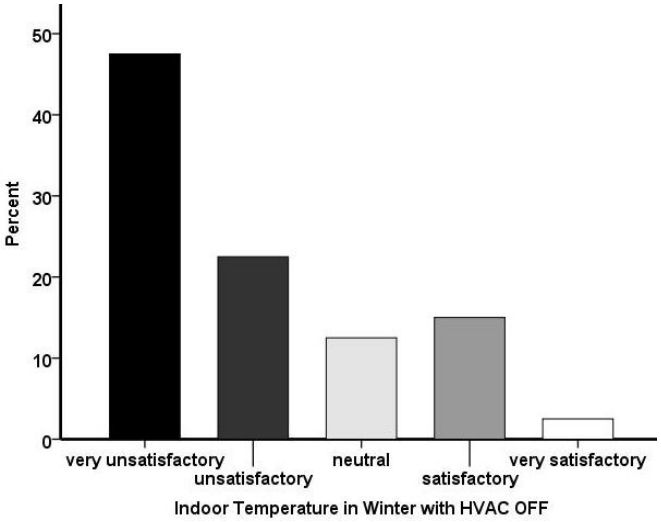


Figure 51: Question of Indoor Temperature in Winter with HVAC-OFF

4.4.6 Evaluation of Ventilation and Air Quality

In the last graphical result of the questionnaire, the question was asked for satisfaction with the Ventilation and Air Quality of Indoor Space. 10% of users are answered as very unsatisfactory, 35% unsatisfactory, 30% for neutral, 20% satisfactory and 5% very satisfactory (Figure 52).

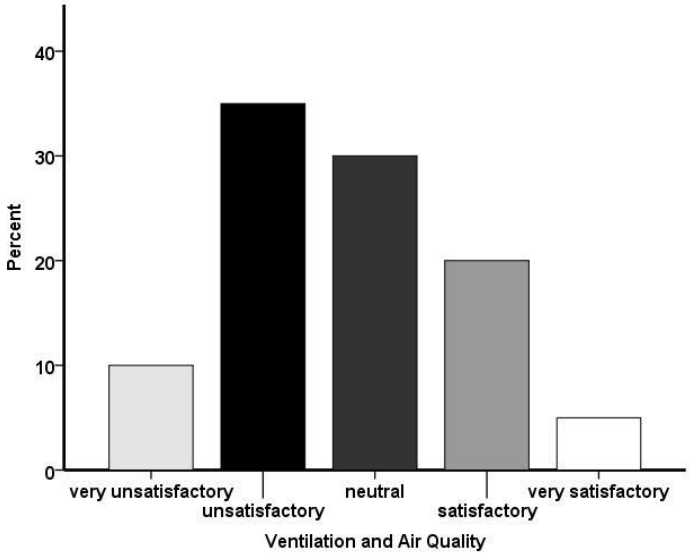


Figure 52:Question of Satisfaction with Ventilation and Air Quality

4.4.7 Additional Feedbacks of Questionnaire Participants

The results of multiple choice questions were shown above. In the last question of the questionnaire “Is there anything else you would like to add?” was asked and some of the participants added their feedbacks with text. Some participants wrote in details and some other underlined the main problem/s that they face in their offices almost every day. The feedbacks are shown below in the format of quotation. These feedbacks are important to be mentioned before going into discussion part of the study;

- Participant 5: “Office size is small for two people. The window is located on the one side and it is only possible to be controlled by one user.”
- Participant 10: “I prefer to use cross ventilation for cooling of the office.”
- Participant 18: “The building designed like train wagons. Windows in both directions are opposite to each other and keeping windows open in both sides is creating a problem. There is not enough sunlight. There is no possibility to get a sea view. Windows frames are old. The breeze coming in during winter. Mosquito problem in this side of the city is great. So, keeping windows open create another problem. The rooms facing towards the sea do not get any sunlight during winter. Sun enters partially in summer. So heating conditions are lacking in these rooms since heaters are not on in autumn and spring. Working in offices at late hours or weekends is not possible. The tea room and the cleaner’s room do not have any heating or cooling facility. The seminar room lacks any natural ventilation facility. The external part of the building has no aesthetic value. Hygienic conditions are not considered and some friends feed the animals. Flower pots could be added to make it attractive. Windows are not cleaned frequently. Things thrown from the roof of the extended part are not picked. There is no logic in the design of the windows in the whole

building. People could jump in on the ground floor while 1st floor windows are high."

- Participants 23: "There is a nice breeze in the afternoon, however, when this is maximized with the open door due to cross ventilation all paperwork flies, leading to discomfort. The room is very uncomfortable during the summer afternoon. The inner shutter is not enough as a shading element. The HVAC system does not work for me."
- Participant 26; "Offices are not heated well in winter and are not cooled in summer because of the inappropriate HVAC system and lack of thermal insulation."
- Participant 28: "Facing to the west, precautions for summer period should be taken."
- Participant 29: "The glass lost its transparent character. It is a primitive windows detail. I do not like this in the architecture department. There was a tree in front of my window but a few years ago it overturned in a rain. It was better when the tree was there. It was blocking the afternoon sun. Giving more privacy and beautiful view with colorful birds visiting it."
- Participant 30: "Limited amount of openings prevents the diffusion of sufficient daylight into the office. Although the level of a window is above the eye-level(while sitting) limited openings and less amount of daylight cause more dissatisfaction than the placement of window. Even the current level of a window is appropriate for bookshelves arrangement underneath them. In my point of view, I need more openings for more daylight and visual connection to the outside! I prefer a horizontal window strip which might be controlled (sun-control) vertical breakers/sun breakers-brise soleil."

- Participant 32: “The cross ventilation possibility is not well organized. There are no openable upper windows. I have to keep the door open. Facade does not have any climatic precaution like the sun breaking elements, pergolas or no landscape solution to support this need!”
- Participant 36: “It is hard to breathe in office during winter because of the HVAC system.”
- Participant 37: “Windows are not very easy to open/close it. The window height creates a problem. Facade design does not match to user needs for achieving a better working environment.”
- Participant 38: “Besides windows, the door fenestrations are poorly designed, of variable functionality, poorly located and distributed for safety concerns, poorly accessible for those with disabilities, and overall inappropriate in terms of emergency egress.”
- Participant 40: “In an office of shared type, it is not easy to reach windows while working because of its location. The window level is too low, it creates privacy problems since the office is located on a ground floor which could be considered as basement level due to topography level.”

4.5 Discussion and Results

In this research, the facade design and performance for user satisfaction is underlined with the literature and case studies were analyzed to understand the importance of users feedbacks for the building and design process of the next projects. According to this, the facade design and performance of Architecture Office Building is evaluated in terms of user satisfaction via Indicative Post-Occupancy Evaluation; questionnaire and observation method. The result of all questions is shown in graphics with the explanations which are prepared in the SPSS program. According to POE questionnaire, the result of 24 questions is showed in 21 charts in the case study chapter of the thesis (Figure 32 - 52) and the participant's feedbacks are added at the end of the previous section.

In the questions 1 - 4, understanding the user profile was aimed. The gender, health problem, age, and educational level questions were asked and results were analyzed. According to these results; the importance of gathering feedbacks from different people in terms of gender, age and education are underlined. The users with health problems were more sensitive about facade performance because of having an uncomfortable working environment in terms of temperature, air quality, and window usage-control.

In the questions 5 - 6, the questionnaire asked for a working year of users and the time spends in an office during the day. The results were showing that the users using their offices almost every day during the week and even some users prefer to work at weekends as well. Due to the building's HVAC system which is controlled from one main control, the system does not function after working hours and at weekends.

As a result of this, thermal comfort in the offices is not sufficient during the weekends and out of working hours.

In the questions 7 - 9, were asked to understand user satisfaction about the overall quality, stylistic attributes and relation with outdoor with the privacy of facade design. According to the results; most of the users are preferred to reply as very unsatisfactory and unsatisfactory, only in the result of facade relation and privacy question; 40% of the users replied as satisfactory. Additionally, the feedbacks about facade design of the building shows that the facade design and its performance is not matching with the needs of users and contextual thermal factors, even the design is not reflecting the modern office typology in a such a faculty which is architecture.

In the questions 10 - 12, the location of user's offices, type and overall quality of office were asked. The level and direction of offices data are analyzed, space distribution between the facades were similar. In the second floor the number of offices were less due to the administration offices. There is two types of office in the building; shared or occupied by alone. Most of the users share their offices with other users. The user's comfort needs may change in the same place, feedbacks were important to find out the common needs to have satisfaction in an office room. Even, the users who share the same office, gave different feedbacks. In general, 40% of users were satisfied with the quality of office room while 25% replied as neutral and 18% users were not satisfied.

In the questions 13- 16, were asked to understand their thoughts about window's usage, design, place and size. The users in the offices which shared by others were unsatisfied with the usage of windows due to its location and size. Windows were usually located at the one side of the office room and it was not easy to have control unless the user

was not sitting next to the window. Another problem was in the workmanship of window detail which is creating unwanted air gaps. This cause air movement in winter and noise pollution. The users stated that opening direction of window creates discomfort as well because of all the windows of offices open to outside direction. Since there is no shading element/sunlight breaker on the facades, users need to keep their curtains closed all during the daytime, especially offices located at south-west facade (Figure 53).

Figure 53:Typical Window Type and Closed Curtains of Office Rooms
(Taken by author, 2018)

In the questions 17 - 20, the questions was about indoor temperature during summer and winter with HVAC system ON or OFF condition for both seasons of the year. The HVAC system units were not working properly for all offices and answers may show differences according to people preference and as well as office location in the building (south-west or north-east facade). The question for the first condition was; indoor temperature in summer with HVAC is ON. 15% of participant was very satisfied and 40% is satisfied while 23% is not satisfied with the temperature and 12% is neutral.

The second was in summer as well but the condition was HVAC is OFF. 64% of participants were replied with very unsatisfactory and 30% is unsatisfactory. In total 6% for neutral, satisfactory and very satisfactory.

For the winter season, the first question was with HVAC is ON; in a total 48% was very satisfied or satisfied but 32% was unsatisfied with the indoor temperature even with use of a mechanical heating system. 20% replied as neutral. When the HVAC is OFF condition was asked; 70% of users were very unsatisfied or unsatisfied while only 20% is satisfied with indoor temperature and 10% replied as neutral for the question.

Figure 54:Typical Mechanical Cooling&Heating Unit in an Office Room
(Taken by author, 2018)

In the question 21, ventilation and air quality were asked. 45% of participants were unsatisfied while only 25% was satisfied. 30% was replied as neutral for the question. The users with health problems were more sensitive about air quality and natural ventilation factors.

The last question was left open for participants to write if there is an additional comment about facade design and performance with their observations. The 13 out of 40 participants wrote a comment and these feedbacks were added to research in page 71-73.

Chapter 5

CONCLUSION

This study aimed to evaluate a user's comfort and satisfaction levels and perceived productivity in relation to facade design and performance of the office building. The objective was to identify possible relationships between the facade design characteristics within its performance, and the overall satisfaction of users with the office environment. In order to achieve the aim of the research, the first chapter presents an introduction to the subject with problem, aim, scope & limitation and methodology of the study are statement. The literature reviews are started from the field which can make a base for the research. The applied methodology (POE) is explained in third chapter and previously done studies are given.

According to the evaluation, the results show that users were not satisfied with many factors. The indoor temperature during summer and winter, ventilation and air quality, windows design and general facade design were the most unsatisfied factors among other feedbacks. The building was very depended on HVAC system. The precaution for indoor temperature without HVAC was not considered in design phase. Thermal insulation on facade was not applied and window details and materials were not selected correctly. Low quality of workmanship for windows application cause air gaps. Size and location of windows create low privacy for the offices which located on the ground floor. Cross ventilation was not considered carefully, it is difficult supply a fresh air with comfortable working space.

The users in offices located on the north-east facade should keep the lighting elements on, during the day in the winter period, otherwise, lack of natural lighting will not be enough to create visual comfort for the work. This problem is repeating for the corridors as well during the year. The offices get sunlight during the morning time, this can be good opportunity to have low temperature during summer, but it creates a low thermal comfort during the winter. The need of modern HVAC is necessary since the building is very depended on mechanical systems.

For the offices on the south-west facade, daylight and glare is higher compared to other offices. During summer period, users prefer to keep the curtains off to have shaded space and the cooling system is always working during the day, otherwise high temperature will effect to user's comfort. In winter period, sunlight helps to warm the offices but since the sun level is low, the low winter sun shines across the room for most of the daylight hours. As a result of this, most of the users prefer to work behind wall where sunlight can not effect them directly.

The south-east facade has openings for corridors and chair's offices. These offices are located at the edge of the second floor, the office which located between south-west and south-east has thermal comfort problem during summer, and the other office has during winter period.

The north-east facade has openings for dean office, corridor and one of the seminar room. Due to the colored building of the faculty and trees; these spaces are shaded during the day. Lack of sunlight decrease the indoor temperature.

5.1 Recommendations

According to the evaluation result, it is important to provide recommendations for the case building and future projects. The recommendations will be based on results and literature review. Some possible solutions for improving the facade design and increasing the performance of facade for user satisfaction in the building;

- Application of plaster for necessary parts and special thermal exterior paint which can increase the thermal comfort and give an aesthetical good condition. Selection of colors by defining important spaces on the facade of the building can create an architectural value.
- The consideration of the trees at north-east for the sea view, natural lighting and privacy factor is important to be mention.
- Application of secondary window/opening for the offices which are shared type due to the need for natural lighting and well-ventilated space can be option.
- Due to feedbacks about window; air gaps, size, location, transparency, a way of opening, privacy at ground floor and usage, the change of window type is necessary. Double glazed window with the upper opening can be recommended as a modern and easily operated type. Mosquito screen can be integrated within the frame because of having mosquito in the area.
- Regular maintenance for the HVAC units, application of shading elements by considering the sunlight for necessary facades, especially for the south-west are the possible solutions to increase thermal comfort at offices. Egg crate shading element is a good option to be applied for a south-west facade of the building (Figure 16).

- In order to increase the air quality and ventilation which can be controlled and will not disaffect the office rooms, the application of stack effect ventilation at the roof level can be a solution (Figure 12). This can also help to achieve a low temperature in the building during the summer period of the year.

The double-skin facade can provide a good thermal comfort during the under-heated (cool) period in Famagusta. Single-skin facade offices get warm during noon-time, while double-skin facade offices have a more balanced temperature. For the other times, a double-skin facade keeps contributing for the heating of the building (Alibaba & Ozdeniz, 2016).

Due to the Cyprus climate conditions and amount of the wind, users needs, building type and the case of the thesis show that importance of facade design is high and must be considered from the beginning of the project. Double skin facade with ventilation solutions such stack effect ventilation is a great design solution to be considered during the design phase of future projects in Cyprus.

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APPENDICES

Appendix A: Ethics Committee Permission Letter

Doğu Akdeniz Üniversitesi
"Uluslararası Kariyer İçin"
Eastern Mediterranean University
"For Your International Career"
P.K.: 99628 Gazimağusa, KUZEY KIBRIS / Famagusta, North Cyprus, via Mersin-10 TURKEY
Tel: (+90) 392 630 1995
Faks/Fax: (+90) 392 630 2919
bayek@emu.edu.tr
Etik Kurulu / Ethics Committee

Sayı: ETK00-2018-0195 22.06.2018
Konu: Etik Kurulu'na Başvurunuz Hk.

Ömer Anıl Sürme

Mimarlık Fakültesi
Yüksek Lisans Öğrencisi

Doğu Akdeniz Üniversitesi Bilimsel Araştırma ve Yayın Etiği Kurulu'nun ***21.05.2018*** tarih ve ***2018/59-10*** sayılı kararı doğrultusunda, ***"User Satisfaction and Interaction with Building Façade: Assessment of Office Building, Faculty of Architecture, EMU"*** adlı araştırmanız, Bilimsel ve Araştırma Etiği açısından uygun bulunmuştur.

Bilginize rica ederim.

Doç. Dr. Şükrü TÜZMEN
Etik Kurulu Başkanı

ŞT/ba.

Appendix B: Sample of Questionnaire

Particapant No:……

Eastern Mediterranean University – Faculty of Architecture

SUBJECT:

User Satisfaction and Interaction with Building Façade: Assessment of Office Building, Faculty of Architecture, EMU

QUESTIONAIRE

Student Name: Ömer Anil Sürme Student Number: 16500128

The aim of this survey is to find out the effect of façade design on user's life in their working area.

Before continuing, please take a few moments to read and acknowledge the following terms.

I understand that my participation in this questionnaire is voluntary. I can request for my data to be withdrawn from the study and I am under no obligation to respond to all questions.

I understand that all information will be treated with the utmost confidentiality and that my anonymity will be respected at all times.

I agree to the above terms and would like to take part in this survey.

a. Yes b. No

Part. I

1- Do you have any health problem?

a. Yes b. No

(If your answer is **YES**, please write in the place provided) ……

2- Sex of respondent

a. Female b. Male c. No Answer

3- Age of respondent

a. Below 30 b. 30 - 40 c. 41 - 50 d. 51 - 60 e. Above 60

4- Educational level of respondent

a. High School Education b. Undergraduate c. Master d. PHD

5- Which direction your office room is facing?

a. to Car Parking Area (North-East) b. to Garden (South-West)

6- On which floor your office room is located in the building?

a. Ground (0) b. First (1) c. Second (2)

7- Your office room in the building

a. Occupied by alone b. Shared with others

8- How long have you worked in this building?

a. Below 1 year b. 1-3 years c. 3-6 years d. Above 6 years

9- How long did you spend in the current office room?

a. Below 1 year b. 1-5 years c. 3-6 years d. Above 6 years

10- How long do you spend in office room during the day?

a. Below 1 hour b. 1-4 hours c. 4-8 hours d. Above 8 hours

11- How many days you spend in office room during the week?

a. Below 1 day b. 1-3 days c. 3-5 days d. Above 5 days

End of Part I.

Part. II - Please answer the following questions by choosing your response according to;

1: Very Unsatisfactory **2:** Unsatisfactory **3:** Neutral **4:** Satisfactory **5:** Very Satisfactory

---

12- How would you rate the overall quality of your office room?

a. 1 b. 2 c. 3 d. 4 e. 5

13- How would you describe the summer indoor air temperature with HVAC system ON? *(HVAC: Heating, ventilation, and air conditioning system)*

a. 1 b. 2 c. 3 d. 4 e. 5

14- How would you describe the summer indoor air temperature with HVAC system OFF? *(HVAC: Heating, ventilation, and air conditioning system)*

a. 1 b. 2 c. 3 d. 4 e. 5

15- How would you describe the winter indoor air temperature with HVAC system ON? *(HVAC: Heating, ventilation, and air conditioning system)*

a. 1 b. 2 c. 3 d. 4 e. 5

16- How would you describe the winter indoor air temperature with HVAC system OFF? *(HVAC: Heating, ventilation, and air conditioning system)*

a. 1 b. 2 c. 3 d. 4 e. 5

17- How would you describe the ventilation and air quality of the office room?

a. 1 b. 2 c. 3 d. 4 e. 5

18- How would you rate the overall degree of ornament, detail and relief on the façade design (exterior wall) of your office room?

a. 1 b. 2 c. 3 d. 4 e. 5

19- How would you rate the windows' design of your office?

a. 1 b. 2 c. 3 d. 4 e. 5

20- How would you rate the windows' place on wall?

a. 1 b. 2 c. 3 d. 4 e. 5

21- How would you rate the windows' size?

a. 1 b. 2 c. 3 d. 4 e. 5

22- Are you satisfied with the usage of windows?

a. Yes b. No

(If your answer is **NO**, please write the problems) …….

23- How would you rate the overall stylistic attributes of the building façade?

a. 1 b. 2 c. 3 d. 4 e. 5

24- How would you rate the office façade relation with outdoor, in the sense of privacy?

a. 1 b. 2 c. 3 d. 4 e. 5

25- Is there anything else you would like to add?

(please write in the place provided) …….....

……

Thank you for your participation in this survey. ☺

Appendix C: Letter of Information/Voluntary Participation

Department of Architecture,
Eastern Mediterranean University,
Famagusta, TRNC

LETTER OF INFORMATION/ VOLUNTARY PARTICIPATION

User Satisfaction and Interaction with Building Façade: Assessment of Office Building, Faculty of Architecture, EMU

Introduction/ Purpose: Assoc. Prof. Dr. Sadiye Müjdem Vural of Department of Architecture and student Omer Anil Surme of Architecture Department at Eastern Mediterranean University are conducting a research study to find out the effect of façade design on people`s life in their working area. You have been asked to take part because you are a member of EMU and working at selected buildings which will be analyzed for a case study. There will be approximately 50 total participants in this research.

Procedures: If you agree to be in this research study, you will participate in answering a series of questions about your office room. With your permission, photographs will be taken of your working space. Your participation in this one-time study will take approximately 15 minutes to complete.

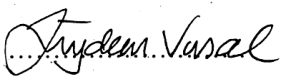
Risks: There is no risk in participating in this research.

Voluntary nature of participation: Participation in this research is entirely voluntary. You may refuse to participate or withdraw at any time you so wish.

Criteria for Exclusion: Your participation will be excluded if you give any information which is deemed inconclusive or if you do not satisfactorily complete the questionnaire.

Confidentiality: Research records will be kept confidential. To protect your privacy, personal, identifiable information will not be collected. Photographs will be kept indefinitely for the purpose of developing future studies. Items in the photographs taken that can be directly linked to your identity will be blurred. There will not be any voice recorded data.

Assoc. Prof. Dr. Sadiye Müjdem Vural, Supervisor
Department of Architecture
+90 548 857 06 90
smujdem@gmail.com
Date: 22/6/2018

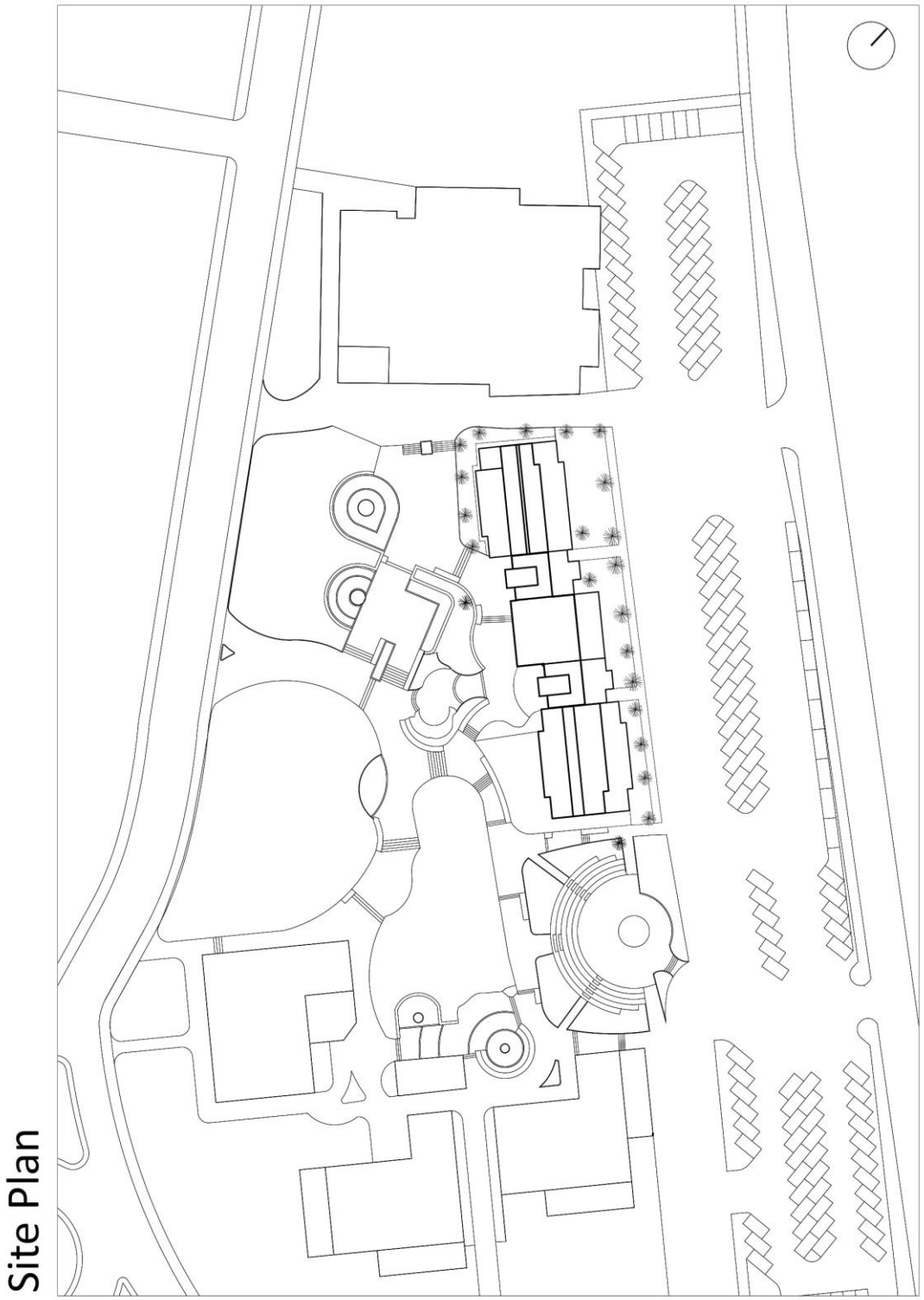


Ömer Anil Sürme, Student
+90 533 861 64 55
omersur@hotmail.com
Date: 22.06.2018

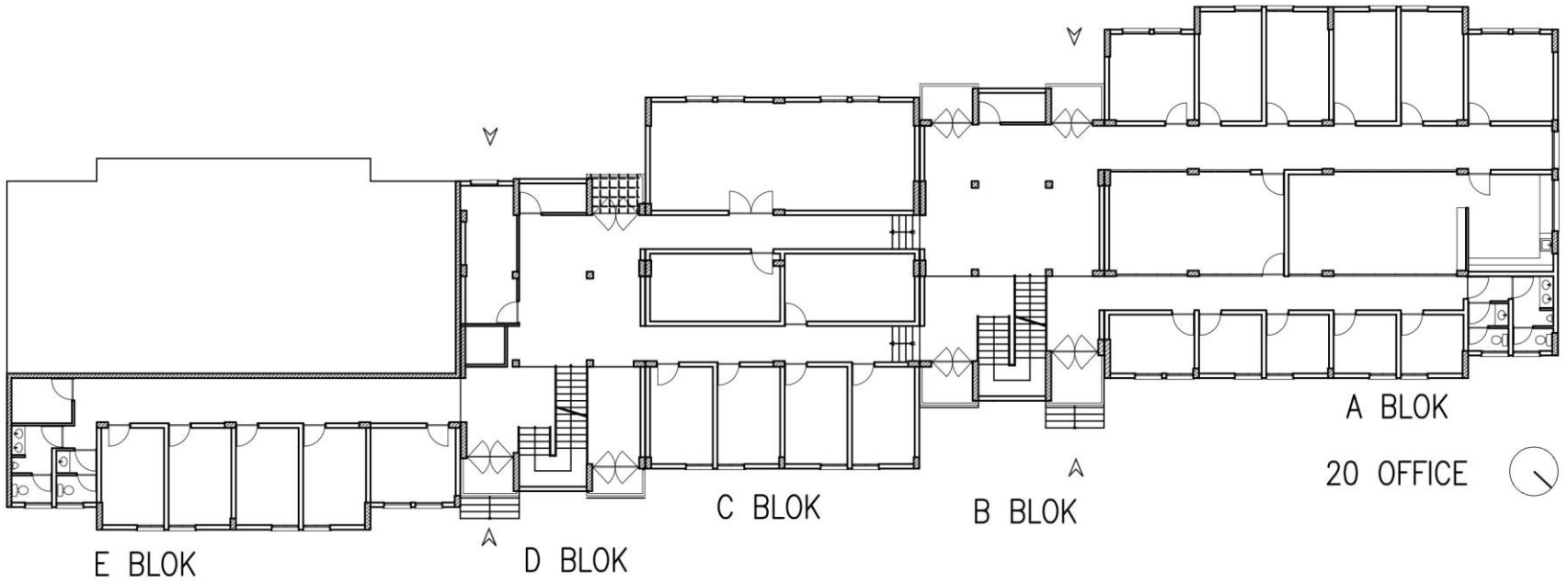
Volunteer Participant:
Date:

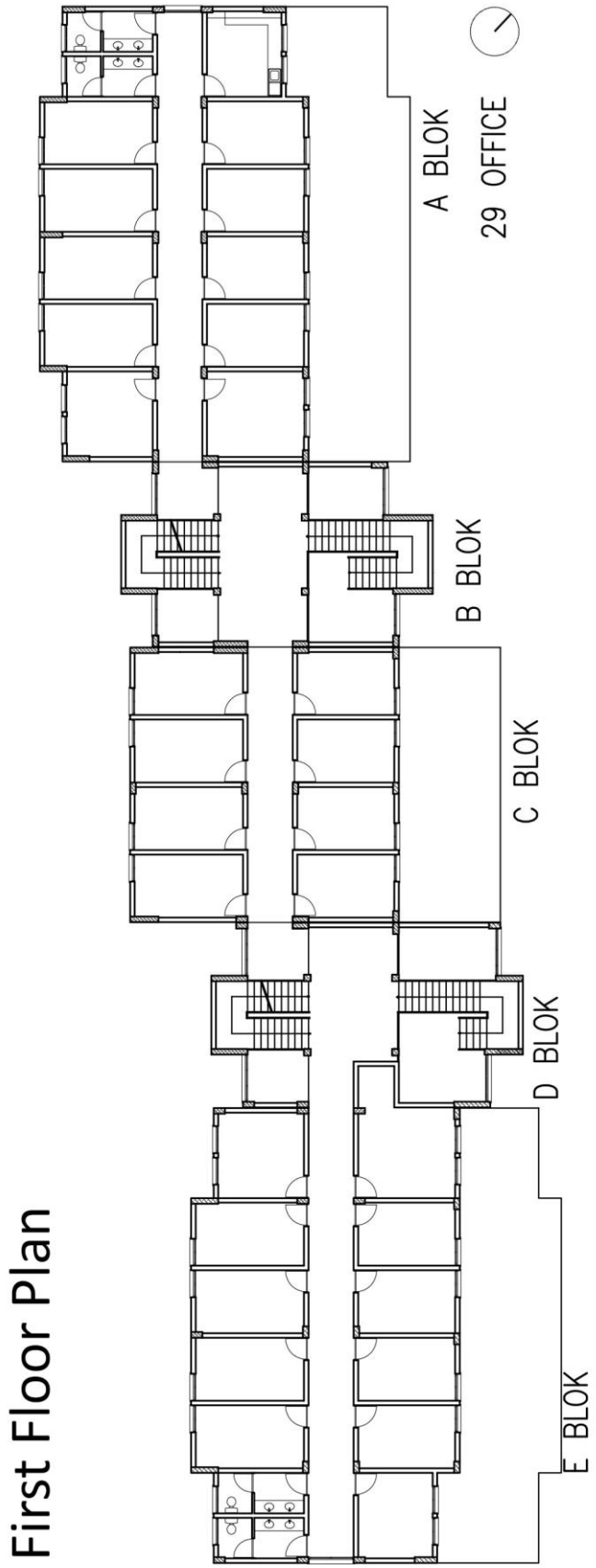
.....

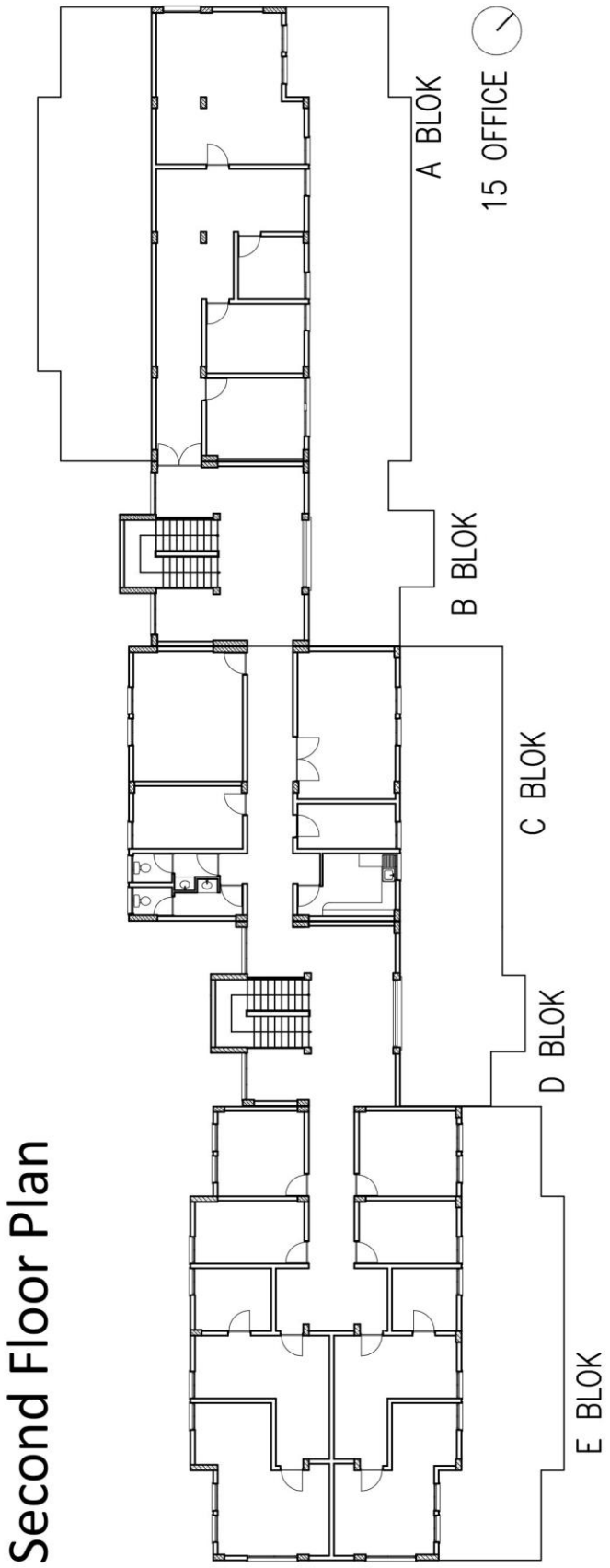
Appendix D: Drawings of the Architecture Office Building



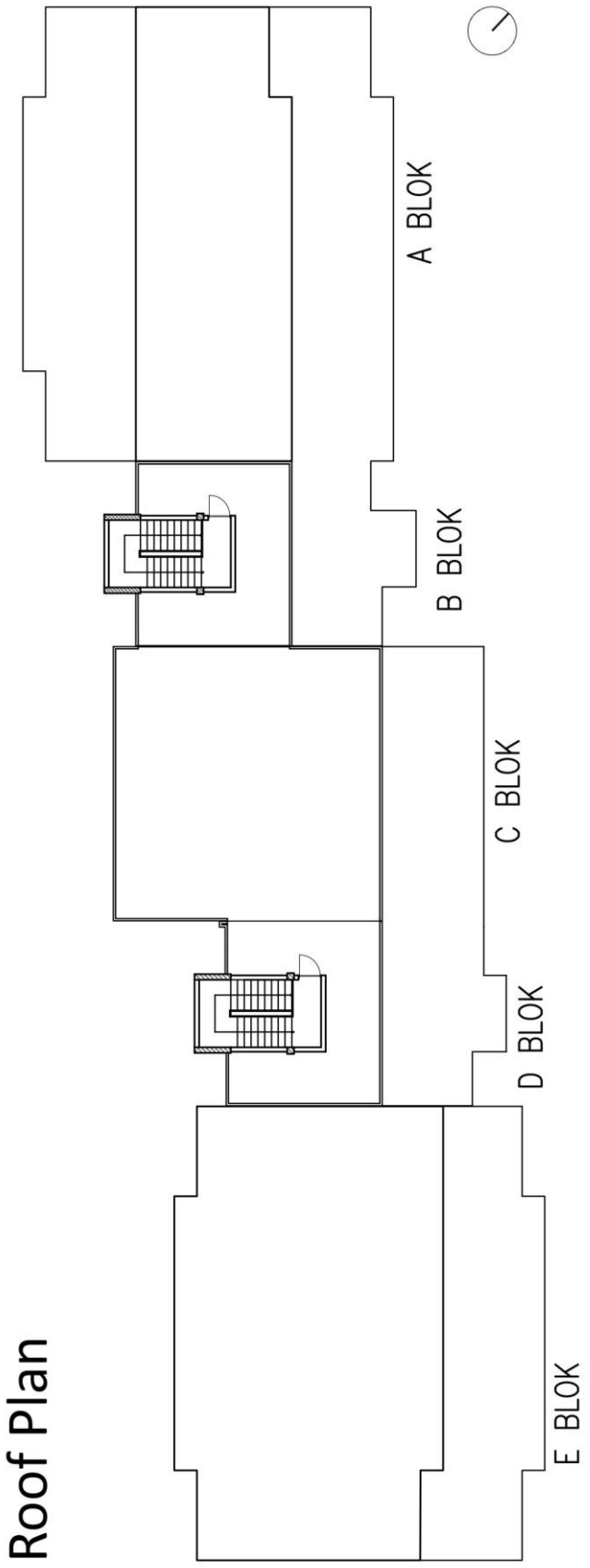
Ground Floor Plan



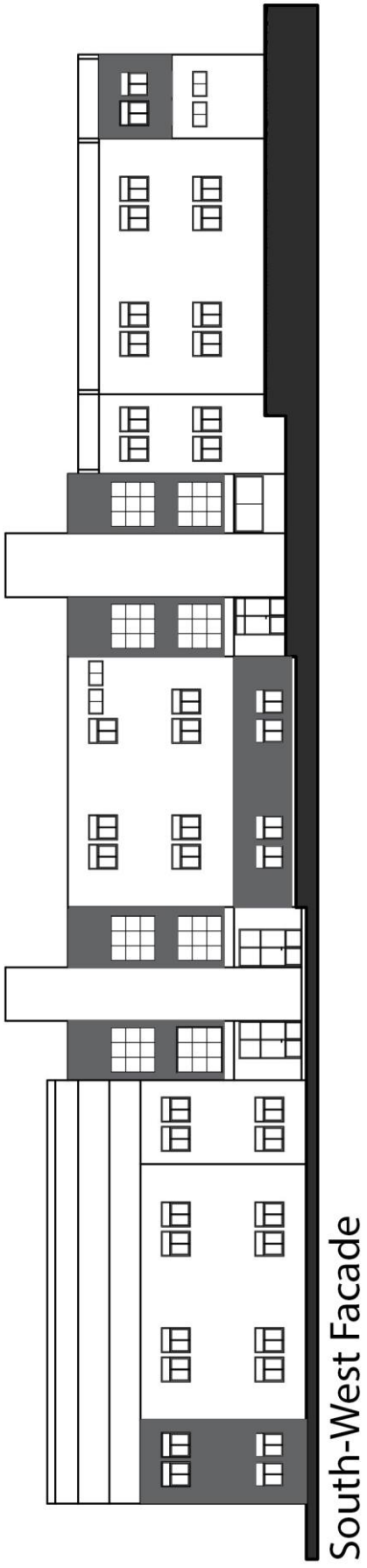

First Floor Plan
A BLOK
29 OFFICE
B BLOK
C BLOK
D BLOK
E BLOK

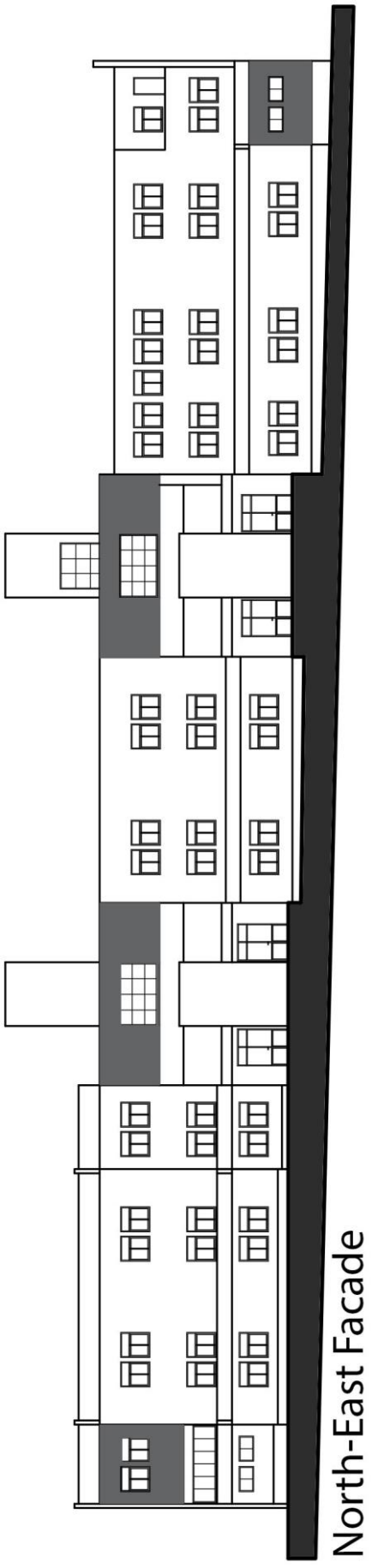


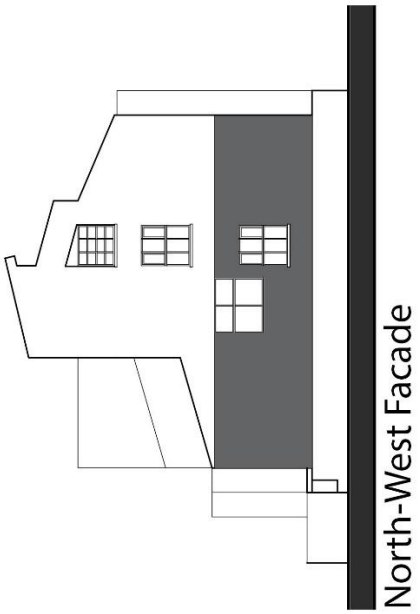
Second Floor Plan

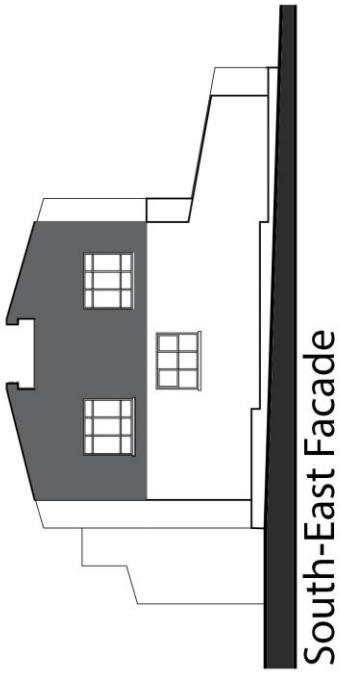


Roof Plan

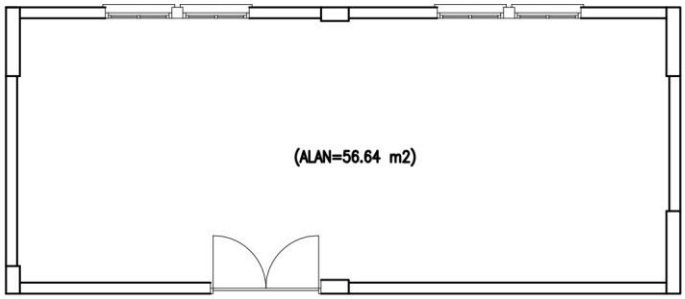

South-West Facade

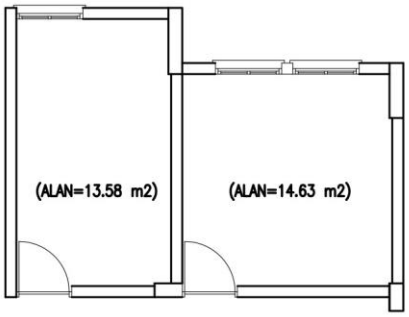

North-East Facade

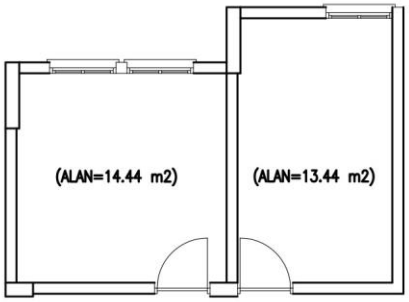

North-West Facade

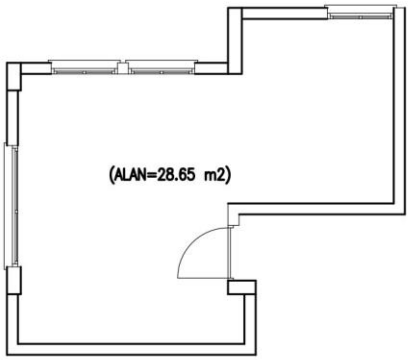

South-East Facade

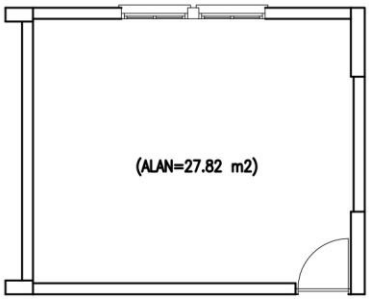
TYPCIAL OFFICE PLANS ON SOUTH-WEST











TYPCIAL OFFICE PLANS ON NORTH-EAST