LIGHTING PREFERENCES OF INSTRUCTORS FOR OFFICES: CASE STUDY IN ÇANKAYA UNIVERSITY FACULTY OF ARCHITECTURE

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LIGHTING PREFERENCES OF INSTRUCTORS FOR OFFICES: CASE STUDY IN ÇANKAYA UNIVERSITY FACULTY OF ARCHITECTURE

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Submitted by **Naima Issa**

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ABSTRACT

LIGHTING PREFERENCES OF INSTRUCTORS FOR OFFICES: CASE STUDY IN ÇANKAYA UNIVERSITY FACULTY OF ARCHITECTURE

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The aim of this thesis is to study the artificial lighting preferences of instructors in the offices of Interior Architecture and Architecture departments in Çankaya University. In addition, to find out if there is an effect of the intensity of artificial lighting, age, gender, Correlated Color Temperature (CCT) of light on the preferences of artificial lighting of office users. In order to measure the intensity of artificial light in the offices, a field study was conducted and a questionnaire was administered to the office users. The results of the study revealed that most of the office users prefer to use both artificial and natural lighting, and fluorescent light is the most preferred artificial lighting. Results showed that there was no significant relationship between gender and the type of lighting preference and the main type of artificial lighting preferred in the offices. Likewise, there was no significant relationship between gender and the sufficient intensity of the artificial lighting in the offices.

Keywords: Lighting, lighting intensity, lighting preferences, office

ÖZET

ÖĞRETİM ELEMANLARININ OFİSLER İÇİN IŞIKLANDIRMA TERCİHLERİ: ÇANKAYA ÜNİVERSİTESİ MİMARLIK FAKÜLTESİ'NDE SAHA ÇALIŞMASI

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Bu tezin amacı Çankaya Üniversitesi İç Mimarlık ve Mimarlık bölümlerinde bulunan ofislerin öğretim elemanları tarafından yapay aydınlatma tercihlerini araştırmaktır. Ayrıca, yapay ışıklandırmanın yoğunluğu, yaş, cinsiyet, ışığın benzer renk sıcaklığı (BRS)'nin bu ofisleri kullanan öğretim elemanlarının yapay ışıklandırma tercihlerinde bir etkisinin olup olmadığını araştırmaktır. Ofislerdeki ışığın yoğunluğunun ölçülmesi için alan çalışması yapılmıştır ve ofis kullanıcılara anket verilmiştir. Bu çalışma ofis kullanıcılarının çoğunun hem yapay hem de doğal ışıklandırma kullanımını tercih ettiğini ortaya çıkarmıştır. Sonuçlara göre ofis kullanıcılarının çoğunun floresanı tercih ettiğini göstermiştir. Bunun yanında ofis çalışanları ve aydınlatma tercihleri türleri arasında cinsiyete dayalı önemli bir bulgu bulunmadığını ve ofis ortamında yapay aydınlatmanın genel tipinin tercih edilmekte olduğunu göstermektedir. Ayrıca, ofis çalışanları ve ofislerinde yapay aydınlatmanın yeterli düzeydeki yoğunluğu arasında da önemli bir ilişki olmadığını göstermiştir.

Anahtar Kelimeler: Aydınlatma, aydınlatmanın yoğunluğu, aydınlatma tercihleri, ofis

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1. INTRODUCTION

Most of the information in life is received through the eyes because the people live in a visual world, and sight is the most important sense in the human body which is responsible for more than 80% of the all information reception such as reading, writing, and watching. But without light, people cannot do any of the visual activity (El Hawary, 2011). Lighting is an important element in life and it is divided into two types: natural and artificial lighting (Ezzat, 2012).

Natural light comes from the sun and it is entered into the buildings through the windows and other openings (El Hawary, 2011). Artificial light is a type of light that comes from electrical sources like electrical lamps. It is used to replace the natural light during the night and in places where daylight or natural light cannot reach. Now there are some designs that use artificial lighting instead of windows.

Light is a major element in architecture. It affects the usefulness of a building and the enjoyment of the interior of it. It also impacts the way user's sense about themselves and others (Gordon, 2005). According to Lighting Deluxe (2003) "the design of lighting in a building requires advanced planning to achieve the best result, as we know the function of light isn't limited to lighting itself, but it has the most role in highlighting of details and decoration and also furniture, there is a variety of light bulb types that provide good lighting and reduce the tiredness and stress".

In offices, the natural light that comes from the outside is the major source of lighting while the artificial lighting is essential especially for the night work. Recent studies have shown that the combination of natural and artificial lighting is necessary in order to improve the quality of work (Lighting Deluxe, 2003). Today, there is no longer need to make a sufficient amount of windows to provide the necessary light during the day, but its presence is very important because it connects the worker to the exterior environment. Artificial lighting in the offices is usually based on the shining light bulbs that are fixed on the ceiling in both visible and hidden form in order to give homogeneous lighting over the whole workplace and allow the arrangement of office according to work requirements and the taste of the occupant (A Handbook of Planning of Office Buildings, 2013). “Design of office lighting should be made by a special method where it needs to distribute the lighting around the area of reading, writing or drawing” (Lighting Deluxe, 2003). Artificial lighting in the offices must be designed by the interior design engineers by following specific rules in order to make well lighting and guarantee good reflection to light the ceilings, surfaces and walls, reduce anxiety, noise and guarantee good and comfortable work environment to the user to make him feel comfortable especially if the work hours are long.

Through the years offices have changed. When they were with unique use, the offices consisted of multiple organizations that depended on providing sophisticated and dynamic resources especially artificial lighting. Thus, organizations must spend greater effort than ever in order to support multiple and different activities and many class of employees. At the present time, designers and office managers highly focus on the productivity and health of the employee, in addition to providing energy and national efficiency. Through the use of control elements and delivery technology, the artificial lighting can be customized on the individual level. At the same time, the suitable lighting enhances the work environment for these persons who are inside the office.

Through the previous studies that have been conducted in buildings and on many users of these buildings, it is noticed that the efficiency degree of employees in the offices are affected by some factors and one of these factors is lighting. It is noticed that the intensity of the light highly affects the mode and efficiency of the workers. As well as the temperature of the light affects the user preferences. Furthermore, age and gender differences are considered highly affected factor at the lighting preferences in the work area (Roelofsen, 2002).

1.1. Aim of the Study

The aim of this thesis is to study artificial lighting preferences of instructors for offices of Interior Architecture and Architecture departments of Çankaya University and find out if the current lighting is suitable for their use of reading, writing and computer use. In addition, to found out if there is an effect of the intensity of artificial lighting, age, and gender, CCT of light in the preferences of artificial lighting of office users or not, as well as to find better methods for lighting in offices. This topic has been chosen because it has been seen that the users of these offices created their own lighting environment but no lighting choice has been given in the office.

1.2. Structure of the Thesis

The thesis consists of five chapters. The first chapter is the introduction in which lighting is explained and the importance of lighting in the architecture and the effect of lighting in our life are stated, the aim of the study and the structure of the thesis are stated.

In the second chapter, lighting is defined with respect to its importance and history. Types of lighting are discussed in relation to natural and artificial lighting. Artificial lighting is described according to its types and characteristics.

The third chapter states the interior lighting in offices, design guides for office lighting and the factors affecting user preferences of lighting in workplace such as intensity of lighting, correlated color temperature, age, and gender. The fourth chapter includes the case study in which the aim of the study, the research questions, hypotheses, participants, and procedure are described. The results of the case study are evaluated and discussed. In the last chapter, major conclusions about the study and suggestions for future research are stated.

2. LIGHTING

Lighting plays a very important role in our lives. Lighting is one of the factors that affect interiors. By the 1940s, daylight was a major source of lighting in buildings until artificial lights supplemented natural light. In a short span of 20 years, electric lighting has transformed the workplace in order to meet most or all of the lighting requirements of the occupants (Musa, Abdullah, Che-Ani, Tawil, & Tahir, 2012). The history of light begins with the discovery of fire. Human's ability to dominate fire has set us apart from all other creatures on earth (Thum, 2013).

Light sources are instruments of producing light. Light sources are technical devices that convert usually electric energy into radiation - partly to light. Based on the way they work, light sources are divided into two types of lamps (Majoros, 2011). According to the Handbook of Planning of Office Buildings (2013) "office is an architectural and design phenomenon, whether it is a small office or a massive building. The main purpose of an office environment is to support its occupants in performing their assignments at minimum cost and maximum satisfaction. In recent times, the importance of changing the climate and its effects on the environment are being given more attention in design practices. Sustainable workspaces are becoming more prominent" (p.3).

The light of the offices has an impact on the mood of persons working there (Küller, Ballal, Laike, Mikellides, & Tonello, 2006). Good visual and lighting conditions help to maintain that workers feel at comfort, both physically and mentally. It is absolutely necessary that the lighting does not confuse the users. The really luxurious art of good lighting solutions is to provide smart options for changing or adapt the lighting and visual situation according to the users' individual needs (Kelter, n.d). The standards and guidelines incorporate the following key principles: departments should be empowered to plan their office space. Standards and guidelines should be simplified. Space should be allocated according to functional requirements. Space should be flexible (Kelter, n.d.). According to Zumtobel (2014) “The quality of office lighting from the viewpoint of the user, and with the discrepancy between the actual case and the users’ preferences allows for specific design principles to be derived as a basis for effective lighting concepts that are sufficient to users and activities, beyond existing standards and procedures” (p.6).

2.1. Definition of Lighting

Light is considered one of the most well-known forms of energy which are known as electromagnetic radiation that also comprises radio waves, X-rays, and heat. Electromagnetic radiation travels outward from its original source in a waveform, such as ripples in a pond (Tippens, 2007). The speed of light in a space is the same as the speed of electromagnetic waves which is approximately 300,000 kilometers per second (Figure 2.1.).

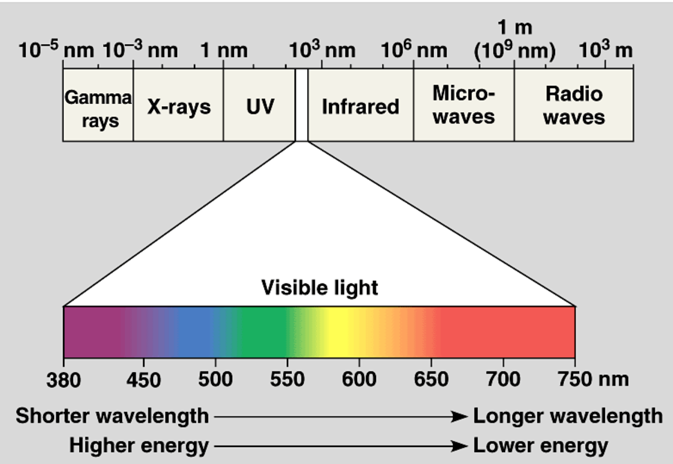

Figure 2.1. Visible Spectrum (Color Physics, n.d.)

Light is very important for vision. If the light reaches an object, some of it will be absorbed and some will be reflected by the object. When some of the reflected light reaches the eye, it will give the eye the ability of vision. As it can be seen in Figure

2.2, the light comes from the object passes through the pupil and is focused by the lens onto the light sensitive retina. The lens is attached to a group of muscles that are the contract and relax in order to change the shape of the lens and this change gives the ability to focus the near and far objects. The light is converted to electrical impulses by the retina in order to be sent to the brain by the optic nerve. The retina consists of two types of light-sensitive cells which are rods and cones. The cones need a high level of light in order to work well and they distinguish the color information, whereas rods work well at low light levels and they enables individuals to distinguish only white and black and this explains the lack of good vision at night (Abramowitz, Neaves, & Davidson, 2016; Garcia-Diaz, Leboran, Fdez-Vidal, & Pardo, 2012).

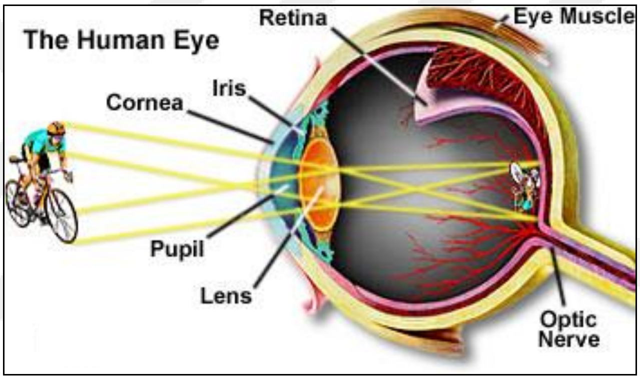

Figure 2.2. The Human Eye (Abramowitz et al., 2013)

In order to get a fully or good lighting to a specific building, it should find a good design to that building and that's required to enhance the design of that building or replace it with a new one. We have to design a lighting scheme even if we want to get a good lighting for one room. The process of implementing the lighting system is not only done by choosing the lighting units but it must be taken into consideration the elegance and attractiveness of the place to be illuminated (Amaireh, 2012).

2.2. The Importance of Lighting

Light is considered a vital and natural phenomenon and the people need it in order to see the world around us. At present time and after relying on a wide range of electric and artificial lighting sources, which been invented by a human, the people are less depend upon lighting sources that are emitted from sun, moon, stars and flames from combustible fuels. The sense about the environment is determined by quality, quantity, and the intensity of light surrounding us (Musa et al., 2012). It should realize the relationship between colors and light surrounding us, what we see and how we see. If the place is not occupied or visited by people, there is no need for the presence of natural lighting. The main and the only reason for the existence of lighting is to allow people to adequately execute their physical or visual functions and jobs and perform their tasks depend heavily on the quantity and quality of the existing lighting of that environment (Thum, 2013).

Lighting installation must be designed primarily for the comfort of people who occupy the spaces. The mission of effectiveness, energy effectiveness and aesthetic value of the lighting installation are the secondary consideration. Nevertheless, there are many issues that contribute and highly increase the efficacy of energy using such as energy pricing and climate change which together affect the society. In order to achieve the highest quality of product or image, it should provide correct or optimal lighting, while recognizing the need for energy efficacy. Furthermore, the employees' productivity and morale are highly dependent on the type, quantity, and quality of the lighting system installed. The most significant thing that must be remembered is that lighting is based on 50% fact and 50% psychology. The complaints of people and employees who have occupied one place are highly about the inadequacies of the lighting system installed *(*A Handbook of Planning of Office Buildings, 2013).

2.3. History of Lighting

The history of light begins with the discovery of fire (Thum, 2013). By the 1940s, daylight was the major source of lighting in buildings and artificial lights were supplemental to natural light. In a short span of 20 years, electric lighting has transformed the workplace meet most or all of the lighting requirements of the occupants (Musa et al., 2012).

The history of lighting extends for long periods (around: 300,000 years ago) where the humans started using fire and made it as sources for light and warmth. Humans used the glowing flame for the purpose of lighting and warmth in the caves where sunlight did not reach inside. The wonderful drawings, which are inside the cave of Altamira that dates back to 15,000 years, points that they have been made by using artificial lighting. Light emitted from the flames have changed radically the life of a prehistoric human. Furthermore, artificial lighting has been used in outdoor applications in addition to its use in enclosed spaces (Nordhaus, 1996).

In the early stages of history, there were flares and their functions were to give decorations. However, liquid-fuel lamps that were used for thousands of years have not subjected to any enhancement until the invention of Aimee Armand's for the central burner in 1783. In the same year, Dutchman Jan Pieter Minckelaers developed a process that enabled gas to be extracted from coal for streetlamps. Nearly concurrently, experiments have been started on electric arc lamps – fueling research that acquired practical significance in 1866 when Werner Siemens succeeded in creating electricity economically with the dynamo help (El Hawary, 2011). However, it can be said that the age of light started in 1879 by Thomas A. Edison reinvention and technological application of the incandescent lamp invented 25 years previously by the German clockmaker Johann Heinrich Goebel where the sources of light have been developed with different phases starting from campfire and kindling to a candle and electric light bulb (Latson, 2014). In recent past decades, the lamp has been highly developed with various aspects depending on modern materials and technologies in order to achieve the maximum efficiency and also reduce the environmental impact (El Hawary, 2011).

Artificial lighting began working out thousands of years ago and being developed in each period to suit the technology in that period until the present time. Lighting era extends to the prehistoric starting from a fire, torch and in the time advent many improvements and technologies are added related to light technologies. In the nineteenth century, and with the discovery of electricity and electromagnetism, scientists tried to devise a simple electrically powered light in order to light homes with reasonable prices. Such attempts led to one of the most important inventions of mankind which was the invention of the light bulb (Ropp, 1993). Lights that have been invented previously do not light up a room with age of' less than 15 hours. The credit for mounting the first long lasting filament goes to Edison and in 1979; he finally prospered in creating a bulb carbon filament, which burnt brightly for 600 hours at its first trail. Later, scientists forced to advance the filament until they discovered that tungsten filaments outlasted the whole types. Thereafter, these long lasting lamps took great popularity and installed immediately in billions of houses distributing all over the world. Progressively, considerable trend progressed with the creation of fluorescent lamps. Nevertheless, they contain mercury-hazardous waste. Thus, a new alternative lighting has emerged recently which are eco-friendly and energy efficient lighting (Chitnis, Swart, & Dhoble, 2016). A brief history of lighting can be seen in Figure 2.3.

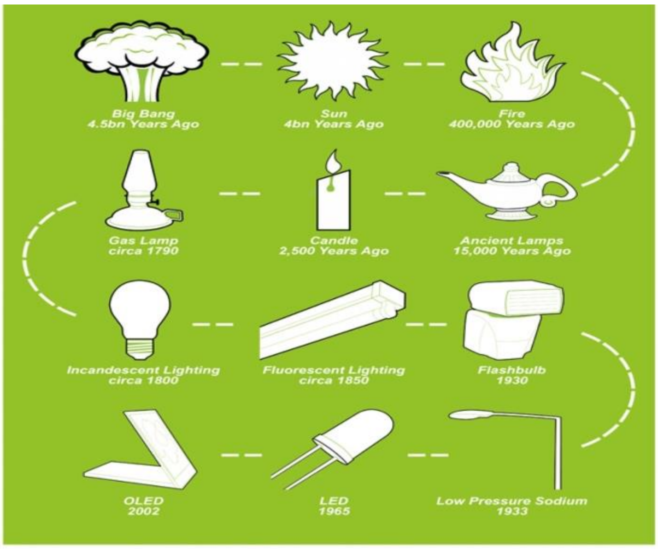

Figure 2.3. A History of Lighting (http://visual.ly/brief-history-lighting)

2.4. Types of Lighting

2.4.1. Natural Lighting

The sun is considered one of the most common natural light sources. The quantity of radiation that is emitted by the chromosphere of the sun at nearly about 6000 K crests in the visible region of the electromagnetic spectrum when plotted in wavelength units (Natural Light, n.d.). Around 44% of the sunlight that reaches us from the sun is visible (Wikipedia, 2017a).

2.4.2. Artificial Lighting

The artificial lights work on the electrically powered lamps by phenomena of luminescence or incandescence. Thus, the artificial lights that work on the electrically powered lamps are classified as incandescent or luminescent lamps. The sub-classification of electrically powered lamps can be seen in Figure 2.4. Furthermore, the electrical lamps can be defined as that device that works by the electricity and produces the artificial lights by the flow of electrical energy and they are considered one form of electrical lighting (Waymouth, 1971). The light source is identifying the performance of any light fixture. There are wide differences in the performance of bulbs and the way of their flaming according to the differences of the light sources of the bulbs and the effects of their lighting. Compared with the current scenario, the efficient lighting lumps are those which have the ability to emit the white light with high quality and save the essential energy (Chitnis et al., 2016). In order to optimize the vision in the architectural studios, the artificial lights are used. This situation will affect the ability of the user to observe visual stimuli in short period and health in vision terms in the long run (Musa et al., 2012).

Figure 2.4. Types of Artificial Light Sources

(http://pt.slideshare.net/suhailtp91/types-of-lamps-38363471/5

2.4.2.1. Types of Artificial Light Source

There are many types of artificial light sources, this part discusses these types, characteristics, and how they work.

2.4.2.1.1. Incandescent Bulb

In an incandescent lamp, light occurs by passing electricity through a tungsten filament that heats it and produces light (Lechner, 2009). The incandescent lamp provides the light by the phenomenon which is known as the incandescence. This phenomenon is working when a wire filament is heated to a great temperature by passing the current electric through it as shown in Figure 2.5. In order to protect the filament it is covered by quartz or glass bulb which is evocated or filled with inert gas. The light that is created will be at the whole frequencies from the infrared to the ultraviolet at the other end of the light spectrum. They have less efficiency as they are able to convert less than 10% of their energy as visible light and the rest in infrared (MacIsaac, Kanner, & Anderson, 1999). The array sizes of these lumps are wide with light output and rating voltages. The light that is produced by these lights are yellow-white, warm and are realized into the whole directions and are existing in either a frosted finish or clear. As well as, these bulbs can be of the reflective category, with the reflective coating inside the bulb which will direct the light in one way rather than entirely around through controlling the light more exactly (Paget, Lingard, & Myer, 2008). These bulbs became so commercial due to the low manufacturing cost and the requirements of the external devices which they need. The efficacy of luminous for the ideal incandescent bulb is 12–18 lm/W. These bulbs are considered typical choice for lighting that requires high brightness levels. Also, these bulbs contain the greatest problem in the quantity of heat radiation possessed which belong to inefficient way to the energy transforming into visible light and the most radiation is lost by the infrared radiation (Paget et al., 2008).

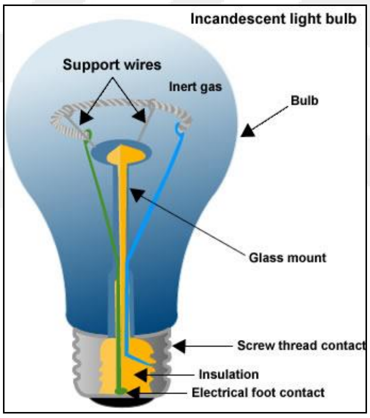

Figure 2.5. Incandescent Bulb
(http://craluxlighting.com/lighting/incandescent-light-bulb-diagram.php)

2.4.2.1.2. Halogen Lamps

A halogen lamp is considered an incandescent type of lamp where high-pressure halogen gas located inside the bulb permitting the filament to burn hotter and longer. Due to this a halogen lamp is a type of incandescent lamp, it comprises of a tungsten filament sealed with a compact transparent envelope filled with an inert gas and high-pressure halogen gas such as bromine or iodine in minor quantity. When the halogen lamps are compared with the other types, it will seen that they provide more light, last longer, and light brighter. Luminous efficiency of a halogen lamp is in the range 16–29 lm/W. Main milestones in the electrical lighting field comprise the invention evolution of the subsequent light sources as showed in Figure 2.6. (Baker et al., 2008).

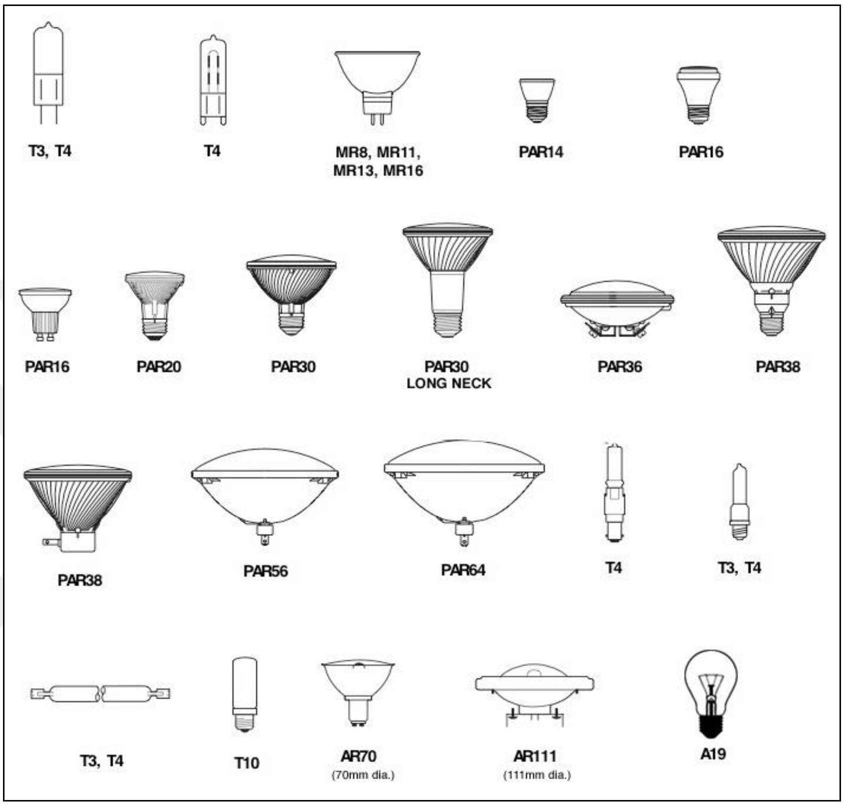

Figure 2.6. Types of Halogen Lamps (http://www.topbulb.com/halogen-bulb-types)

2.4.2.1.3. Gaseous Discharge

This type of technology works by passing the electricity through the gas which works on exciting it that lead to its glow. This technology is used by high-intensity discharge lights (HID), low-pressure sodium lights and fluorescent (Goldwasser & Klipstein, 1999). There are different lamps that use HID in order to produce light (see Figure 2.7):

- Mercury Vapor

- Metal Halide
- High-Pressure Sodium

Figure 2.7. Gaseous Discharge
(http://thegrowersedgeonline.com/GrowLights/GrowLightsHome.html)

2.4.2.1.4. Light Emitting Diode (LED)

The newest types of the artificial lighting are the light emitting diode (LED) that is born out of the electronics and computer industry. LED is defined as the tiny electronic device that emits the light.

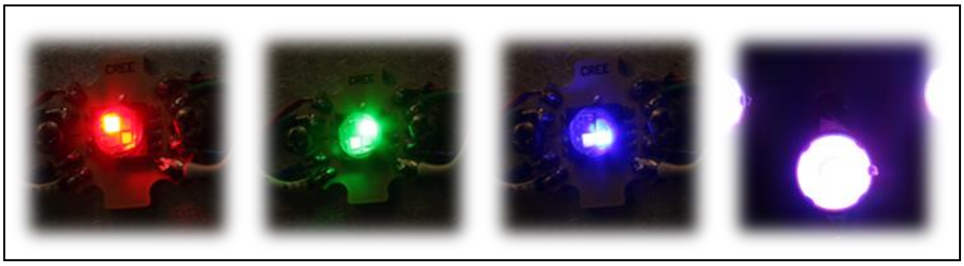

Figure 2.8. Different Colored LEDs
(http://www.noveltylights.com/9-led-assorted-multi-color-s14-bulb-medium-base-e27-led-s14-asst)

2.4.2.2. Characteristics of Artificial Light

Brightness, color, and temperature are considered the three significant features of light. The temperature and color are considered relatively subtle concepts but the brightness does not need to more explanation.

2.4.2.2.1. Intensity of Lights

The term intensity is used to define the rate at which light spreads over a surface of a given area some distance from a source. The intensity is different according to the distance from the source and the power of the source. The power is the property of light source that describes the rate where the energy of light which emitted from the source and the power is expressed by the unit of a Watt. Different light bulbs are characterized to have different power values. Usually, the power bulb which is determined the purpose of lighting. Typically, the purpose of light regulates what type of power bulb will be used in the light (Wikipedia, 2017b).

In photometry, illuminance is considered the whole luminous flux incident on a surface, per unit area. It is a measure of how much the incident light illumines the surface, wavelength-weighted by the luminosity function to relate with the perception of human brightness. Likewise, luminous emittance is the luminous flux per unit area emitted from a surface. As well as, the emittance of luminance is known as luminous existence. Illuminance is measured in lux (lx) or lumens per square meter. Previously, the illuminance called brightness but leads to the confusion with the other use of the word for example to mean luminance. The brightness is used only for no quantitative references of psychological sensations and perceptions of light and should never be used for the quantitative descriptions. The human eyes have the ability to see of somewhat greater than a two trillion fold range. The occurrence of white objects is somewhat visible under starlight, at $5\times10{-}5$ lux, while at the bright end, it is possible to read the large text at 108 Lux or about 1000 times that of direct sunlight. Though, this can be very uncomfortable and cause long-lasting afterimages (Wikipedia, 2017c).

2.4.2.2.2. Correlated Color Temperature (CCT), Contrast and Reflection of Light

Correlated color temperature (CCT) is the presence of light source color that can be measured by Kelvin degrees (Egan & Olgyay, 2002). Lighting is considered a major factor in highlighting and supporting the image of building and effect the feeling of the space itself. Color rendering and correlated color temperature are the two units that can be used to define the light source color characteristics. All the sources of light are not equal. Two white light sources may look the same but can make the colors look differently or give a different feeling to space. Consistent lighting in all over the space can be gotten by using lamps of the same CCT and with the same or very similar color rendering indices.

The color temperature perception is particularly beneficial for incandescent lamps that differ closely approximate a blackbody spectrum through the visible region. As well as, the color temperature of these lamps can define the spectrum in this region. CCT is an important metric in the general lighting industry to identify the supposed color of fluorescent lights and other no incandescent white-light sources for example LEDs and the high-intensity discharge HID lamps (Kumoğlu, 2013). The color produced by using these lamps when they are activated is classified as white and ranging between from a very cool light to a very warm white (Flynn, Segil, & Steffy, 1988). The whiteness degree is indicated by using Kelvin value. It ranges from the red at low temperatures through orange, yellowish white, white, and finally bluish white at the highest temperatures. CCT or the chromacity are simply denoted to the color appearance of a light source, “warm” for low CCT values and “cool” for high CCT values (Figure 2.9; Kumoğlu, 2013).

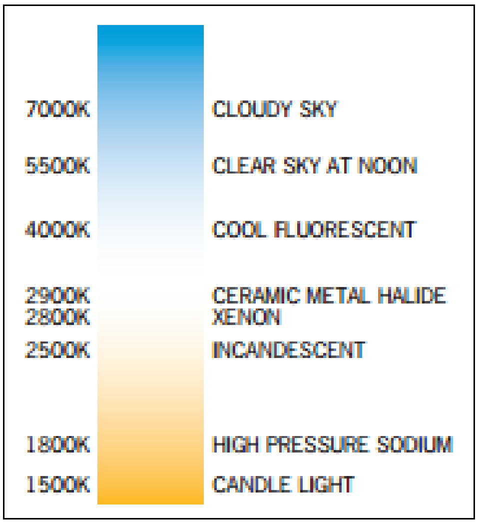

Figure 2.9. Cool and Warm Color Temperature
(Commercial Lighting Design Guide, 2014)

Choice of lighting and put it properly works to create a welcoming and productive environment. CCT is considered the amount of a lamp's color appearance when lighted. The color temperature emitting from the lamps depends on the emitted color of light. Warm, neutral and cool are three categories of white light. White light with a hint of yellow-like candlelight is named "warm white" (below 3000K); it improves reds and oranges, dulls blues, and adds a yellow tint to whites and greens. Neutral white (3000K - 3500K) improves most colors similarly and does not highlight either yellow or blue. Bluish white, like moonshine on snow, is considered "cool white" (above 3500K); improving blues, dulls reds and imparts a bluish tint to whites and greens. Cool light makes the place seem wide, while the warm light makes the place look comfort and familiar (Commercial Lighting Design Guide, 2014).

Glare and reflection are useful to the lighting of offices and the good design of offices may help in performing the tasks and functions clearly and easily but at the same time can cause unproductive and damaging conditions. Using luminaries and controlling the glare emitted from them in good manners can avoid direct glare and distressing reflections on the surfaces. Bright space significantly is not the ideal solution for lighting (Commercial Lighting Design Guide, 2014).

Color contrast occurs when one color induces the opponent color to the adjacent surface. Normally, the inducing surface is big and completely surrounds the target surface: such as a small gray disk acquires a pinkish tinge when surrounded by a large green annulus. Though it is a labile phenomenon, which happens only under specific conditions, it is nonetheless powerful when it does happen. Under optimum conditions, color contrast is instantaneous, cannot consciously be 'turned off, and practically completely controls the color appearance of a surface (Hurlbert and Wolf, 2004).

The reflection of light is the ability of a specific surface to reflect the color falling on it to be seen by the viewer. The white surface reflects the light 100%, whereas the reflection factor of the black color is not more than 2% and the reflection factor of the gray surface is about 40% from the falling light. If the surface prosiest of light in all directions such as velvet dark surfaces, the reflection factor close from one and the lighting became subject to direct light, i.e. the quantity of light falling on that surface (Amaireh, 2012).

2.4.2.2.3. Color and Wavelength of Lights

The eyes are so sensitive to the lights that lie in a very small region of the electromagnetic spectrum known as the visible light. The visible light consists of a wavelength range of 400 - 700 nanometers (nm) and a color range of violet through red (see Appendix A, Table A1). The wavelength that is outside the visible spectrum cannot be seen by the human eye. Violet, blue, green, yellow, orange, and red represent the colors from the shortest to the longest wavelength. The wavelength of the infrared radiation is longer than the visible red light while the wavelength for ultraviolet radiation is shorter than the visible violet light. The sun is considered one of the most important energy sources on the earth surface and its light involves the whole electromagnetic spectrum (Harrington & Mackie, 1993). Through the electromagnetic spectrum, the light is considered the visible part which locates between the wavelengths of l = 380 -780 -nm. Its symbol is Φe and its unit is Watt (W).

Each wavelength corresponds to a given color as exposed in the following Figure 2.10. The colors at the longer wavelengths are called warm colors such as orange and red colors, whereas the colors at the shorter wavelengths are called cool colors such as purple and blue colors (Mueller, Mueller-Mach & Lowery, 2004). White color is considered the color which human being has employed in order to use it for lighting. White light contains the particularity of a radiation at each wavelength for the visible range, and that the intensity of radiation at different wavelengths is different to some extent. Therefore, white lights are with different quality according to their differences from each other in the combination of color (Majoros, 2011).

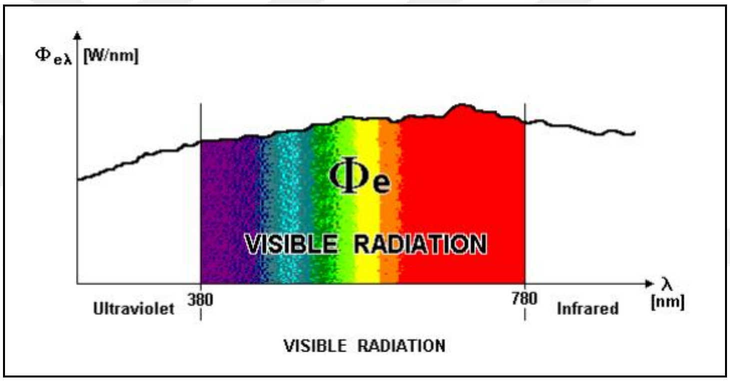

Figure 2.10. Color of Wavelength (Mueller et al., 2004).

3. FACTORS AFFECTING USER PREFERENCES OF LIGHTING IN OFFICES

The light is considered an incentive for the social evolution of life. Recently, the lighting research stated that the lighting social effect has been underexposed. The environment where we live is used for different activities associated in our daily life. Therefore, the lighting conditions must be sensitive in order to adopt with numerous actions that being implemented (Magielse & Ross, 2011).

3.1. Interior Lighting in Offices

The artificial lighting in the workplace represents one of the most important factors in enhancing and increases the worker's efficiency. The good lighting contributes in raising the ability of the individuals to see the objects clearly. Thus, well lighting is an urgent necessity to doing the business to the fullest and the bad lighting may lead to cause damages, stress, and efforts to the workers (Mohamed, 2007).

Increasing the intensity of the lighting lead to gradual weakening in the strength of the vision because of the stress of the eye nerve and increase the effect on the central nervous system that lead to the speed of fatigue, stress and the lack of the ability to perform the mental work because of the feeling of lightheadedness, dizziness and headache at the head area and increase the percentage of incident and injuries especially in the great disparity of illumination between the converged places at the workplace. Poor lighting faced by the staff in the offices lead to pupil dilation to the greatest extent possible in order to allow a large amount of light falling on the retina to register muscle relaxant associated with the lens which lead to increase its strength to close from the visible part or close it to the eye to watch its details (Mohamed, 2007).

Glare or light variation resulting from the presence of glare source in the area of direct vision such as the existence of a lamp and the glare may be direct according to its incidence in the vision area and causes the following symptoms: reduce the brightness of the object or reduce the vision ability where the eye moves when seeing any object heading toward it. So that the eyes locate the center of the retina and the eye stays steady in order to make the image of the object in its place from the retina; feeling pain in the eyes especially if the glare source stayed for a long period (Amaireh, 2012).

3.1.1. Lighting Concepts

One of the most important factors which work on increasing the efficiency of employees and workers inside the work environment is the existence of interior lighting. The artificial lighting works on seeing objects inside the work environment more clearly. Therefore, good lighting is considered a necessity in order to perform a work well while the bad lighting, may lead to stress and tension exerted to do something (Magdi, 2007).

Increasing the intensity of light leads to weakness in vision strength since it increases the pressure on the eye nerve. This increases the effect on the central nervous system that causes an increase of fatigue and the inability to conduct some job because of the feel of lightheadedness. Also, increasing the intensity of light causes headaches and an increase in the rate of accidents and injuries, especially in places that witness a great disparity in the intensity of light mainly the converged places in the workplace. Also, poor lighting faced by the staff in the offices lead to pupil dilation to the maximum possible degree in order to permit a large amount of light falling on the retina to register muscle relaxant related with the lens which lead to increase its strength to close from the visible part or close it to the eye to watch its parts. The glare or light variation caused by the existing of the lamp in the direct field of vision may cause many symptoms or problems including decreasing the ability of vision, reduce the brightness of the object because the eye moves when any object moving towards it. Consequently, the eyes localize in the center of the retina and they stayed steady in order to make the object's image in its place from the retina. Furthermore, there are pains appear in the eyes particularly if the light source stayed for long periods (Amaireh, 2012; Figure 3.1.).

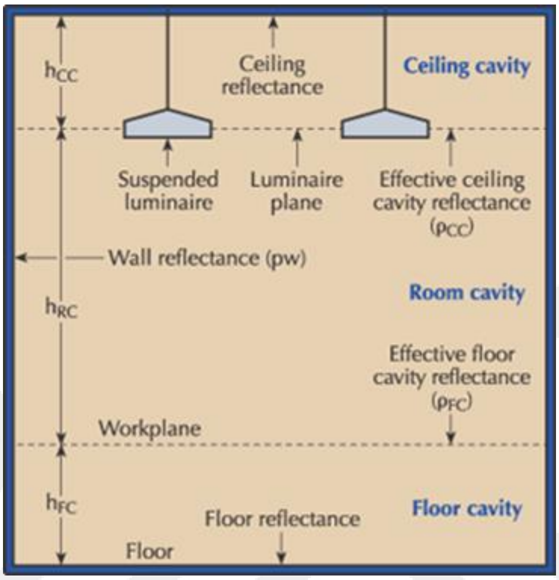

Figure 3.1. Interior Lighting Concepts (Knisley, 2002)

3.1.2. Distribution of Artificial Lighting Fixture According to Work Environment Needs

3.1.2.1. Room-related Lighting

Uniform lighting in the room creates roughly the same visual lighting in all the parts of the room. This is commended because the task areas are unknown during the design phase or the arrangement of task areas must be flexible (Fördergemeinschaft Gutes Licht, n.d.).

3.1.2.2. Task Area Lighting

Room always contains many places and parts and each part of them is specialized to perform specific tasks and thus must have lighting that suits these places and their requirements (see Figures 3.2a and 3.2b). Also, the visual divisions are needed to determine the different workplaces and clusters (Fördergemeinschaft Gutes Licht, n.d.).

Figure 3.2a. Direct Lighting (ceiling luminaires)

Figure 3.2b. Direct/indirect Lighting (pendant luminaires)

2.5.2.3. Work Surface Lighting

In order to achieve specific lighting level that suits the basic visual requirements or the personal needs, the luminaires are usually used to achieve this issue which are places at the workplace and used to complete the basic lighting (see Figures 3.3a and 3.3b; Fördergemeinschaft Gutes Licht, n.d.).

Figure 3.3a. Task Lighting with Special Optical Control

Figure 3.3b. Indirect Lighting with Direct Workplace Lighting (Fördergemeinschaft Gutes Licht, n.d.).

3.2. Design Guide for Interior Lighting in Offices

The good lighting can contribute to reducing the operating cost of the building and enhance the work efficiency. In the past years, in order to calculate the number of lighting fixtures for an indoor office space, it is just required you to regulate the average uniform horizontal illumination, in foot candles (FC) for the entire room, select a fixture from a catalog, and then consistently space the fixtures through the room. Nevertheless, in modern office design, the standards of lighting have completely changed where there is no specific standard for this purpose. As well as, the workstations are usually equipped with customized lighting fixtures for each location and each environment, and everybody is interested in using the daylight in order to decrease the cost and energy waste (Kinsley, 2002). In order to help in determining the suitable lighting levels, the Illuminating Engineering Society of North America (IESNA) recommends illuminance levels, or lighting power density (LPD) values for a diversity of spaces. The recommendations spread from lighting a public area using 2 FC to 5 FC level, to lighting special visual task areas of particularly low contrast and small size using 1,000 FC to 2,000 FC. The recommendations consider many factors including the age of occupant and the reflectance of background and room surface. Nevertheless, in order to calculate your lighting, you have to start from your lighting measurements and then apply another formula that takes into consideration number of factors such as the obstruction and lighting cavities. For the first half of the mission, the lumen technique permits you to regulate the probable level of uniform illumination on an imaginary horizontal plane, 2.5 ft. above the floor, which is the typical height of a desktop, for a precise lamp-fixture combination or luminaire (Kinsley, 2002).

3.3. Intensity of Light and Preferences of User Lighting

Luminous intensity is an angled power from a source of light such as a lamp that is expressed by the candle (Candela). There are special standards to the light intensity which in force in major countries and the International Committee of the lighting. As it has been mentioned in the previous chapter, the intensity of light has an impact on the efficiency of the user both in the high and low intensity of light. The mood of humans and their productivity is affected by the intensity level of light. Many experiments and researches mentioned the impacts of lighting intensity on the user preferences and the work efficacy and these experiments and researchers (Amaireh, 2012).

It is stated that exposure to light can affect the activities that are performed by the human. The study conducted by Smolder (2013) stated that there was high subjective awareness and energy, in addition, quicker reactions on a continued attention task under exposure to 1000 lux then compared to 200 lux. These impacts related to light exposure were dependant on the subjective experience, and performance was dependent on the time of day or persons' previous mental state. The study proposed that the exposure to a greater illuminance level profited participants' capability to sustain responsiveness in the morning, but not in the afternoon. Furthermore, the other results of the study showed that exposure to the higher level of illuminance will increase vigilance among workers particularly when they feel tired. Until now there is no evidence that tries to find out the effects of lighting.

Previous studies and researches showed that the exposures into preferred lighting settings work on to stimulate the mood on increasing the satisfaction on the environment and lighting (Newsham & Veitch, 2001; Newsham, Veitch, Arsenault, & Duval, 2004). These studies point to the importance of investigating not only the optimal lighting settings for users in terms of the potential alarm and vital impacts but to search on the user's preferences. Researchers and studies that investigate the environmental preferences have given indicators that users may choose environmental conditions which have potential effects on the performance and well-being (Hartig & Staats, 2005).

This refers to that people may highly prefer the environmental conditions that encourage on the vitality and alertness especially when there is a need for the optimization. For example, many studies pointed that people who feel nervous and mental fatigue may take benefit from the exposure to the natural lighting more than the urban environment (Berman, Jonides, & Kaplan, 2008). Consistent with these effects, the results of many studies showed that people who feel mental fatigue are highly preferred to exposure themselves into the natural environment (Smolders, 2013). Dynamic lighting has been designed to make positive effects on the performance and well-being.

The experiment field of de Kort and Smolders (2010) tested whether these effects were demonstrable and steady with time if they employed in real work settings. The experiment involved of two branches, the first branch followed a monthly alternating experimental design, and the other branch followed a yearly alternating one. In a double balanced design, office workers experienced static or dynamic lighting over three successive phases. The results proposed that there were no major differences in need for alertness, recovery, mental health, vitality, headache, and eye strain, sleep quality or subjective performance. Though, employees were more gratified with the dynamic lighting. As well as, the limitations and implications of the study have been discussed. The study results stated that there was no major effect of lighting conditions on need recovery, mental health, headache and eyestrain, vitality, global sleep quality, alertness and subjective performance (de Kort & Smolders, 2010).

3.4. CCT of Lighting and Effects on Human's Mood

As it is mentioned in the second chapter, the CCT is the appearance of the color of light. In order to discuss the effects of CCT profoundly, it is necessary to understand the basic terminology of lighting. The main terms of lighting are the luminance and illuminance. IESNA Lighting Handbook (2000) defines illuminance as "luminous flux density, the perceived power of light, incident at a point on a surface". This means that the illuminance is the amount of the intensity of the light falling on the surface. it can measure the illuminance in lux (lx) and also foot-candle (FC), with an illuminance meter (Egan & Olgyay, 2002).

Luminance can be defined as "the intensity of observable illumination of a source or surface in the direction of the witness, divided by the surface seen or source area" (IESNA, 2000). Luminance is measured in candela per square meter (cd/m2), with the luminance meter. The temperature of the color is frequently conveyed in Kelvin (K). The color temperature perception is particularly beneficial for incandescent lamps that differ closely approximate a blackbody spectrum through the visible region. As well as, the color temperature of these lamps can define the spectrum in this region. CCT is an important metric in the general lighting industry to identify the supposed color of fluorescent lights and other no incandescent white-light sources for example LEDs and the high-intensity discharge HID lamps (Kumoğlu, 2013).

In spite of all that has been said about lighting effects mood, there are few experiments that support this issue. These reports about lighting and their effects on the human mood have been formed by using a wide range of assumptions about the daily practices of institutions that ranges from domestic conditions to restaurants and offices. Further research is needed in this field. The study that has been reported here is a part of the wider study to prove if the artificial interior lighting has an effect on the human behavior and mood. Inside the scientific society, nonvisual lighting has been observed with a degree of uncertainty. The reported impacts of the spectral composition or illuminance on mood have been discarded by some, who their mood is twice and could consequently the change of mood measure through the course of his experiment (Kumoğlu, 2013).

When issues were exposed to high CRI lamps, the negative mood of women decreases under warm CCT (2950 K), but the negative mood of men decreased most under the cool CCT condition. At low (51-58) CN, there is an interaction influence between illuminance and correlated color temperature has been found. Good mood was conserved best under low illuminance circumstances (300 lux) combined with a cool associated color temperature (4000 K) or at the higher illuminance level (1500 lux) combined with the warmer CCT (2950 K). In contrast, another study found that there are no any differences in the mood between the different lighting levels or the types of lamps. One contributing factor to these conflicting reports is the diversity of experimental procedures used, differences in independent variables manipulated and differences in mood measuring instruments used (Kumoğlu, 2013).

3.5. Effect of Gender and Age in Preferences of Lighting in Workplace

The working environment is considered one of the basic requirements that allow people to perform their work efficiently under comfy circumstances. Given that buildings, air conditioning systems and lighting design are designed on the basis of a convinced level of wellbeing (Roelofsen, 2002). In general, working in the field of lighting seeks to create luminous conditions which lead to enhance the production for the individuals. The effects of luminous on people are varied according to the individual characteristics such as the age and sensitivity. These luminous conditions, like other environmental conditions, have effects on people, and they may do so through any of numerous mechanisms. Mechanisms are the constants that are useful to many disciplines according to their ability to organize the experimental suggestions and inductive cognitive in the explanatory systems. For suitability, these parallel methods can be separated into two broad classifications: psychological and psychobiological processes for instance visibility, photo-biological and arousal. The knowledge of specific mechanisms that occur from the research will enable accurate forecasts of expected results that derived from lighting research and from other topic areas that investigate the same processes (Veitch, 2013).

According to the study of Knez and Kers (2000) the effect of the indoor lighting, gender, and age, on mood and cognitive performance was examined in a between-subject experiment. The assumption was that the light in the indoor environment would hold different emotional meanings distinguished by age, gender or both. The two-way interaction between lamp type and age on negative mood exposed that younger adults (about 23 years old) best conserved a negative mood in the “warm” (more reddish) white lighting while working with a battery of intellectual tasks for 90 minutes, while, for the older adults (about 65 years old), “cool” (more bluish) white lighting accounted for the matching effect. The younger females were exposed to reserve the positive mood in addition to the negative mood better than the younger males. Also, the major effect of age in all intellectual tasks exposed the superiority of younger to older adults in intellectual performance (Dikel, Burns, Veitch, Mancini & Newham, 2014).

The effects of lighting conditions and color on our emotional and physical health gain great importance at the urban communities. There are few scientific pieces of evidence that support the allocation of a large amount of money to choose the colors and lighting in properly and appropriately. Close associations between cardiac activity, our emotions, and health are well reported in the literature and therefore, it is predictable to be a good measure of environmental circumstances on people (IEEE-EMBS, 2005).

Previous researches and studies showed that controlling the levels of lighting by the individual benefits the individual and institution. As a first step to test whether the selection of light source spectrum that is possible with LED systems deliver similar benefits (Viitanen, Lehtovaara, Tetri, & Halonen, 2013). One of the most important observations in the modern psychology is the finding that perceived control can moderate the stress reaction. When control over aversive stimulus is not obtainable, learned helplessness can result where the individuals suffer from the emotional, intellectual and behavioral shortfalls. Moreover, the belief that the control absence leads to the feeling of discontent and weakness is common. This belief is regularly used to explain the individual lighting control adoption, while few experimental investigations presented to validate this added cost. Several field studies confirmed that many of offices employees prefer to control the level of their office's lighting by themselves (Veitch, 2013). Offices must be designed in a way that guarantees the high benefit of the daylight with the availability of supplementary electric lighting in a suitable form by designing the lighting system in a good manner.

The Lighting Control System (LCS) can manage the output of the auxiliary electric lighting which controls where, when and even how the light is delivered. The attainable energy reserves by using LCSs can be important (Dubois & Blomsterberg, 2011), but it depends on “human factors”, as indicated by Boyce (2014), which means the behavior, receipt and probable waste of the LCSs by the residents showed that controlling the lighting environment has important effects on the final energy that used for lighting. As well as, the human factors are significant because poorly designed of LCS may lead to stress and displeasure (Galasiu & Veitch, 2006) resulting in a reduction in productivity. Previous researches and studies showed that in small scale application like individual office rooms, the occupants of these offices are generally prefer to control the lighting system by themselves or responding in negative ways to the automatic controls (Gentile, Laike, & Dubois, 2016). In several cases, the automatic LCS causes so much stress that they are even destroying by the occupants of that place (Galasiu & Veitch, 2006).

The greatest apparent finding concerning CCT in the test of the user was that subjects considered the color of the ruled lighting at CCT 6000 K less pleasant than at 3000K and 4500 K. Related results have been found when subjects were asked about the common pleasantness of lighting. The assessments of the user at many CCTs were however not considerably dissimilar from each other at other tested questions. There were great deviances in the user set CCTs and illuminance levels, which specifies that the favorites of the individual for different people can vary greatly. Furthermore, this has been set in the previous studies and researchers of the topic (Villa & Labayrade, 2016; Newsham & Veitch, 2001). Consequently, the user convenience can be increased by further CCT and dim control by giving the individual the ability to set their lighting according to their own preferences (Viitanen et al., 2013).

3.6. Improvement of Office Lighting with User Preference

It is necessary to light the office with suitable lighting because the preferred lighting conditions in the office environment help on creating a good mood which leads to enhancing the performance of the work, creativity and social behavior. The illuminance level combination (E) of 750 lux with associated CCT of 4000 K is favored for LED office lighting for the pleasantness of lit environment, visual wellbeing, colors naturalness, and general preference of lit environment. The results of this study can be used in the office lighting to guarantee the preferred selections. The perfect lighting is highly influenced in creating the wellbeing for the office staff. Also, apart from the visual effect is necessary to create the biological effect on the human body. Thus, the effects of preferred lighting conditions on office staff must be studied deeply (Tetri, 2015).

The amount of electrical energy consumed by light is about 19% around the world (IEA, 2006). Also, the quantity of light that is consumed within the same building like school and office is about 35% of the total primary energy consumption (Roisin, Deneyer, D’Herdt, Diga, & Eugene, 2006). Consequently, the continuous and constantly increase the electric energy during the last years requires an efficient consumption of electric energy in lighting (Hamdy, Hasan, & Siren, 2013). While at the same time the regulations of energy efficiency became more constrained. While the use of energy efficiently and savings is considered a vital issue, achieving suitable visual conditions to the place users and help them to create comfortable visual conditions to perform their work efficiently is the most important function of lighting. So, the quality of produced light is considered and important issue and equally important to the quantity of light and how to produce it in an efficient manner (Viitanen et al., 2013).

Villa and Labayrade (2016) proposed a multi-objective enhancement study of lighting installations which dedicated on energy objectives and user preferences. They collected user comments and fed them into a computer model that computed trade-offs between the preferences of user and energy savings. In the study, the room was illumined by two recessed T5 ceiling luminaires and a compact fluorescent task area luminaire located on the table. The perfect solution between the user preferences and power consumption was found to be 436 lux for task area illuminance, with illuminance consistency of 0.52. Logadottir, Christoffersen, and Fotios (2011) examined favored illuminances on the office by using an adjustment task. Fluorescent lamps with three different CCTs 3000 K, 4000 K and 6500 K were used. They concluded that the preferred illuminance was affected by the available ranges of illuminances with a larger range of adjustment that resulted in higher desired luminance. The preferred illuminances were 337 lux, 523 lux, or 645 lux that depended on the range of adjustment. The difference between preferred lighting among individuals was rather large. The adjustment starting point which is named anchor has affected the results as well. They concluded that the adjustment of single interval task is not suitable research method in order to regulate the preferred illuminance (Viitanen et al., 2013).

4. CASE STUDY

4.1. Aim of the Study

The aim of this thesis is to study artificial lighting preferences of instructors for offices of Interior Architecture and Architecture departments of Çankaya University and find out if the current lighting is suitable for their use of reading, writing and computer use. In addition, to found out if there is an effect of the intensity of artificial lighting, age, and gender, CCT of light in the preferences of artificial lighting of office users or not, as well as to find better methods for lighting in offices.

4.1.1. Research Questions

1. Is there a significant effect of gender on the lighting preferences of the office users?
2. Is there a significant effect of gender on the artificial lighting preferences of the office users?
3. Is there a significant effect of gender on the sufficient intensity of artificial lighting of the office users?
4. Is there a significant effect of the CCT of artificial lighting in the preferences of artificial lighting of office users?
5. Is there a significant effect of the noisiness that comes from artificial lighting sources in the comfort and preferences of artificial lighting of office users?

4.1.2. Hypotheses

1. There is a significant effect of gender on the lighting preferences of the office users.
2. There is a significant effect of gender on the artificial lighting preferences of the office users.
3. There is a significant effect of gender on the sufficient intensity of artificial lighting of the office users.
4. There is a significant effect of the CCT of artificial lighting in the preferences of artificial lighting of office users.
5. There is a significant effect of the noisiness that comes from artificial lighting sources in the comfort and preferences of artificial lighting of office users.

4.2. Description of the Site

The offices of the faculty members of the departments of Interior Architecture and Architecture at Çankaya University are located on the southern part of the Faculty of Architecture. The offices of the Interior Architecture faculty members are located on the first floor and the offices of the department of Architecture faculty members are located on the second floor. The offices cover an area of approximately 9 meters; they consist of a façade with 3 windowpanes and have fluorescents on the ceilings.

4.3. Participants

The sample group consisted of faculty members who work in the departments of Interior Architecture and Architecture at Çankaya University within the 2015-2016 academic year. The study took place in the offices of the faculty members on the first and second floors of the Faculty of Architecture. There were 23 (62.2 %) females and 14 (37.8 %) males whose age range was from 25 to 75 years. The age distribution can be seen in Table 4.1.

Table 4.1. The Age Distribution of the Faculty Members

Age Group	No. of faculty members
Lower than 25	0
26-35	7
36-45	20
46-55	3
56-65	5
Over 66	2

4.4. Procedure

The study was conducted in two phases. In the first phase, the participants filled a questionnaire; the questionnaire consisted of 15 questions. The first part of the questionnaire consisted of personal information of the office users and information about the office room; the second part was related to the characteristics of artificial lighting preferences of the users. The second stage included the process of measuring the intensity of light in the office in the afternoon, where the measurement period was from four to five o'clock as it was the time of sunset, taking into account closing all windows and curtains. Four different measurements were collected in four different parts of the office room and then the arithmetic mean was calculated to get the correct measurement.

4.5. Results

The amount of time spent in front of the computer can be seen in Table 4.2. It can be seen that the majority of the faculty members spent between 3-5 hours in front of the computer with the percentage of 51.4%.

Table 4.2. Time Spent in front of the Computer

Amount of time spent every day	No. of faculty members
1-3 hours	8
3-5 hours	19
More than 5 hours	10

The amount of time spent for reading/writing tasks in front of the computer can be seen in Table 5.3. It can be seen that the majority of the faculty members spent between 3-5 hours in reading\writing tasks with the percentage of 51.4%.

Table 4.3. Time Spent for Reading/writing Tasks

Amount of time spent every day	No. of faculty members
1-3 hours	14
3-5 hours	17
More than 5 hours	6

The type of lighting preferred in the offices was both natural and artificial lighting. The distribution of the preferred lighting by the faculty members can be seen in Table 4.4. No faculty member preferred artificial lighting alone.

Table 4.4. Type of Lighting Preferred by the Faculty Members

Type of preferred lighting in the office	No. of faculty members
Natural	14
Artificial	0
Both	17

The type of artificial light preferred by the faculty members is displayed in Table 4.5. The faculty members mainly preferred fluorescent in their offices with the percent of 35.1%. Thirty faculty members out of 37 (81.1%) indicated that the artificial lighting was sufficient and properly distributed in the offices and there was no problem related to this issue. However, there were seven faculty members (19.9%) who saw that the lighting was not distributed in a good manner without giving any explanation about the problem.

Table 4.5. Type of Artificial Lighting Preferred by the Faculty Members

Type of preferred artificial lighting in the office	**No. of faculty members**
Fluorescent	13
Spotlight	8
Incandescent	6
LED	8
Other	2

Thirty-one faculty members found the electrical switches sufficient and properly distributed in the offices. Only 1 faculty member indicated that the electrical switches were not sufficient. When the reasons for the problems of electrical switches were stated, 2 faculty members indicated that there was only one switch, 2 faculty members indicated that dimmer would be better and 1 faculty member stated that the switch was far from the desk (Table 4.6).

Table 4.6. Reasons for the Problem of Electrical Switches

Problems for electrical switches	**No. of faculty members**
Only one switch	2
Dimmer is better	2
Far from the desk	1

Twenty-one faculty members indicated that they did not use other lighting sources other than the lighting fixtures on the ceiling. On the other hand, 8 faculty members used other artificial light sources. Four of the faculty members indicated that they used a table lamp; 2 faculty members used other lighting sources and 2 faculty members found the lighting unnecessary.

In Table 4.7. the locations of the additional light source in the offices when additional artificial light is needed are indicated. The majority of the faculty members (51.4%) indicated that they did not need additional light source in their offices. Ten faculty members preferred the artificial light source to be in front of them.

Table 4.7. Location of the Additional Light Source in the Offices

Location of additional light source	**No. of faculty members**
On the ceiling	7
In front of you	10
Behind you	1
I don’t use	19

According to the adjective pairs that were given in the questionnaire, the mean for each pair was calculated see Table 4.8. The faculty members found the artificial lighting motivating (M=1.46), exciting (M=0.49), comfortable (M=1.38), nosy (M= 0.97), bright (M=0.73) and glimmering (M=0.81).

Twenty faculty members (54.1%) rated the CCT of the artificial light in their offices as cool, 14 faculty members rated as warm and 3 rated as I don’t know. Twenty-one 56.8% faculty members found the intensity of daylight in the offices sufficient, whereas 12 faculty members found it insufficient and 4 faculty members indicated as having no idea. Twenty-seven (73%) faculty members indicated that there was no glare in their workplaces. The majority of the faculty members found no noise problem related to light in their workplaces with the percentage of 62.2%. However, some of them (16.2%) stated there was a noise problem related to light in the form of constant buzzing.

Table 4.8. Feelings of Faculty Members towards the Artificial Lighting in the Offices

The status	No. of faculty members	Mean
Motivating Normal Annoying	26 3 8	1.46
Exciting Normal Boring	20 3 14	0.49
Comfort Normal Discontent	25 4 8	1.38
Nosiness Normal Quietness	18 13 6	0.97
Bright Normal Dim	10 26 1	0.73
Glimmering Normal Dark	11 25 1	0.81

According to the Chi-square test, there was no significant relationship between gender and the type of lighting preferred in office ($\chi 2 = 0.910$, df = 2, p = 0.635). Likewise, there was no significant relationship between gender and the main type of artificial lighting preferred in the offices ($\chi 2 = 3.069$, df = 4, p = 0.546).

There was no significant relationship between gender of office users and the sufficient intensity of the artificial lighting in the workplace ($\chi 2 = 4.86$, df = 2, p = 0.088).

5. CONCLUSION

Offices must be designed in a way that guarantees the high benefit of the daylight with the availability of artificial lighting. Artificial lighting in offices is one of the most important factors that increase the employees' efficiency. Good lighting contributes in raising the ability of the employees to do their jobs and give their best.

It is stated that exposure to light can affect the activities that are performed by the human. Smolder (2013) stated that there was high subjective awareness and energy, in addition, quicker reactions on a continued attention task under exposure to 1000 lux then compared to 200 lux. These impacts related to light exposure were dependant on the subjective experience, and performance was dependent on the time of day or persons' previous mental state. The study proposed that the exposure to a greater illuminance level profited participants' capability to sustain responsiveness in the morning, but not in the afternoon. Previous studies and researches showed that the exposures into preferred lighting settings work on to stimulate the mood on increasing the satisfaction on the environment and lighting (Newsham & Veitch, 2001; Newsham et al., 2004). These studies point to the importance of investigating not only the optimal lighting settings for users in terms of the potential alarm and vital impacts but to search on the user's preferences. Researchers and studies that investigate the environmental preferences have given indicators that users may choose environmental conditions which have potential effects on the performance and well-being (Hartig & Staats, 2005). In addition, several field studies confirmed that many of offices employees prefer to control the level of their office's lighting by themselves (Veitch, 2013).

The present study discovered that most of the office users prefer to use both artificial lighting and natural lighting when they have been asked about the preference type of artificial lighting, the results showed that most of the office users prefer fluorescent. In the present study, the faculty members found the artificial lighting in the offices to be motivating, exciting, comfortable, bright and glimmering. However, they indicated that it was nosy. It can be inferred that the characteristics of the artificial lighting did not affect the office users. It was hypothesized that there would be a statistically significant effect of gender and the type of lighting preference and also, the main type of artificial lighting preference. However, the results indicated that there was no significant relationship between gender and the type of lighting preference, and the main type of artificial lighting preferred in the offices.

It was also hypothesized that there would be a statistically significant effect of gender and the sufficient intensity of the artificial lighting in the office, but the results showed that there was no significant relationship between gender and the sufficient intensity of the artificial lighting in the office. Although the maximum intensity of the artificial lighting that was measured in the offices of the Interior Architecture and Architecture departments of Çankaya University was less than 500 lux, this level is not suitable for reading, writing and computer use (see Appendix A, Table A2). However, this did not affect the awareness and and energy of the office users.

This study is significant because there are not many studies that focus on artificial lighting in offices within a university. From the results of this study, new methods for the design of artificial lighting for offices in universities can be proposed. It can be suggested that interior architects need to provide several types of artificial lighting in the same office as well as several electrical switches so that the users can use the lighting that they prefer. A comfortable and a good working environment that is suitable for all users of the offices in universities can accomplished. For further studies, the study could be done with different faculty members of the same university and see if there are differences in the preferences. The preference for CCT of artificial lighting can be investigated with respect to age and gender differences in the offices.

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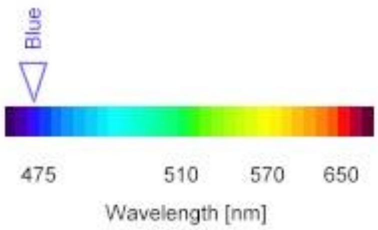
APPENDIX A

Table A1. The wavelength for visible lights

Violet Light The wavelength for the visible violet is about 400 nm. Within the visible wavelength spectrum, violet and blue wavelengths are scattered more efficiently as compared to the other wavelengths. Because of our eyes are more sensitive towards the blue light, the sky looks blue not violet. Also, the sun emanates more energy as blue light than as violet.	
Indigo Light The wavelength of the visible indigo light is 445 nm.	
Blue Light The wavelength of the visible blue light is about 475 nm. The blue wavelengths are scattered efficiently by the molecules in the atmosphere because they are shorter in the visible spectrum. This is what causes the appearance of the sky in the blue color through the middle of the day when the blue color is scattering into our eyes regardless of the direction that we see.	

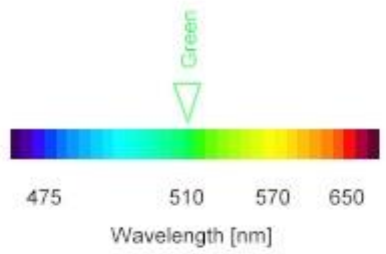
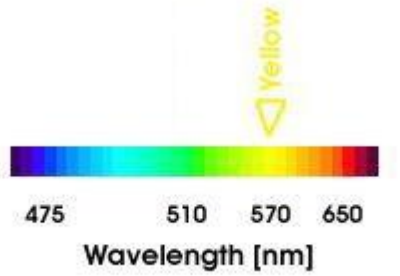
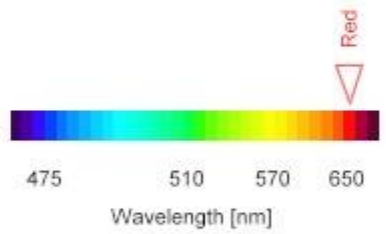
Green Light The wavelength of the visible green light is about 510 nm. For example, the grass looks green because the whole colors which are existed in the visible spectrum been absorbed by the leaves except the green color which reflected and grass appear green.	
Yellow Light The wavelength of the visible yellow light is about 570 nm.	
Orange Light The wavelength of the visible orange light is about 590 nm. Low-pressure sodium lamps, such as those which are used in some parking lots, emit an orange-ish (wavelength 589 nm) light.	
Red Light The wavelength of the visible red light is about 650 nm. The light what we see through the sunrise and sunset has been traveled a long distance across the atmosphere. As a result of scattering al large amount of violet and blue lights have been removed. The colors which can be more readily seen are the colors with longwave such as red and orange colors.	

Table A2. Measuring of the Intensity of Light in the Offices

Subject no.	Office room no.	Location	The intensity of light / LUX	No. Of lighting fixtures
1	104/1	West	112	2
2	104/2	West	270	3
3	104/3	West	233.4	4
4	105/1	West	210.3	3
5	105/2	West	115	2
6	105/3	West	113.5	2
7	106/1	West	273.2	4
8	106/2	West	293.4	4
9	106/3	West	267	4
10	107/2	West	183.7	3
11	107/3	West	175.2	2
12	116/1	West	257	2
13	116/2	West	296	3
14	120	East	173.2	2
15	201/1	East	132.2	2
16	201/2	East	133.9	2
17	201/3	East	114.7	2
18	202/1	East	159.1	2
19	202/2	East	103.7	2
20	202/3	East	122	2
23	**204**	**West**	**118**	**2**
24	205/1	West	123.4	2
25	205/2	West	132.7	3
26	205/3	West	139	2
27	206	West	270	4

28	207/1	West	308	4
29	207/2	West	183.9	3
30	207/3	West	112	2
31	228	West	398	8
32	229	West	273	4
33	208/1	East	98.7	2
34	208/2	East	101.4	2
35	208/3	East	192	3
36	209/1	East	89.2	2
37	209/2	East	180.3	2

APPENDIX B

Figure B1. Location of Çankaya University

Figure B2. An aerial view of the Experimental area

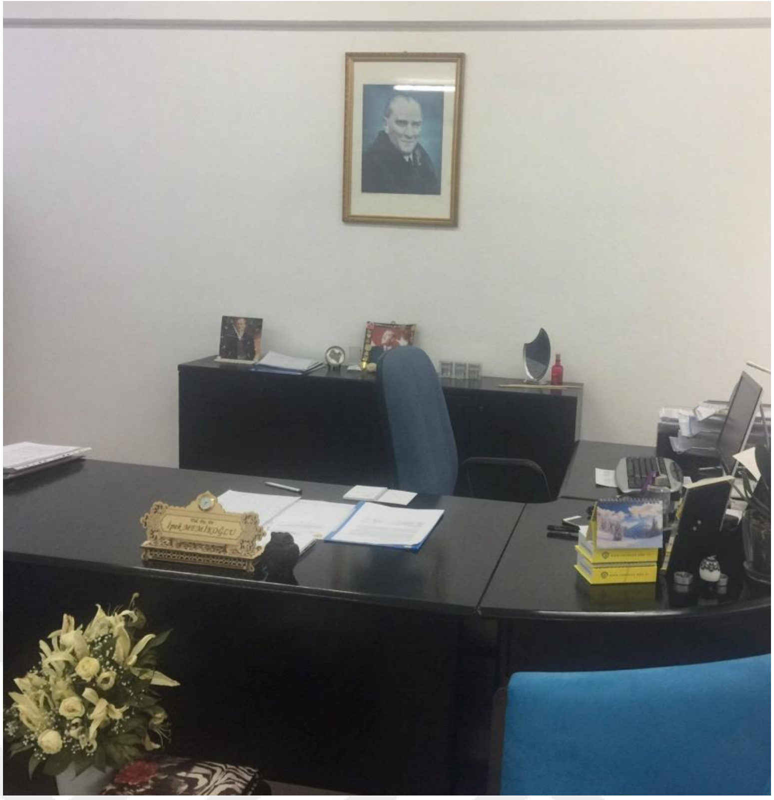


Figure B3. An interior view of the Experimental area

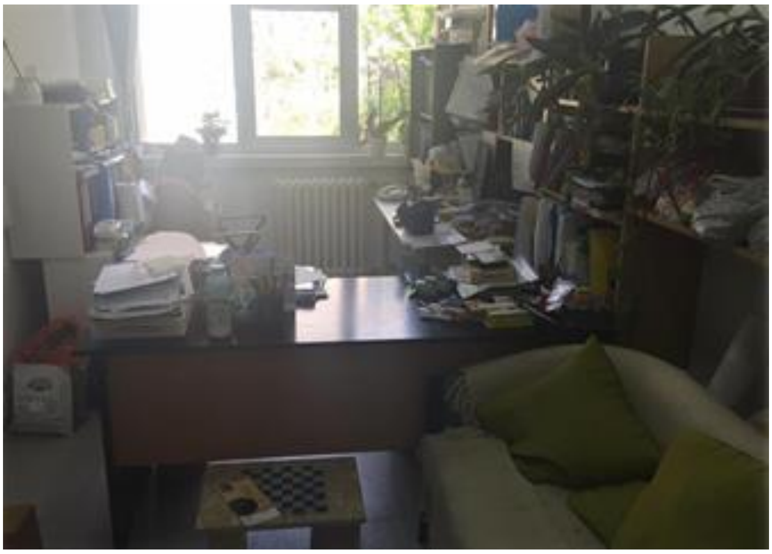


Figure B4. An interior view of the Experimental area

Figure B5. An interior view of the light source of the Experimental area

APPENDIX C

The aim of this questionnaire is to reveal the factors that affect user preferences for artificial lighting. Previous studies indicate that the efficiency of employees in the offices is affected by lighting. Thus the study aims to bring an understanding to the effect of light intensity on the mood and work efficiency of users and whether Correlated Color Temperature (CCT) - which is the color appearance of a light source - affects lighting preferences of users or not.

Room No :

Orientation :

No. Of lighting fixtures :

Light intensity :

1. AGE

   Lower than 25 ☐
   26 – 35 ☐
   36 – 45 ☐
   46 – 55 ☐
   56 – 65 ☐
   Over 66 ☐

2. GENDER

   Female ☐
   Male ☐

3. How much time a day do you spend in front of the computer?

   1 – 3 hours ☐
   3 – 5 hours ☐
   More than 5 hours ☐

4. How much time a day do you spend for reading / writing tasks?

   1 – 3 hours ☐
   3 – 5 hours ☐
   More than 5 hours ☐

5. What is the main type of lighting you prefer in your office? Why?

Natural ☐
Artificial ☐
Both ☐
………………………………………………………………………………………………
………………………………………………………………………………………………

6. What type of artificial lighting do you prefer?

Fluorescent ☐ Spotlight ☐
Incandescent ☐ LED ☐
Other
………………………………………………………………………………………………
………………………………………………………………………………………………

7. Are the lighting fixtures sufficient and properly distributed in your office? If no please explain.

Yes ☐
No ☐
………………………………………………………………………………………………
………………………………………………………………………………………………

8. Do you think that the electrical switches are sufficient? If no, please explain.

Yes ☐
No ☐
………………………………………………………………………………………………
………………………………………………………………………………………………

9. Do you use other lighting sources rather than the lighting fixtures on the ceiling? If yes please explain.

Yes ☐
No ☐
………………………………………………………………………………………………
………………………………………………………………………………………………

10. Related to your answer in Q9, Where do you use this lighting source?

On the ceiling ☐
In front of you ☐
Behind you ☐
Don’t use ☐

11. Which of the following terms best describes the artificial lighting fixtures in your office?

Motivating	3	2	1	0	1	2	3	Annoying
Exciting	3	2	1	0	1	2	3	Boring
Comfort	3	2	1	0	1	2	3	Discomfort
Noisiness	3	2	1	0	1	2	3	Quietness
Bright	3	2	1	0	1	2	3	Dim
Glimmering	3	2	1	0	1	2	3	Dark

12. Which of the following terms best describes the Correlated Color Temperature (CCT) of artificial lighting in your office?

Cool colors ☐
Warm colors ☐
I don't know ☐
Other…………………………………………………………………….

13. How do you find the intensity of artificial Lighting in your workplace ?

Sufficient ☐
Insufficient ☐
Don't know ☐

14. Are there any problems of glare in your office? If yes please explain.

Yes ☐
No ☐

………………………………………………………………………………………………
………………………………………………………………………………………………

15. Are there any noise problems related to the light source? If yes, please explain.

Yes ☐
No ☐

………………………………………………………………………………………………
………………………………………………………………………………………………