YAŞAR UNIVERSITY
GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES

MASTER THESIS

INVESTIGATIONS OF LIGHTING CONDITIONS IN PATIENT ROOMS: CASE STUDY IN IZMIR

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

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ABSTRACT

INVESTIGATIONS OF LIGHTING CONDITIONS IN PATIENT ROOMS: CASE STUDY IN IZMIR

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This study examines the criteria of lighting design in hospitals where lighting conditions are very important. The physiological and psychological effects of light on patients are emphasized. For this reason, the light intensity standards which should be especially in the patient rooms and the criteria to be considered in the design for the patient comfort are explained. Six private hospitals are selected in İzmir and artificial lighting measurements have been made in the rooms of general surgery department and their results are compared with the standards.

Key Words: lighting, patient, hospitals, lighting design, patient rooms.

ÖZ

HASTA ODALARINDA AYDINLATMA KOŞULLARININ ARAŞTIRILMASI: IZMIR'DE ÖRNEK İNCELEMESİ

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Kasım 2017

Bu çalışmada, aydınlatma koşullarının çok önemli olduğu hastanelerde aydınlatma tasarım kriterleri incelenmektedir. Işıkların hastalar üzerindeki fizyolojik ve psikolojik etkileri vurgulanmaktadır. Bu nedenle, özellikle hasta odalarında olması gereken ışık şiddeti standartları ve hasta konforu için tasarımda dikkate alınması gereken kriterler açıklanmaktadır. İzmir'de seçilen altı özel hastane genel cerrahi odasında yapay aydınlatma ölçümleri yapmış ve uygunluğu standartlarla karşılaştırılmıştır.

Anahtar Kelimeler: aydınlatma, hasta, hastaneler, aydınlatma tasarımı, hasta odaları.

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Fehime DOĞAN YUSUF

İzmir, 2017

TEXT OF OATH

I declare and honestly confirm that my study, titled "INVESTIGATIONS OF LIGHTING CONDITIONS IN PATIENT ROOMS: CASE STUDY IN IZMIR " and presented as a Master's Thesis, has been written without applying to any assistance inconsistent with scientific ethics and traditions. I declare, to the best of my knowledge and belief, that all content and ideas drawn directly or indirectly from external sources are indicated in the text and listed in the list of references.

Fehime DOĞAN YUSUF

Signature

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December 15, 2017

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SYMBOLS AND ABBREVIATIONS

ABBREVIATIONS:

CRI	Color Rendering Index
EN	European Standard
LED	Light-Emitting Diode
SCN	Suprachiasmatic Nucleus
SMPTE	Society of Motion Pictures and Television Engineers
UGRL	Unified Glare Restriction
WHO	World Health Organization
SC	Shading Coefficient
UV	Ultraviolet
UK	United Kingdom
SAD	Seasonal Affective Disorder

SYMBOLS:

l	Luminous intensity
ϕ	Luminous flux
E	Illuminance
L	Luminance
M	Luminous exitance
cd	Candela
lm	Lumen
fc	Footcandle
m^2	Square meters
lx	Lux
K	Kelvin

nm	Nanometer
r	Distance between the light source and the illuminated surface
E_m	Minimum values of the mean brightness
U_0	Luminosity uniformity
Ra	Values of the color rendering index

CHAPTER 1
INTRODUCTION

1.1. Problem Statement

Lighting design is significant factor in our daily lives. The most important purpose of lighting is to provide visual comfort for users. Especially in health facilities, which are used 24 hours a day, the visual comfort of patient's becomes critical compared to other types of facilities. Lighting has psychological effects on patient and it is important for patient to being well fast. Inadequate lighting, prevents health professional from performing diagnostic or operational duties the healing process of the patient. Or more lighting, a fact that irritated the eyes and can cause vision prevent again to adverse effects of treatment. Therefore the proper lighting design application, especially in hospitals is a matter that should be given much importance. It's not known that the hospitals in İzmir are compitable with the lighting standarts, but the results of in this study will be revealed.

1.2. Aim of the Study

The aim of this study is to investigate lighting design criteria in the hospitals and to find answer how must be right lighting design in patient rooms. And research the criteria in selected hospitals in Izmir then identify positive or negative effects of this lighting design on patients health.

1.3. Research Questions

- What is the importance of visual comfort in hospitals?
- What are the effects of lighting on patients?
- What are the lighting standards in patient rooms?
- What are the important criteries in patient rooms lighting design?
- What extent appropriate the hospitals selected in İzmir lighting design criteria of patient rooms?

In this study, all these questions will be tried to be answered in accordance with the method mentioned.

1.4. Methodology

In the first part, for the literature review, the determined subject headings will be searched from both books and articles. During the research more importance is attached to the lighting design of the patient's room.

In the second part; case study will be conducted in hospitals in Izmir. Lighting design of each selected room will be examined and photos will be taken. The powers and properties of the lighting luminaires will be asked and information will be get from hospital technical staff. Firms are professionalist about hospital room lighting design will be consulted with their and will be obtained information. The electrical engineer's room will also be consulted on the subject. The furnishing elements and lighting fixtures in the room will be measured and their positions be determined. The luminosity values will measured in selected regions to compare the suitability of the light requirements determined in the standards. All the values in the room will be measured at a height of 85 cm with luxmeter. Because the height of the patient's bed is about 85 cm, when patient is on the bed. To be uniform, measurements at the points outside the patient's bed plane will also be taken from a height of 85 cm.With the information about the lighting design applied in the rooms, the room will be modeled in the program called Dialux. This program will be used both to obtain a visually more impressive presentation and to confirm the correctness of the values measured in the field.The results of the measured values will be compared with the standards and will be analyzed.

1.5. Limitation

The boundaries of this study have been identified as private hospitals in Izmir. Public hospitals were not included in the scope of the thesis. By accepting this, 6 sample hospitals were selected from among the hospitals with a bed capacity of 50-150. In order to achieve more hospitals, 50-150 bed capacity hospitals were selected. From the general surgery department of these hospitals, there was a randomly selected room study area. Some rooms have single beds and some have two beds.

CHAPTER 2
EYE, VISION AND LIGHT

2.1. Vision

Vision process is how light reflected off of the objects that people see, that can produce molecular changes with important consequences such as ability to perceive images. While the eyes absorb the light by undergoing chemical changes, the brain creates the image for visual information (Casiday and Frey, 1998). Human eye was evolved such that objects can be seen in the visible region of the electromagnetic spectrum (400–700 nm). Vision is the most efficient at interval of wavelengths between blue (400 nm) and red (700 nm) (Webb, 2006).

Color vision is performed under conditions of relatively high brightness which is known as photopic. Blue-green light focuses onto fovea while violet-blue light focuses a bit in front of fovea in healthy eyes. In this process, the lens of eye becomes convex so that violet-blue images appear to be slightly away. Red light focuses behind the fovea where the lens becomes more convex, therefore red images appear to be slightly closer. It is used to advantage in design in which warm colors tend to advance while cool colors tend to recede (Steffy, 2002).

2.1.1. Vision And Age

Visual ability reduces starting from late twenties. For old eyes, visual acuity getting lower because of yellowing of the lens and other factors, take longer time in order to adaptation also increased sensitivity to glare. With getting older normal sighted persons need a higher illumination level and ideal contrast level of visual tasks to reach best visual performance. Presbyobia define as reduction in ability of accommodation owing to loss of the ciliary muscles influences and the lens resilience which generally happen after the age of 40. The graph on the right shows mentioned effect, as the near sight distance increases fastly around age 40. The effect of aging can be adjusted with prescription glasses (Egan and Olgway, 2001).

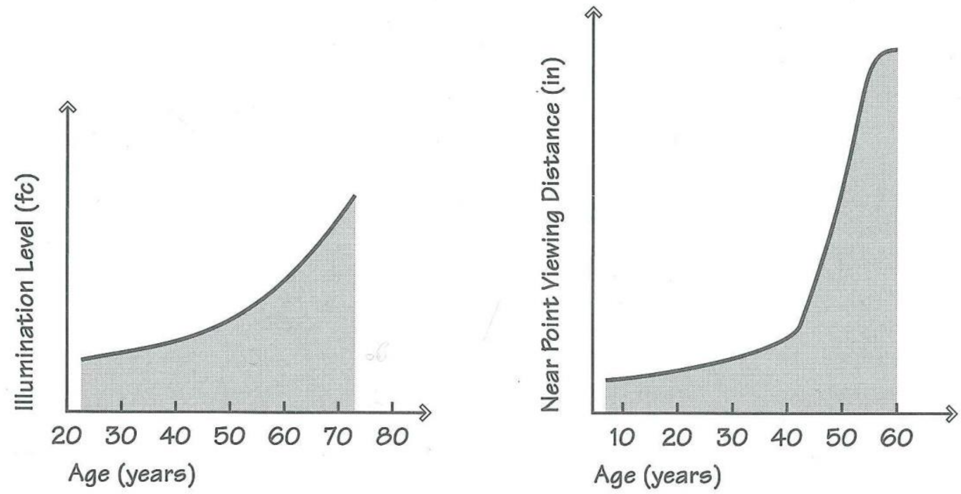


Figure 2.1. Illumination Level is the Quantity of Light Reaching a Surface

2.1.2. Day And Night Vision

Night vision circumstances appears at low brightness level (less than about 0.003 cd/ft2). Under the low light levels, inrease the sensitivity of retina rods and this process called dark adaptation. In sunny day adaptation to a dark theater on a bright may take 2 minutes or more for complete dark adaptation can take up to 1 hour. Light adaptation can be fast but can be painful because of getting eyes squint and tear.

In the 1800's Johannes Purkinje discovered that red flowers generally seemed brighter than blue flowers under the sunny weather. Conversely, at dawn or dusk seemed that blue flowers brighter than red. Such a change in eye color sensitivity called as Purkinje shift, due to the shift from perpection by cones to perception by rods. Cones function under bright light have greatest sensitivity to blue-green wavelenghts (blue flowers). The solid curves shows the Purkinje shift between day and night vision on the graph below. The dashed vision curve shows these rods which are more sensitive to light than cones, require less energy for vision (Egan and Olgway, 2001).

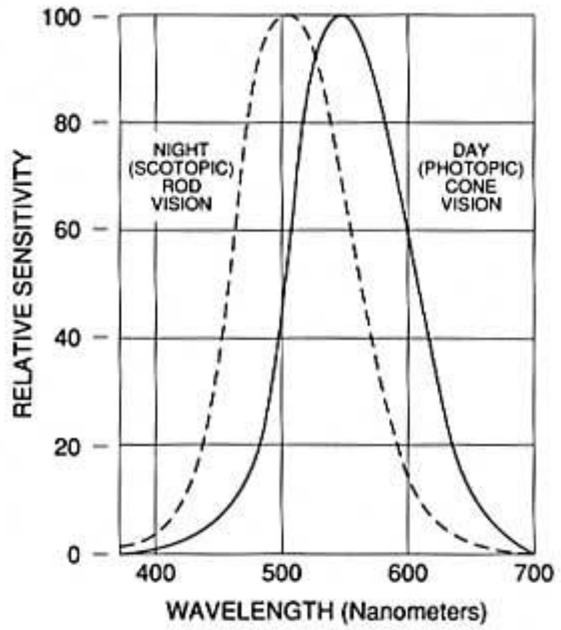


Figure 2.2. Day and Night Vision Wavelength

2.1.3.Color of Object

Color perception by humans is personal. It depends on subjective factors such as expectations, experience, and the nature of the object being viewed. For example, a green carpet could be acceptable while green hamburger meat is not. Under conditions of normal adaptation, the color of an object is relatively independent of the spectrum (or color distribution) of its reflected light if the light source contains the entire spectrum. The color of objects can define form by constrasting with the surround. Perceived color changes when the surround or backround changes. In addition, color can contribute a sense of weight, as dark-colored building elements appear heavy and light-colored elements appear lightweight. (Egan and Olgyay, 2001).

2.2. Glare

Glare can be defined as “unpleasant sensation caused by a relatively strong source of light, which results in unpleasantness, discomfort and the lowering of optimal vision characteristics” (Avramovic and Vukosavljevic, 2007).

The purpose of a good daylight design is primarily to achieve high visual performance by creating light sufficiently. Another purpose is to achieve a comfortable and pleasing environment appropriately for its goal. Glare problem has strong relationship with comfort of the daylight. Glare depends on characterisations and assessments performed by the subject as well as the physical factors such as luminance of glare source, background luminance and solid angle of the glare source (Wienold and Christoffersen, 2006).

Glare formed by windows within an environment generally arises when direct sunlight comes to this environment followed by shining into the eyes or reflects off visual tasks and surrounding surfaces. Another formation may ocur as a result of high window luminance, that can be caused by sunlight reflections off exterior surfaces. A glazed facade of buildings nearby or a view of sky can be given as examples to this surfaces (Osterhaus, 2005).

2.3. Shine

The concept of shine relates to a light size of a source that causes shining. Studies of perceived properties of surfaces, which may be called subjective brightness or skylight, have shown that those with higher levels of lightness are perceived to be larger than others with equal size materials. There is an inversely proportional relationship between the perceived distances of the surfaces and their luminosity.

2.4. Lighting

Light is defined as that "part of the electromagnetic spectrum (380–780 nm) that gives rise to a visual sensation" (Webb, 2006). American Medical Association (AMA) stated that necessity of developing lighting technologies at home and at work which minimize circadian disruption, while maintaining visual efficiency, is important (Stevens et al., 2013).

Effects of light on human body include direct and indirect effects. Indirect effects are the production or entrainment of biological rhythms. It is mediated by photoreceptors in the human eye and involve brain and neuroendocrine organs. Ultraviolet radiation acts on human skin and regulates the synthesize of vitamin D. Erythema is caused by ultraviolet wavelengths between 290-320 nanometers. Melanocytes increase the melanin pigment synthesis which causes a darker color of skin. In some people, interaction of light with photosensitizers circulating in the blood causes rash (Wurtman, 1975).

Measurement Of Light

The basic properties of light (concepts), their symbols, and corresponding preferred units of measure are given below.

Table 2.1. Light Measure Unit

Concept	Symbol	English Unit	Metric Unit
Luminous intensity (or Candlepower)	*I*	Candela (cd)	Candela (cd)
Luminous flux	ϕ	Lumen (lm)	Lumen (lm)
Illuminance (or Illumination level)	*E*	Lumen per square foot [footcandle (fc)]	Lumen per square meter [lux(lx)]
Luminance (or measured Brightness)	*L*	Candela per square foot (cd/ft^2)	Candela per square meter (cd/m^2)
Luminous exitance	*M*	Lumen per square foot (lm/ft^2)	Lumen per square meter (lm/m^2)

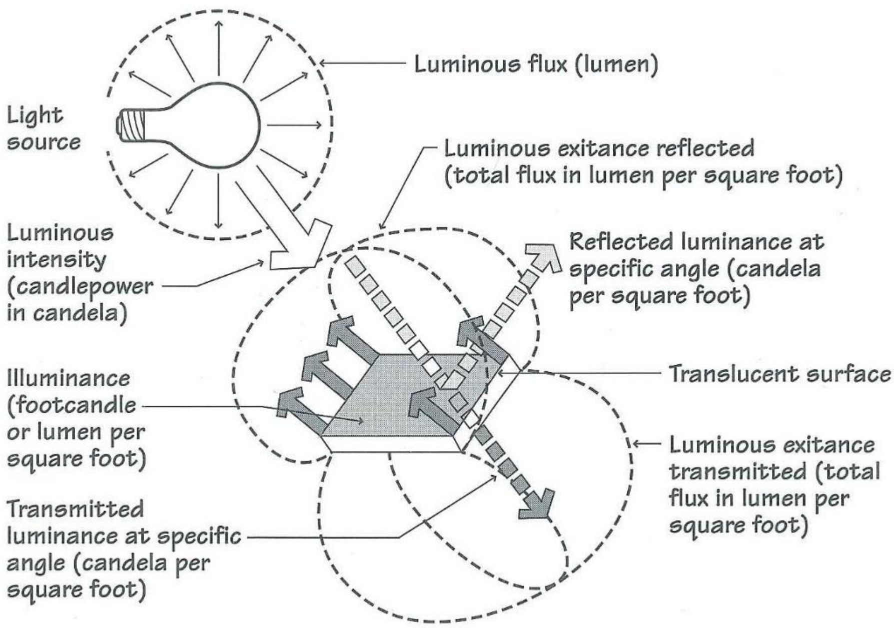


Figure 2.3. Light Measure Units

The most important factor for space sensing is light which is obtained in two ways. The first one is natural light, the natural illumination, which we can obtain by changing the formal features of the space. The second, artificial light, is artificial illumination, which has evolved since the invention of the fire, with the progress of the technology. Both types of lighting meet the need for lighting, but they are different from each other (Temel, 2010).

Some basic concepts are needed to be known in order to understand lighting problem problems. Unit of measure of light intensity lux (lx). This value is the flow of light per unit area. The intensity of illumination is 100.000 lx on a clear summer day. On a closed winter day, this value drops to 3000 lx (Akbaş, 2013).

2.4.1. History of Lighting

Since the beginning of the life, people have used the sun as their main source of light. The nights are warmed and enlightened by burning wood and similar solid fuels. A system was used in the year 70000 B.C. in which algae or similar material to be ignited was filled into a hole, a shell, or other naturally occurring object filled with animal fat. Oil lamps were invented around 4500 B.C. After that (Akbas, 2013);

- In the year 1300 the torch was invented and in 1780 the Aimé Argand invented an adjustable oil lamp with central air flow.
- In 1784, Aimé Argand added the central airflow to the oil lamp glass pan.
- In 1792, William Murdoch performed experiences and found gas lighting.
- In 1815, Humphry Davy invented miner’s lamp.
- In 1825 the hydrogen/oxygen/calcium lamp was invented.
- In 1835, James Bowman Lindsay showed that the electric lighting system of the lamp was based.
- In 1840, a fuel-burning lamp obtained from petroleum Paraffin (gas) lamp was invented.
- In 1841 the arc lamp was experimentally used as general lighting in Paris.
- In 1853, Ignacy Lukasiewicz invented the oil lamp.
- In 1854, Heinrich Göbel invented the first bright lamp in which an electric current passes through a bamboo coil transformed into carbon placed inside a glass bulb.

- In 1856 Heinrich Geissler tested the electric arc in a tube.
- In 1867, A.E. Becquerel first invented a fluorescent lamp.
- In 1879, Thomas Edison and Joseph Wilson Swan patented the carbon-lacquer lamp.
- In 1880, Thomas Edison produced a 16 W light bulb that could light continuously for 1500 hours.
- Nick Holonyak Jr. in 1962, developed the first practical visible-spectrum light-emitting diode lamps.
- In 1991, when Sodium / Sodium Oxide lamp was invented in 1986, Philips invented a fluorescent lamp that continues to light for 60,000 hours.

Figure 2.4. Samples of Lighting Sources

Due to the development related to incandescent light bulbs, various methods aiming to produce more efficient white light have been researched. According to these researches, white-light sources based on light-emitting diodes (LEDs) seemed to have significant impacts related with energy consumption, environment and human health (Pimputkar et al., 2009).

Until the 1940s, the daylight was used as primary lighting source for buildings while artificial lights were used as supplementary lighting sources to the natural light. After that, electric lighting has become a fundamental lighting method for workplaces by meeting most of lighting needs. Later, concern related to energy and environmental issues revealed so that daylighting has discovered for building lighting design. The physical mechanism of daylighting didn’t change from the beginning of original use. However, the building designs had some changes time after time. Daylighting is generally integrated into a building as an architectural statement and to achieve energy savings (Edwards and Torcellini, 2002).

From 1990s to day, high quality lighting was used to optimize human requirements, economic and environmental problems, and architectural design. Good lighting should provide for the needed level of visual performance as well as determining spatial appearance, providing safety, and contributing to wellbeing (Bellia et al., 2011).

Rapid increases in energy prices in the early 1970s and power shortages in 2001 have renewed interest in daylighting as a strategy to reduce building energy costs and delay the societal costs of new power plant construction (Leslie, 2003).

Lamp Color Spectrum

The graph of relative energy emitted by a light source is called a spectral energy distribution curve (or lamp spectrum). Each source has identifiable characteristics revealed by its curve.

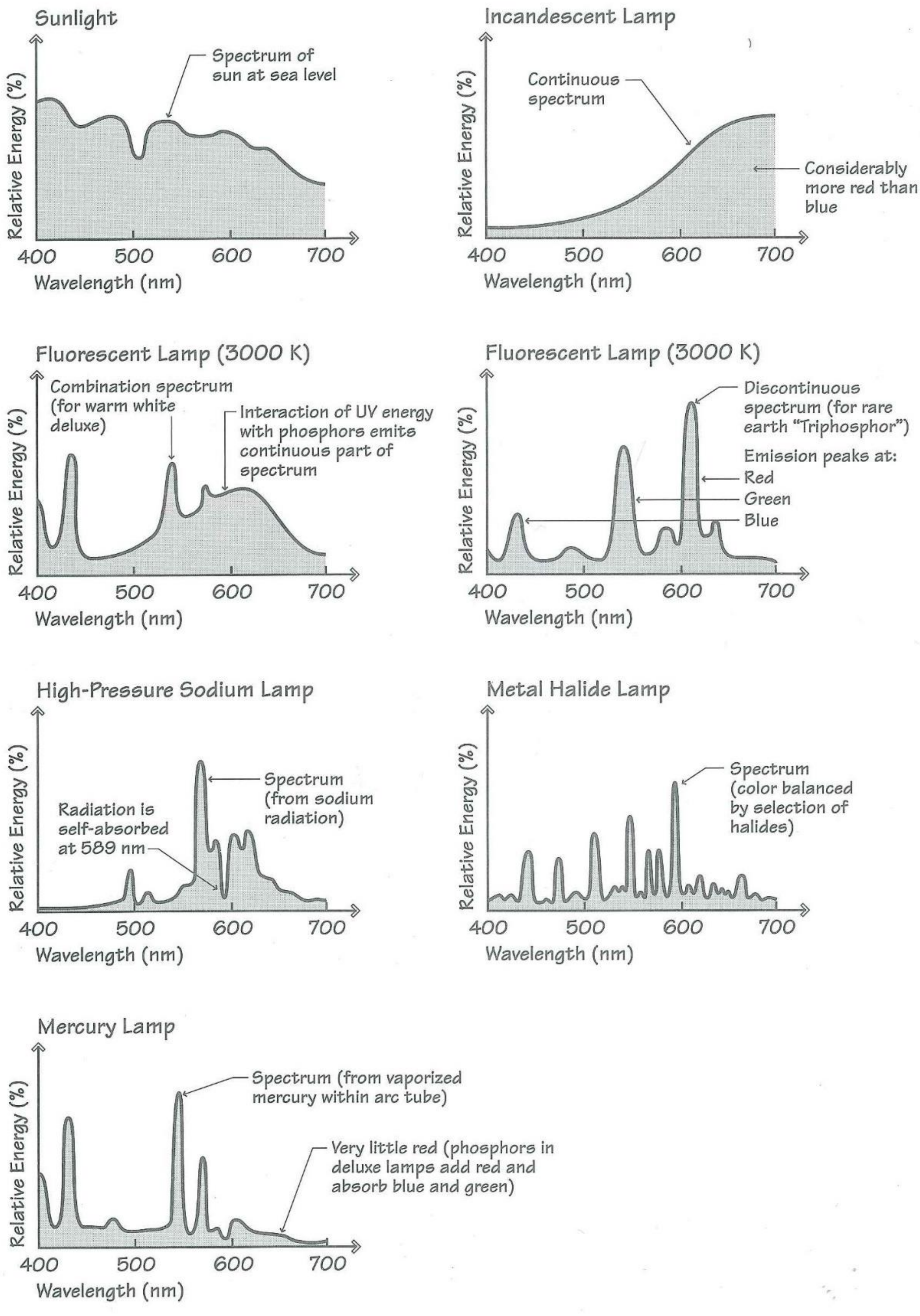


Figure 2.5. Lamp Color Spectrum

Color Spectrum

The visible portion of the electromagnetic spectrum, which contains all visible colors, occurs at about 380 to 780 nm. The nanometer equal to 10^{-9} meter (m), is used to express wavelenght in the visible spectrum so that specific values will not have so many zeros. (Egan and Olgway, 2001).

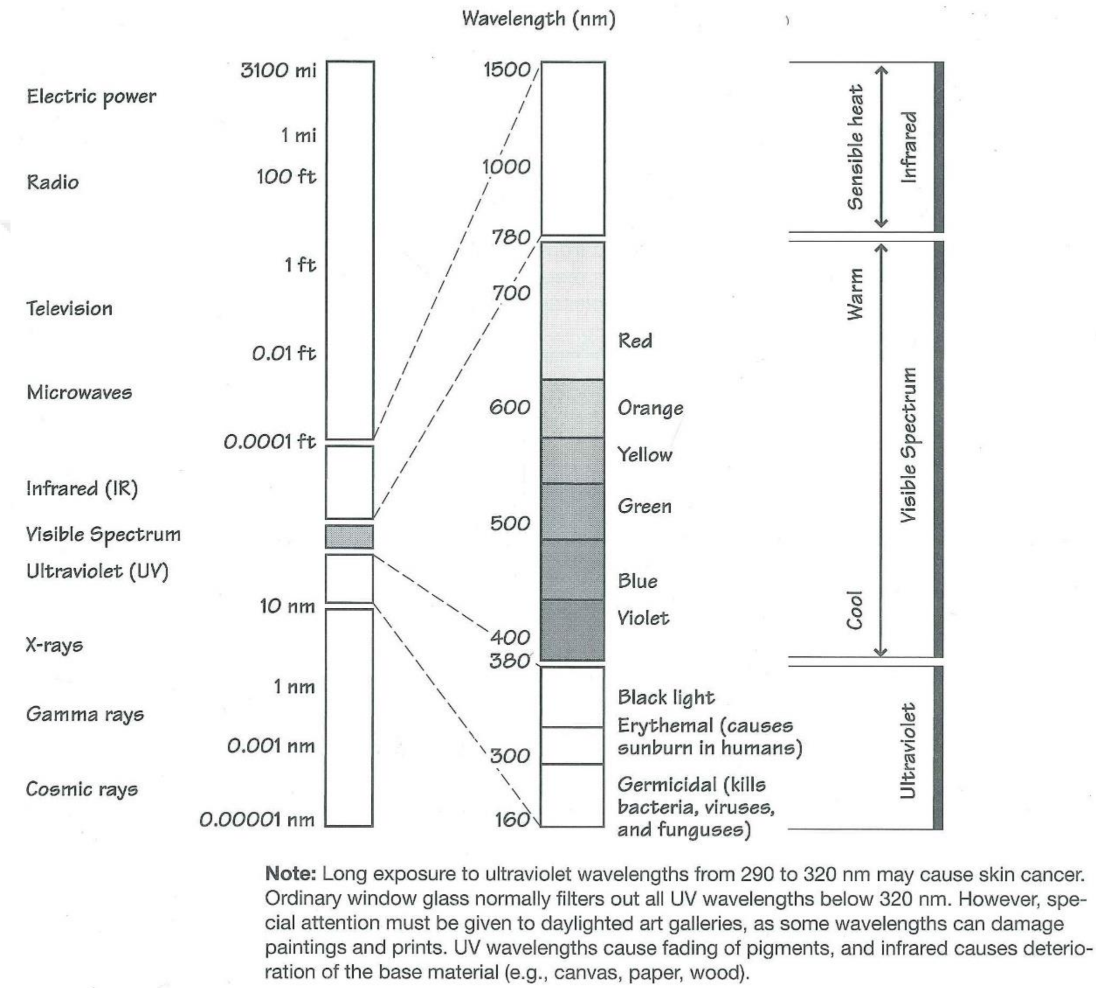


Figure 2.6. Color Spectrum

Color Temperature

Color temperature in degrees kelvin (K) of an electric light source expresses its warmth or ‘’coolth’’ not the spectral energy distribution or the physical temperature. On the scale below, color temperatures are given for electric light sources and daylight.

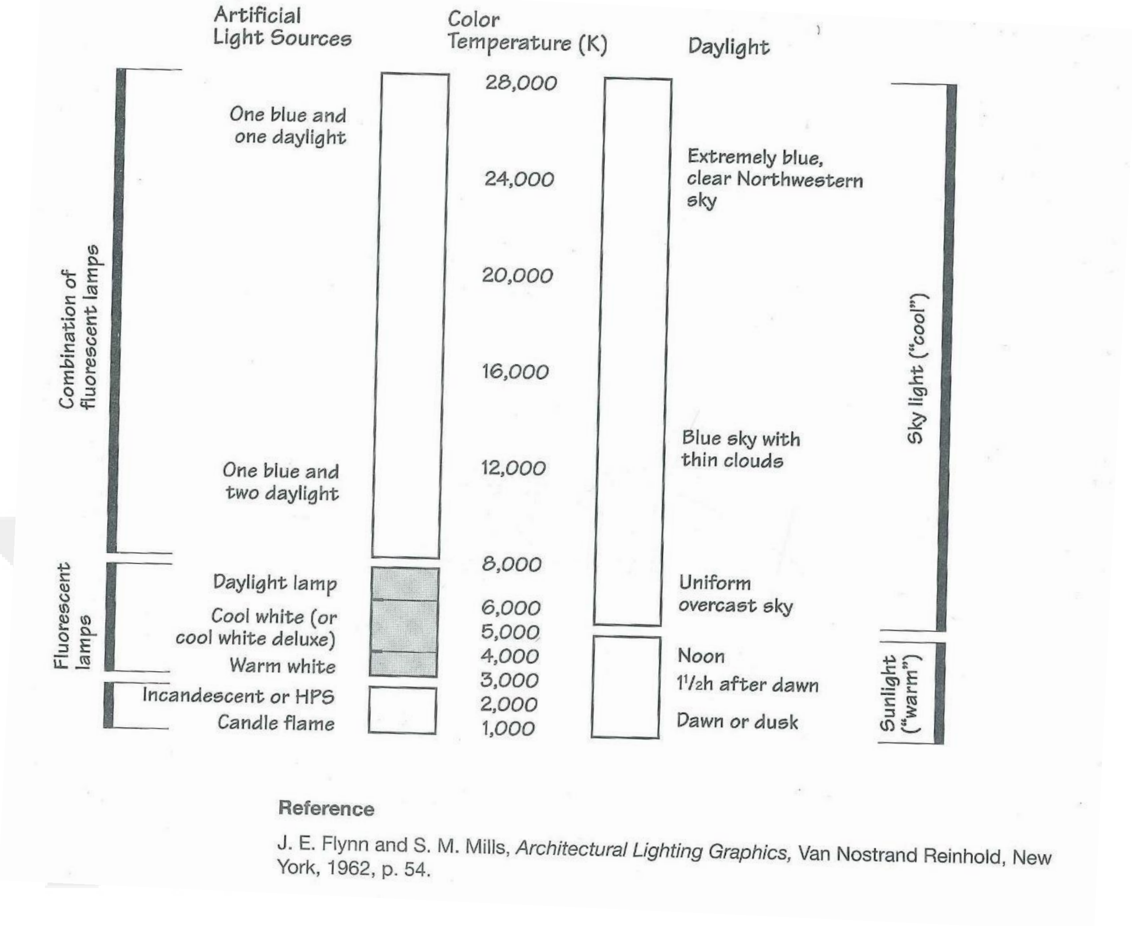


Figure 2.7. Color Temperature

2.4.2. Architecture and Lighting Relations

Light may stimulate individuals' perception via type, range, colors of exposure to a lighting source to affect emotional and behavioral status. In an architectural manner, this stimulation for individuals may create excitement, movement, impression, communication, healing and wellness that forms harmony and syntony with the surrounding environment such as a home interior, a store corner, an office space, or an exhibition wing of a museum (Tomassoni et al., 2015). El-Zeiny (2012) highlighted the indicators of workplace interior design include lighting as well as furniture, noise, temperature, spatial arrangement, color, outside view and presence of plants and flowers.

Planned lighting may change the perception of a space in different ways. As an example, color features of a lamp affect the perception of an illuminated interior space. The attraction of the space, impressions of spaciousness, playfulness and cheerfulness can be improved by changing the quantity and quality of light. Also, sensations of spatial intimacy or warmth can be stimulated. Non-uniform lighting, peripheral (wall) lighting and warm tones of white light can be improved by impression of relaxation of a space (Odabaşıoğlu, 2009).

Luminance distributions and lighting patterns affect subjective impressions of architectural interiors. Many researches agreed that the distribution of light is related to the perceived quality or adequacy of lighting installations (Bodmann, 1967; Houser et al., 2002).

Lighting design is integrated into the fabric of the architecture for to be successful It integrates the lighting concept with the architectural one ; it integrates the technology that produces light with the mechanical and structural systems that erect the building. The objective is to use modern lighting techniques in a manner sympathetic and expression of, spirit of the architectural concept. When light and architecture are combined, we are not aware of the mechanics of light production- only of a comfortable environment that encourages productivity and boosts well-being. Because light influences our sense of well-being, we are ultimately concerned with not only the quality of light, also the quality of life (Gordon, 2003).

In a daylighting example for architectural building, the basic principles of daylighting are listed as;

- “Configure the building so that most of the floor area occupied by people is within the daylight zone. The typical daylight zone is about 5 m deep from the window wall or the top floor of a building with skylights.
- Elongate a building along an east–west axis to avoid excessive solar heat gain in the summer months and to maximize north daylighting apertures (south apertures in the southern hemisphere).
- Locate critical visual tasks near the building’s perimeter.
- Bring the light in high. Windows higher on the wall will allow the light to penetrate further into the space.

- Admit daylight from more than one side of a space where possible. Bilateral lighting, for example, increases uniformity and balances the brightness within the room.
- Control the direct sun. Bounce the direct sun off horizontal elements, window blinds, and other non-specular surfaces to distribute and diffuse the light.
- Use light-colored interior surfaces. Light surfaces reduce the luminance contrast between the windows and surrounding surfaces, increasing visual comfort.
- Locate workstations and computer screens perpendicular to the windows to reduce reflected glare in the screens or visual discomfort" (Leslie, 2003).

2.4.3. Rules of Lighting Design

The following rules are for general lighting principles:

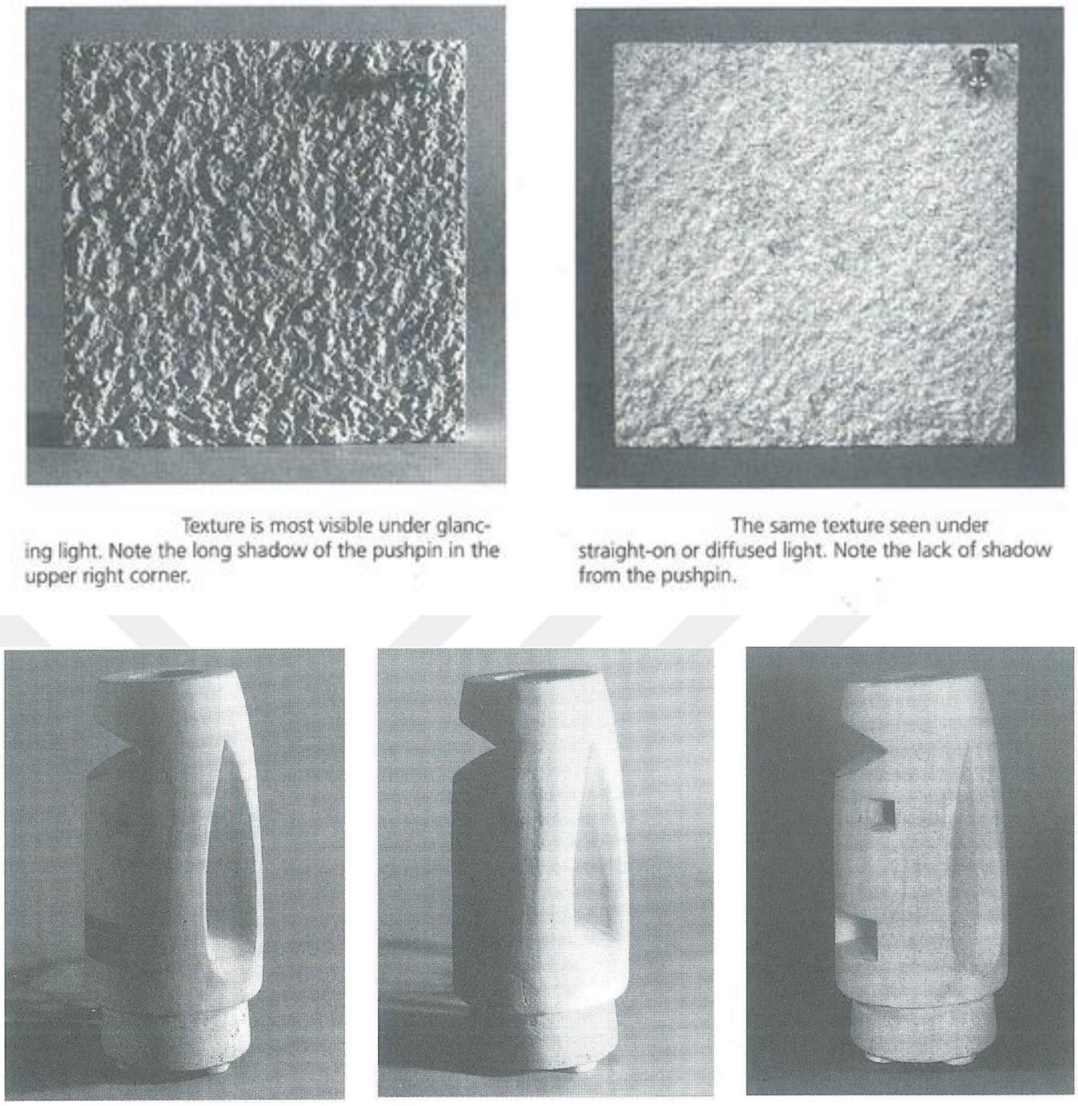
1. First, establish the lighting program with fully determining what the seeing task is in each space. For example, is illumination valid for vertical or horizontal surfaces? Colors are very important? Does it cover task of very fine print? Will be used to day-lighting to reduce the need for electric lighting?
2. Illuminate those things that we want or need to see. Since this usually includes the walls and some furnishings, the light reflected from these surfaces can supply much of the required illumination. Except for decorative light fixtures, like chandeliers, we usually want to see objects and not light sources.
3. Quality lighting is largely a problem of geometry. Direct glare and veiling reflections are avoided mainly by manipulating the geometry between the viewer and light source. The main light source should never be in front of the viewer. Glare can also be prevented by baffling the light sources from normal viewing angles. Baffles can be louvers, eggcrates, or parts of a building. With indirect lighting, the ceiling becomes a large-area, low-brightness source with minimal glare and veiling reflections.
4. In most cases, the best lighting occurs of a combination of direct and diffuse light. The resulting soft shadows and shading enable to us fully understand the three-dimensional quality of our world.
5. ''Darkness is as important as light: it is the counterpoint of light- each complements the other'' (Hopkinson). However, avoid very large brightness ratios that force the eye to readapt continually.

6. An object or area can be highlighted by either increasing its brightness of the immediate surroundings. The absolute brightness matters little. What does matter, however, is that the brightness ratio should be about 10 to 1 for the purpose of highlighting.

7. Paint is one of the most powerful lighting tools. In most cases, light colors are desirable, and with indirect lighting, the most reflective white is almost mandatory.This is one of the most economical lighting tools; usually it costs nothing because paint or some finish is specified anyway. Dark colors should be considered only when drama rather than performance of visual tasks is the goal for the lighting design. Important examples of places where drama is the goal are museums and theaters; here the highlighting of objects or the stage , perspectively, draws the viewer’s attention. Dark paint is often used to hide the clutter of pipes, ducts, and beams where a suspended ceiling is not possible or desirable. In such a case, direct lighting that does not depend on reflections of the ceiling should be used. Remember, you cannot make a room with dark finishes look light.

8. Use daylighting wherever possible. Most people prefer the quality and variety of daylight. They especially desire and need the views that often accompanies daylighting. Eye muscles are released only when we look at a distant object. There is evidence that both health and productivity benefit from the use of daylight in buildings. Recent research has shown that children performed better in daylight rather than electrically lit classrooms.

9. Flexibility and quality are more important than the quantity of light. Generally, illumination greater than 30 footcandles can be justified only for small areas where difficult visual tasks are performed (task lighting) or for elderly (Lechner, 2001).



Texture is most visible under glancing light. Note the long shadow of the pushpin in the upper right corner.

The same texture seen under straight-on or diffused light. Note the lack of shadow from the pushpin.

The best modeling occurs with strong directional light along with some diffused light to soften the shades and shadows.

If all the light comes from one direction, strong shadows and shade will obscure much of the object.

An object will appear flat under completely diffused light.

Figure 2.8. Lighting and Detail View

2.4.4. Principles of Lighting and Design Process

General lighting is used in environments where the workplace is not stationary (Alver, 2011). Lighting process of an indoor or outdoor space which can be summarized within three stages such as design, application and usage, starts with architectural design, can be performed with application and continues during the use of it. In design stage, important limitations on space and user characteristics listed below (Okutan, 2012):

- Function of space such as housing, accommodation, education, health, office, theater etc., size of space, internal surface properties (color, reflection shape, reflection multiplier), presence of natural illumination, window position and size, hours of usage,

- User type and action of the user (reading, watching television, lying down, sewing, etc.), user age and time of usage of the room,
- The relationship between interior architecture-lighting devices, architectural topics-lighting facade, furnishing-brightness, architectural expression-quality of brightness, energy use and related standards, environmental pollution, requirements of disabled individuals.

The need for lighting in a business environment depends on the characteristics of the work being done, and on the criteria such as detail perception due to job characteristics. The business environment and the level of illumination required by various workplaces are important. In fact, it is known that the highest illumination is not the most appropriate approach. The fundamental objective is achieving the proper illumination.

Enlightenment is a quantity related to the illuminated surface, not the source, and it means the flow of light perpendicular to the unit field. There is a relationship between intensity of light and intensity of illumination that is formulated as;

$$E = I \backslash r^2$$

where E is the intensity of illumination, I is the intensity of light, and r is the distance (in meters) between the light source and the illuminated surface (Akbas, 2013).

While the application of lighting is being prepared, the locations, types, interior surface materials of natural and artificial light sources must be determined and final calculations should be made (Karlen and Benya, 2011). The necessary energy power, connection points, lighting control system characteristics are determined for the artificial lighting, contacted with the individuals/ institutions about the selected materials, followed by the organization of usage and maintenance manuals (IES, 2008).

“The conformity to the standards can be useful in order to choose size and locate lighting systems to assure the required mean maintained illuminance values on the task areas and on the immediate surroundings for the different working activities.

Besides, uniform illuminance distributions and sufficient uniformity ratios on both task areas and immediate surroundings should be achieved. The reflectance of surfaces is another parameter used to obtain well balanced luminance distribution and to avoid glare or veiling reflections" (Bellia et al., 2011).

In various cases, a sample application (mock up) is performed to reveal the problems and deficiencies that may occur in the lighting system. The purposes of the mock up application process is to determine each different details (wall, ceiling, floor, etc.) thought to be critical through the lighting system and to make sample applications at these determined points. During the sample application controls, necessary notes should be kept and if necessary, required changes can be made in the design (Okutan, 2012). After simulation and presentation of the lighting design and measurement of lighting installations, the use and maintenance stage follows (Ganslandt and Hofmann, 1992).

Operational manuals containing technical specifications of the lamps, devices and control systems used in the lighting system, details of installation and installation, and special conditions to be taken into consideration during use shall be helpful during operation of the user's lighting fixtures. A maintenance manual that includes information on periodic maintenance, repair and product cleaning that can be done by the user himself or herself on how often and how to clean or replace the lamps, devices and control systems used in the lighting arrangement will provide user support in the event of system failure and productive use for many years (Okutan, 2012).

The lifetime of a lighting installation can be decreased by the accumulation of dirt on surface and equipment age. Equipment preference and environmental- operating conditions can affect the rate of this decrease. In lighting scheme design, use of a maintenance factor and plannig a suitable maintenance schedule should be takne into consideration in order to limit the reduction (CIE, 2005).

The main purpose of maintenance is achieve the maintaining of planned illuminance such as limiting unavoidable reduction of luminous flux of a lighting installation. The reduction may be caused by a defective lamp and luminous flux loss. Soiling of reflectors or other parts can also lead a reduction in ligthing output. For avoiding these reductions among luminous flux and illuminance, it is suggested that all lamps must be replaced and luminaires shuold be cleaned within periodical intervals. All maintenance procedures seen practical due to time and technical equipment, such as lifting trucks and cleaning equipment, are essential costly factors in maintenance (Ganslandt and Hofmann, 1992).

2.5. Lighting Sources

Ligthing sources are light-emitting devices that illuminate the surroundings by emitting light spontaneously in situations where at nights or objects can not be seen by the human eye, allowing the objects to be seen. Everything that illuminates the surroundings by radiating light is a source of light.

Almost at all workplaces, daylight was the primary sources of lighting. Daylighting is the process of incorporating natural lighting into the design of buildings. Along with the heating and cooling expanses, electricity usage to provide lighting to buildings leads extra overall cost of operation. Besides the daylighting is cheaper, it is intrinsically more efficient than other sources due to greater amounts of brightness per unit of heat content (Ander, 2003).

The sky gains its appearance of a self-luminosity by scattering of sunlight with the aid of molecules such as air, water vapor, dust, etc. The luminance of the sky produces the illumination. Sky luminance depends on various meteorological, seasonal, and geometric parameters which are difficult to specify. Characterizing the sun and sky for lighting simulation is equivalent to light source photometry for electric luminaires (Mardaljevic, 2000).

Incandescent lamps emit energy within the range between small amount of deep-blue radiation near ultraviolet range and deep-red of the spectrum. Incandescent lamp color is warm in tone and most of its energy concentrated in red and yellow range. This light is deficient in blue and green but it complements the appearance of warm colors and human faces. Color rending in incandescent lamp is a bit more advantageous than other lamps due to a century of use establish them as a norm (Gordon, 2003).

2.5.1. Artificial Lighting

The most common type of artificial light is indandescent lamp wich hsa a radiant source of hot tungsten filament. There is a temperature of 2,850 degrees K. in a typical 100 Watt indandescent lamp so that radiation shifted to end of spectrum. Unlikely, fluorescent lamps generate visible light by nonthermal mechanism. In a glass of tube, ultraviolet photons are generated by mercury-vapor arc. Inner surface of the tube is coated with phosphors that emit visible radiations of colors. Standard cool white fluorescent lamps designed to give maximum brightness for a certain energy consumption (Wurtman, 1975).

Artificial lighting is is necessary for every environment where natural lighting is achieved and not, and it requires a totally separate technical work. It is necessary to carefully examine the ceiling, floor, wall parts of the environment before lighting and to install the lamps at appropriate height for homogenous lighting. Both the general and local types of artificial illumination are utilized to ensure the most appropriate visual conditions in the operating rooms in hospitals (Alver, 2011).

Increase in performance, higher effort and willingness to help other individuals and less conflict can be achieved by environmental conditions which form a positive mood. It has been found that illuminance levels and fluorescent lamps has positive affect on performance and workplace cooperation (Veitch, 2001). Artificial lighting provides a consistent radiation field which can be turned on or off. However, it has rather different spectral characteristics to the sun, directed towards allowing suitable visual performance in a simple and economic fashion (Webb, 2006). Artificial lighting has been found as one of the major electricity-consuming systems in several non-domestic buildings. It is estimated that artificial lighting is responsible for approximately 20–30% of the total building energy load (Li and Tsang, 2008).

For indoor night time lighting, dim light, that eliminates wavelengths in the blue, and employs lights with wavelengths shifted toward the yellow and orange, is suggested. Incandescent lights can reduce the exposure to blue color emissions compared to fluorescent lights for the purpose of reading (Pauley, 2004). The ieffect of light while sleeping causes disruption of sleep and circadian which in turn resulting in metabolic disorders and other health problems in individuals (Stevens et al., 2013).

Light pollution is the alteration of natural light levels in the night environment produced by introduction of artificial light. Due to the continuous growth of nighttime artificial lighting, this problem is increasingly debated and many localities have developed regulations to constrain the wasteful loss of light into the sky and environment (Falchi et al., 2011).

2.5.2. Natural Lighting

Natural lighting is the lighting of closed areas with natural light and provides different lighting throughout the day. Natural light acts on the perception of the person in the room and helps the people to use the space via elements such as window doors that directly or indirectly introduce natural light into enclosed spaces. As the angle of fall of the daylight changes, the appearance and perception of the architectural form will change as well as the contrast. The different positions of the sun during the day give the impression of different places in the same place depending on the light. In addition, changing the openings in the same room also changes the entire character of the room and gives the user a different ambient sensation (Temel, 2010).

Natural window views with daylight are recognized as a significant factor in increasing indoor environmental quality (Ulrich et al., 1991). Windows are generally seen as favourable influences on health and well-being, providing access to views of the outside and the potential for restorative experiences (Chang and Chen, 2005). It has been shown that most natural windows views apparently elicit positive feelings, reduce fear in stressed subjects, hold interest, and may block or reduce stressful thoughts, they might also foster restoration from anxiety or stres (Ulrich et al., 1984). These environmental trends have recently led researchers to study the beneficial aspects of indoor space that includes window views and daylight (Choi et al., 2012).

Another study on the effects of light on the production of stress hormones, classroom performance, body growth, and sick leave, of school children showed that classrooms with windows can improve children's physical and psychological conditions (Küller and Lindsten, 1992). Lighting improvement and workplace design in terms of ergonomic principles can reduce visual discomfort and shoulder and neck pain in office workers (Aaras et al., 2001). It has been reported that daylight is better for psychological comfort, for office appearance and pleasantness, for general health, for visual health, and for colour appearance of people and furnishings. Also, natural daylight is preferred for working than artificial light due to health beliefs (Veitch et al., 1993). These findings, work efficiency/productivity could also be enhanced by windows and daylight, are supported by other studies (Galasiu and Veitch, 2006; Newsham et al., 2009).

Daylight can be used for limited areas in the operating rooms and areas outside the operation room. The benefits of daylight can not be denied in the working environment, but natural lighting is not preferred in the operating rooms due to reasons such as varying times during the day and making windows more difficult to sterilize (Alver, 2011).

The desings should be optimised for daylighting for the climates where there is no visible sun for spesific times of the year due to coverage of clouds in the sky. From this point, the source is the sky itself rather than sun or other surfaces. In this situations, the light control and efficient use of light by entegration with architecture ar main strategies to benefit from daylight. These strategies are listed below (Egan and Olgyay, 2001).

- *Maximizing the solid angle* of the sky from the task or light-reflecting surfaces. It can be understood that the tasks shouldn't be far from light from windows (sky). Also, the apertures may be larger compared to sunlighting. In this case, *D* is the maximum room depth which can be approximately maximum 2.5 times *H*, window head height.
- *Glare prevention by shading:* Direct views of glare from ovarcast sky should be avoided but shading is not necessary for building exterior due to heat gain which is not consireder as a problem for conditions including overcast sky.
- *Do not block light*: Solid light shelves and overhangs are not suggested to use due to being uneffective for overcast sky conditions and the chance to reduce the amount of light through the task.
- *Locate openings high*: The brightest of the sky should correspond with the openings of a building and sky at zenith should be 3 times brighter compared to the horizon. Light provided from overcast sky is better achieved from higher Windows and horizontal skylights.

• *Minimizing light absorption by shaping space*: Interior finishes having higher reflectance is suggested to use. Interior surface area can be minimized by maximising the ceiling height.

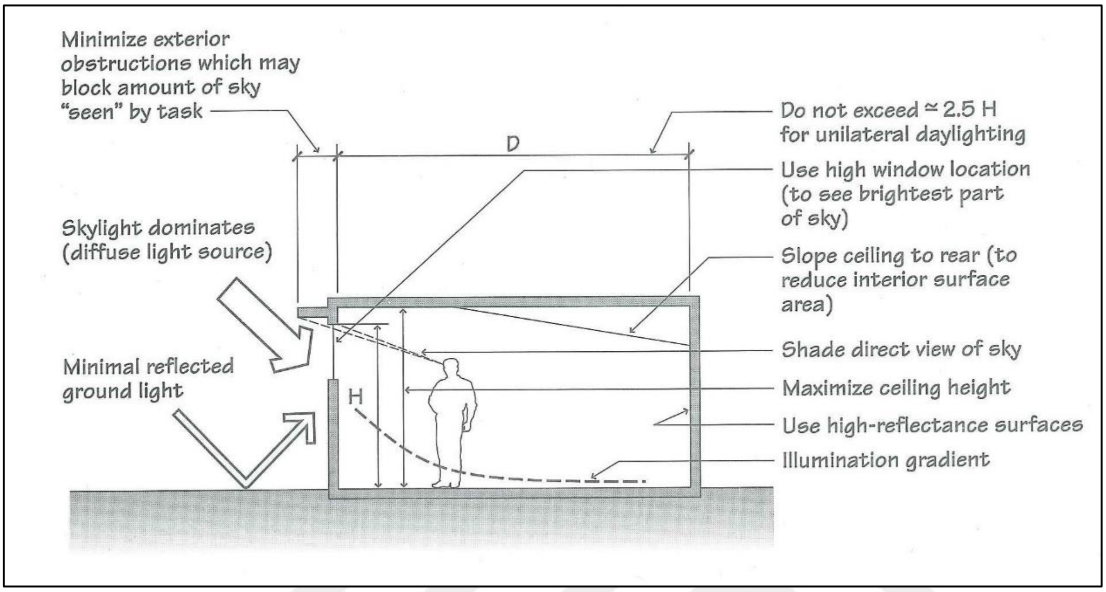


Figure 2.9. Daylighting Use Scheme

2.6. Lighting Types

2.6.1. Indirect Lighting

For indirect illumination, in most eases a uniform ambient light has been considered, even though the interreflection gives very complex effects with the shaded images. Nishita and Nakamae (1985) suggested a method for indirect lighting that forms shadows. The method includes some points:

• "The indirect illuminance caused by the surfaces of objects such as ceilings, floors, walls, desks, bookcases etc. gives added realism to images.

• The proposed method is suitable for every type of light source such as point sources, linear sources, and area sources."

Figure 2.10. Indirect Lighting Application of a Hospital Corridor (Tutkunlar, 2014)

2.6.2. Semi Indirect Lighting

The light emitted by the lighting device is a direct lighting of 60-90 percent of the current and 10-40 percent of the lighting. To take advantage of the reflected light, the ceiling reflectance must be high. Semi-direct lighting provides a more diffuse light field than direct lighting (Reynolds, 2000).

Figure 2.11. Semi-Indirect Lighting of A Patient Room (Tutkunlar, 2014)

2.6.3. General Diffuse Lighting

The form of illumination in which the light flux from the device reaches the working plane directly and indirectly in almost equal proportions is defined as diffuse illumination. In diffuse illumination, light sources are used with naked or spherical spreading devices. The diffuse, surface reflectance factors are more important than the illumination models. Maintenance and cleaning of the devices must be done frequently to reduce the effect of the value decrease in system efficiency. Transparent illumination is commonly preferred, especially in residential buildings, due to the small number of shade occurrences and a diffuse light distribution (Kılıçarslan, 2011).

Diffuse lighting is a type of lighting that directs 40-60 percent of the light emitted from the device to the surrounding area, 40-60 percent directly to the working area. In this case, the light is scattered over the entire area of the device. These devices, which consist of light-transmitting devices, must be maintained frequently to prevent the waste of light energy. In the case of diffuse illumination, the reflectivity of all surrounding surfaces must be high. Transparent lighting is one of the most commonly used lighting schemes in residential buildings. It is applied to prevent glare, to obtain a diffuse light field, and to create a shadowless light (Reynolds, 2000).

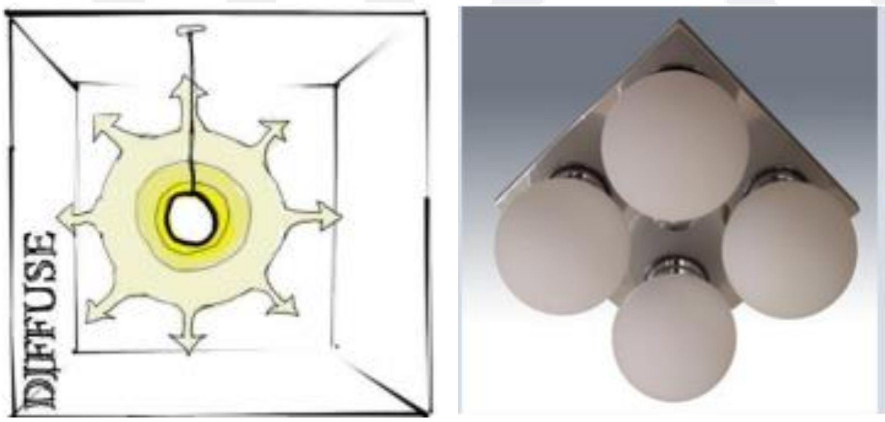


Figure 2.12. Diffuse Lighting

2.6.4. Direct Lighting

The light intensity distribution is the illumination of the luminous fluxes in such a way that the 90% to 100% of the emitted light flux will fall into the unlimited default useful pitch.

In direct illumination, nearly all of the light flow out of the illumination is sent directly to the working plane. The influence of surface factors are very low due to the fact that the light flux from the device directly reaches the surface in direct illumination. The efficiency is high however due to the light coming directly to the surface, ghosting problems and differences in the brightness level distribution within the room can emerge. For this reason, single point illumination in a volume that can be directly illuminated can cause the effects of these problems to increase. By appropriately distributing the used devices within the volume, differences in shadow effect and brightness level distribution can be reduced. In direct lighting, the devices can be mounted with a certain size of hanger. The hanger size of the device should be chosen to suit the room architecture and light distribution. All devices designed for direct lighting have a reflective feature. It is a lighting technique that can be preferentially used in dark-colored surfaces or in high-volume spaces (Kılıçarslan, 2011).

Figure 2.13. Examples of Direct Reading Illumination On A Patient's Bed

2.6.5. Semi Direct Lighting

Unlike direct illumination, a larger part of the light emitted from the source is reflected off the surfaces and comes to the working plane. This system results in a more diffused illumination compared to direct lighting models. However, some of the negative effects of the indirect illumination are also softened as a part of the emitted light flux from the device reaches the working plane by reflecting off the surfaces (Kılıçaslan, 2011).

Figure 2.14. Semi Direct Lighting

2.7. Material and Lighting

Lighting and material are very important aspects of the visual appearances (Chen and Liu, 2008). In architecture, lighting and its reflection can be used for many purposes such as displaying, protection, cognition etc. Kurtay et al. (2003) listed the fundamental purposes of material-lighting relationship as:

- The prevention of the dazzling which prevents the visible objects from appearing with a conscious use of a lighting scheme, the recognition of a qualified monitoring opportunity by ensuring that objects are perceived clearly and accurately.
- Protection of exposed objects from harmful radiation.
- Providing an artificial lighting scheme that supports daylight.
- Depending on the development of exhibition methods, detection of the objects' formal, instrumental, color properties.

A place is defined as a space which is bounded by a specific purpose and has many connections physically. With light and shadow, spaces become more perceptible and understandable. The correct and proper use of the light and the shadow increases the effectiveness of the aesthetic perception in the architecture, resulting in the emotional intensity. The sunlight entering through the window is scattered in the room, allowing the area to be enlightened. If someone is in the place where the sunlight enters, or on the side, we will see that the sunlight shining through the window will awaken a feeling of comfort and spaciousness. It is pleasing to see the patterns of light watched the rhythmic game, or seeing that any objen is different due to the constantly changing angle and quantity of light source. In a properly-lit space, individuals feel enthusiastic and cheerful, but on the contrary, it is inevitable to be uncomfortable and restless if they are not properly lit (Albayram, 2009).

Definition of the object appearances is the most fundamental aspect for scene design. This appearance is formed by the interaction of surface material and lighting. Appearance design process is used to arrange the lighting and material features to achieve a desired appearance. Generally, appearance design is a complex and laborious process, since artists are manually solving an under-constrained inverse problem: given a desired appearance, determine the material and light settings to achieve it.

Edition of lighting and material includes following elements;

- "Lighting design: the editing of lighting parameters to define a final scene appearance, which is fundamental to computer cinematography;
- Material design: the definition of the reflectance properties of a surface or the scattering properties of materials, ranging from whole surface changes to precise adjustment in textured regions;
- Whole appearance design: the coupled editing of the interaction between surface materials and scene lighting, when it may be difficult to segment and treat separately;
- Preview rendering: rendering systems tailored to adapt to the more flexible demands of an appearance editing framework" (Schmidt et al., 2016).

The reflection pattern of many surfaces present a strong specular component. The various measures in the literature shows that the processes of absorption, reflection and transmission account for all the incident radiation in any particular situation. The relative importance of these three physical phenomena can be altered by modifying the surface conditions (e.g. the surface roughness) or the angle of incidence and the wavelength of the incident beam (Paterna et al., 2013).

For incident light of a given wavelength, the roughness of a surface may be estimated by studying the manner in which the surface scatters light in different directions. If the surface irregularities are small compared to the wavelength of incident light, a large fraction of the incident light will be reflected specularly in a single direction. On the other hand, if surface irregularities are large compared to the wavelength, the surface will scatter the incident light in various directions. Conversely, the same surface can be made to appear smooth or rough by varying the wavelength of incident light; or for the same wavelength it can be made to appear smooth or rough by varying the angle of incidence (Nayar et al., 1989).

For wooden surfaces, the inner surfaces of the cell walls are highly reflecting, and the light received from them greatly influences the visual quality of the material. When a highly inclined mirror facet is illuminated, much of the light reflected will fall on other elements of the surface which, whether mirror or rough, will in general be highly curved, and will consequently distribute the light over a wider angle at each reflection (Barkas, 1939).

The reflection factor is the ratio of reflected light to incident light. Some typical reflection factors of materials has been shown at Table 3.1

Table 2.2. Reflection Factors of Some Materials (Dialux4, 2016)

Materials	**Factors**
Clear glass	6-8 %
Prismatic glass	5-20 %
Plaster	80 %
Cement/concrete (untreated)	20-30 %
Light wood	30-60 %
Dark wood	10-15 %

For glazing in buildings, amount of light and wavelenght are considered as main properties. Shading coefficient (SC) which is defined by ASHRAE as "'the ratio of solar heat gain coefficient of a glazing system for a particular angle of incidence and incident solar spectrum to that for clear, single pane glass with the same angle and spectral distribution", is commonly used index for evaluating the reduction of solar energy through openings. SC value is necessary to evaluate thermal loads while specific wavelenghts should be evaluated for lighting design (Egan and Olgyay, 2001).

Requirements of thermal and luminous can be provided by using glazing materials which consist of aluminosilicate glass, high-silica glass, and some plastic filters. These materials can reduce UV radiation and prevent UV damage.

Angle of incidence affects the light transmission through glass which is maximum at 0 degree and it diminishes at angles higher than 70 degrees. Transmittance data are shown for single and double-glazed windows at Table 2.3. (Egan and Olgyay, 2001).

Table 2.3. Transmittance for Single and Double-Glazed Windows

Angle of incidence (deg)	Transmittance (%)	
	Single-glazed window	Double-glazed window
0	90	81
20	90	81
40	89	80
50	87	77
60	82	71
70	77	59
80	44	29
90	0	0

CHAPTER 3

HOSPITAL BUILDING AND EFFECTS OF LIGHTING

3.1. Hospital Buildings

Hospitals are defined as institutions in which patients and injured persons, those suspected of having a disease and those who want to be controlled, diagnosed, treated and rehabilitated their health status (Kavuncubaşı ve Yıldırım, 2010; Tengilimoğlu, 2014). According to the World Health Organization (WHO) (2010), health is defined as “a state of complete physical, mental, and social wellbeing and not merely the absence of disease or infirmity”. The health services are the protection and development of the health, the treatment of all possible diseases with treatment and the rehabilitation of the disability.

Hospitals have four basic functions, varying in accordanec with organizational goals and missions. These functions are;

- Treatment Services,
- Protective and developmental health services,
- Education,
- Research.

Treatment services are the oldest and most basic functions of hospitals. Hospitals also provide preventive health care services for the sick and wounded individuals. Child units in hospitals are given as examples to these services. Hospitals also play an active role in fighting against harmful habits such as alcohol, cigarettes, and drugs (eg. smoking cessation, balanced nutrition, pregnancy and newborn care sessions) and are thus effective in improving community health (Kavuncubaşı and Yıldırım, 2010).

Hospitals are complex open-dynamic systems, organizations operating in a matrix structure that serve 24 hours a day. Hospitals are classified as their type of care, management and controls, financial resources (ownership), size (bed capacities), and patients' length of stay. Hospitals are also categorized according to their type of treatment and whether educated is given or not (Korkmaz, 2008).

There are 5 key elements for hospital planning goals. The first one, patient focused care, considered as a fundamental part of caring process because the patients are the reason of existence of hospitals. Second element is efficient operations in which safety of clinics, optimization of functions, installation of modern systems, value for Money and low upkeep needs are highlighted. The third element is flexibility which consist expansion and inovations for technological developments that provides long term success. Fourth element is sustainable design which can provide hospitals to reduced use of energy for 24 hours and high occupancy. Final element is healing environment includes art and hospitality as well as technology and science (Sprow, 2012).

3 main groups mentioned that should be examined when designing hospital buildings. These are management, medical personel, and patients and their families.

Management: This group consists of the hospital owner or the owners and the hospital management.

Medical personnel: this group includes doctors, nurses, technicians, nurses and other personnel dealing with patient care.

Patient and their relatives: This group includes patients and their families who have come to the hospital to attend control, training, and meetings to provide information and counseling about patients' health or well being (Sungur Ergenoğlu, 2006).

Gesler et al. (2004) points out that cost efficiency and clinical functionality are the main criteria for several hospital designs in the UK. The design processes are based on these criteria and assumptions related to these criteria seemed to have a relationship with healing. Disciplines such as medical science, landscape and design aesthetics, environmental psychology have significant contribution to the hospital designs. They make possible to 'read' physical layouts of hospitals as embodying particular social relations. For instance, it is apparent that certain (generally most powerful group or groups) stakeholders are able to manipulate the social space of the hospital so that distinctions between medical ‘experts’ (e.g., doctors and consultants), medically trained staff (e.g. nurses), non-medical support staff (e.g. porters, security, kitchen staff) and non-staff (e.g. patients and visitors) are maintained. Also, reception staff can be positioned to act as first line gatekeepers between experts and the public.

A key area of significance in understanding the effects of architecture upon health and health care is in terms of power relations invested in health spaces. Social scientists have largely focused on human relationships in their analysis of health care. For example, medical sociologists have predominantly considered power relations in terms of lay and professional interrelationships and medical power and dominance in health care delivery. These have traditionally focused on doctor patient relationships and health professionals and clients as well as access to services and gatekeeping (Gillespie, 2002).

Moreover, for the beginning of twenty first century, hospital architecture has increasingly embraced the open space model of the shopping mall, housing commercial spaces such as shops, banks and restaurants which came to embody the power of commercialism. As in some hospital examples; space, light and transparency create a naturally ventilated atrium. Each hospital floors overlook a central lobby containing paintings, plants and sculpture designed to promote wellbeing, hasten recuperation times and inevitably in a more competitive health market, attract patients/clients (Gillespie, 2002).

3.1.1. Hospital Departments

Hospital departments has many services and ligthing conditions. Definitions of services in hospital listed as below:

Services: A team work carried out jointly by service professionals, specialist educators, nurses, pharmacists, dietitians, physiotherapists, psychologists and other professionals. It is aimed to provide the most appropriate conditions to patient with accurate diagnosis with reliable tools, and also to provide in-service, patient-centered training in training hospitals.

Polyclinic Services: Polyclinics are the first application units in the inpatient treatment institutions of the patients where remote inspection, examination, diagnosis and treatment services are performed.

Emergency Services: Emergency outpatient services or emergency services, if not available, are carried out by the on-duty doctors for 24 hours a day.

Laboratory Services: It is organized in a central place according to the service and outpatient services in polyclinic and service patients and inpatient treatment institutions which do not have polyclinic laboratories as well as other laboratory necessities such as public health of Ministry of Health when necessary.

Operating Room Services: The chief surgeon is responsible for the management of the operating, the availability of equipment and supplies, the maintenance and repair needs of the operating rooms, and the management and training of the personnel who work here and directly responsible for office of chief surgeon.

Central Sterilization Services: Instruments and materials used in service departments such as operating room in central sterilization, all patient services, polyclinics, laboratories, endoscopy, intervention and birth rooms, intensive care unit are ready to be used by being sterilized collectively in sets of papers or special bundles. They are distributed here readily.

Intensive Care and Reanimation Services: Inpatient care units where intensive care and reanimation services are provided, where care is provided for physically and/or life-threatened patients who must be constantly monitored and controlled for medical, nursing and other technical, health and laboratory services.

End-of-Surgery Care Unit Services: These are in-patient care units where patients stay up to 24 hours before surgery to wake up and correct short-term surgical complications (Kavuncubaşı and Yıldırım, 2010; Tengilimoglu, 2014).

3.1.2. Patient Room

When a hospital comes to mind, it is seen as an image of patients, their bedrooms, nurses assisting them. Besides these images, developments in technology is also a key element for healthcare facilities. While designing hospitals including patient rooms and nursing units, evidence-based designs are started to be preferred, bringing a new approach and supporting higher recovery of patients with their families. It has been suggested that decentralized work stations for nurses, single patient rooms which provide more privacy and flexibility for care as well as time spend on patient transfers make occupational environment better.

These improvements is reflected by architectural form of inpatient elements such as compact blocks of rooms with nurse assistance, shorter corridors, high amount of windows etc. When patients rooms are always occupied, some spaces should support this insufficiency. Conference and staff facilities can be used as closed spaces by some arrangements such as storage of supply and equipment for medication. In this case, orientation of room and environment are important for these patient rooms. The driving forces of new patient ward designs are financing systems, cultural expectations, and medical practice. When the payment system supports more staff and more generous use of space, the current trends, and latest regulatory requirements, are moving toward larger private rooms which can be adapted from intermediate step down care to longer term care, with optimal infection control and with amenities such as private toilet and shower, entertainment and communications, and visitor accommodations. As the patient rooms getting larger, the equipment requirements can be met more flexible. Periodical updates can achieve long term plans but this specialized layout can not be used other purposes. Subsidized healthcare systems in which two-bedded rooms or larger multi-bed patient wards exists, provides patient and family centered care and a healing environment. However, for inpatient care, the spaces are specialize for only this purpose and when more beds are needed to support hospital plan, inpatient units can be expanded by incresaing bed towers, more floors of nursing units (Sprow, 2012).

Hospital staff, especially nurses, can give better health care services while shortes traffic flow exist whic can be achieved by grouping beds for efficient numbers from 24-40. Also, patients should see nature views and need local codes during their lenght of stay. For example, some health codes require a high percentage of patient rooms in Northern Hemisphere countries to face generally south for maximum sun, while in hot climates the opposite may be required. Nursing units need to be separate from public areas, traffic restricted to staff and visitors, and no traffic through one unit to reach another. Within the unit separate visitor and staff/patient traffic needs to be considered, especially at elevators (Sprow, 2012).

According to Service Units and Qualifications of Private Hospital in Private Hospital Regulation in Turkey, patient rooms must be cleaned easily in a position where they can be illuminated directly and with sufficient daylight, and the bases and walls must be suitable for disinfection. The door width of the patient rooms is at least one meter to ten centimeters; the toilet and bathroom doors in the patient rooms are arranged to be opened outdoors.

With the regulation in 2004, rooms with two patient beds must be suitably detachable for use where appropriate, provided that they meet the minimum area measurements per patient bed. Also, there can not be more than two patient beds in a room. According to another regulation in 2004, Rooms with two patient beds must be suitably detachable for use where appropriate, provided that they meet the minimum area measurements per patient bed. In 2017, it is stated that the patient room where the hospital personnel use it extensively, can not be a room that does not receive enough daylight which affects the health and rest of the patient in a negative manner. According to regulations in 2006, in the case of private hospitals, at least one patient’s bed is reserved for each specialist who is admitted and treated. Patient rooms have central oxygen and vacuum fittings for each bed. For the disabled, at least one in special hospitals with thirty or fewer sick beds and an additional one in each additional thirty bed will be established for the disabled patient room in accordance with the relevant legislation. The wet spaces in the patient’s room for the disabled are arranged to allow the use of the obstacles.

In terms of areas to be allocated per patient; Article 22 states that For patient beds in private hospitals, the minimum area measurements to be separated per patient bed, excluding wet floors, in patient rooms are shown below:

a) Single bed patient rooms must be at least nine square meters,

b) Two-bedded rooms, at least seven square meters per patient bed,

c) The rooms reserved for children are at least six square meters per patient,

d) Single-bedded rooms for sleeping with children at least twelve square meters and two bedrooms, at least ten square meters per bed,

e) Intensive care units, at least twelve square meters per intensive care bed.

f) Newborn intensive care units, at least six square meters per intensive care bed.

g) Observation observation at least six square meters per bed,

After the Wolrd War 2, mega hospitals contain patient housing regions in a tower atop a platform that housed all other functions of the hospital. These functions are given as "arrival, intake, accounting, administration, medical records, laboratories, diagnostic and treatment services, emergency department, surgery, dietary support, materials management, and outpatient services". The units including this medical arrangements was configured in plan as a rectangle, square, radial pattern, sawtooth, L-shape, triangle, and myriad variations. Horizontal variations provide closeness to the ground for patient care with the configuration of a wing rather than a tower, typically up to four levels in height. In a subsequent construction phase, additional levels can be stacked atop existing ones. Frequently, the interior remains completely cut off from the outdoors except for its windows and views. One can see outside but not be outside. Internal health villages configured as pavilions with umbilical cord are alternative strategies for supporting health care functions. Each pavilion is semi-autonomous, with exterior space interspersed in between such as transitional and semi private spaces (Verderber, 2010).

3.1.2.1. Standards of Patient Rooms Lighting Design

Lighting design practice is influenced by lighting societies and learned bodies, lighting associations, lighting standards and legislation. A standard is defined as "a document that provides rules, guidelines or characteristics for activities or their results, aimed at achieving the optimum degree of order in a given context". EN12464-1 is the European standard for indoor lighting.

Both interior and exterior lighting need to achieve a reasonable uniform illuminance in all relevant working areas, therefore illuminance across any given task area needs to be uniform in workplace. For minimum lighting, the illuminance needed depends on how much detail needs to be seen. It also depends on the age of the worker, and the speed and accuracy by which the task needs to be performed (EN 12464-1: 2011).

The distributions of light within a space substantially influence the perception of the space as well as people within it. Hospital lighting system has two main functions: one is to meet the task requirements in each area of the hospital and the second is to create an environment that is visually satisfying the patients as a good lighting system design can influence human emotions and feelings of well-being (Alzubaidi and Soori, 2012).

When designing systems for health lighting, it is necessary to decide what light levels of the surfaces in the room will be and to control them. In this way, the medical staff, the patients and the hunters are prevented from feeling tired. This also increases the visual labor power of the users. The color reflection properties of interior surfaces are important in terms of lighting rates, application of light and atmosphere of the room. Ceiling, wall and floor surfaces work like a light source because they reflect the light that reaches them, and become part of the lighting system (Özgen, 2014).

Research on lighting indicates a preference on the part of patients and family members for a variety of lighting types within the room. This allows for personal control of the ambient conditions and foot-candle distribution within the five principal zones- room threshold/entry, caregiver area, patient bed, family area, and bath/shower room and outdoor zone. A mixture of full spectrum fluorescent and incandescent light fixtures is recommended because different lighting is preferred at different times of the day and night. For example, an over-bed flourescent light source is recommended for staff use and also in the bath/shower room to facilitate safety, observation, and assistance. Above-bed recessed ceiling configurations allow for these uses without being visually intrusive. Wall-mount and tabletop lamps create a residental ambiance and help to extend an ambiance of home into the hospital environment. Incandescent task ambient fixtures mat pivot on an armiture, allowing light to be redirected based on individual preference. The patient should be able to control all light sources and their intensity from the bedside control panel (Verderber, 2010).

Besides the treatment possibilities, the atmosphere of the hospital and the appearance of the rooms are important criteria in the hospital selection of the patients. Accurate general illumination can provide a perceptible contribution to creating a pleasant and homely environment in patient rooms. In addition, correct general illumination should be sufficient to fulfill simple nursing tasks. Separate switched-mode lighting systems such as general comfort lighting, reading lighting for the patient, lighting for bedside treatments and treatment, night/observation lighting, orientation lighting must meet the lighting requirements of patient rooms. The creation of indirect lighting, which brings at least 100 lux brightness and warm-white lights, provides a comfortable atmosphere in the patient's rooms. The rooms preferred by indirect lighting end patients appear larger. In addition, another positive effect is also tranquilizing. Another general illumination requirement for patient rooms is the maximum brightness allowed by indirect lighting of 500 candela per square meter (Licht, 2012).

Patients need enough light (indirect lighting and bedside reading lights) provided by integrated lighting on each bed to perform personal activities such as reading and manual activities. The reading lamp creates satisfactory reading conditions with at least 300 lux in the reading plane required for each hospital bed. Patients, especially those who are always in the hospitalization position, should see the color variation of the pan with a reflection factor of less than 0.7. In patient rooms, adequate light levels are required for medical and auxiliary personnel to ensure that medical examinations and maintenance activities are performed on patients. Due to the visual task difficulties, the lighting system should provide optimum illumination at high levels of visual comfort and no flash in the staff. From this point of view, it is also important to use the sources of illumination as close to natural light as color rendering (Francesco et al., 2016).

According to DIN EN 12464-1 and DIN 5035-3, the standards provide an illumination of approximately 300 lux on the examination plane for nursing tasks and simple examinations. The recommended illumination for examinations and treatments or emergencies is at least 1,000 lux. Night / observation lighting systems are a possible solution to how patient rooms are illuminated at night when patients are asleep. The required average brightness level is 5 lux at a level of 0,85 m above the floor. The staff at night should be able to control patients without unnecessary discomfort and perform simple tasks at a very low level of brightness when necessary. The quality of orientation lighting should be taken into account to help patients find their way in the night without disturbing other patients sleeping in the immediate vicinity. Wide-angle LED luminaires mounted below the bed level and near the door may comply with the requirements of patient rooms or care facilities. Due to the positive effects of light and dynamic lighting scenarios on the biological well-being of patients and staff, biologically effective artificial lighting solutions in hospitals should be established alongside functional illumination for hospital operations. A patient's sleep/wake rhythm (human circadian system) can be positively affected by changing brightness and lightness. The patients' natural active and resting phases, good night's sleep and fast recovery are supported by biologically effective artificial lighting (Licht, 2012).

In patient rooms, a different number of patients have to share the same room. In such a case, hygiene is important. It is necessary to prevent bacterial formation in luminaires by using antibacterial dyes. The protection type used should be IP65 so that people can stay in clean sanitary rooms. The standards define the most important lighting parameters, the minimum values of the mean brightness (E_m), the luminosity uniformity (U_0), the values of the color rendering index (Ra) of the lamps and the maximum glare values.

The basic design considerations in the clinical rooms include the combination of direct and indirect fittings, proper luminaire placement, inhibition of computer monitor reflections, task lighting not directly mounted on the work area, and a lamp with a high color rendering index (CRI) of 80 or higher (Health Solution 2002).

Figure 3.1. A Lighting Application of A Polyclinical Room

Separate wall mounted uplights, frequently installed where the ceiling height does not exceed 3m should be at a minimum mounting height of 1.8 m. They may require supplementary ceiling mounted luminaires to enhance the light at floor level in the centre of the ward for circulation and nursing functions. A selection of the most popular lighting layouts is illustrated here using visualisations. LG2 makes recommendations for luminance limits as seen by a patient lying in bed. The ceiling height for suspended luminaires should not be less than 3m to ensure adequate clearance for mobile apparatus used at the bedside. The mounting height above the floor should not be less than 2.7m nor greater than 3.5m.

Ceiling mounted luminaires

The ceiling height may be 3 meters or less. In areas with ceiling heights between 2.4m and 2.7m, it is possible to provide the recommended illuminance at the bedhead only by using ceiling mounted luminaires.

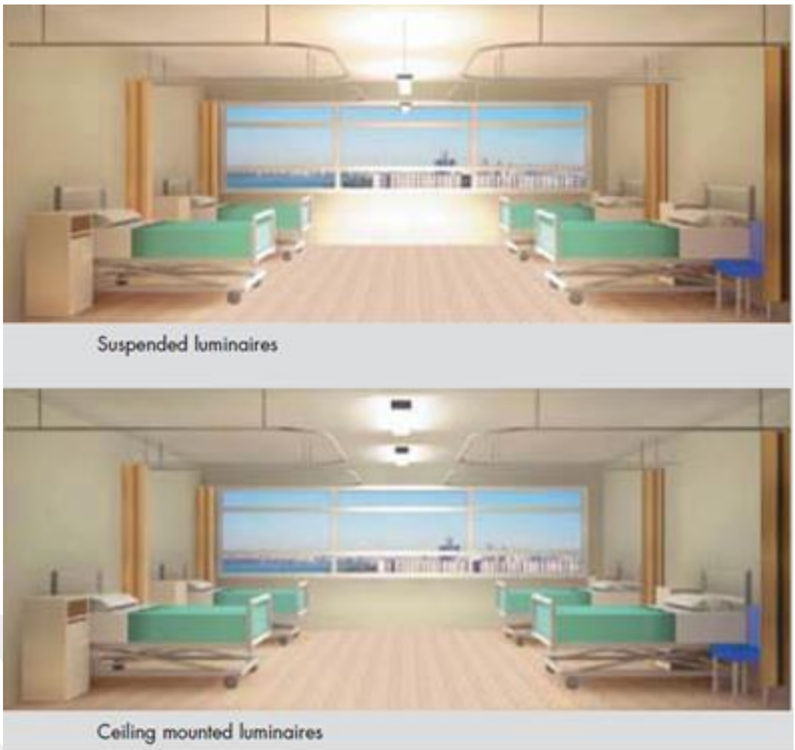


Figure 3.2. Suspended and Ceiling Mounted Luminaires

Wall mounted luminaires

Modern lighting systems comply with the general recommendations using only semi-direct wall mounted luminaires with fluorescent lamps.

Figure 3.3. Wall Mounted Luminaires

Recessed and semi-recessed luminaires

Recessed and semi-recessed luminaires may be used in ceilings between 2.4 meters and 3 meters high. If these luminaires will not provide the illuminance required at the bedhead a dual system is required.

Figure 3.4. Recessed and Semi-Recessed Luminaires

Dual systems

For dual systems in which supplementary lighting along the side walls of the bedded area is used, ceiling mounted luminaires may still be suitable.

Figure 3.5. Dual Systems

Night lights

Shifting patterns of light and shade on the ceiling can trigger the subconscious and cause some patients to experience phantasmagoria and the design should avoid directly illuminating the ceiling at night. To allow staff and patients to move around safely when the main lighting is switched off at night, it is necessary to make provision for night lighting. Where uplighters are used it will normally be necessary to provide for night lighting by separate luminaires (probably downlighters). The luminance of any luminaire left on during the night should not exceed 30 cd/m2 at angles of above 35 degrees from the downward vertical. Where the ward layout is fixed it would be practical to consider this limitto be at angles viewable by the patient. To allow patients to sleep the illuminance for the circulation space should be an average of 5 lux with.a maximum 10 lux at any point. The illuminance on the bedhead should not exceed 0.1 lux, higher levels will be appropriate for watch lighting and for specific patient needs.

Watch lighting

This allows continuous observation of a particular patient after the general lighting has been switched off, without the disturbance which would be caused by the patient's reading light.

Reading lights

The provision of separate reading lights is nowadays reduced to longstay wards and/or for the elderly since; hospital beds are used more intensively, few patients stay for long periods and generally TV is available. The patient's reading light is required to give 30 lux directly on a 1 x1 m^2 area based around the pillow area and can also be used by staff for nursing tasks at the bedhead.

Important aspects of the lighting design to be applied for examination and treatment in clinical rooms are;

- Color view,
- Glow,
- Flicker,
- Modeling of faces and objects,
- Surface properties,
- Blinds,
- Shadows,
- System control and flexibility,
- Light distribution on the surface,
- Task plane (uniformity) light distribution,
- Brightness of room surfaces (Tutkunlar, 2014).

Local lighting is used in areas where it is necessary to be illuminated with a strong light source such as a surgical operation. In the choice of illumination of surgical intervention area; factors such as color, light intensity, shadow, vibration, heat dissipation, and movement ability must be considered. The operating table lamp should give a high-intensity, shadowless light on the table. In local illumination, moving lamps must illuminate the table 20 times more than necessary for normal operation illumination from different angles. For example; general lighting in operating room illumination should balance operating room illumination. The color characteristics of both enlightenments completes each other and should be chosen so as to ensure that tissues and body fluids are visible in their natural colors during surgery (Alver, 2011).

Figure 3.6. General and Local Lighting in Operation Rooms

The overall illumination, when used alone, should be equal to the desired brightness level for a given visual function. Table 4.1 gives the distribution ratios formed by lighting devices (Reynolds, 2000).

Table 3.1. Luminous Flux Ratios that Determine the Lighting Pattern (Reynolds, 2000)

	Dispersion ratio	
Lighting Type	**Toward the ceiling**	**Toward the working area**
Direct lighting	0-10	100-90
Semi-direct lighting	10 40	90-60
Diffused lighting	40 - 60	60-40
Semi-indirect lighting	60 - 90	40-10
Indirect lighting	90 - 100	10-0

Developed standards for brightness level are summarized in Table 4.1 as specific levels for eliminating visual needs. Generally, recommended light levels are minimum quantities. Effects such as the retention of the light source, the maintenance of the cleanliness of the light source, and the variability of the reflectance values of the inner surfaces are taken into consideration. Contrast sensitivity in the definition of visual function should be considered in relation to glare, the size of the view, the relationship between visual acuity and visual acuity, and the importance of the patient's location. As known, the speed of vision is a function of the magnitude of the image. The visibility increases as the detail is looked at. In addition to this, visual acuity increases with the increase in image size and brightness. The ability to adapt to the eye depends on the brightness level and the glare distribution on the scene. In addition, since the brightness increases with the increase in the brightness level, it will be easier to distinguish the contrast between the brightnesses of the eyes at high brightness levels.

Table 3.2. Illuminance Levels According to Visual Needs (Aydoğan, 2014)

General Lighting	Reading Illumination for Patients	Nighttime Ligthing
Minimum: 30 lux Maximum: 50 lux Corridor: 200 lux	Minimum 150 lux	1 lux (adult) 10 lux (child)

According to EN 12464-1 illuminance standards for hospital and healthcare buildings has been shown at Table 4.2 Em represents illuminance (lux) while Ra is color rendering group and UGRL is unified glare restriction class. The ratings for service illuminance, color rendering group, and direct glare restriction class represent minimum values to be met by the lighting system.

Table 3.3. EN12464-1 Schedule of Illuminance and Recommendations Related to Hospitals and Healthcare Buildings

Type of task or activity	Em	UGRL	Ra
Rooms for general use			
Waiting rooms	200	22	80
Corridors (during the day)	200	22	80
Corridors (at night)	50	22	80
Day rooms	200	22	80
Staff rooms			
Staff office	500	19	80
Staff rooms	300	19	80
Wards, maternity wards			
General lighting	100	19	80
Reading lighting	300	19	80
Simple examinations	300	19	80
Examination and treatment	1000	19	90
Night lighting, observation lighting	5	-	80
Bathrooms and toilets for patients	200	22	80
Examination rooms (general)			
General lighting	500	19	90
Examination and treatment	1000	19	90
Eye examination rooms			
General lighting	300	19	80
Examination of the outer eye	1000	-	90
Reading and colour vision tests with vision charts	500	16	90
Ear examination rooms			
General lighting	300	19	80
Ear examination	1000	-	90
Scanner rooms			
General lighting	300	19	80
Scanners with image enhancers and television systems	50	19	80
Delivery rooms			
General lighting	300	19	80
Examination and treatment	1000	19	80

Type of task or activity	Em	UGRL	Ra
Treatment rooms (general)			
Dialysis	500	19	80
Dermatology	500	19	90
Endoscopy rooms	300	19	80
Plaster rooms	500	19	80
Medical baths	300	19	80
Massage and radiotherapy	300	19	80
Operating areas			
Pre-op and recovery rooms	500	19	90
Operating theatre	1000	19	90
Intensive care unit			
General lighting	100	19	90
Simple examinations	300	19	90
Examination and treatment	1000	19	90
Night watch	20	19	90
Dentists			
General lighting	500	19	90
At the patient	1000	-	90
Operating cavity	5000	-	90
White teeth matching	5000	-	90
Laboratories and pharmacies			
General lighting	500	19	80
Colour inspection	1000	19	90
Decontamination rooms			
Sterilisation rooms	300	22	80
Disinfection rooms	300	22	80
Autopsy rooms and mortuaries			
General lighting	500	19	90
Autopsy table and dissecting table	5000	-	90

Em - Illuminance (Lux)
UGRL - Glare rating
Ra - Colour rendering

According to the Table 3.3, it is considered that hospitals and healthcare buildings consist of general rooms, staff rooms, examination rooms, ear examination rooms, scanner rooms, delivery rooms, treatment rooms, operating areas, intensive care units, dentists, decontamination rooms, autopsy rooms and mortuaries.

When the illuminance values of these areas are examined, lighting parameters of rooms for general use are 200 lx, 22 and 80 Ra, respectively except from corridors (50 lx, 22 and 80 Ra). Staff rooms have parameters of 300 lx, 19 and 80 Ra while staff offices have 500 lx, 19 and 80 Ra. For the operating areas, higher values of illuminance and colr rendering are needed as expressed for pre-op and recovery rooms about 500 lx, 19 and 90 Ra and for operating theater about 1000 lx, 19 and 90 Ra.

It is not possible to evaluate the glare in a patient room using normal methods. Due to horizontal line of sight of the patient lying, lack of a smooth light accessibility, recommendations are given related to the patient's lying position. In general, low-level glare is preferred for maximum comfort and long-term smooth viewing. The glare of natural and artificial light sources used to achieve this should be considered. The brightness of all other interior surfaces should be uniformized by selecting appropriate reflectance values and by providing light distribution proportional to illuminated surfaces. The uniformization of the glare, ie; its uniform distribution, will prevent the glare in the room. As a result, some measures must be taken to prevent glare. For a patient room, these are;

- Reducing the high glare areas,
- Reducing the general glare of the light source,
- Increasing the angle between the light source and the viewing angle,
- Increasing the brightness of the near periphery of the light source
- Combining the glare of light sources and interior surfaces,
- Avoiding high-value reflective values within the patient’s line of sight glare (Aydogan, 2014).

Task Lighting

Lighting systems in the workplace provide for accurate perception at a specific task area (a desk, counter, machine, or workbench). This is achieved by using one of two lighting methods; a general- ambient approach or task-ambient approach.

General-ambient systems provide a uniform quantity of light throught a space. This approach is often used when the task location is apt to vary widely or when the space will be reconfigured frequently.

Task-ambient systems are more energy-effective. Higher values of task illuminance are provided for the workplane while lower values of ambient illuminance are provided for surrounding areas.

Task-ambient systems are appropriate in rooms where task areas are permanently located, such as private offices, factories, laboratories, and stores. Task lighting is provided for task areas, with the remaining space lighted for more casual activities.

When designing a task-ambient system, first light the task (focal glow), then supplement the task lighting with ambient room lighting. In typical task-ambient systems, task-oriented luminaires are mounted on or near the furniture and supplemented by an ambient (uniform) lighting system that provides lower illuminance.

Ambient lighting provides overall illumination for circulation, provides balance between the VDT task illuminance and its surround, and provides part of the illuminance for paper-based tasks. Areas surrounding visual tasks need less illuminance than the visual tasks. For comfort and ease of adaptation, make the ambient illuminance at least 33 percent of the task illuminance (Gordon, 2003).

3.2. Effects Of Lighting Design On Patient

Light, as an energy type that comes to the end of the anatomical interactions in the material’s physical structure, not only allows us to see the physical environment, but also affects our psychological and biological as well as physiological conditions. This situation, which is regarded as the invisible effects of light, is related to psychology in connection with human biology.

Early Greek places of healing, the Aesculapian temples, placed great emphasis on surroundings. The temples were built in positions of great beauty so that the patients could enjoy the views, they were near natural springs so that the water would be pure and in raised positions so that there would be cooling breezes. In the days before most forms of what we now call health care intervention existed, people could do no more than eat good food, rest and sleep, listen to healing music, watch theatrical productions and gain spiritual strength from praying to the Gods. More recent history suggests that this kind of approach survived in church buildings, most frequently monasteries, until the early 19th century, when large hospitals began to be built (Biley, 1996).

In the late 19th century, Florence Nightingale suggested that patients would recover more quickly if they were cared for in an environment that had natural light, ventilation, cleanliness and basic sanitation which are especially responsible for child mortality (Nightingale, 1860). However, healtcare facilities including hospitals are often seemed to be starkly institutional, unacceptably stressful, and unsuited to the emotional needs of patients, their families, and health care personnel (Salonen and Morawska, 2013).

The improvement of the visual environment in hospitals can provide many benefits such as;

- Ambience,
- Confidence and safety,
- Accessibility and inclusion,
- Attractive environments and visual stimulation,
- Stress reduction,
- Sense of place and spatial orientation,
- Enhanced patient recovery, staff productivity,
- Ease of navigation and wayfinding,
- Energy efficiency,
- Compliance with disability discrimination act,
- Empower specifiers and design teams,
- Corporate badging of key areas (Dalke et al., 2006).

3.2.1. Effects of Lighting On Human Health

Nigthingale (1860) admits that light has tangible effects upon human body. Light is effective at the control of periodic depressions, the improvement of performance of night workers, the regulation of brain activities, and the melatonin hormone secreted by the body. According to this, the user of the lighting should be able to adjust according to his/her needs during the day without affecting the visual comfort conditions, keeping the user away from the horrifying darkness. This feeling also provide patient/individual recognize the space as comfortable, warm, and will make sure that recovery process may be affected. Taking advantage of daylight directly due to positive effects on the psychological and physiological system is an indispensable issue in hospital illumination. The presence of the antiseptic properties of daylight is also a supporting feature (Altuncu and Tansel, 2009).

Before the advent of artificial light periods of activity were largely controlled by the rising and setting of the sun. Dark periods were for sleep when the body was at rest, and light periods were for activity. Many of our daily rhythms are still attuned to what was a natural cycle of light and dark, and patterns such as the sleep/wake cycle, daily patterns of hormone secretion and body temperature cycles are controlled by light (Webb, 2006).

Natural lighting or daylight benefits on the psychological effects to patients. It gives an impact of daylight on patients psychology and physical diseases to recover from illness faster (Phiri, 2003). Meanwhile, artificial lighting also plays a role in improving and increasing the productivity and health well-being by creating comfortable ambience and positive distraction in the healthcare setting, and increases the productivity among staff (Ghazali and Abbas, 2012).

3.2.1.1. Physiological Effects

The skin is the largest human organ, and the dermal effects of light are many sunburn, called erythema, is perhaps the best known, and it is caused primarily by wavelengths in the UV B range. As with all tissue damage, the biological response is dependent on the energy contained in the wavelengths as well as the spectral absorption and sensitivity of the tissue.

The redness of sunburn is due to the increased blood circulation. Protection from UV is chemically possible through the use of sunscreens applied to the exposed skin, which reduce the effect of UV by absorption and subsequent degradation of the chemical compounds. Darker skin generally contains more melamin, which protects againts UV skin damage by decreasing the transmittance of the skin and increasing light scattering. Deep tanning results from the production of additional melanin from UV-stimulated cells. The fading of a tan occurs as a by-product of the normal human skin-shedding process. With repeated tanning the skin suffers additional morphologic changes, including thickening, wrinkling, and other irregularities. Extensive exposure to UV radition can also result in various skin cancers, including basal cell, squamous cell, and melanoma.

Exposure to UV radition produces vitamin D in the skin. Vitamin D is essential for many metabolic functions, including the absorption of calcium and phosphorus. In most European countries and North America, vitamin D is added to foods as a dietary supplement, making itd deficiency unusual and rendering photochemically skin-produced vitamin D unnecessary. However, in many nations, dermal obsorption of UV radition remains an important source of vitamin D (Egan and Olgyay, 2001).

Melatonin, known as the nighttime hormone, defined as an important time regulator that allows us to wake up and sleep in approximately 24 hours, has been investigated in different ways for its interaction with light; the darkness triggers the production of melatonin in our bodies, and the light suppresses it. When people are exposed to a lot of light at night or when they work in daylight, our biological rhythm, and therefore our 24-hour life cycle, is affected (Altuncu, 2008). In humans, melatonin can be suppressed by exposing the eyes to light both in visually blind and colour blind people who have intact neural pathways between eye and SCN (Webb, 2006).

Circadian is originated fro Latin and it means ‘’about a day’’. Circadian rhythm refers to the biological cycle of plants and animals. It is concluded that light absorption in the human eye sets and affects individual’scircadian rhythms. For example light therapy is seen as a method including of adjustment of circadian rhytms for jet-setters and night-shift workers. Doses of daylight or daylight-like intensities (thousand of lux) during the waking hours are important to setting or adjusting the circadian rhythm. Similary, the absence of light during the sleeping hours is important. Designs can accommodate both of these conditions. Special ‘’light rooms’’ where shift workers can take a ‘’day break’’ might be designed into those facilities where two or three shifts are common, although this should be done only under consultation of specialized medical personnel. Residential settings such as houses, apartments, and hotels can be designed with blackout shades as well as with carefully controlled exterior lighting at the minimum intensities of safety and security for the particular nighttime activity situation (to maximize the integrity of the normal sleeping period of darkness. If any nightlight whatsoever is required or desired, this should be very low level red light which is an excellent application for LEDs (Steffy, 2008).

The primary human concerns with nighttime lighting include potential carcinogenic effects related to melatonin suppression, especially breast cancer. Other diseases that may be exacerbated by circadian disruption include obesity, diabetes, and reproductive problems (Stevens et al., 2013). In addition, totally blind people with no light perception to interfere with melatonin production have lower incidences of breast cancer than blind people with at least some light perception. Adding to these data is the observation that breast cancer rates are lower in the developing world where there are far lower night time lighting levels than in the industrialized world which has excessively bright levels of night time lighting (Pauley, 2004).

3.2.1.2. Psychological Effects

Individuals perceive the spaces in which they are in by light and make sense according to the light. An effective interior space from the visual point of view is defined by the user as “comfortable” and “warm”. Feeling relaxed is more important in some places than in others especially fear, anxiety etc. In hospitals identified with emotions, the importance of relaxation is greater. There is no feeling of trust or relief in a place that is dark or over-illuminated (Altuncu, 2008).

According to many studies, psychological and biological effects of light has found to be related to character of the light source and ambient ligthing environment (Wurtman, 1975). Insufficient indoor ligthing or dim may affect mood or stres level of people negatively as well as working capacity. Therefore, the illumination level and distribution, duration, and timing of indoor lighting seem to be important. Total environment lighting has consist of natural dayligt the windows and artificial light sources in that environment (Küller, 2002). Besides these, spectral composition of light can affect well-being and performance of human regarding different spectra (Veitch and McColl, 2001). The primary human concerns with nighttime lighting include depression and mood disorders (Stevens et al, 2013).

In a study, the use of color and light in child psychology in the waiting areas, the areas where children spend the most time in the hospital environment, was emphasized and analyzed on the samples. According to the data obtained from 200 children in policlinics from two different types of hospitals, psychological and physiological effects of the waiting spaces of polyclinics has affected the children positively or negatively (Temel, 2015).

Seasonal affective disorder (SAD) is a syndrome of seasonal depression associated with the reduced ambient light levels during winter months. SAD is most prevalent in extreme latitudes, where the charge of light levels over the course of a year is most pronounced. Recent research has shown that light theraphy can be effective in treating SAD patients.

Light therapy for SAD involves the patients being exposed to a moderate level of light for a duration of time over several days or weeks. The beneficial results appear to derive from lighting entering through the eyes. The spectral requirements of the light source appear to be those in the visible range; incandescent, cool white fluorescent, ‘’full-spectrum’’ lamps, and sunlight have all been used with successful results. More research needs to be done to determine the specific nature of this effect.

Biological rhythms represent the coordination of external time cues with internal metabolic activities. These synchronizations occur throughout the plant and animal kingdoms and include day-night cycles (circadian rhythms), sleep-wake cycles, lunar cycles, and seasonal cycles.

The biological clock which regulates internal processes in response to external cues can become ‘’desynchronized’’ by various stresses, such as sleep deprivation, illness, or jet travel across time zones. When out of phase, a person may feel disoriented or irritable and may suffer other ailments such as insomnia or difficulty of eating. Light therapy has been used with some success to help resynchronize internal biological rhythms with external time cues. (Egan and Olgyay, 2001).

Colour and appropriate lighting not only provide for a pleasant and ambience environment, but are powerful tools for coding, navigation and wayfinding. Colour is an important element of interior design; it can influence diverse outcomes such as hospital staff morale and productivity. A window or view out, onto a courtyard or garden is known to be beneficial and is an important link to the outside world for bedridden patients.

Lighting varies with intensity, duration of exposure, and pattern. Artificial light can cause visual fatigue and headaches. Healing environments stimulate positive awareness and connection with nature, culture, and people (staff and families). Softening the technological side of care can create a healing environment. Due to increased stress experienced when caring for intensive care patients, professional staff also benefit from softening of this environment. Ultraviolet light has been shown to enhance healing by increasing protein metabolism, decreasing fatigue, stimulating white blood cell production, increasing the release of endorphins, decreasing blood pressure, and generally promoting emotional well being (Altimier, 2004). Natural lighting also helps with the implementation of day/night cycling for humans and animals. Cognitive disturbances can occur if there is a lack of natural light for patients and staff. There is some evidence that bright light can improve nursing performance, leading to a decrease in errors (Figueiro et al., 2016).

Exposure to bright artificial light has been associated with reduced depression and improved mood. However, in counselling rooms, people feel more comfortable talking, and they talk longer with dim lighting than with bright lighting (Ulrich et al., 2008). It is argued that too much blood red, deathly black, biomorphic shapes, painful expressions, or distressing surrealism could easily disturb already unsettled patients (Behrman, 1997).

Figure 3.7. Lighting of an Individual "Pod" Room and Neonatal Intensive Care Nursery (Altimier, 2004)

Korkmaz (2008) examined the ligthing system of a healthcare facility in terms of motivation. According to the findings of the study, it has found that 61 people (50.8%) of the respondents had given absolutely effective response, while 55 people (45.8%) of 116 people in total had normal response, 3 people (2.5%) ineffective response and finally 8 people give an unstable response. As a result, the effect of the lighting system can effect the motivation of healthcare staff.

Wade and Brennan (2014) argued the diagnostic efficacy in terms of viewing conditions. They aimed to assess monitor performance and ambient lighting in radiology departments. Within the scope of the study, 20 monitors were addresses in 4 hospital in Ireland. Maximum luminance, spatial uniformity of luminance, temporal luminance stability, brightness and contrast resolution, geometry and ambient lighting were evaluated by using Society of Motion Pictures and Television Engineers' (SMPTE) test pattern. According to the findings of the study, temporal luminance stability and spatial uniformity were found to be acceptable while maximum luminance and geometry values were not in accordance with SMPTE. They concluded that cleaning the monitor face had no impact and 90% of viewing areas had acceptable ambient lighting levels.

Illumination is effective in controlling periodic depressions, improving nighttime performances, organizing brain activities, and regulating the melatonin hormone secreted by the body. Accordingly, adjustment of the lighting for requirement during a day without affecting the visual comfort of users, by keeping the users away from the horror of darkness, making them comfortable, warm, and ensure that this feeling is influenced during the recovery process. For this reason, provision of artificial lighting control, especially in hospital spaces, may indirectly affect the healing process, as it affects the psychological state of the patient. At this point, it can be concluded that a photo-treatment-like application can be performed with the use of lighting control systems in healthcare facilities such as hospitals, at a certain time, by providing a certain level of brightness through the lighting system in the room. By using the lighting as a therapeutic way, the entire hospital environment can be effective during the patients' healing process (Altuncu ve Tansel, 2009).

New Technologies in Biodynamic Lighting

After childbirth, a baby trying to adapt to a new world. It wakes up every night, and after each awakening, the problem of falling asleep again exists. If you sleep at night, you will feel tired the next day. There can be problems such as postpartum depression, skin changes, hormonal fluctuations etc. The most important reason of them is the incorrect lighting system that you use when you wake up at night. The product is designed to make it easier for the sleeping mothers to suppress melatonin synthesis at night, for breastfeeding babies or to change the diaper so that they can fall back to sleep again.

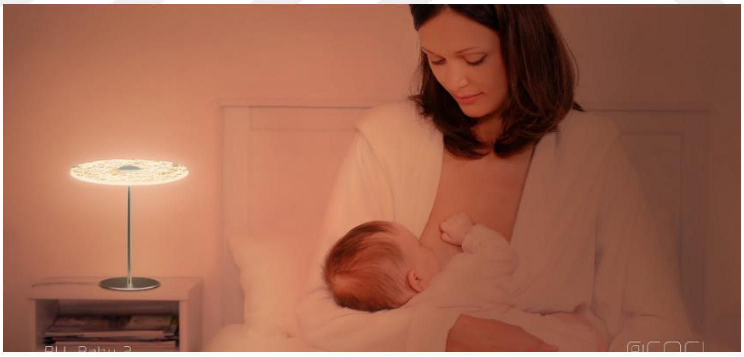


Figure 3.8. Biodynamic Lighting-Table Type

Figure 3.9. Biodynamic Lighting-Wall Type

Melatonin also allows your baby or your children not only to have better fit, but also to have a healthy BIOLOGY. It has been shown that melatonin controls the secretion of growth hormone, and the decrease in melatonin secretion causes a decrease in growth hormone. Many mothers, babies or children leave the light in the baby room open until the sleeping dip. Many night lights are used in many baby or child's rooms. Especially for children who are afraid of sleeping alone, it is inevitable to follow a path in this way, so it is necessary to use the biodynamic rhythm for infants and children and the lamps which do not reduce the melatonin secretion. This product is not only produced according to the principles of BIODYNAMIC LIGHTING, but also aims to minimize the anxiety problem in children with special figures.

Nanotechnology- Artificial Sky-Sun System

Via the technology integrated into the ceiling of spaces that do not receive sufficient daylight, artificial daylight can be obtained by mimicking large-scale events of the sunlight in the atmosphere. Via LED system that gives the daylight spectrum, an optical system that models the sun and sky, and nano particles, both the volumetric perception of the space is strengthened and the psychological and biological conditions of the users are positively influenced and integrated into the space. Since the product can simulate not only the color temperature but also the quality of the light very close to reality, It is used in illumination of underground spaces such as subway and parkin lots as well as in home, office, store, hospital, sports hall and hotel applications, or special lighting projects designed for museums and exhibitions. Besides, artificial daylight produced; the equatorial, the Mediterranean, and the Arctic, can be adjusted according to different zones and different zones at different angles.

Figure 3.10. Artificial Sky-Sun System-Horizontal type

Figure 3.11. Artificial Sky-Sun System -Ceiling Type

CHAPTER 4

INVESTIGATION OF THE STANDARTS CONFORMITY IN PATIENT ROOMS LIGHTING, SELECTED HOSPITALS IN IZMIR

4.1. Research Approach

4.1.1. Collecting Information

Which types of hospitals should be employed before starting field research. (Private hospital or public hospital?) Restriction criteria should be determined for these hospitals, according to the position or bed capacity. if the bed capacity is selected as the criterion, bed capacities of all the hospitals should be investigated. Should be controlled which hospitals can be admitted for entry. A common clinical department must be identified and a room must be selected for each hospital. More rooms can be selected to create more samples. The furnishings and lighting equipments in the selected room must be measured and be drawn the room plan. The properties of the lighting elements used in the room must be learned from the hospital technical staff. Photographs of the room and lighting luminaires must be taken.

4.1.2.Measuring the Values

Light measurements must be make at night time. Because only artificial lighting values will be evalueated. Measurements should be made in the room according to the lighting criteria specified in the standards. For example general lighting; the points to be measured should be homogeneously taken from 3-4 points according to the size of the room. Patient bed for reading and examination lighting from three points; the bed should be from the head, middle and foot. For night / observation lighting, measurements should be made from the hospital bedside area. The luminosity values are measured in selected regions to compare the suitability of the

light requirements determined in the standards. All the values in the room should be measured at a height of 85 cm with luxmeter. Because the height of the patient's bed is about 85 cm, when patient is on the bed. To be uniform, measurements at the points outside the patient's bed plane will also be taken from a height of 85 cm. When measuring the patient out of the plane of the bed, care should be taken to ensure that the luminometer is not directly under the lighting element and that no shadow falls on the device. In order to control the accuracy of the measured values as well as to visually express the results more clearly, the information must ve evaluated in the program called Dialux.

4.1.3.Making Simulations by Using Dialux Programme

Dialux, with this free software can design, calculate and visualize light professionally – single rooms, whole floors, buildings and outdoor scenes. DIALux is used as a planning tool by over 680.000 lighting designers worldwide. DIALux constantly undergoes further development and meets the requirements of modern lighting design and lighting calculation. You can plan and design using the electronic luminaire catalogues of the world's leading luminaire manufacturers. Superimpose on the CAD data of other architectural programs and can create own lighting design. It is the most preferred program by both user and manufacturer due to its ease of use. For this reason, this program has been chosen because more product catalogs for Dialux can be found.

The level of brightness is a value related to the quantity of intellectuality. By taking different values according to the action and the place where it will take place, the amount of brightness required for the action to take place in a comfortable and correct way depends on such factors as increasing the detail of the task or decreasing the size, decreasing the contrast, the length of the work, or the visual capacity being normally low.

4.2. Investigation Of Selected Hospitals According To Research Approach

4.2.1. Private Tınaztepe Hospital

The hospital have started to serve within 32 branches in Buca in 2010. It has 10.000 m^2 closed area with the capacity of 101 patient beds inside. Floor plan of the hospital has been shown in Figure 4.1 and room plan has been shown in Figure 4.2.

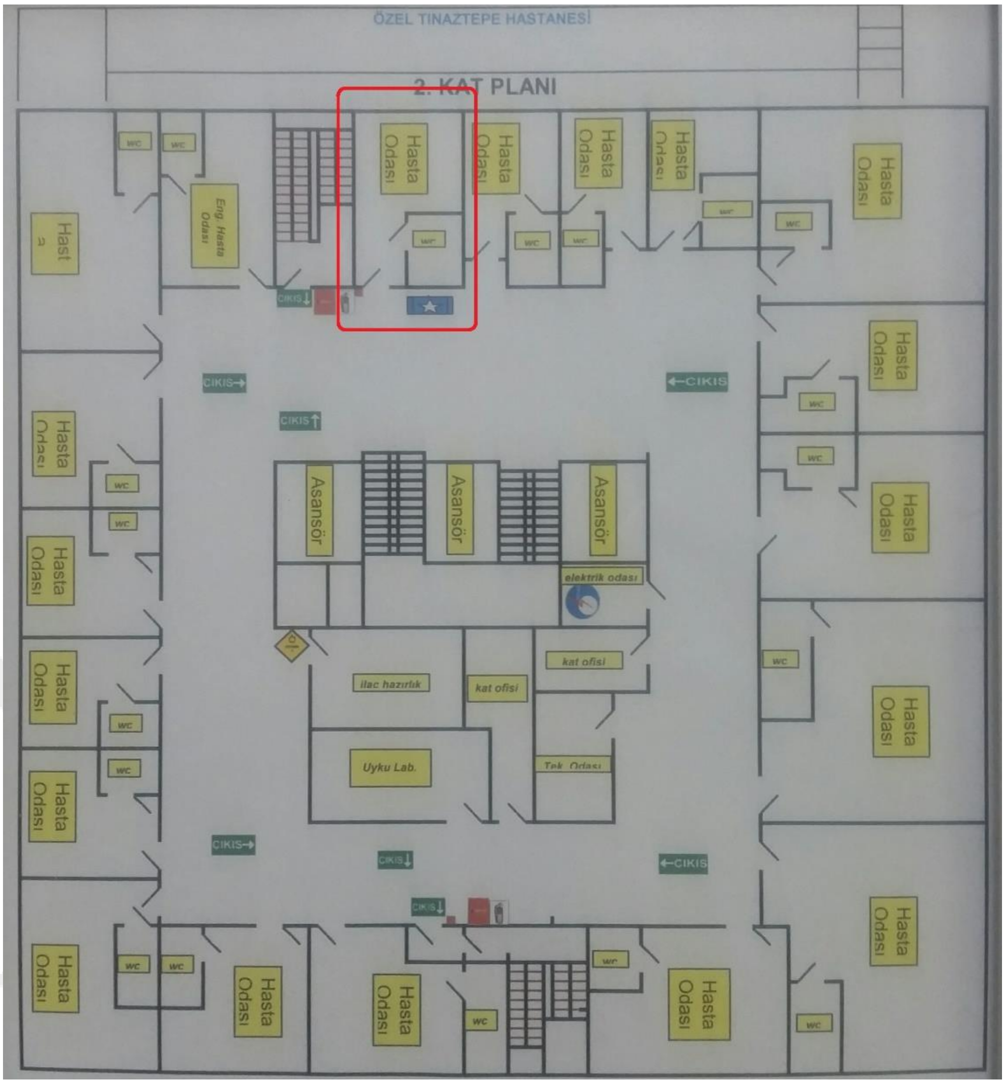


Figure 4.1. Private Tınaztepe Hospital-Floor Plan

The room opposite the elevator and stairs framed in red on the 2nd Floor plan shown in Figure 4.1 was selected and the examination was made here.

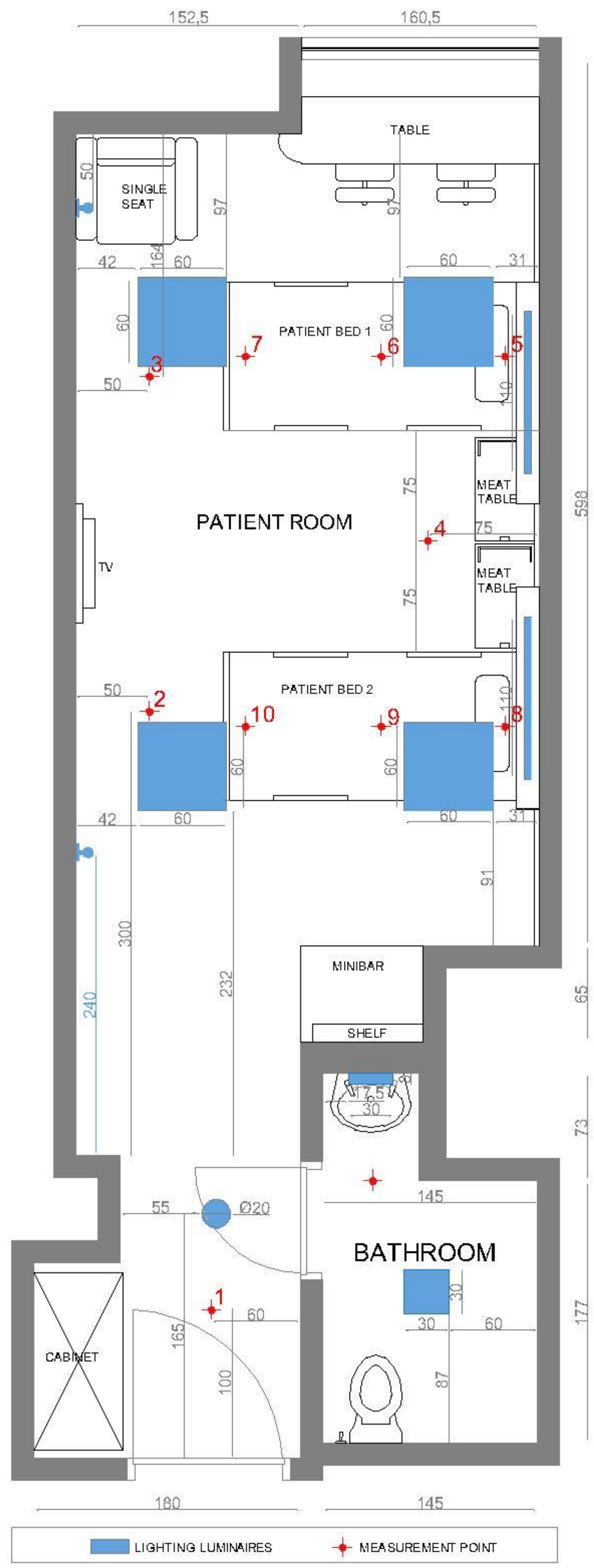


Figure 4.2. Private Tınaztepe Hospital-Room Plan

The furnishings in the selected room are drawn in the plan. The lighting fixtures, which are expressed in blue color, are shown at their places. The first point marked with red; 100 cm from the doorway in the middle of the corridor. The second and third points are spaced 50 cm from the wall in the direction of the beds. The fourth point is located between two patients bed and 75 cm from the wall. 5.6 and 7 points on the first patient bed respectively; the head of the bed, the middle of the bed, and the foot. 8.9 and 10 points on the second patient bed respectively; the head of the bed, the middle of the bed, and the foot. In bathroom has been measured in the point showed by red.

4.2.1.1. Lighting Equipments of Private Tınaztepe Hospital

General Lighting

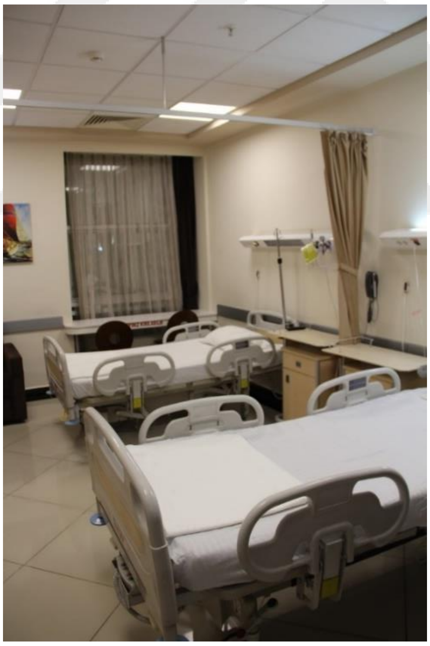


Figure 4.3. Private Tınaztepe Hospital -Patient Room General View 1

Four led panels 28W 60x60 cm were used as general lighting luminaires in the ceiling. The color temperature of the LEDs is 6,500 Kelvin. The ceiling height is 275 cm. Panels are placed in a grid suspended ceiling.

Figure 4.4. Private Tınaztepe Hospital-Ceiling Luminaires

Entrance Lighting

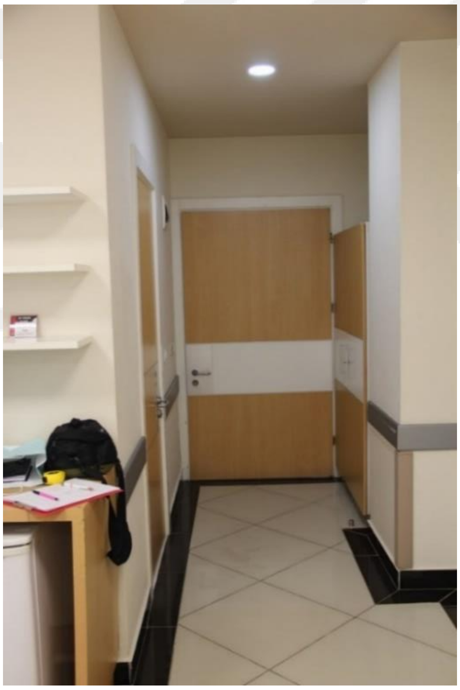


Figure 4.5. Private Tınaztepe Hospital -Patient Room General View 2

The entrance lighting located at the near door is selected as 14 W spot led. The ceiling height is 275 cm. The spot led is placed in a grid suspended ceiling. The diameter is 20 cm.

Figure 4.6. Private Tınaztepe Hospital-Entrance Ceiling Luminaire

Direct and Indirect Lighting

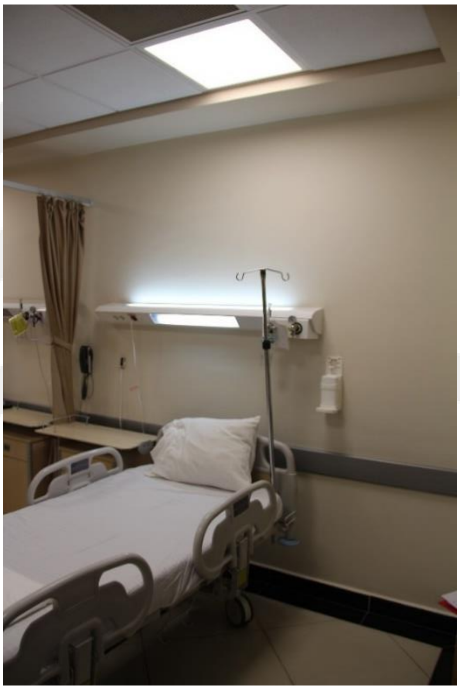


Figure 4.7. Private Tınaztepe Hospital-General View 3

Luminaires are over both beds and 150 cm high on the floor. It is a 36 W fluorescent light bulb that indirect illuminates upward. It is a 18 W fluorescent light bulb that directs illuminates downwards. The width of each module is 150 cm and 20 cm high.

Figure 4.8. Private Tınaztepe Hospital-Direct and Indirect Lighting

Night/Observation Lighting

Figure 4.9. Private Tınaztepe Hospital- Patient Room General View 4

Observation / night luminaires are at the wall, opposite of the patient beds and the center height is 195 cm. Two 15 W fluorescent bulbs are used.

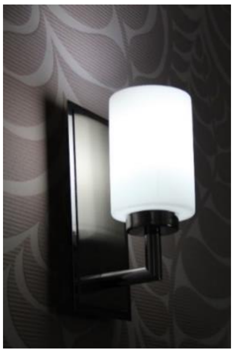


Figure 4.10. Private Tınaztepe Hospital-Wall Mounted Luminaires

Bathroom Lighting

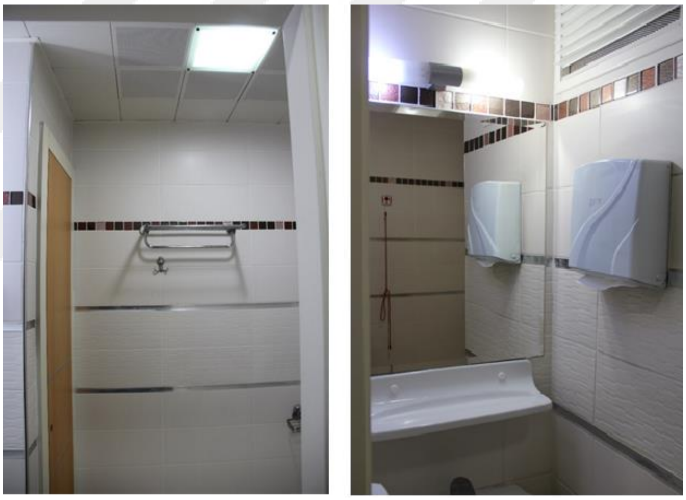


Figure 4.11 Private Tınaztepe Hospital-Bathroom View

Two separate luminaires were used on the ceiling and on the mirror as bathroom lighting. The wall mounted luminaires above the mirror have 2 pieces of the 12 W e14 led bulbs located at a distance of 190 cm from the floor. 15 W e27 led bulb is placed in a grid suspended ceiling. The height from the ground is 260 cm. There is opal glass in front of the bulb.

Figure 4.12. Private Tınaztepe Hospital-Bathroom Ceiling and Wall Mounted Luminaire

Table 4.1. is shown results of measured values. the results of the measurements made with the lux meter at the indicated points and the minimum standard values were written.

Table 4.1. Private Tınaztepe Hospital-Measured Illuminance Values

	ON PATIENT BED				GENERAL LIGHTING- min. 100 lx	BATHROOM LIGHTING- min. 200 lx
	POINT 5-8	POINT 6-9	POINT 7-10	POINT 1	80 lx	135 lx
OBSERVATION LIGHT- min. 5 lx	5 lx	*	*	POINT 2	550 lx	
TREATMENT LIGHT- min.1000 lx	800 lx	620 lx	550 lx	POINT 3	570 lx	
READING LIGHT & SIMPLE EXAMINATION - min. 300 lx	260 lx	*	*	POINT 4	305 lx	

4.2.1.2. Dialux Calculation of Private Tınaztepe Hospital

The properties of the luminaires were transferred to the Dialux program according to the measured values. In the following diagram are shown, the functions of the luminaires indicated by their location.

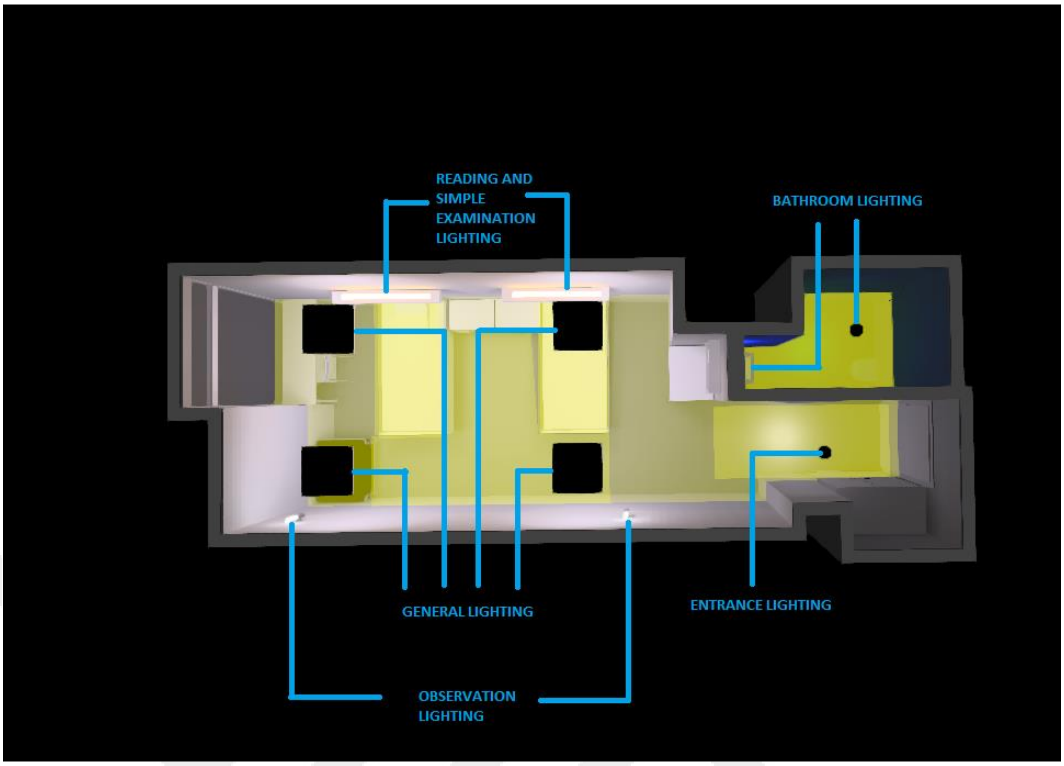


Figure 4.13. Private Tınaztepe Hospital-All Luminaries in Room

The effect region of all luminaires in the patient's room are shown below.

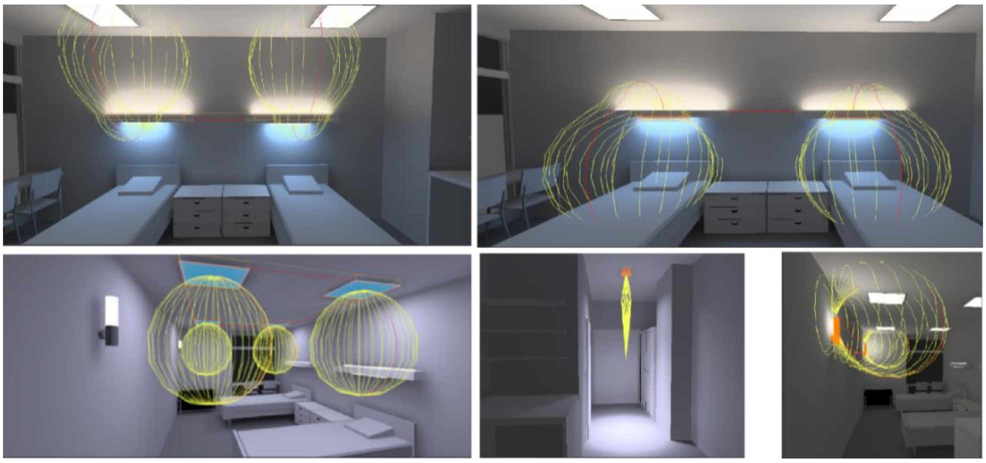


Figure 4.14. Private Tınaztepe Hospital- Effect Region of Luminaires in Room

Dialux has created scenarios for each lighting group. Direct and indirect lighting, general lighting, observation lighting, all lighting and bathroom lighting are grouped as its. Colors are expressed the light intensity of the entire room. Each color represents specific lux values. The color scale is below each photo.

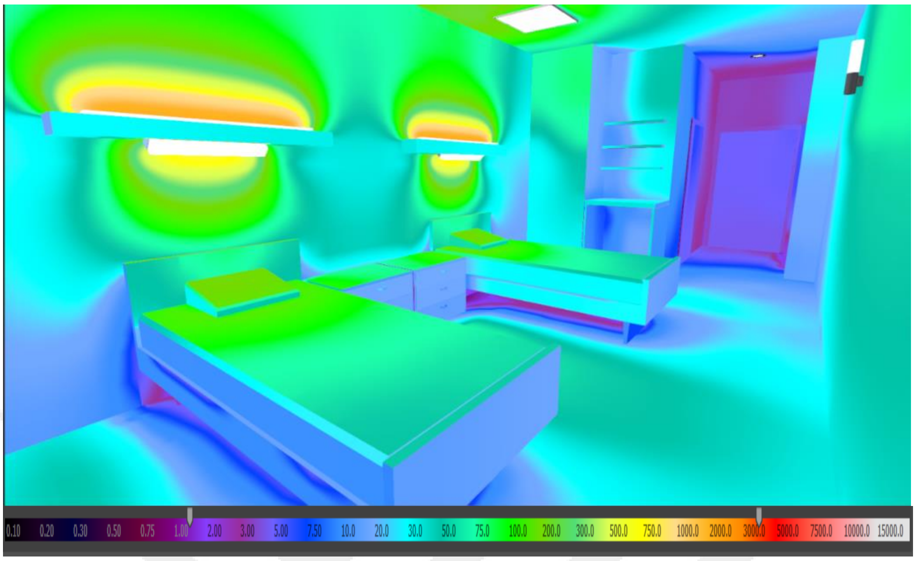


Figure 4.15. Private Tınaztepe Hospital-Brightness Levels of the Room When Direct and Indirect Luminaires are on

The results of direct and indirect lighting was open, the result was examined in the bedside area. In Figure 4.15. the result found in the program is in the range of 100-200 lux in the bedside area. The measurement made with lux meter showed 260 lux value.

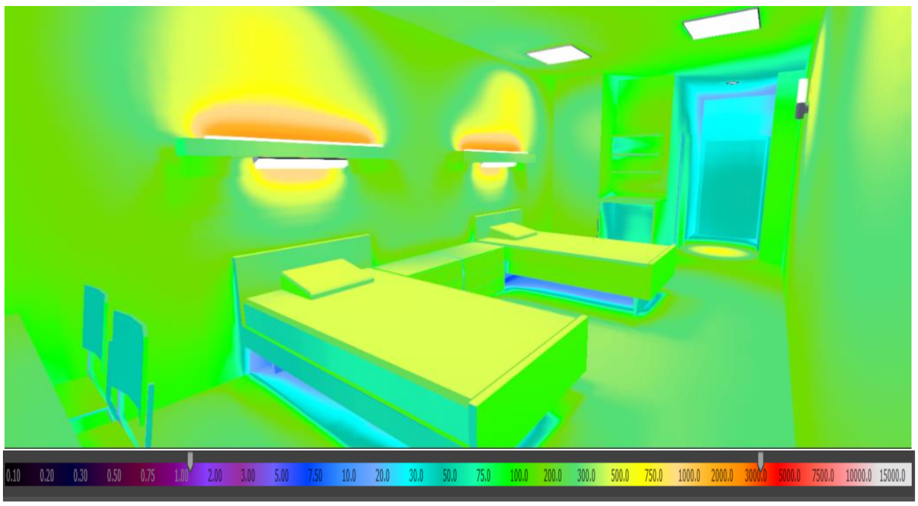


Figure 4.16. Private Tınaztepe Hospital-Brightness Levels of the Room When Direct and Indirect Lighting-General Lighting-Entrance Lighting on

The result of direct and indirect lighting, general lighting, entrance lighting and night / observation lighting were open, examined in three regions on the patient bed. In Figure 4.16. the result found in the program is in the range of 500-750 lux homogeneously on the bed. Measurement with lux meter showed 800 lux at 5 ve 8 point, 620 lux at points 6 and 9, and 550 lux at 7-10 point.

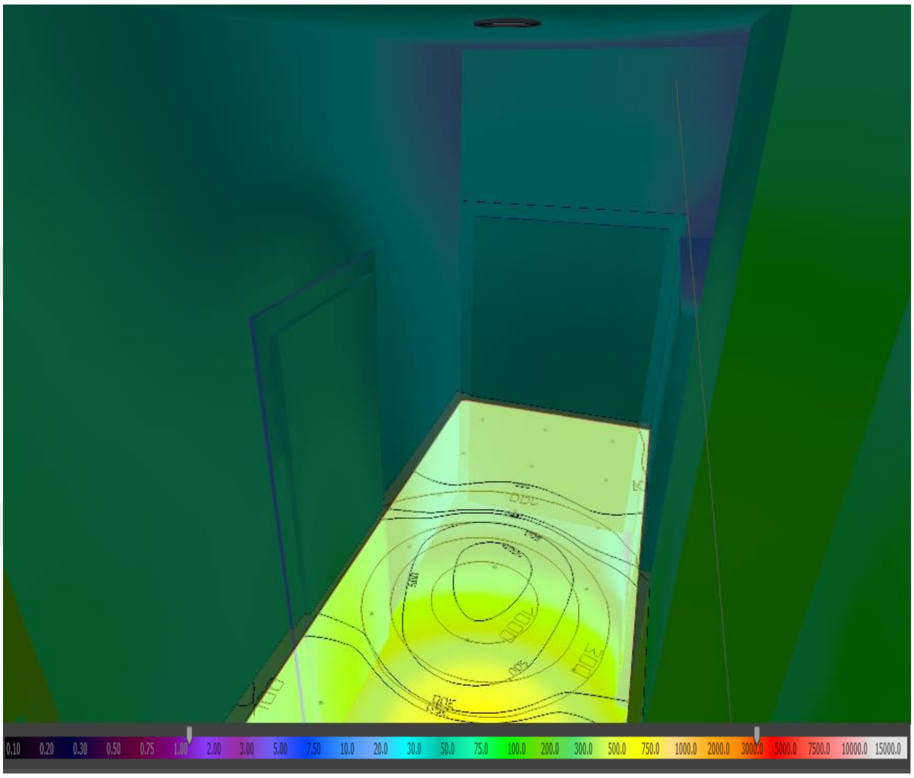


Figure 4.17. Private Tınaztepe Hospital- Brightness Levels of The Room When General Luminaires (entrance) are on

The four points determined on the plan when general lighting is open. Curves were used for a clearer view of the points taken at the height of 85 cm. In Figure 4.17. the result in the program is in the range of 75-100 lux at the point 1. The measurement made with lux meter showed 80 lux value.

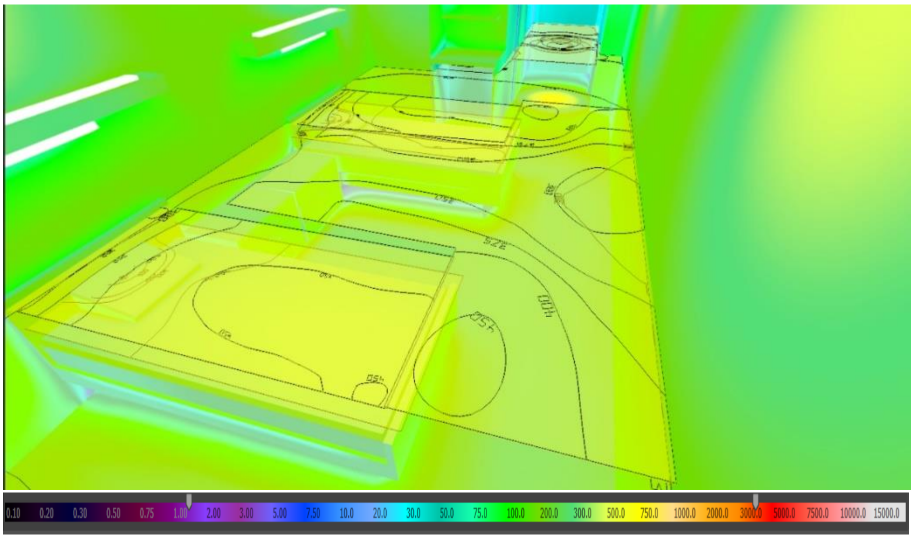


Figure 4.18. Private Tınaztepe Hospital-Brightness Levels of the Room When General Luminaires are on

In Figure 4.18. the result in the program is 450-500 lux at the point 2. A measurement of 550 lux was observed with the Luxmeter. The result in the program is 400-450 lux at the point 3. The measured value was 570 lux. The result in the program is 300-375 lux. The measured value was 305 lux.

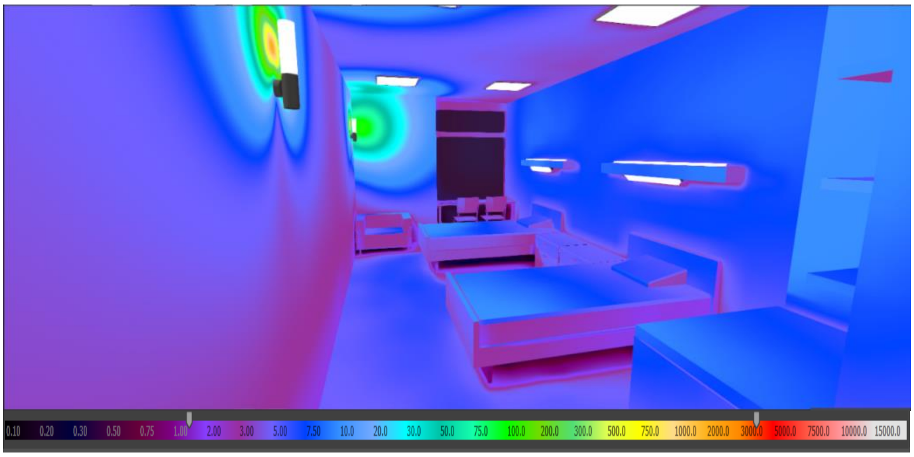


Figure 4.19. Private Tınaztepe Hospital-Brightness Levels of the Room When Wall Mounted Luminaires are on

The result of the night / observation illuminations are open, examined in the bedside. In Figure 4.19. the result is 5-7 Lux in the bed head area. The measurement made with lux meter showed 5 lux value.

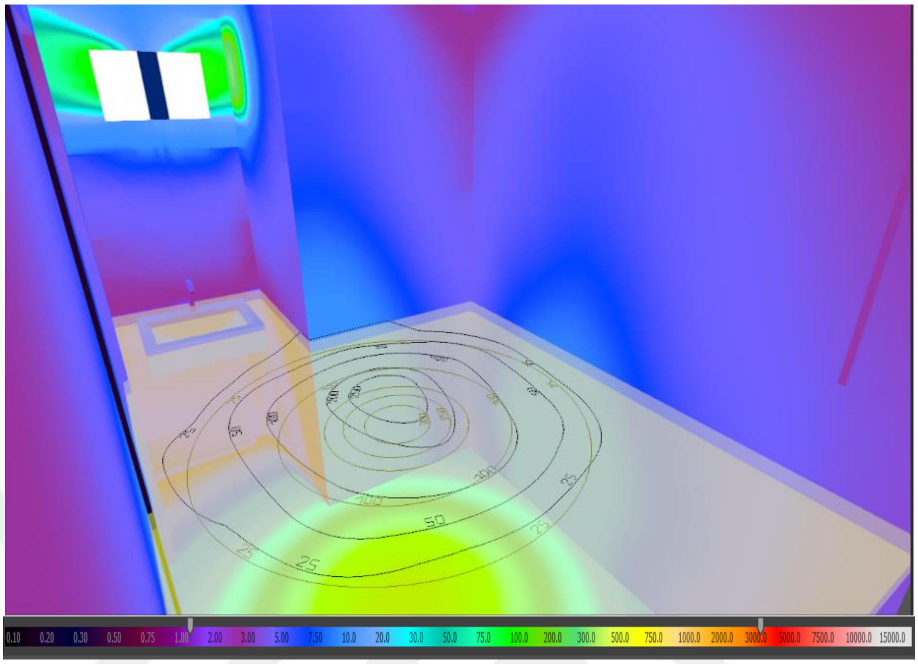


Figure 4.20. Private Tınaztepe Hospital-Brightness Levels of the Bathroom When Luminaire is on

The result, the bathroom lights are on are examined in the marked area in plan. In Figure 4.20. the result in the program is in the range of 100-200 lux. The measurement made with lux meter showed 135 lux value.

Table 4.2. is shown results of measured values with lux meter ,minimum standard values and result of dialux calculations

Table 4.2. Private Tınaztepe Hospital-Measured and Calculated in Dialux Illuminance Values

	STANDARTS(LUX)	**LUXMETER** (LUX)		**DIALUX** (LUX)
GENERAL LIGHTING	**100**	POINT 1	80	75-100
		POINT 2	550	450-500
		POINT 3	570	400-450
		POINT 4	305	300-375
TREATMENT LIGHT	**1000**	POINT 5-8	800	500-750
		POINT 6-9	620	500-750
		POINT 7-10	550	500-750
OBSERVATION LIGHT	**5**	5		5-7
READING LIGHT & SIMPLE EXAMINATION	**300**	260		100-200
BATHROOM LIGHTING	**200**	135		100-200

4.2.2. Private Ata Saglık Hospital

The hospital have started to serve within 15 branches in Bornova in 2014. It has 7.000 m^2 closed area with the capacity of 75 patient beds inside. Floor plan of the hospital has been shown in Figure 4.21. and room plan has been shown in Figure 4.22.

Figure 4.21. Private Ata Saglık-Floor Plan

The second room was selected and the examination was made here in the corridor and framed in red on the 1st Floor plan shown in Figure 4.21

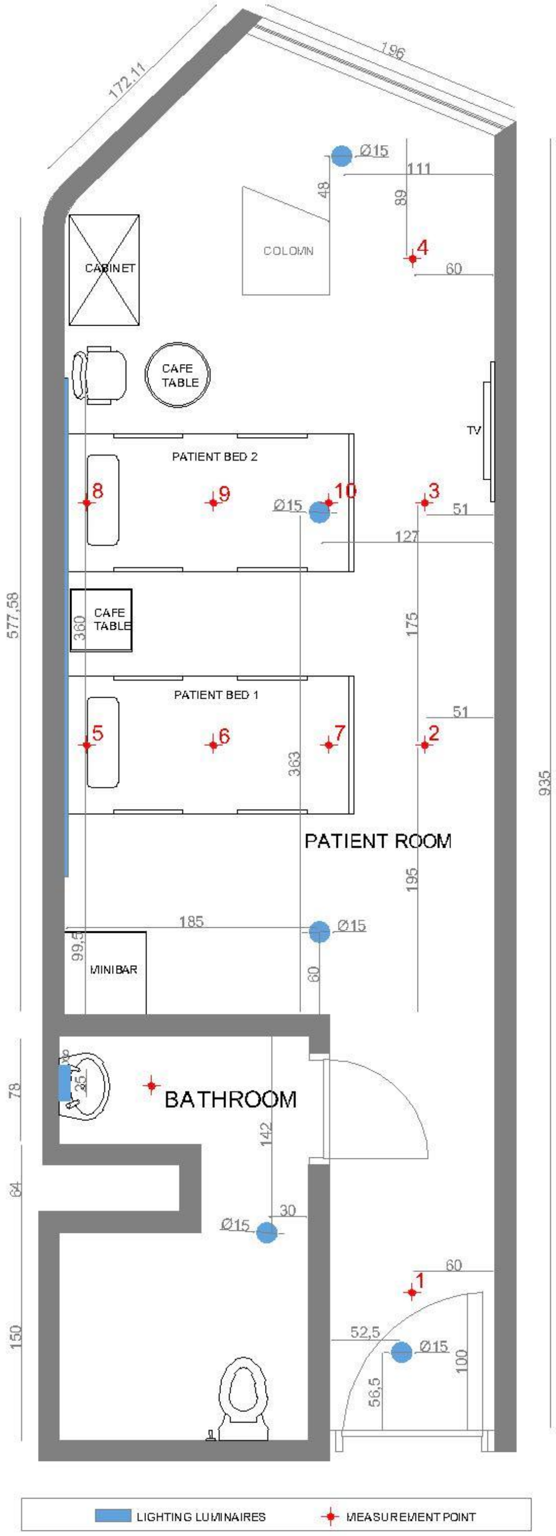


Figure 4.22. Private Ata Saglık-Room Plan

The furnishings in the selected room are drawn in the plan. The lighting fixtures, which are expressed in blue color, are shown at their places. The first point marked with red; 100 cm from the doorway in the middle of the corridor. The second and

third points are spaced 51 cm from the wall in the direction of the beds. The fourth point is located beside the cloumn and 60 cm from the wall. 5.6 and 7 points on the first patient bed respectively; the head of the bed, the middle of the bed, and the foot. 8.9 and 10 points on the second patient bed respectively; the head of the bed, the middle of the bed, and the foot. In bathroom has been measured in the point showed by red.

4.2.2.1. Lighting Equipments of Private Ata Saglık Hospital

General and entrance lighting

Figure 4.23. Private Ata Saglık-Patient Room General View 1

Figure 4.24. Private Ata Saglık-Patient Room General View 2

Four spot leds 12W were used as general and entrance lighting luminaires in the ceiling. The ceiling height is 240 cm and diameter is 15 cm. Panels are placed in a grid suspended ceiling.

Figure 4.25. Private Ata Saglık-Ceiling Luminaires

Night/Observation lighting

On the wooden panel above the bed, a strip led is used at a height of 185 cm.. Some parts of the 360 cm long LEDs did not work.

Figure 4.26. Private Ata Saglık- Led Strip on Bed

Bathroom lighting

Figure 4.27. Private Ata Saglık-Bathroom View 1

Figure 4.28. Private Ata Saglık-Bathroom View 2

Two separate luminaires were used on the ceiling and on the mirror as bathroom lighting. The wall mounted luminaires above the mirror has 13 W energy saver bulbs located at a distance of 165 cm from the floor. 8 W spot led is placed in a grid suspended ceiling. The height from the floor is 230 cm.

Figure 4.29. Private Ata Saglık-Bathroom Ceiling and Wall Mounted Luminaire

Table 4.3. is shown results of measured values. the results of the measurements made with the lux meter at the indicated points and the minimum standard values were written.

Table 4.3. Private Ata Saglık Hospital-Measured Illuminance Values

	ON PATIENT BED 1				GENERAL LIGHTING- min. 100 lx	BATHROOM LIGHTING- min. 200 lx
	POINT 5	POINT 6	POINT 7	POINT 1	80 lx	50 lx
OBSERVATION LIGHT- min. 5 lx	2 lx	*	*	POINT 2	72 lx	
TREATMENT LIGHT- min.1000 lx	20 lx	90 lx	160 lx	POINT 3	126 lx	
READING LIGHT & SIMPLE EXAMINATION - min. 300 lx	NOT	*	*	POINT 4	62 lx	

	ON PATIENT BED 2		
	POINT 8	POINT 9	POINT 10
OBSERVATION LIGHT- min. 5 lx	2 lx	*	*
TREATMENT LIGHT- min.1000 lx	35 lx	300 lx	555 lx
READING LIGHT & SIMPLE EXAMINATION - min. 300 lx	NOT	*	*

4.2.2.2. Dialux Calculation of Private Ata Saglık Hospital

The properties of the luminaires were transferred to the Dialux program according to the measured values. In the following diagram are shown, the functions of the luminaires indicated by their location.

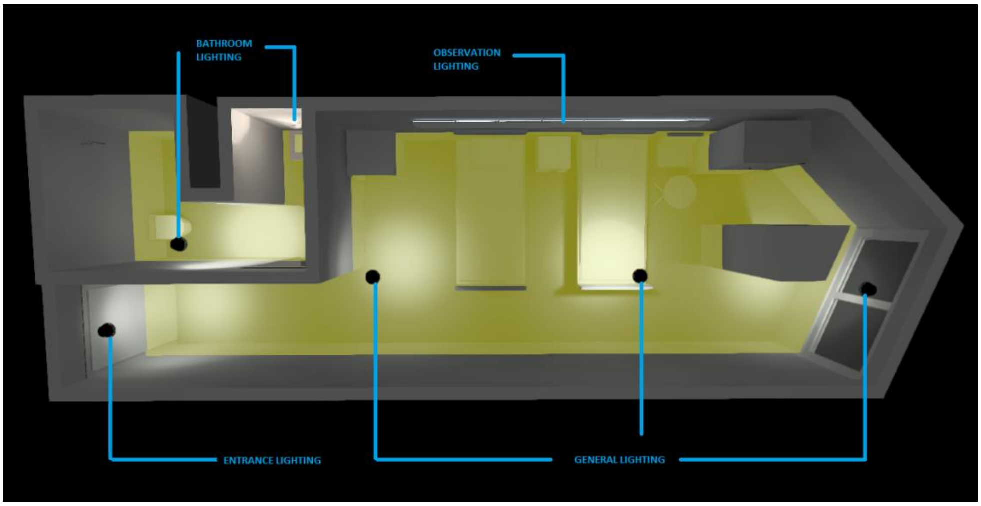


Figure 4.30. Private Ata Saglık-All Luminaires in Room

The effect region of all luminaires in the patient's room are shown below.

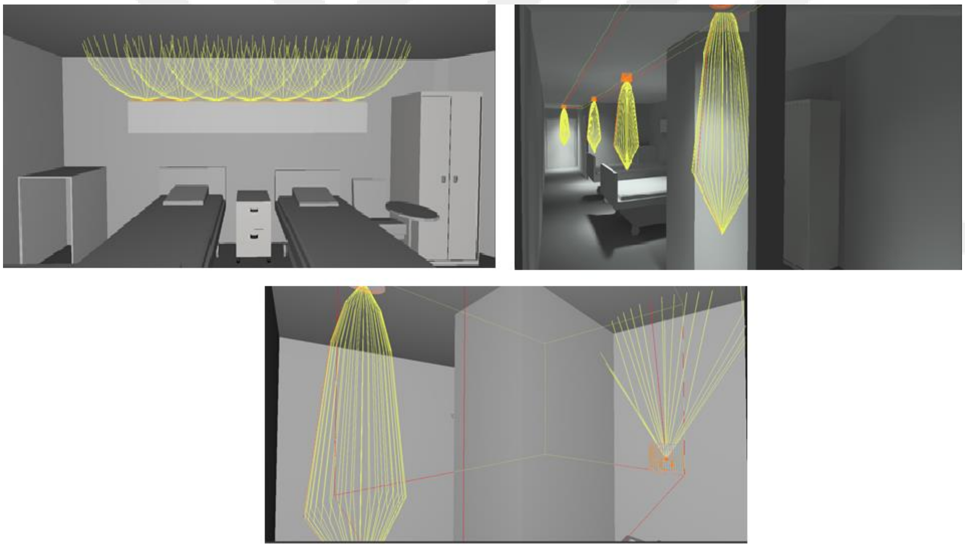


Figure 4.31. Private Ata Saglık-Effect Region of Luminaires in Room

Dialux has created scenarios for each lighting group. Direct and indirect lighting, general lighting, observation lighting, all lighting and bathroom lighting are grouped as its. Colors are expressed the light intensity of the entire room. Each color represents specific lux values. The color scale is below each photo.

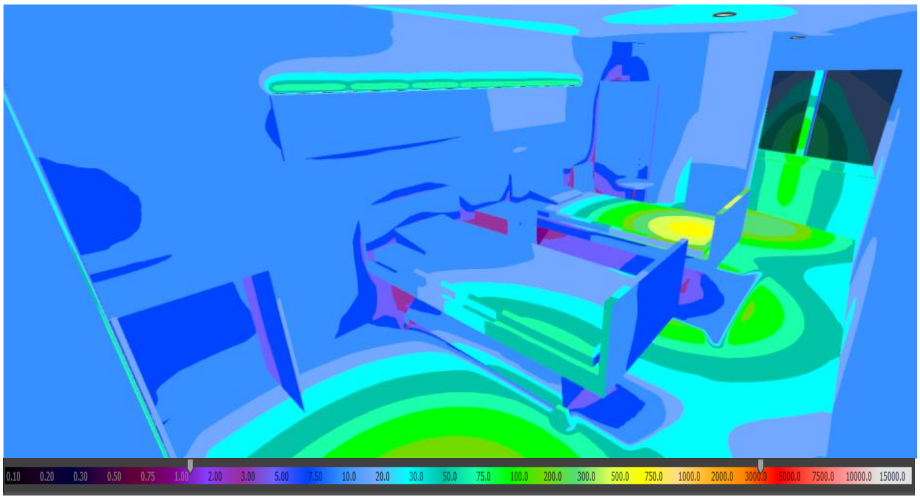


Figure 4.32. Private Ata Saglık-Brightness Levels of the Room When General and Night/Observation Luminaires are on

The result of general lighting, entrance lighting and night / observation lighting were open, examined in three regions on the both patient bed. In Figure 4.32. first bed; the result found in the program at the point 5 is in the range of 7.5-10 lux. Measurement with lux meter showed 20 lux at 5 point. The result found in the program at the point 6 is in the range of 20-75 lux. The measured value was 90 lux at 6 point. The result found in the program at the point 7 is in the range of 20-75 lux. The measured value was 160 lux at 7 point.

Second bed; The result found in the program at the point 8 is in the range of 10-20 lux. The measured value was 35 lux at 8 point. The result found in the program at the point 9 is in the range of 200-300 lux. The measured value was 300 lux at 9 point. The result found in the program at the point 10 is in the range of 500-750 lux. The measured value was 555 lux at 10 point.

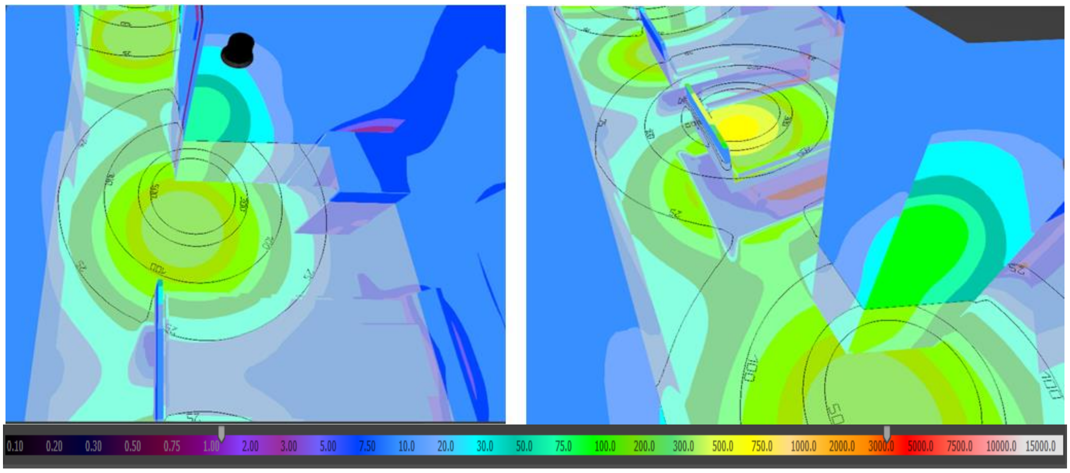


Figure 4.33. Private Ata Saglık-Brightness Levels of the Room When General Luminaires are on

The four points determined on the plan when general lighting is open. Curves were used for a clearer view of the points taken at the height of 85 cm. In Figure 4.33. the result in the program is in the range of 50-100 lux at the point 1. The measurement made with lux meter showed 80 lux value. The result in the program is in the range of 75-100 lux at the point 2. The measurement made with lux meter showed 75 lux value. The result in the program is in the range of 100-200 lux at the point 3. The measurement made with lux meter showed 125 lux value. The result in the program is in the range of 25-100 lux at the point 4. The measurement made with lux meter showed 62 lux value.

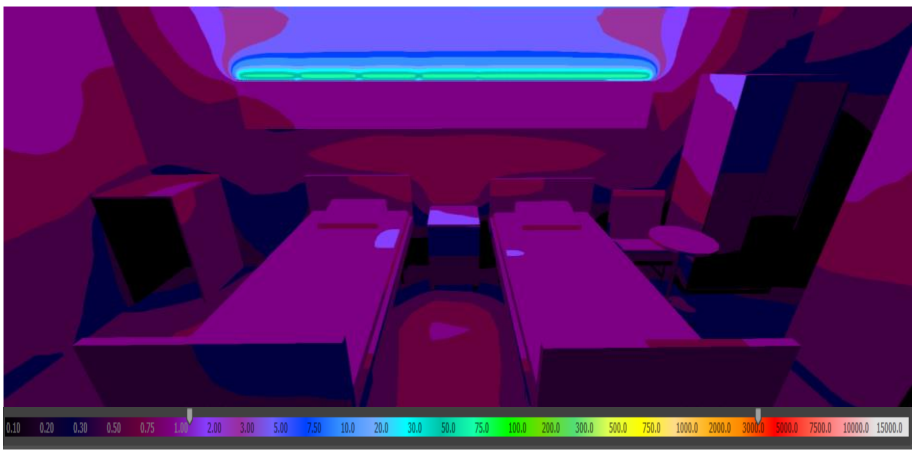


Figure 4.34. Private Ata Saglık-Brightness Levels of the Room When Night/Observation Luminaires are on

The result of the night / observation illumination is open, examined in the bedside. In Figure 4.34. the result is 2-3 lux in the bed head area. The measurement made with lux meter showed 2 lux value.

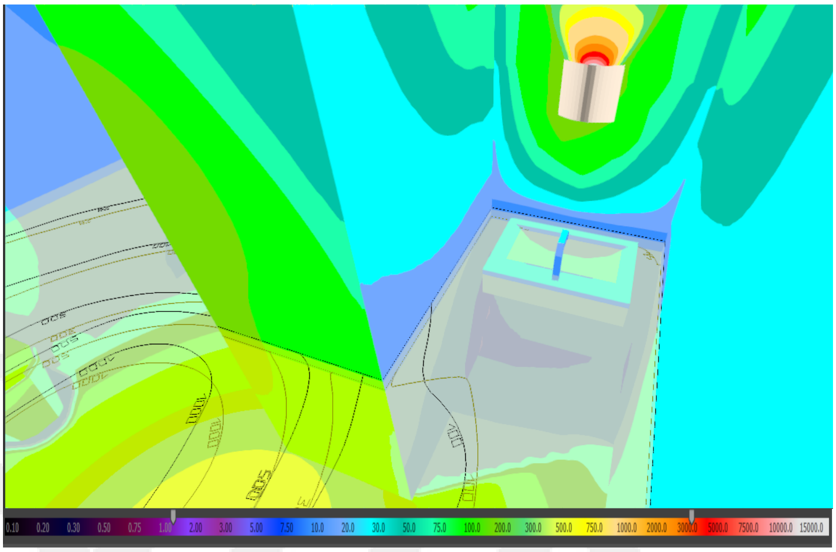


Figure 4.35. Private Ata Saglık-Brightness Levels of the Bathroom When Luminaires are on

The result, the bathroom lights are on are examined in the marked area in plan. In Figure 4.35. the result in the program is under 100 lux. The measurement made with lux meter showed 50 lux value.

Table 4.4. is shown results of measured values with lux meter ,minimum standard values and result of dialux calculations.

Table 4.4. Private Ata Saglık Hospital-Measured and Calculated in Dialux Illuminance Values

	STANDARTS(LUX)	**LUXMETER** (LUX)		**DIALUX** (LUX)
GENERAL LIGHTING	**100**	POINT 1	80	50-100
		POINT 2	72	75-100
		POINT 3	126	100-200
		POINT 4	62	25-100
TREATMENT LIGHT	**1000**	POINT 5	20	7,5-10
		POINT 6	90	20-75
		POINT 7	160	20-75
		POINT 8	35	10-20
		POINT 9	300	200-300
		POINT 10	555	500-700
OBSERVATION LIGHT	**5**	2		2-3
READING LIGHT & SIMPLE EXAMINATION	**300**	NOT		NOT
BATHROOM LIGHTING	**200**	50		100

4.2.3. Private Ege Yasam Hospital

The hospital have started to serve within 13 branches in Karabaglar in 2014. It has a capacity of 54 patient beds inside. Floor plan of the hospital has been shown in Figure 4.36 and room plan has been shown in Figure 4.37.

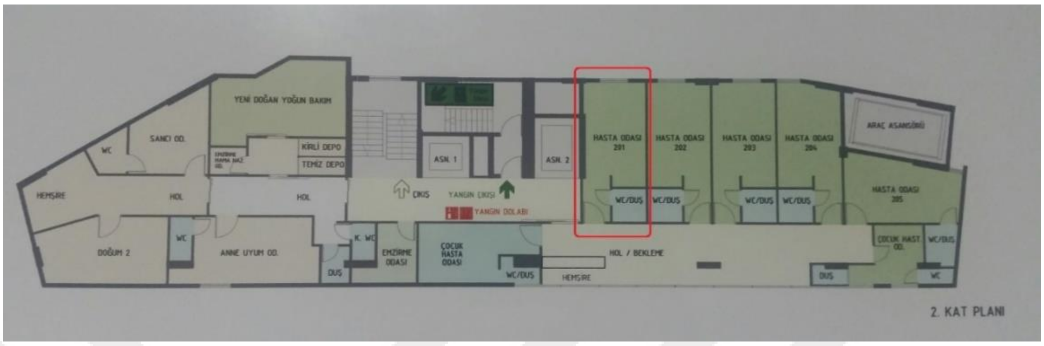


Figure 4.36. Private Ege Yasam Hospital- Floor Plan

The room opposite the nursery station framed in red on the 2nd Floor plan shown in Figure 4.36 was selected and the examination was made here.

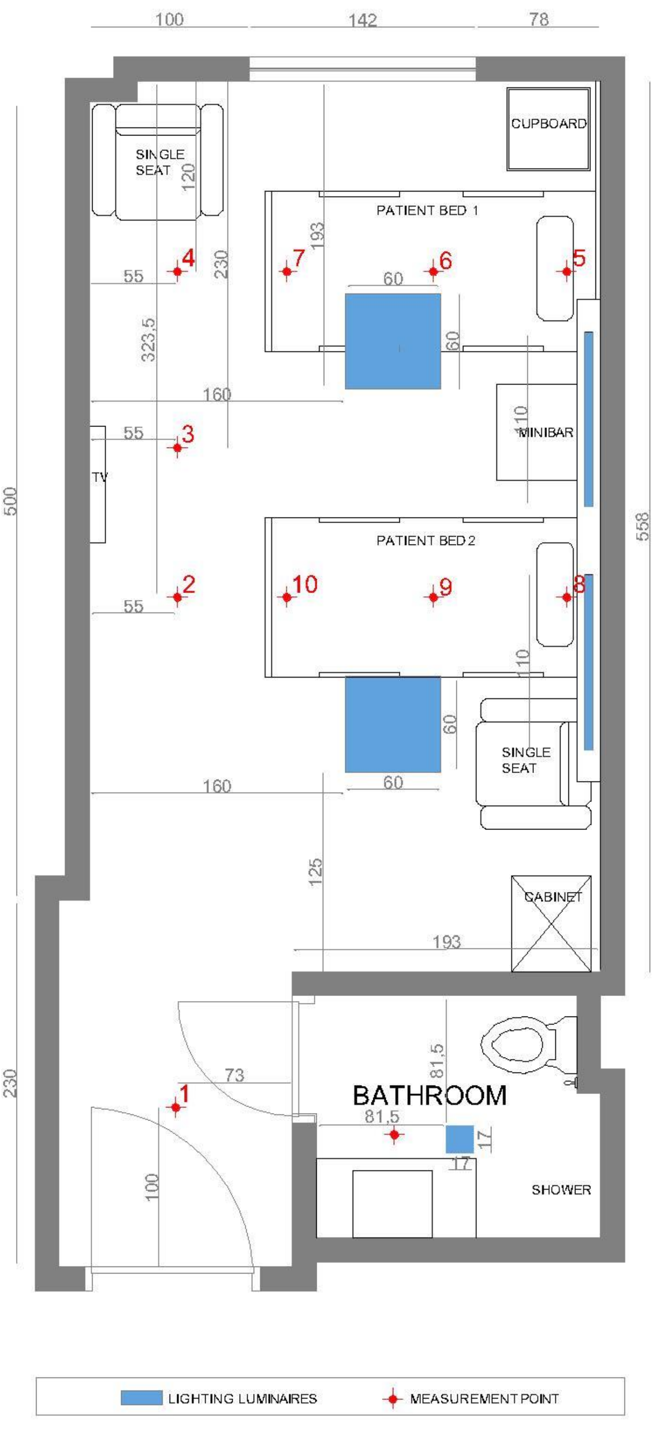


Figure 4.37. Private Ege Yasam Hospital-Room Plan

The furnishings in the selected room are drawn in the plan. The lighting fixtures, which are expressed in blue color, are shown at their places. The first point marked with red; 100 cm from the doorway in the middle of the corridor. The second and fourth points are spaced 55 cm from the wall in the direction of the beds. The third point is located between two patients bed and 55 cm from the wall. 5.6 and 7 points on the first patient bed respectively; the head of the bed, the middle of the bed, and the foot. 8.9 and 10 points on the second patient bed respectively; the head of the bed, the middle of the bed, and the foot. In bathroom has been measured in the point showed by red.

4.2.3.1. Lighting Equipments of Private Ege Yasam Hospital

General lighting

Figure 4.38. Private Ege Yasam Hospital-Patient Room General View 1

Figure 4.39. Private Ege Yasam Hospital-Patient Room General View 2

Two led panels 36 W 60x60 cm were used as general lighting luminaires in the ceiling. The ceiling height is 230 cm. Panels are placed in a grid suspended ceiling.

Figure 4.40. Private Ege Yasam Hospital-Ceiling Luminaires

Direct and indirect lighting

Figure 4.41. Private Ege Yasam Hospital-Patient Room General View 3

Luminaires are over both beds and 135 cm high on the floor. It is a 36 W fluorescent light bulb that indirect illuminates upward. It is a 18 W fluorescent light bulb that directs illuminates downwards. The width of module is 300 cm and 25 cm high.

Figure 4.42. Private Ege Yasam Hospital-Direct and Indirect Luminaires

Bathroom lighting

Figure 4.43. Private Ege Yasam Hospital-Bathroom View

The ceiling luminaire is 11 W ecotone bulb is placed in a grid suspended ceiling. The height from the ground is 230 cm. There is opal glass in front of the bulb.

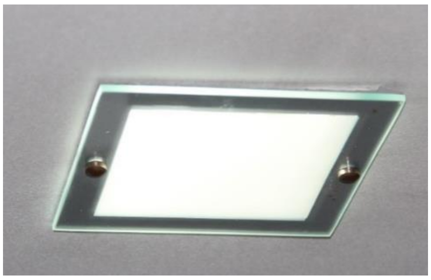


Figure 4.44. Private Ege Yasam Hospital –Bathroom Ceiling Luminaire

Table 4.5. is shown results of measured values. the results of the measurements made with the lux meter at the indicated points and the minimum standard values were written.

Table 4.5. Private Ege Yasam Measured Illuminance Values

	ON PATIENT BED 1				GENERAL LIGHTING- min. 100 lx	BATHROOM LIGHTING- min. 200 lx
	POINT 5	POINT 6	POINT 7	POINT 1	28 lx	17 lx
OBSERVATION LIGHT- min. 5 lx	NOT	*	*	POINT 2	140 lx	
TREATMENT LIGHT- min.1000 lx	234 lx	303 lx	214 lx	POINT 3	180 lx	
READING LIGHT & SIMPLE EXAMINATION - min. 300 lx	99 lx	*	*	POINT 4	187 lx	

	ON PATIENT BED 2		
	POINT 8	POINT 9	POINT 10
OBSERVATION LIGHT- min. 5 lx	NOT	*	*
TREATMENT LIGHT- min.1000 lx	265 lx	307 lx	221 lx
READING LIGHT & SIMPLE EXAMINATION - min. 300 lx	175 lx	*	*

4.2.3.2. Dialux Calculation of Private Ege Yasam Hospital

The properties of the luminaires were transferred to the Dialux program according to the measured values. In the following diagram are shown, the functions of the luminaires indicated by their location.

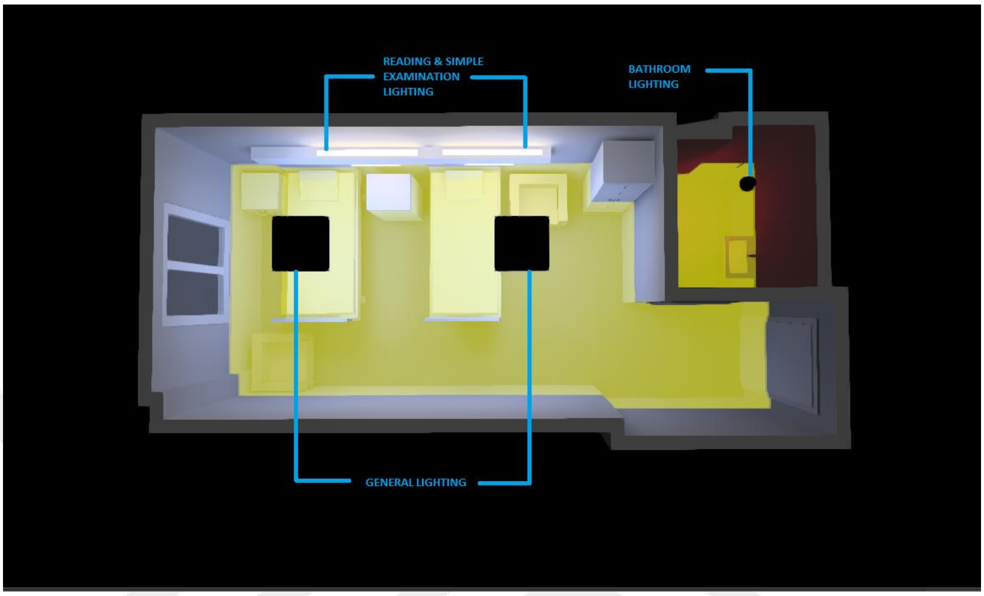


Figure 4.45. Private Ege Yasam Hospital-All Luminaires in Room

The effect region of all luminaires in the patient's room are shown below.

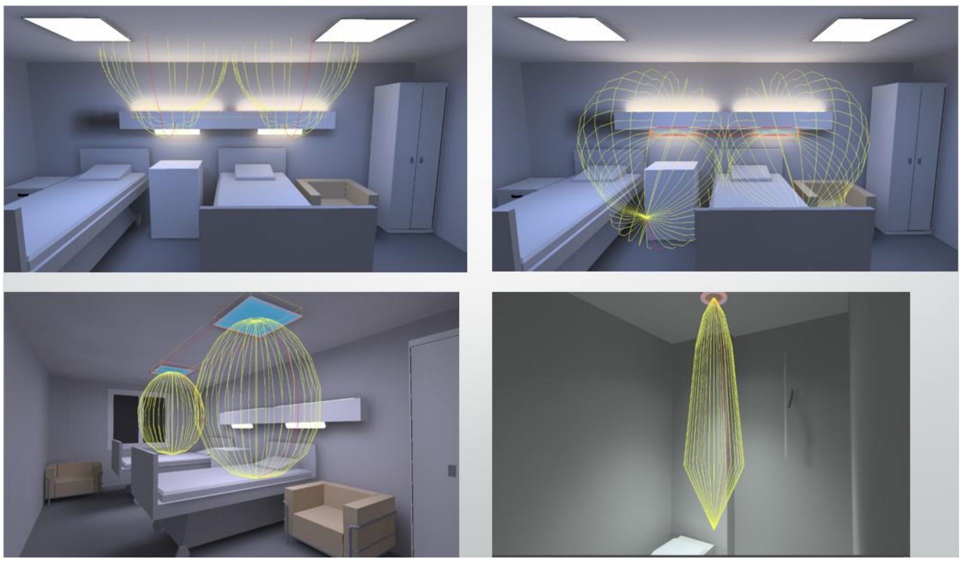


Figure 4.46. Private Ege Yasam Hospital-Effect Region of Luminaires in Room

Dialux has created scenarios for each lighting group. Direct and indirect lighting, general lighting, observation lighting, all lighting and bathroom lighting are grouped as its. Colors are expressed the light intensity of the entire room. Each color represents specific lux values. The color scale is below each photo.

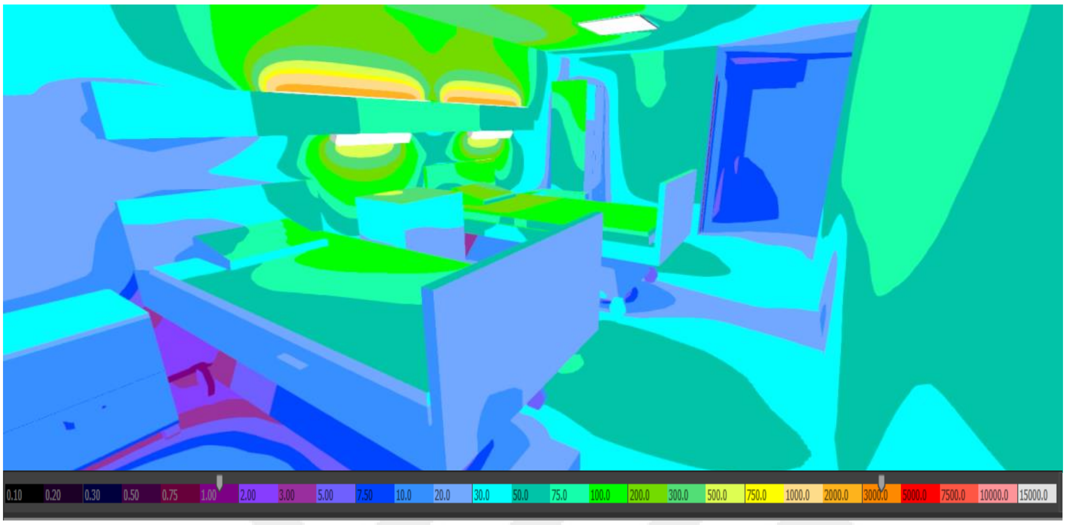


Figure 4.47. Private Ege Yasam Hospital-Brightness Levels of the Room When Direct and Indirect Luminaires are on

The results of direct and indirect lighting was open, the result was examined in the bedside area. In Figure 4.47. first bed; the result found in the program is in the range of 75-100 lux in the bedside area. The measurement made with lux meter showed 99 lux value. Second bed; the result found in the program is in the range of 100-200 lux in the bedside area. The measurement made with lux meter showed 175 lux value.

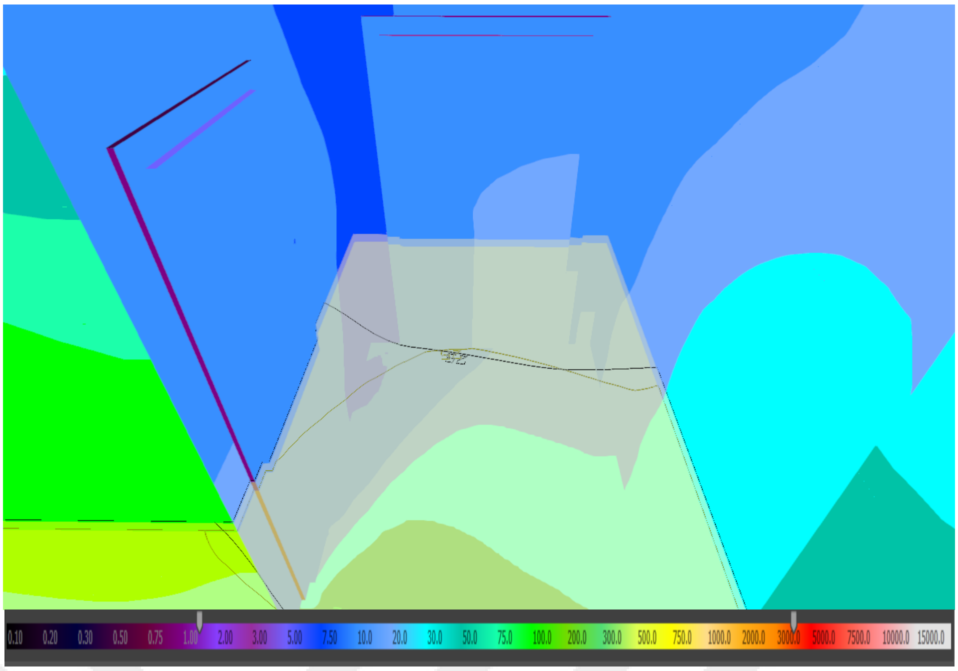


Figure 4.48. Private Ege Yasam Hospital-Brightness Levels of the Room When General Luminaires (entrance) are on

The four points determined on the plan when general lighting is open. Curves were used for a clearer view of the points taken at the height of 85 cm. In Figure 4.48. the result in the program is 25 lux at the point 1. The measurement made with lux meter showed 28 lux value.

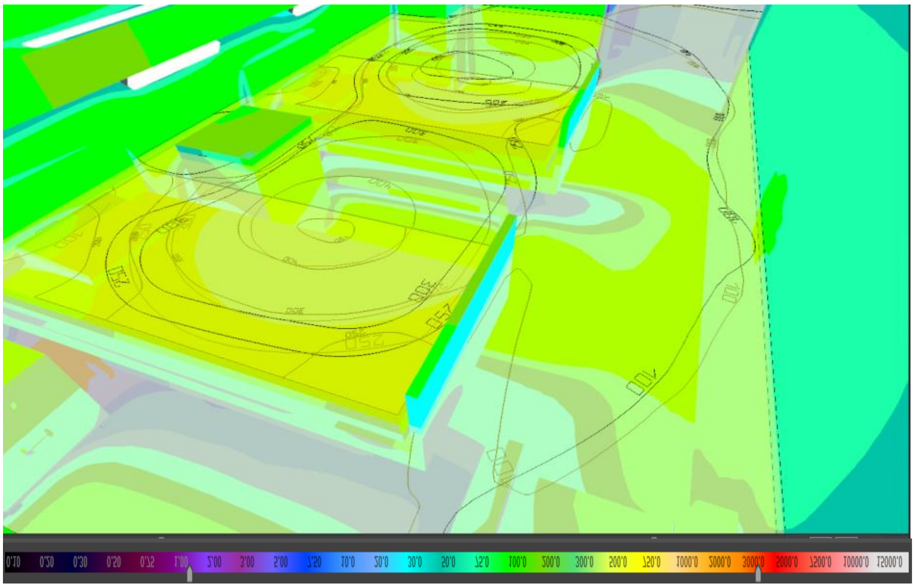


Figure 4.49. Private Ege Yasam Hospital-Brightness Levels of the Room When General Luminaires are on

In Figure 4.49. the result in the program is 100-250 lux at the point 2. A measurement of 140 lux was observed with the Luxmeter. The result in the program is 100-250 lux at the point 3. The measured value was 180 lux. The distance from 4 is 100-250 lux. The measured value was 187 lux.

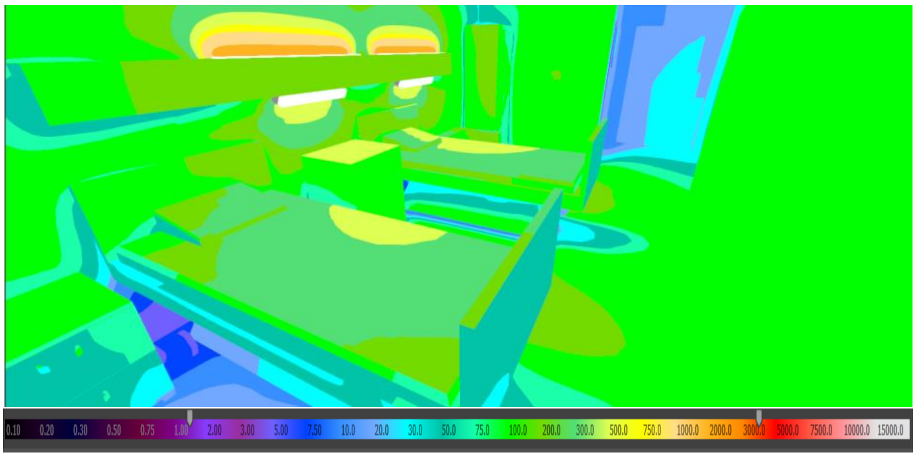


Figure 4.50. Private Ege Yasam Hospital-Brightness Levels of the Room When General-Direct and Indirect Luminaires are on

The result of direct and indirect lighting, general lighting were open, examined in three regions on the both patient bed. In Figure 4.50. first bed; the result found in the program at the point 5 is in the range of 200-300 lux. Measurement with lux meter showed 234 lux at 5 point. The result found in the program at the point 6 is in the range of 300-500 lux. The measured value was 303 lux at 6 point. The result found in the program at the point 7 is in the range of 200-300 lux. The measured value was 214 lux at 7 point.

Second bed; The result found in the program at the point 8 is in the range of 300-500 lux. The measured value was 265 lux at 8 point. The result found in the program at the point 9 is in the range of 300-500 lux. The measured value was 307 lux at 9 point. The result found in the program at the point 10 is in the range of 200-300 lux. The measured value was 221 lux at 10 point.

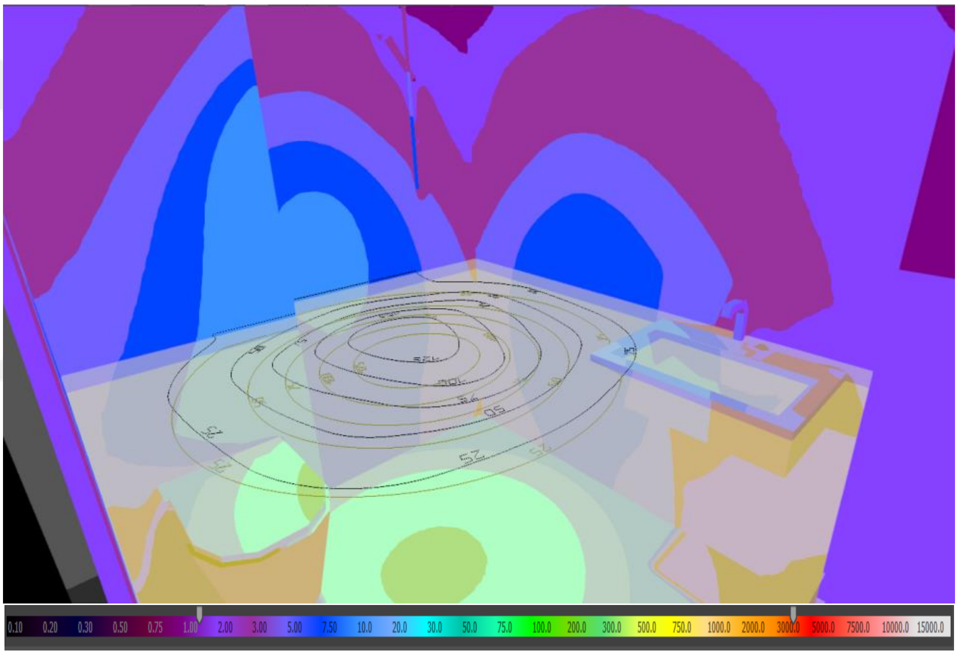


Figure 4.51. Private Ege Yasam Hospital-Brightness Levels of the Room When Bathroom Luminaire is on

The result, the bathroom luminaire is on are examined in the marked area in plan. In Figure 4.51. the result in the program is in the range of 25 lux. The measurement made with lux meter showed 17 lux value.

Table 4.6. is shown results of measured values with lux meter ,minimum standard values and result of dialux calculations.

Table 4.6. Private Ege Yasam Hospital-Measured and Calculated in Dialux Illuminance Values

	STANDARTS(LUX)	**LUXMETER** (LUX)		**DIALUX** (LUX)
GENERAL LIGHTING	**100**	POINT 1	28	25
		POINT 2	140	100-250
		POINT 3	180	100-250
		POINT 4	187	100-250
TREATMENT LIGHT	**1000**	POINT 5	234	200-300
		POINT 6	303	300-500
		POINT 7	214	200-300
		POINT 8	265	300-500
		POINT 9	307	300-500
		POINT 10	221	200-300
OBSERVATION LIGHT	**5**	NOT		NOT
READING LIGHT & SIMPLE EXAMINATION	**300**	BED 1	99	75-100
		BED 2	175	100-200
BATHROOM LIGHTING	**200**	17		25

4.2.4. Private Su Hospital

The hospital have started to serve within 23 branches in Konak in 2012. It has capacity of 109 patient beds. Floor plan of the hospital has been shown in Figure 4.52. and room plan has been shown in Figure 4.53.

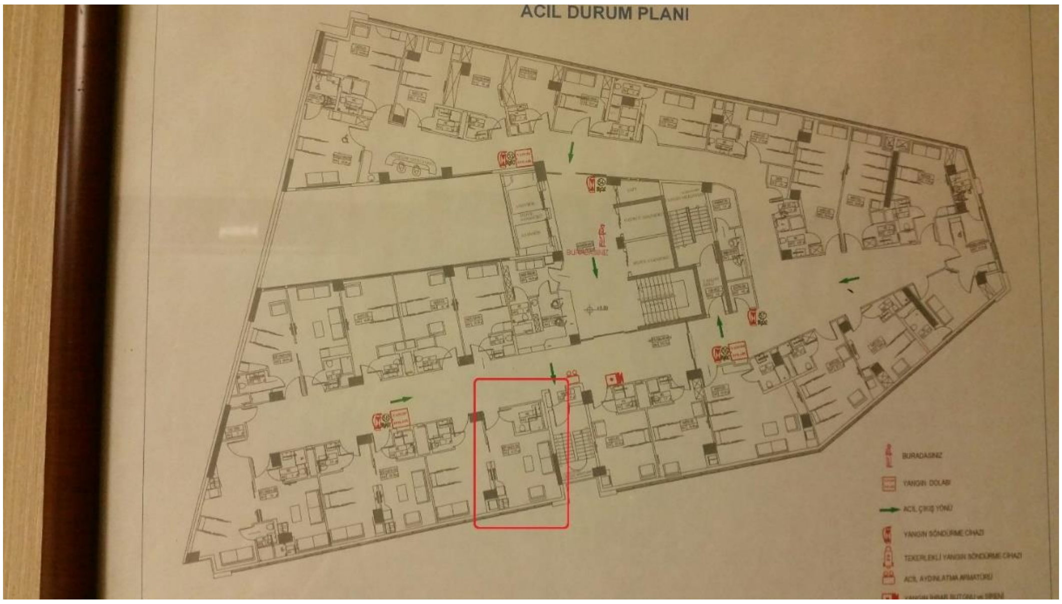


Figure 4.52. Private Su Hospital- Floor Plan

The room beside the emergency exit stairs framed in red on the 3rd floor plan shown in Figure 4.52 was selected and the examination was made here.

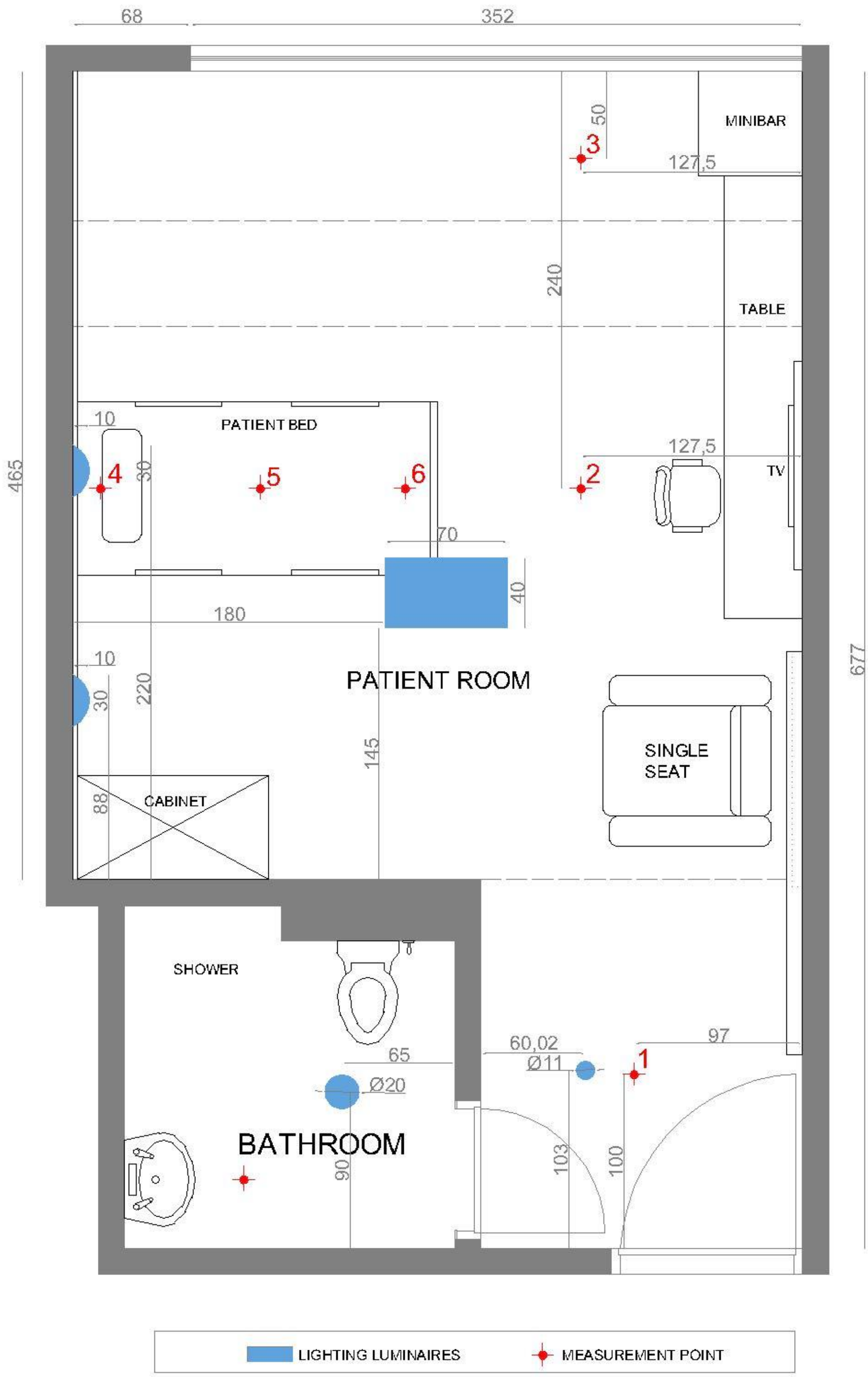


Figure 4.53. Private Su Hospital-Room Plan

The furnishings in the selected room are drawn in the plan. The lighting fixtures, which are expressed in blue color, are shown at their places. The first point marked with red; 100 cm from the doorway in the middle of the corridor. The second point is spaced 127,5 cm from the wall in the direction of the beds. The third point is located near window and 50 cm from the window. 4,5 and 6 points on the first patient bed respectively; the head of the bed, the middle of the bed, and the foot.

4.2.4.1. Lighting Equipments of Private Su Hospital

General lighting

Figure 4.54. Private Su Hospital-Patient Room General View 1

Figure 4.55. Private Su Hospital-Patient Room General View 2

Four flourescent bulbs 18W were used as general lighting luminaire in the ceiling. The ceiling height is 265 cm. Luminaire dimension is 40x70 cm and thickness is 8 cm.

Figure 4.56. Private Su Hospital-Ceiling Luminaire

Entrance lighting

Figure 4.57. Private Su Hospital-Patient Room General View 3

The entrance lighting located at the near door is selected as 18 W e27 spot led. The ceiling height is 240 cm. The spot led is placed in a grid suspended ceiling. The diameter is 12 cm.

Figure 4.58. Private Su Hospital-Entrance Ceiling Luminaire

Wall mounted lighting

Figure 4.59. Private Su Hospital-Patient Room General View 4

Wall mounted luminaires are over the patient bed and the center height is 190 cm. Two 18 W e 27 bulbs are used.

Figure 4.60. Private Su Hospital-Wall Mounted Luminaires

Bathroom lighting

Figure 4.61. Private Su Hospital-Bathroom View

The ceiling luminaire is 18 W plc bulb is placed in a grid suspended ceiling. The height from the ground is 225 cm. Diameter is 20 cm.

Figure 4.62. Private Su Hospital-Bathroom Ceiling Luminaire

Table 4.7. is shown results of measured values. the results of the measurements made with the lux meter at the indicated points and the minimum standard values were written.

Table 4.7. Private Su Hospital-Measured Illuminance Values

	ON PATIENT BED				GENERAL LIGHTING- min. 100 lx	BATHROOM LIGHTING- min. 200 lx
	POINT 4	POINT 5	POINT 6	POINT 1	29 lx	190 lx
OBSERVATION LIGHT- min. 5 lx	NOT	*	*	POINT 2	326 lx	
TREATMENT LIGHT- min.1000 lx	146 lx	202 lx	312 lx	POINT 3	10 lx	
READING LIGHT & SIMPLE EXAMINATION - min. 300 lx	95 lx	*	*			

4.2.4.2. Dialux Calculation of Private Su Hospital

The properties of the luminaires were transferred to the Dialux program according to the measured values. In the following diagram are shown, the functions of the luminaires indicated by their location.

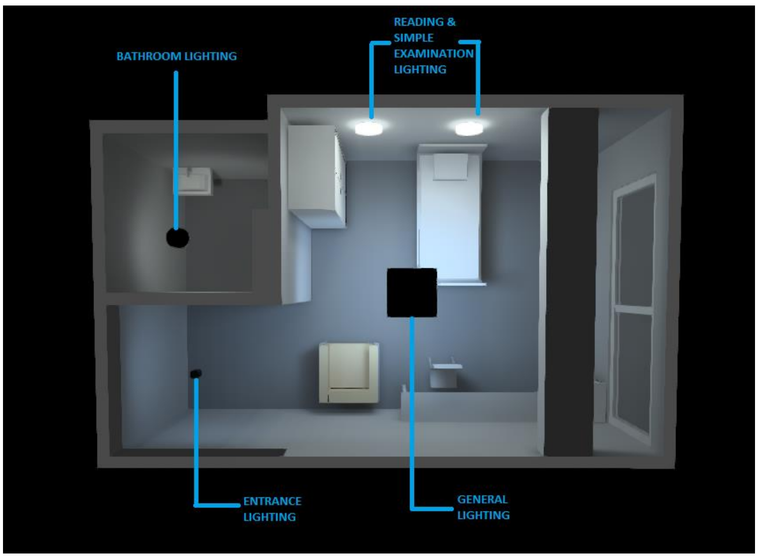


Figure 4.63. Private Su Hospital-All Luminaires in Room

The effect region of all luminaires in the patient's room are shown below.

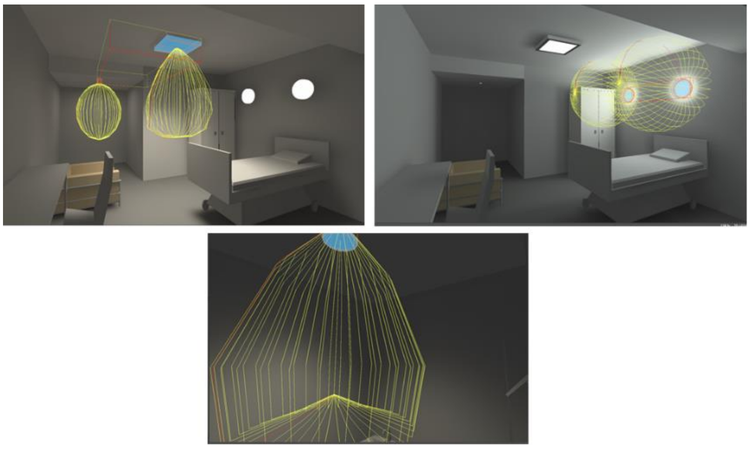


Figure 4.64. Private Su Hospital-Effect Region of Luminaires in Room

Dialux has created scenarios for each lighting group. Direct and indirect lighting, general lighting, observation lighting, all lighting and bathroom lighting are grouped as its. Colors are expressed the light intensity of the entire room. Each color represents specific lux values. The color scale is below each photo.

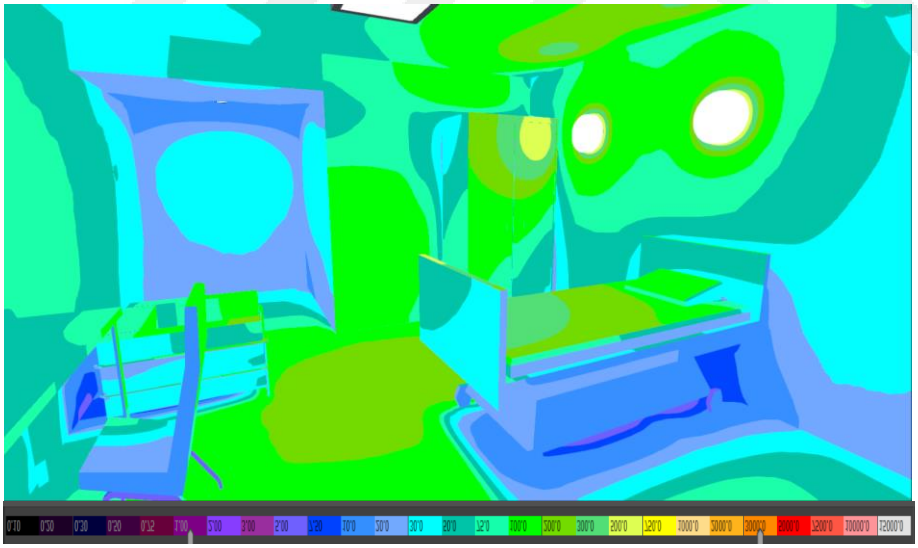


Figure 4.65. Private Su Hospital-Brightness Levels of the Room When General – Wall Mounted Luminaires are on

The result of wall mounted lighting, general lighting were open, examined in three regions on the both patient bed. In Figure 4.65. the result found in the program at the point 4 is in the range of 100-200 lux. Measurement with lux meter showed 146 lux at 5 point. The result found in the program at the point 5 is in the range of 200 lux. The measured value was 202 lux at 5 point. The result found in the program at the point 6 is in the range of 200-300 lux. The measured value was 312 lux at 6 point.

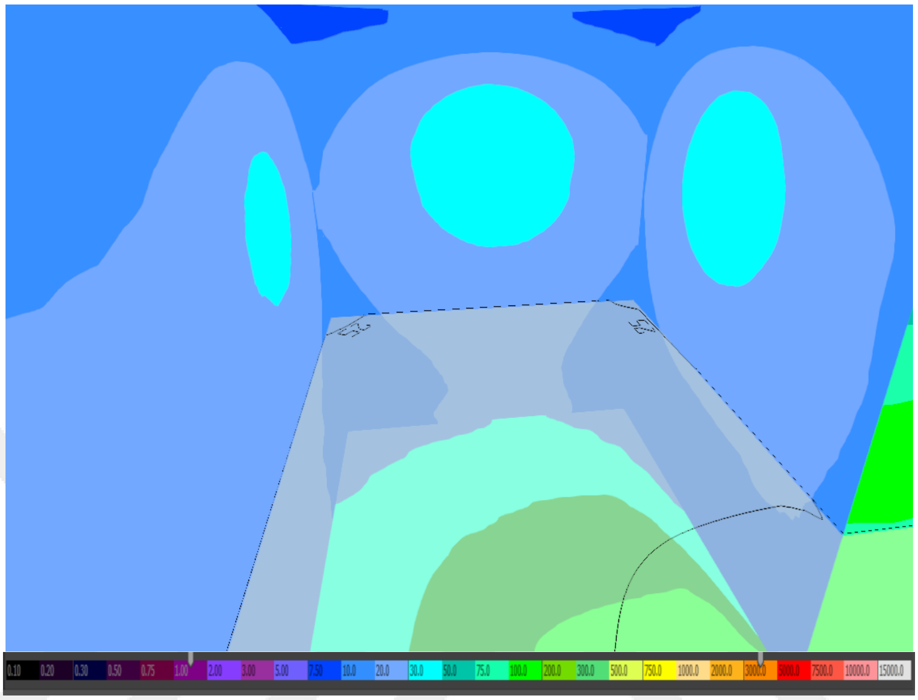


Figure 4.66. Private Su Hospital-Brightness Levels of the Room When General Luminaires (entrance) are on

The three points determined on the plan when general lighting is open. Curves were used for a clearer view of the points taken at the height of 85 cm. In Figure 4.66. the result in the program is in the range of 25 lux at the point 1. The measurement made with lux meter showed 29 lux value.

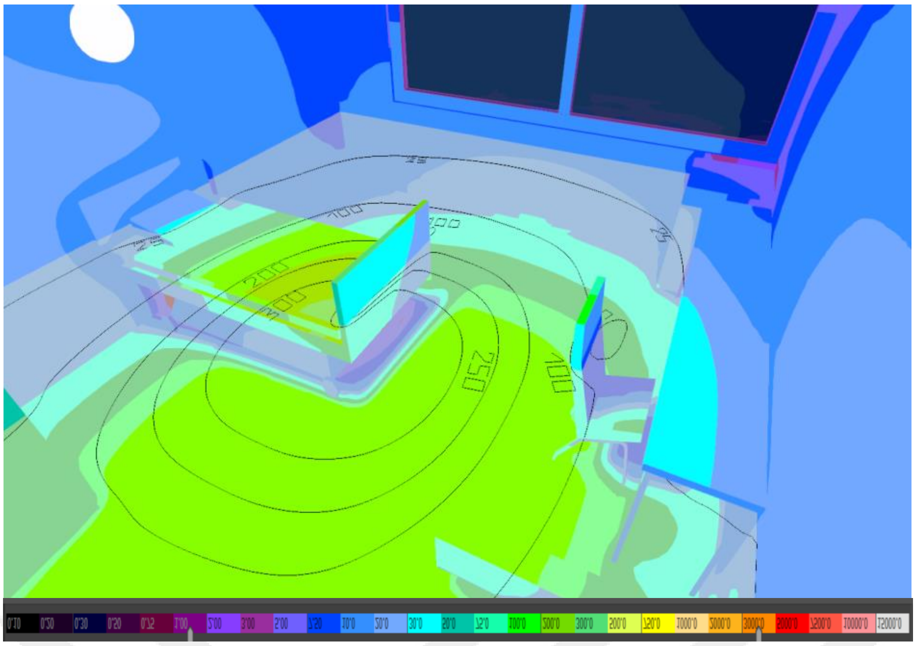


Figure 4.67. Private Su Hospital-Brightness Levels of the Room When General Luminaires are on

In Figure 4.67. the result in the program is 250-300 lux at the point 2. A measurement of 326 lux was observed with the lux meter. The result in the program is 25 lux at the point 3. The measured value was 10 lux.

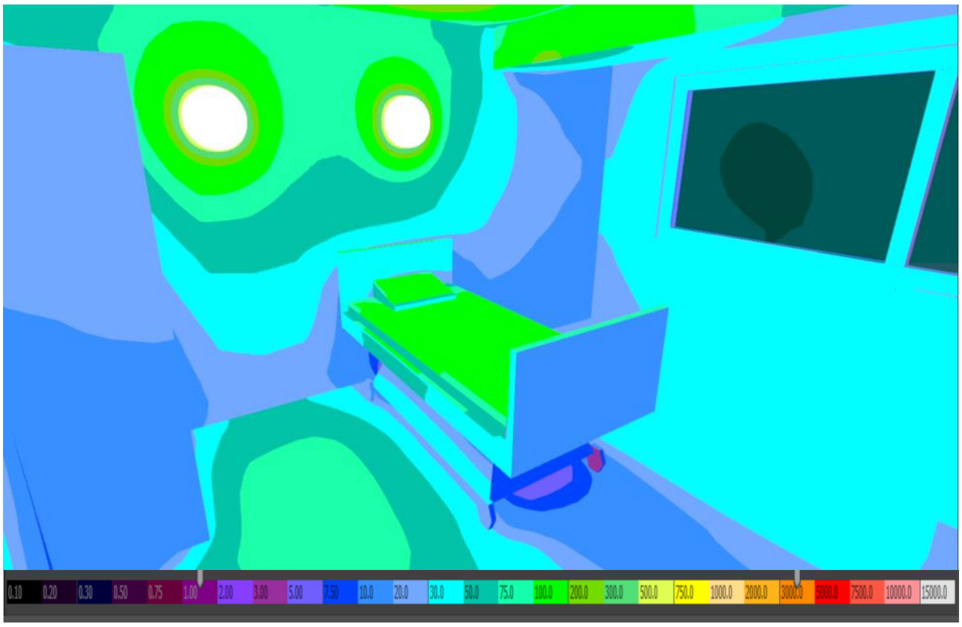


Figure 4.68. Private Su Hospital-Brightness Levels of the Room When Wall Mounted Luminaires are on

The results of wall mounted lighting was open, the result was examined in the bedside area. In Figure 4.68. the result found in the program is in the range of 75-100 lux in the bedside area. The measurement made with lux meter showed 95 lux value.

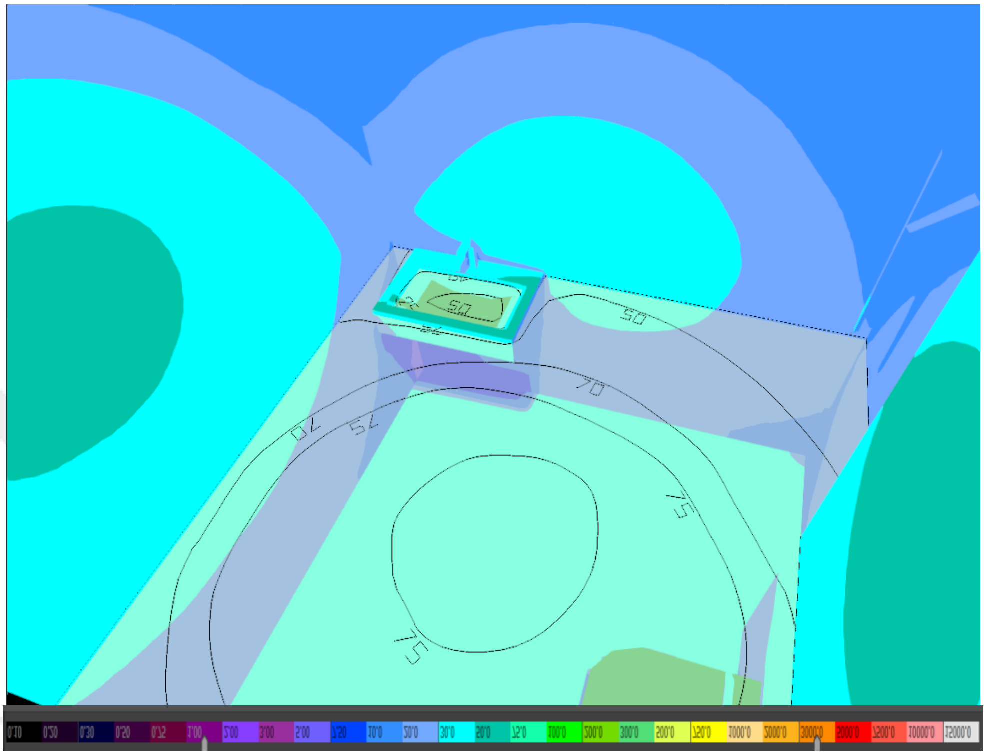


Figure 4.69. Private Su Hospital-Brightness Levels of the Room When Bathroom Luminaire is on

The result, the bathroom light is on are examined in the marked area in plan. In Figure 4.69. the result in the program is in the range of 50-70 lux. The measurement made with lux meter showed 42 lux value.

Table 4.8. is shown results of measured values with lux meter ,minimum standard values and result of dialux calculations.

Table 4.8. Private Su Hospital-Measured and Calculated in Dialux Illuminance Values

	STANDARTS(LUX)	**LUXMETER** (LUX)		**DIALUX** (LUX)
GENERAL LIGHTING	**100**	POINT 1	29	25
		POINT 2	326	250-300
		POINT 3	10	25
TREATMENT LIGHT	**1000**	POINT 4	146	100-200
		POINT 5	202	200
		POINT 6	312	200-300
OBSERVATION LIGHT	**5**	NOT		NOT
READING LIGHT & SIMPLE EXAMINATION	**300**	95		75-100
BATHROOM LIGHTING	**200**	190		50-70

4.2.5. Private Gazi Hospital

The hospital have started to serve within 20 branches in Konak in 2002. It has capacity of 93 patient beds. Floor plan of the hospital has been shown in Figure 4.70 and room plan has been shown in Figure 4.71.

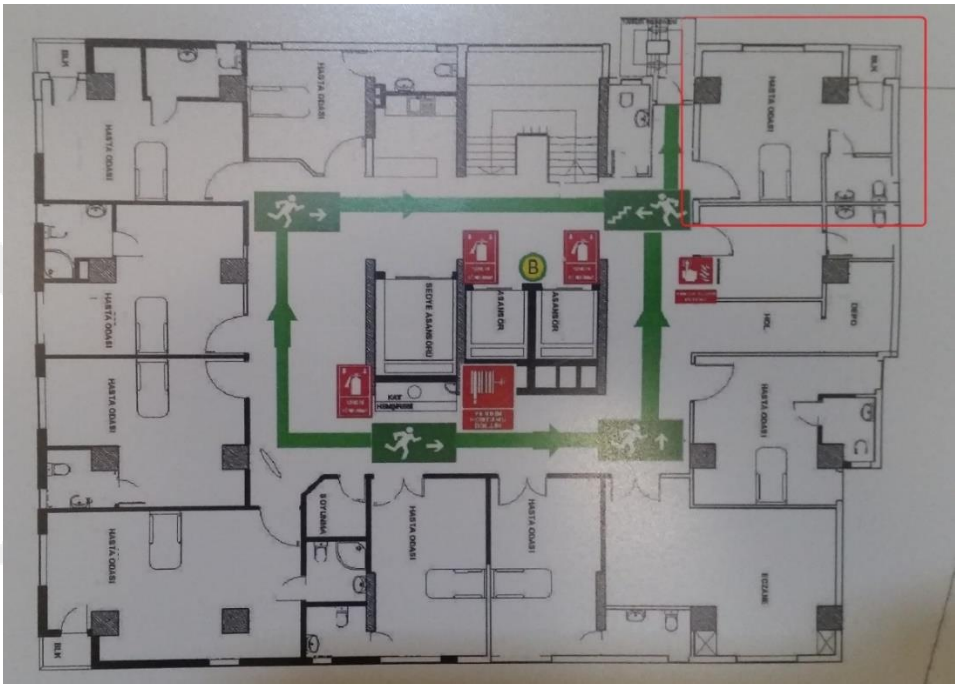


Figure 4.70. Private Gazi Hospital-Floor Plan

The room is beside the emergency exit framed in red on the 5nd floor plan shown in Figure 4.69 was selected and the examination was made here.

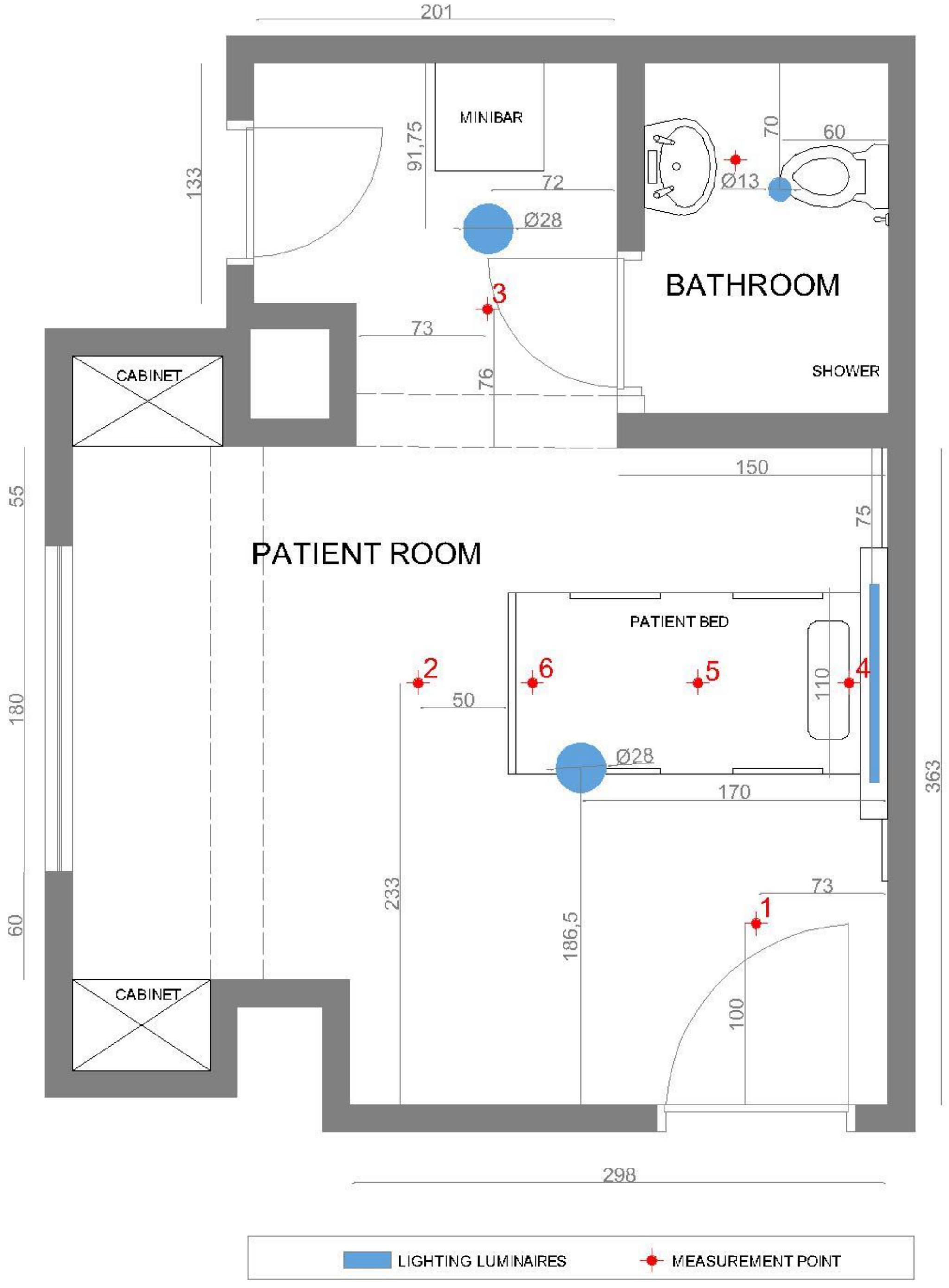


Figure 4.71. Private Gazi Hospital-Room Plan

The furnishings in the selected room are drawn in the project. The lighting fixtures, which are expressed in blue color, are shown at their places. The first point marked with red; 100 cm from the doorway. The second point is spaced 233 cm from the wall in the entrance. The third point is located in front of bathroom door and 73 cm from the wall. 4.5 and 6 points on the first patient bed respectively; the head of the bed, the middle of the bed, and the foot.

4.2.5.1. Lighting Equipments of Private Gazi Hospital

General lighting

Figure 4.72. Private Gazi Hospital-Patient Room General View 1

Figure 4.73. Private Gazi Hospital-Patient Room General View 2

General lighting luminaires has a 16 W led bulbs were used as in the ceiling. The ceiling height is 250 cm, thicknees is 4 cm.

Figure 4.74. Private Gazi Hospital-Ceiling Luminaires

Direct and indirect lighting

Figure 4.75. Private Gazi Hospital-Patient Room General View 3

Luminaire is over bed and 145 cm high on the floor. It is a 36 W fluorescent light bulb that indirect illuminates upward. It is a 18 W fluorescent light bulb that directs illuminates downwards. The width of each module is 150 cm and 25 cm high.

Figure 4.76. Private Gazi Hospital-Direct and Indirect Luminaires

Bathroom lighting

Figure 4.77. Private Gazi Hospital- Bathroom View

The bathroom luminaires placed in a grid suspended ceiling. 18 W spot led located at a distance of 230 cm from the floor. Diameter is 13 cm.

Figure 4.78. Private Gazi Hospital-Bathroom Ceiling Luminaire

Table 4.9. is shown results of measured values. the results of the measurements made with the lux meter at the indicated points and the minimum standard values were written.

Table 4.9. Private Karatas Hospital-Measured Illuminance Values

	ON PATIENT BED				GENERAL LIGHTING- min. 100 lx	BATHROOM LIGHTING- min. 200 lx
	PONT 4	POINT 5	POINT 6	POINT 1	65 lx	110 lx
OBSERVATION LIGHT- min. 5 lx	NOT	*	*	POINT 2	65 lx	
TREATMENT LIGHT- min.1000 lx	304 lx	118 lx	84 lx	POINT 3	85 lx	
READING LIGHT & SIMPLE EXAMINATION - min. 300 lx	277 lx	*	*			

4.2.5.2. Dialux Calculation of Private Gazi Hospital

The properties of the luminaires were transferred to the Dialux program according to the measured values. In the following diagram are shown, the functions of the luminaires indicated by their location.

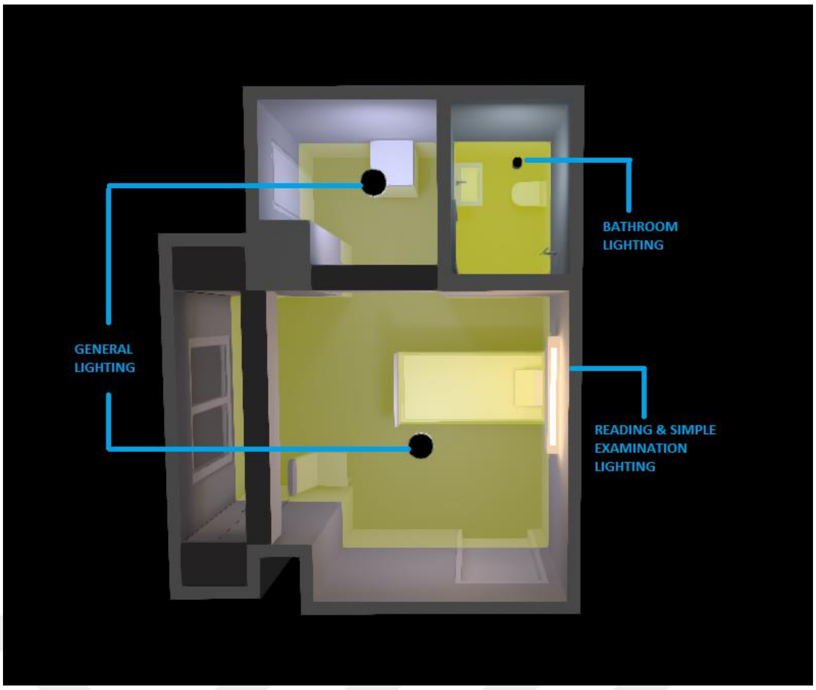


Figure 4.79. Private Gazi Hospital-All Luminaires in Room

The effect region of all luminaires in the patient's room are shown below.

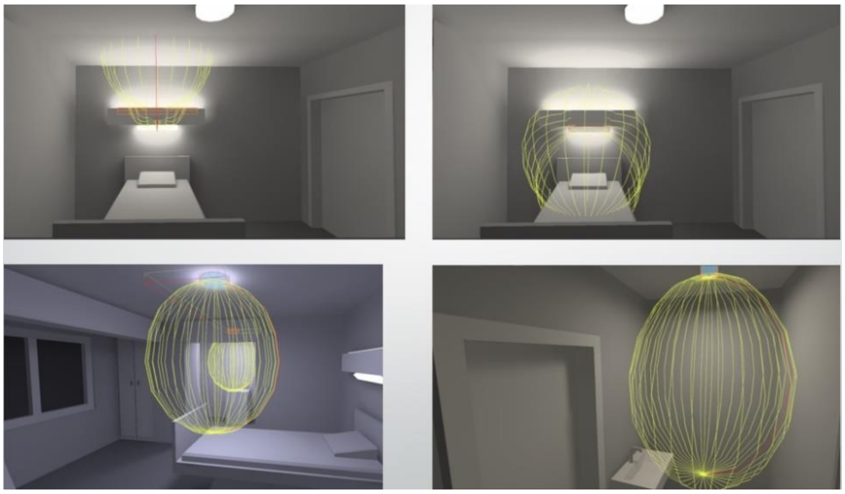


Figure 4.80. Private Gazi Hospital-Effect Region of Luminaires in Room

Dialux has created scenarios for each lighting group. Direct and indirect lighting, general lighting, observation lighting, all lighting and bathroom lighting are grouped as its. Colors are expressed the light intensity of the entire room. Each color represents specific lux values. The color scale is below each photo.

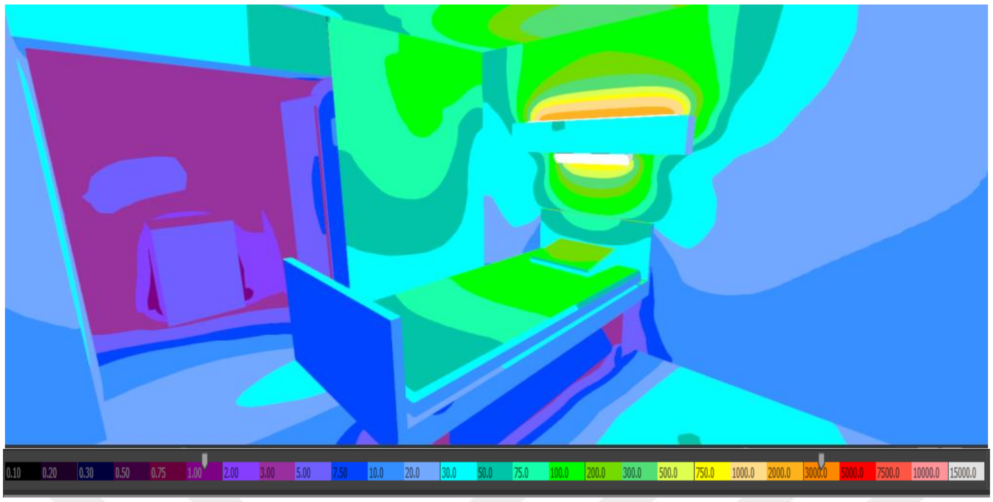


Figure 4.81. Private Gazi Hospital-Brightness Levels of the Room When Direct and Indirect Luminaires are on

The results of direct and indirect lighting was open, the result was examined in the bedside area. In Figure 4.81. the result found in the program is in the range of 200-300 lux in the bedside area. The measurement made with lux meter showed 277 lux value.

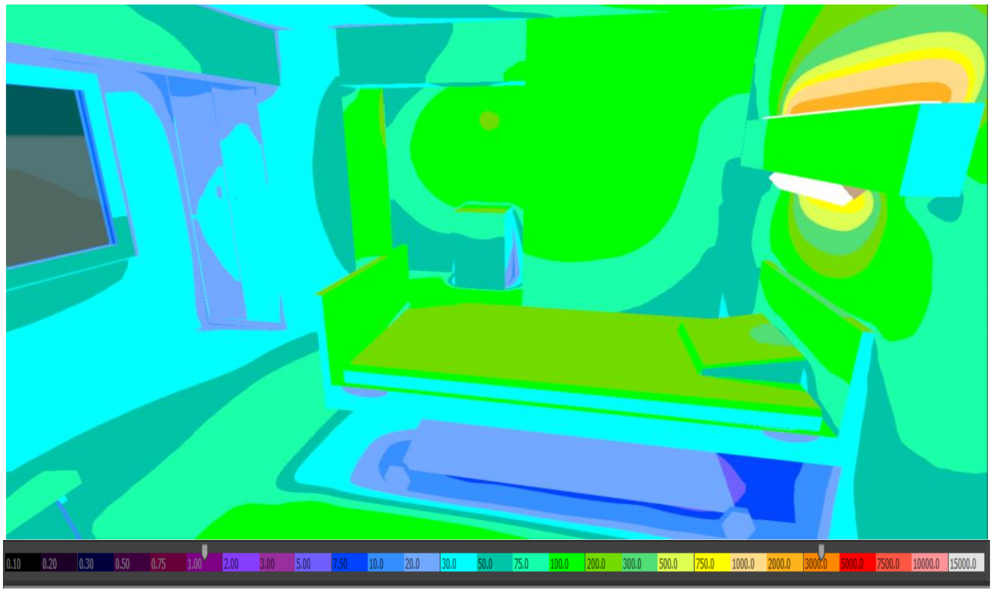


Figure 4.82. Private Gazi Hospital-Brightness Levels of the Room When General-Direct and Indirect Luminaires are on

The result of direct and indirect lighting, general lighting were open, examined in three regions on the patient bed. In Figure 4.82 the result found in the program is in the range of 100-300 lux homogeneously on the bed.. Measurement with lux meter showed 304 lux at 4 point. 118 lux at 5 point, 84 lux at 6 point.

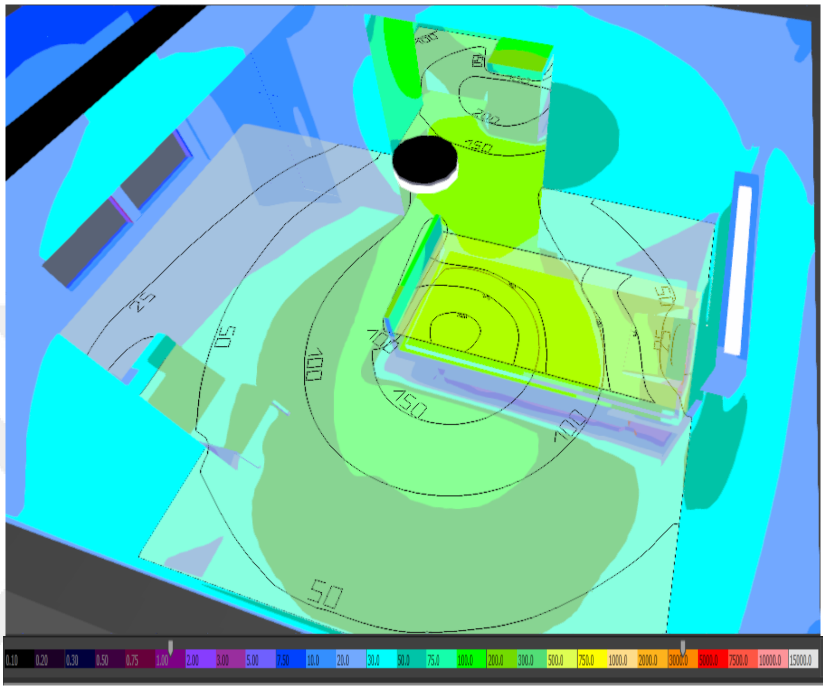


Figure 4.83. Private Gazi Hospital-Brightness Levels of the Room when General Luminaires are on

The three points determined on the plan when general lighting is open. Curves were used for a clearer view of the points taken at the height of 85 cm. In Figure 4.83. the result in the program is in the range of 50-100 lux at the point 1. The measurement made with lux meter showed 65 lux value. The result in the program is in the range of 50-100 lux at the point 2. The measurement made with lux meter showed 65 lux value. The result in the program is in the range of 150-200 lux at the point 3. The measurement made with lux meter showed 85 lux value.

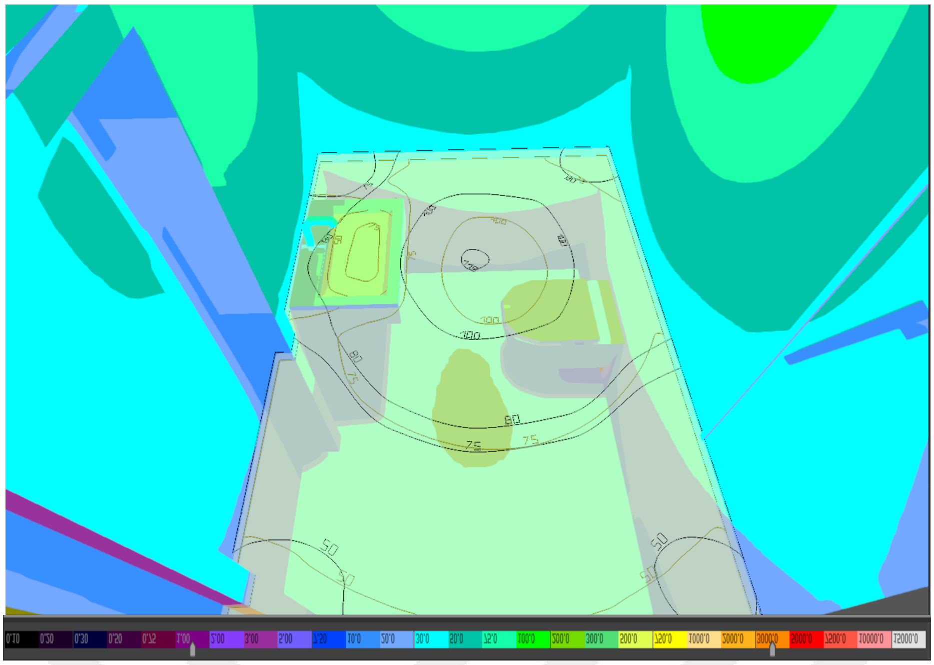


Figure 4.84. Private Gazi Hospital-Brightness Levels of the Room When Bathroom Luminaire is on

The result, the bathroom light is on are examined in the marked area in plan. In Figure 4.84. the result in the program is in the range of 100-1100 lux. The measurement made with lux meter showed 110 lux value.

Table 4.10. is shown results of measured values with lux meter ,minimum standard values and result of dialux calculations.

Table 4.10. Private Gazi Hospital-Measured and Calculated in Dialux Illuminance Values

	STANDARTS(LUX)	**LUXMETER** (LUX)		**DIALUX** (LUX)
GENERAL LIGHTING	**100**	POINT 1	65	50-100
		POINT 2	65	50-100
		POINT 3	85	150-200
TREATMENT LIGHT	**1000**	POINT 4	304	100-300
		POINT 5	118	100-300
		POINT 6	84	100-300
OBSERVATION LIGHT	**5**	NOT		NOT
READING LIGHT & SIMPLE EXAMINATION	**300**	277		200-300
BATHROOM LIGHTING	**200**	110		100-110

4.2.6. Private Karatas Hospital

The hospital have started to serve within 17 branches in Konak in 1827. It has capacity of 90 patient beds. Room plan has been shown in Figure 4.85.

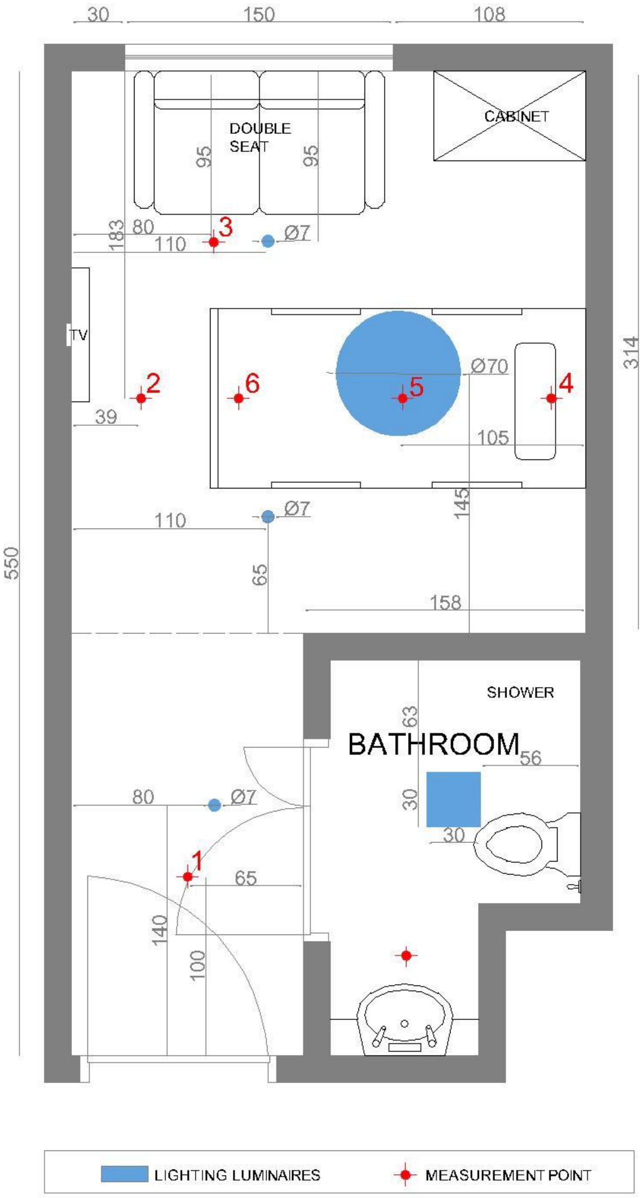


Figure 4.85. Private Karatas Hospital-Room Plan

The furnishings in the selected room are drawn in the plan The lighting fixtures, which are expressed in blue color, are shown at their places. The first point marked with red; 100 cm from the doorway in the middle of the corridor. The second point is spaced 39 cm from the wall in the direction of the beds. The third point is located front of the double seat and 80 cm from the wall. 5.6 and 7 points on the first patient bed respectively; the head of the bed, the middle of the bed, and the foot.

4.2.6.1. Lighting Equipments of Private Karatas Hospital

General lighting

Figure 4.86. Private Karatas Hospital-Patient Room General View 1

Figure 4.87. Private Karatas Hospital-Patient Room General View 2

Led panel is 54 W were used as general lighting luminaires in the ceiling. The ceiling height is 250 cm. Panels are placed in a suspended ceiling and diameter is 70 cm.

Figure 4.88. Private Karatas Hospital-Ceiling Luminaire

Entrance lighting

Figure 4.89. Private Karatas Hospital-Patient Room General View 3

The entrance lighting located at the near door is selected as 8 W spot led. The suspending ceiling height is 220 cm. The spot led is placed in a grid suspended ceiling. The diameter is 7 cm. There are two more in room the same luminaries, ceiling height is 255 cm.

Figure 4.90. Private Karatas Hospital-Ceiling Luminaires (Spot Leds)

Bathroom lighting

Figure 4.91. Private Karatas Hospital-Bathroom View

18 W e27 ecotone bulb is placed in a grid suspended ceiling. The height from the floor is 230 cm. There is opal glass in front of the bulb.

Figure 4.92. Private Karatas Hospital-Bathroom Ceiling Luminaire

Table 4.11. is shown results of measured values. the results of the measurements made with the lux meter at the indicated points and the minimum standard values were written.

Table 4.11. Private Karatas Hospital-Measured Illuminance Values

	ON PATIENT BED				GENERAL LIGHTING- min. 100 lx	BATHROOM LIGHTING- min. 200 lx
	POINT 4	POINT 5	POINT 6	POINT 1	124 lx	75 lx
OBSERVATION LIGHT- min. 5 lx	NOT	*	*	POINT 2	243 lx	
TREATMENT LIGHT- min.1000 lx	662 lx	890 lx	660 lx	POINT 3	557 lx	
READING LIGHT & SIMPLE EXAMINATION - min. 300 lx	NOT	*	*			

4.2.6.2. Dialux Calculation of Private Karatas Hospital

The properties of the luminaires were transferred to the Dialux program according to the measured values. In the following diagram are shown, the functions of the luminaires indicated by their location.

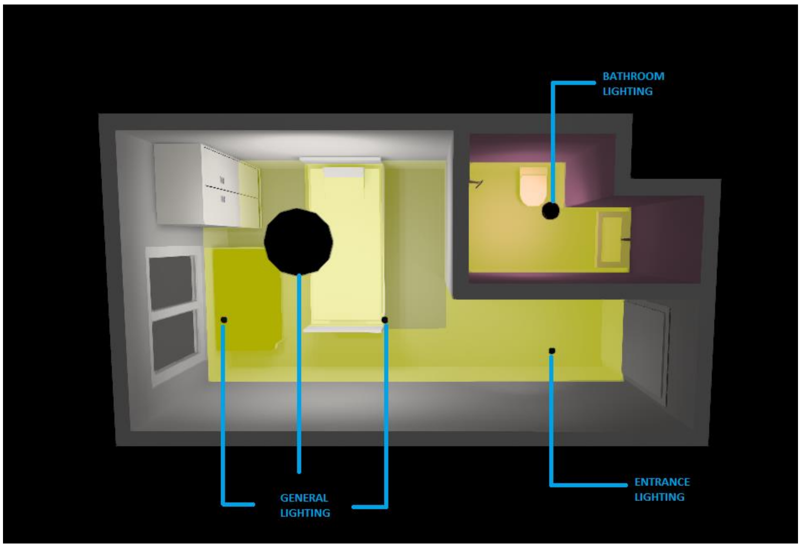


Figure 4.93. Private Karatas Hospital-All Luminaires in Room

The effect region of all luminaires in the patient's room are shown below.

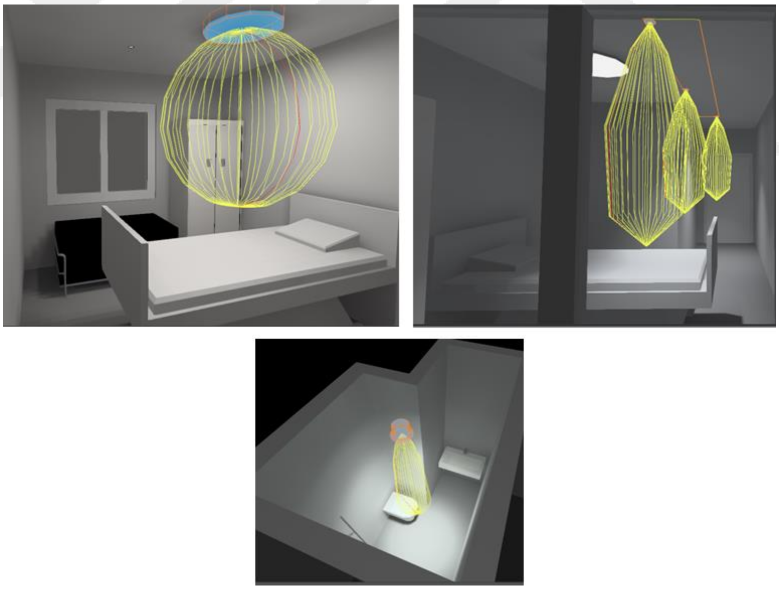


Figure 4.94. Private Karatas Hospital-Effect Region of Luminaires in Room

Dialux has created scenarios for each lighting group. Direct and indirect lighting, general lighting, observation lighting, all lighting and bathroom lighting are grouped as its. Colors are expressed the light intensity of the entire room. Each color represents specific lux values. The color scale is below each photo.

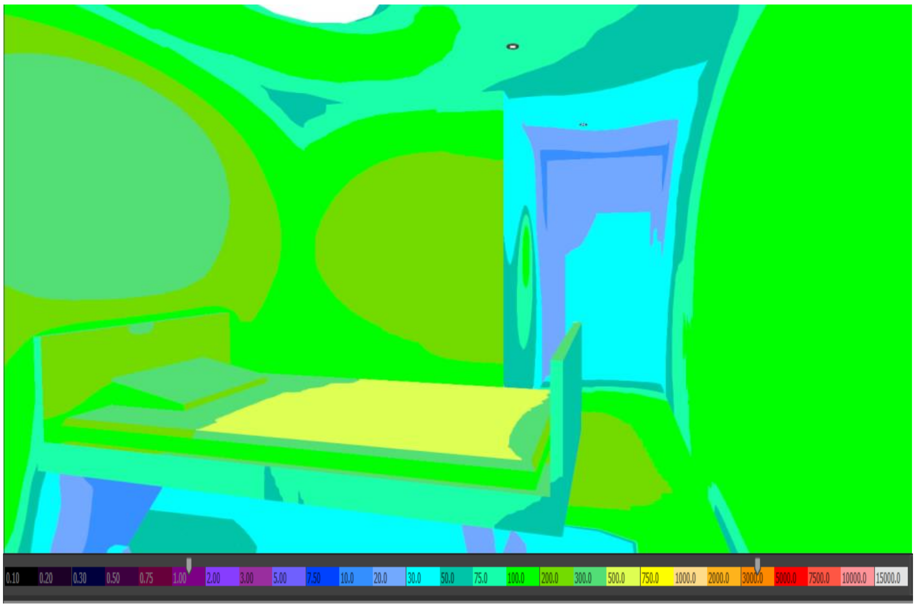


Figure 4.95. Private Karatas Hospital-Brightness Levels of the Room When General – Spot Luminaires are on

The result of general lighting and spots were open, examined in three regions on the patient bed. In Figure 4.95 the result found in the program is in the range of 300-500 lux homogeneously on the bed. Measurement with lux meter showed 662 lux at 4. point, 890 lux at 5. point, 660 lux at 6. point.

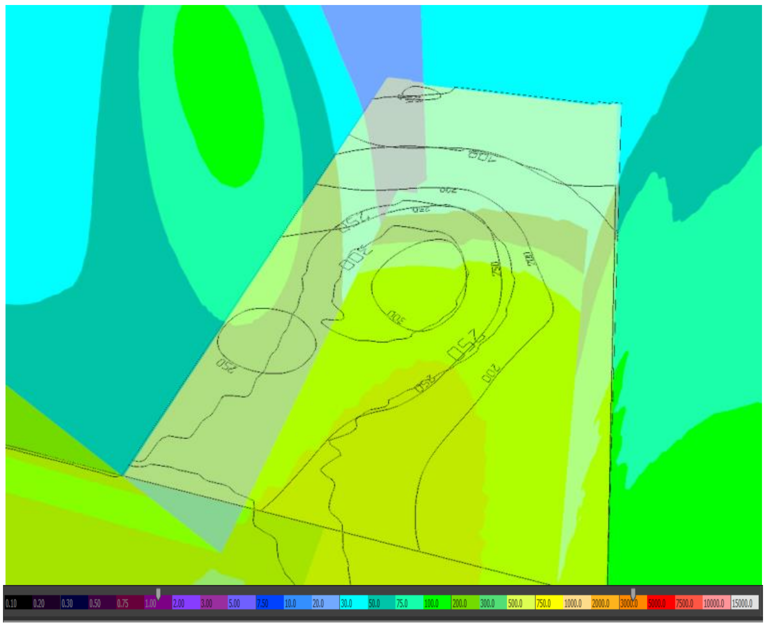


Figure 4.96. Private Karatas Hospital-Brightness Levels of the Room When General –Spot (entrance) Luminaires are on

The three points determined on the plan when general lighting is open. Curves were used for a clearer view of the points taken at the height of 85 cm. In Figure 4.96. the result in the program is in the range of 100-200 lux at the point 1. The measurement made with lux meter showed 124 lux value.

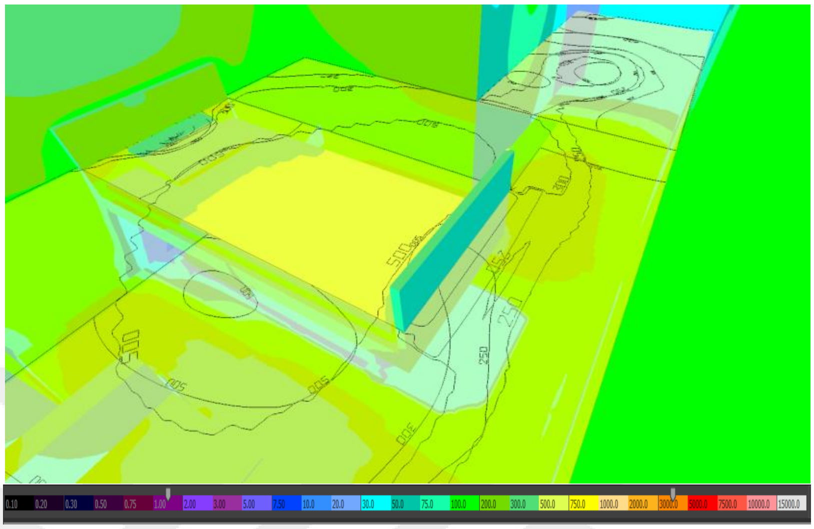


Figure 4.97. Private Karatas Hospital-Brightness Levels of the Room When General-Spot Luminaires are on

In Figure 4.97. the result in the program is 250 lux at the point 2. A measurement of 243 lux was observed with the lux meter. The result in the program is 500 lux at the point 3. The measured value was 557 lux.

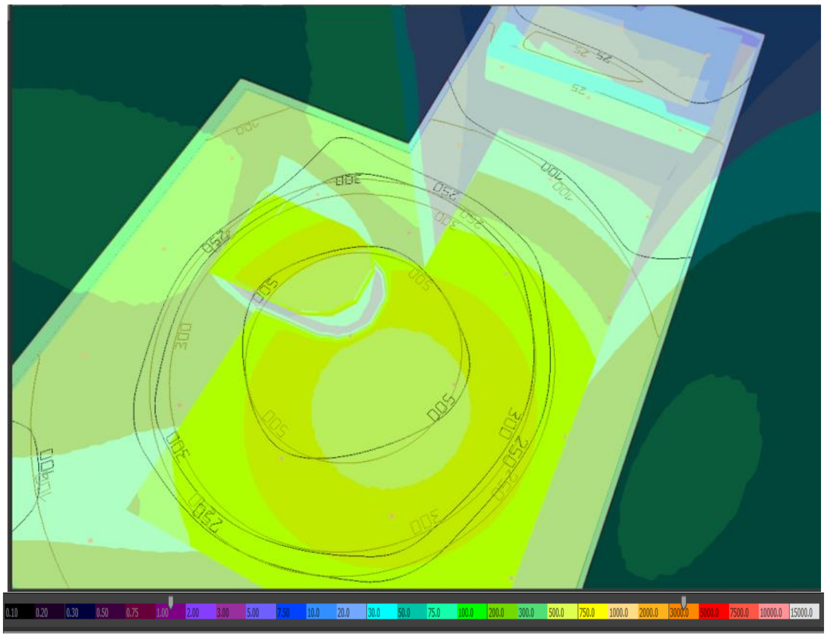


Figure 4.98. Private Karatas Hospital-Brightness Levels of the Room When Bathroom Luminaire is on

The result, the bathroom light is on are examined in the marked area in plan. In Figure 4.98. the result in the program is in the range of 25-100 lux. The measurement made with lux meter showed 75 lux value.

Table 4.12. is shown results of measured values with lux meter ,minimum standard values and result of dialux calculations.

Table 4.12. Private Karatas Hospital-Measured and Calculated in Dialux Illuminance Values

	STANDARTS(LUX)	**LUXMETER** (LUX)		**DIALUX** (LUX)
GENERAL LIGHTING	**100**	POINT 1	124	100-200
		POINT 2	243	250
		POINT 3	557	500
TREATMENT LIGHT	**1000**	POINT 4	662	300-500
		POINT 5	890	300-500
		POINT 6	660	300-500
OBSERVATION LIGHT	**5**	NOT		NOT
READING LIGHT & SIMPLE EXAMINATION	**300**	NOT		NOT
BATHROOM LIGHTING	**200**	75		25-100

4.3. Chapter Conclusion

Private Tınaztepe Hospital patient rooms have been renovated in the last few years. The design was created using several different types of lighting elements. As ceiling lighting panel LEDs, wall luminaires, direct and indirect lighting on the bed, spot led on the entrance, armature on the bathroom ceiling and on mirror are used. The wall lamps have enough light level for the nurses to comfortably see the patient at night. If all the lighting elements are open, the patient can not obtain the necessary value of 1,000 lux on the bed during the emergency intervention. Direct and indirect illumination on the patient's bed can also be used as a reading light. The patient was deemed sufficient for reading light in the measurement made on the bed. It has been observed that the values taken at several points in the room when the general lighting is in the open position correspond to the standards. In the case where both lights are turned on, the light level obtained is below the standards.

Ata Saglık Hospital patient rooms have been designed with LED illumination. Ceiling lighting in the room as a whole and a led strip application to be used as a night light in the head. There is no separate solution for reading light, but it is benefited from general illumination for reading. The night light nurse can not afford the 5 lx needed to control the night patient. It was seen that all the lighting elements in the room were kept under the value of 1.000 lux in case of emergency intervention in the open position. Overall illumination was observed to be close to the standards. The lighting on the bathroom is far below the standard.

Su Hospital patient rooms, the lighting design is designed with entrance lighting, room lighting and wall lightings. Considering that the night wall luminaires will be open, it has been measured that the nurses produce much more light in order to be able to observe. It was seen that there was not enough value for reading when considering the use of wall luminaires. It has been observed that a uniform distribution is not achieved when general lighting elements are open, and very low values are obtained in entrance and window areas. The value measured when all illuminations are turned on is far below the required light value in case of emergency intervention. Only the ceiling lighting luminaire was used in the bathroom and this value was below the minimum value.

Private Gazi Hospital is made up of lighting design, ceiling lighting, patient bedside direct and indirect lighting and bathroom lighting in patient rooms. There is no lighting to use as night light. As a reading light the patient is sufficient when both illuminations on the bed are opened. Low values were observed in the measurements made at certain points of the room when the general lighting elements were in the open position. When all the illuminations are open, it is observed that measurements made on the patient bed are too low to provide the necessary brightness level in case of emergency intervention. The ceiling lighting in the room is not enough according to the standards.

Private Ege Yasam Hospital is made up of lighting design, ceiling lighting, patient bedside direct and indirect lighting and bathroom lighting in patient rooms. There is no lighting to use as night light. As both reading illumina- tion, when two illumina- tions on the patient's bed are opened, the two patients are not enough for the bed. Because bed positions not in middle of illuminations. Illuminations illuminate the seat and the mini-bar, not the bed. When the general lighting elements were in the open position, measurements at certain points of the room were observed in accordance with the standards. It was observed that all the illuminations were open and the measurements made on patient beds were too low to provide the necessary brightness level in case of emergency intervention. The ceiling lighting in the bathroom is not enough according to the standards.

Private Karatas Hospital is made up of lighting design, ceiling lighting, entrance ceiling lighting and bathroom lighting in patient rooms. There is no lighting to use as night light. Tandem spots give much more light than necessary for night lighting. General lighting should be used as reading light, another solution was not considered. When the general lighting elements were in the open position, measurements at certain points of the room were observed in accordance with standards or even higher values. When all the illuminations were open, measurements on patient beds revealed values close to the required brightness level in case of emergency intervention, but no value of 1,000 lux was observed. The ceiling lighting in the bathroom is not enough according to the standards.

Table 4.13. Lighting Type-Hospital Analyze

CHAPTER 5

CONCLUSION

In the literature investigations made within the scope of this thesis, the effects of light on human are emphasized. In particular, it has become clear that the lighting design has to be done correctly in the rooms where the patients during the healing process are staying. Because it is known that the light has positive and negative effects on the healing process. What are the requirements for proper lighting design criteria, and how to do this is discussed. These criteria were evaluated according to the standard of private hospitals and the standards of illumination of work places in enclosed areas. Then field work was started and measurements were made at selected hospitals. Information on the design and features of artificial lighting was obtained and this information was entered into the Dialux program as data. The data obtained from the program and on-site measurements were evaluated.

In the research process it was difficult to find information about the lighting design of the patient room. Because there is not much study done about the subject. For example, a hospital's electrical project is checked and approved, but how many lighting fixtures to be used are not controlled in the patient's room. It is also necessary that the locations of the furnishing elements are clearly visible before the begin of lighting design. Lighting luminaires should be installed in the direction of the furnishing plan. Especially, be carefully for the two-bed rooms both patient beds must have equal lighting conditions. Both bed should be illuminated at an adequate level. The choice of furnishings and accessories should be hygienic. The material that can contain microbes in the room and objects that are difficult to clean can not be used.

All the hospitals have deficiencies and low value. Unfortunately, our country does not have sanctions or standards of regulations for lighting design. Turkey uses the values accepted by the European Union. Each firm or person can choose and use the type of lighting equipment he or she desires, and their supervision is not done. Illumination designs should be made and applied by competent designers who have a commanding background in places such as hospitals where light is important.

There is not exactly a lighting design that meets every standard value. In order for the patient room to be illuminated correctly and according to the standards, it is necessary to make the audits and control the applied designs.

Finally, this study is limited with private hospitals in İzmir. Further works can be done on public hospitals and also with the hospitals with different capacity.

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