YAŞAR UNIVERSITY

GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES

MASTER THESIS

LIGHTING DESIGN PROPOSAL FOR THE UNIVERSITY LIBRARY: THE STUDY OF LIBRARY LIGHTING IN RELATIONSHIP BETWEEN VISUAL HIERARCHY AND HUMAN PERCEPTION

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I certify that I have read this thesis and that in my 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

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Today as it was throughout history the most important thing for the library building design is artificial lighting. Today's society is in an information age and their development measured with their knowledge and their technology. Especially libraries are the most important institutions of the information society. Today's libraries are designed with considering the physical structure of the physiological and psychological needs of the users and employees. Spatial organization of the library becomes an important institution of social life.

One of the most important factor that affects human performance in libraries is constitute of the artificial lighting. The lighting design is shaped by visual, auditory and variety of features such as furnitures, computers etc. Technological developments have been reflected in the results of the lighting equipment's and there have been a lot of new developments to respond to the needs of many different lighting tools.

In this study, the lighting needs of users and the effects of lighting on their psychology have been examined. Lighting has an important role in the shaping of the library. In the

design stages geographic location, shape and natural light should be planned for lighting systems according to the users performance.

The study aims to observe the existing lighting condition of Yaşar University library and propose a new effective lighting system. All the existing documents for the library collected from the university office. They are compared with existing usage.

Dialux and ELI Softwares are used to simulate the existing lighting conditions. Survey results conducted on site about users preferences are implemented on ELI Software. ELI (Ergonomic Lighting Design) it covers a total of five aspects of quality: visual performance, vista visual comfort, vitality and empowerment. It investigates for the human organism features and capabilities and provide the necessary conditions for the work of human harmony. After the software considerations are done, review results have been interpreted and new light proposal is prepared. Considering most efficient model suited for the condition.

Keywords: Artificial Light, Visual Hierarchy, Perception, Light, Library Lighting

ÖZET

ÜNİVERSİTE KÜTÜPHANESİ AYDINLATMA ÖNERİSİ: GÖRSEL HİYERARŞİ VE ALGI İLİŞKİSİNİN İNCELENMESİ

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Yapay aydınlatma, geçmişten günümüze kadar kütüphane tasarımlarında çözülmesi gereken önemli bir işlevdir. Günümüz toplumunu bilgi çağı yönlendirdiği için değeri bilgi birikimi ve gelişmiş teknoloji ile ölçülmektedir. Buyüzden kütüphaneler bilgi toplumunun önemli kurumları oldukları için doğru tasarlanmalıdır. Günümüz kütüphaneleri kullanıcıların ve çalışanların fizyolojik ve psikolojik ihtiyaçları göz önüne alınarak tasarlanmalıdır. Kütüphanelerin mekansal organizasyonu sosyal hayatın önemli bir bileşeni haline dönüştürülmelidir.

Kütüphanelerde kişilerin performansını etkileyen en önemli faktörlerden biri yapay aydınlatma tasarımlarıdır. Aydınlatma tasarımı kütüphanenin görsel, işitsel ve elektronik materyalleri gibi bir çok özelliğiyle şekillenir. Teknolojik gelişimler aydınlatma ekipmanlarına da yansımış durumda ve aydınlatma gereksinimlerini karşılayacak ışıklandırma aletlerinde bir çok yenilik ortaya çıkmıştır. Bu çalışmada, kullanıcıların aydınlatma gereksinimlerinin psikolojileri üzerindeki etkileri incelenmiştir.

Kütüphane tasarımında aydınlatmanın önemli bir rolü vardır. Tasarım aşamasında kullanıcıların performansı için kütüphanenin coğrafi konumu, şekli ve doğal aydınlatma göz önüne alınmalıdır.

Bu çalışmanın amacı, Yaşar üniversitesi kütüphanesinde mevcut aydınlatma durumunu gözlemlemek ve kütüphane kullanıcılarının ihtiyaçlarını karşılayan etkili yeni bir aydınlatma sistemi önermektir. Üniversitesi yapı ofisinin arşivinde bulunan kütüphane ile ilgili tüm belgeler talep edildi. Arşiv belgelerinde bulunan planlarla ile mevcut durumunun mekansal organizasyon karşılaştırıldı. Aradaki farklılıklar değerlendirme kapsamına alındı.

İkinci olarak mevcut aydınlatma koşullarını simüle etmek için Dialux ve ELI yazılım programları kullanıldı ve kullanıcılara uygulanan anket sonuçları ELI programına veri olarak girildi. ELI (Ergonomik Işıklandırma Dizaynı) aydınlatma kalitesinin beş bileşenini kapsamaktadır: görsel performans, vistavizyon konfor, canlılık ve güçlendirme. Uygun ve uyumlu bir iş ortamının koşullarını sağlamak için insan organizmasınının özelliklerini ve iş konusundaki kabiliyetlerini inceler.

Sonuç olarak, programlarda değerlendirmeler yapıldıktan sonra, çıkan sonuç yorumlanmış ve yeni bir aydınlatma önerisi hazırlanmıştır. Mevcut aydınlatma sistemi ile önerilen aydınlatma sistemi karşılaştırılarak araştırma sonlandırılmıştır.

Anahtar Kelimeler: Yapay Aydınlatma, Görsel Hiyerarşi, Algı, Işık, Kütüphane Aydınlatması

To my big hearted Coach and my entire family…

2016

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This thesis, coming after my three years of master program in Graduate School of Natural and Applied Science in Yasar University, is a huge step for me to carry my knowledge on lighting sector which I am in since my childhood into professional life. There are supports of many people I acknowledge.

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On the pursuit of light…

TEXT OF OATH

I declare and honestly confirm that my study, titled “The Lighting Design Proposal for the University Library: The Study of Library Lighting in Relationship Between Visual Hierarchy and Human Perception” and presented as a Master’s Thesis, has been written without applying to any assistance inconsistent with scientific ethics and traditions, that all sources from which I have benefited are listed in the bibliography, and that I have benefited from these sources by means of making references.

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INDEX OF SYMBOLS AND ABBREVIATIONS

Symbols	**Explanations**
nm	Nano Meter
cd	Candela
lm/W	Lumen per Watt
SI	System International (international system of unit measurement)
Ra	Color Rendering Index (CRI)
Em	Electro Magnetic
Cd	Candela

Abbreviations

ELI	Ergonomic Lighting Indicator
EN	European Norm (Standart)
LED	Lighting Emitting Diode
LDC	Load Duration Curve
CIE	Coalation Information Environment
UGR	Unified Glare Rating
IFLA	International Federation of Library Associations
UNESCO	United Nations Educational, Scientific and Cultural Organization
IALD	International Associations of Lighting Designers

RILCP	The Ratio Between the Illumination Level of Calculation Points
CRF	Contrast Rendering Factor
UV	Ultra Viole
IR	Infrared

1 INTRODUCTION

Light has a big role in human life. It is one of the basic needs that human can define to perceive the surroundings with other senses, but the detection and identification with the eyes, much easier and more precise. Humans use their eyes for finding their ways. 80% of all information that human can detected are carried by the eye.

The natural light could not provide the lighting needs of the space in all day. So these spaces are an artificial lighting design which is suitable for it. There must be a light and a surface for reflection to see the environment clearly. So to provide a visual comfort there should be enough artificial lighting.

Generally, architects recognize Le Corbusier's dictum that 'Architecture is the correct and magnificent bringing together of forms in light'. As Le Corbusier had observed, this involvement with light lies at the heart of architecture. When architecture called first libraries comes to mind as a structure. People need to transmit their experience and knowledge to the next generation, so they had developed a way to eliminate this need. Scientists evaluating the first pictures on the cave walls of old-time people as a result of this search. With the development of civilization human communication need increased and first article samples began to shape. Collecting information with the need to transfer to future generations and other people began to form in the first archive temples and palaces. According to that, these archives return to libraries in the human history, so it loads great responsibility to designer.

In time, library spaces changed to answer the users' needs with the help of technology. These spaces have transformed into spaces which correspond also to users psychological needs from just being information centers. Today, library spaces mean more than a storage space for books. It is a space where one can reach and share the information, collect and keep the sources of information as well. In "Understanding Architecture" M. Leland Roth said "The main receiver to feel our environment is our eyes and that's why illuminating our

surroundings has extreme importance to the information that we received. It depends on the quality of the light falling on the textures of the structures. Furthermore, the light creates a strong psychological reaction." So in library buildings visual comfort, glare, color of the light source and color rendering are very important. It is known to have different responses of human to the environmental impacts.

The most powerful element in human active perception is considering the visual objects. To provide a suitable lighting design with visual functions, it should provide light levels which are set by the standards, properly illuminated and have the right color in the lamp selected.

In the third chapter of this study the definition and design of lighting, human factors and relationship between light-human are given. This section contains the basic definitions such as color temperature, color rendering, light intensity, visual conditions, luminous flux, illuminance and glare. According to the EN 12464-1 standards some illumination levels are defined for the spaces. For example; in offices 500 lux, in drawing classrooms 750 lux and in library shelfs 200 lux must be provided. Color temperature and color rendering is important for the visual comfort. The color temperature of the light changes according to the environment that user wants. For example; if user wants a warm environment impact comfortable, relaxing and warm light colored lamps are preferred. Especially in working areas colder light colored lamps should use to feel the crispness and spaciousness.

The researches show that the light not only helps to see it has also effects on human health, biological rhythm, mood and performance. Furthermore, architectural spaces are designed for human activities and technology. The character of a space effects human emotions and behavior *(Fisher,2006*). During the third part human factors contains some definitions like sensing light, eye, adaptation, eye glare and perception. It takes careful

observation to identify the aspects of appearance that rely on to form of perceptions and how they may be affected by lighting.

Chapter 4.3 teaches how libraries illuminated. There are several factors like visual hierarchy, surfaces and lighting criterias for illumination. A hierarchy of things to be seen is determined and selection is made of object characteristics to be revealed. It is this selection that determines the characteristics of the lighting to be provided. The aim is to plan a lighting distribution that is uniquely suited to the design situation, and which may be specified in terms that are capable of being realized.

When illuminating the library designer must be search on human and their perception. The human body biology gives the answers to the designer. Biological rhythms continue in parallel to the light-dark cycle, sleep-wake, vitality or tiredness affects the body temperature and the secretion of certain hormones scheme. With the sunset and darkness body temperature decreases and melatonin hormone will secretion which send signals about resting and sleeping to the body.

In the chapter 4.4 relationships between lighting and human being searched. This part touches the biorhythmic process of the light, psychological effects and human perception subjects. “Our environmental perceptions are also influenced by variables called proceedings, which in turn are affected by our psychological health: Internal proceedings, external proceedings. Internal proceedings are mental processes that help us to represent and explain the world around us. They are the thoughts and feelings that give order to our environments. External proceedings are the thoughts we interact with physical environment and other individuals” *(Kopec, 2006, p:60).* As Kopec says our psychological health influences the way human perceive and make choices about their environments. On the other hand, incandescent lighting is preferred by many owners, but it is more expensive than LED lighting, which has not been shown to have dramatic negative effects on the performance or health of most

students. Despite the inadequate methodology in some studies, and the lack of significant differences in others, it appears that light does affect some kinds of performance, such as basic cognitive and motor activities *(Munson & Ferguson, 1985).* Short exposures to the different kinds of light in many studies may have led to incorrect conclusions that light has no effects.

People with modern lifestyles and working conditions of industrialized began to spend more time in indoors. These places can be designed more comfortable and relaxed for people so "ergonomics" science has developed. Ergonomics is a science which is designed a living and working areas with taking consideration into the psychological and psychological needs. According to this needs "Ergonomic Lighting Indicator- ELI" tool was used. **ELI** covers a total of five aspects of quality: visual performance, vista, visual comfort, vitality and empowerment. In chapter 4.4.3 the definition of the ELI program, lighting design consideration criteria, in chapter 4.4.5 use of the program for the library building and in chapter 5 results of the consideration are given.

In this study these issues are discussed, as well as being a physical size of providing health care for the people to see the light of the biological clock, suggests that an important factor influencing the mood and performance. Artificial lighting plays an important role in the libraries. Designers are expected to satisfy their perceptions and needs. There is an approach which incorporates health, comfort, satisfaction and aesthetic pleasure within the library space as an essential part of artificial lighting quality *(Evans, 1981*).

Consequently, the relationship between satisfaction of users and artificial lighting will be investigated. The university library is chosen, because university is now more concentrated on student centered and problem resource based learning. Thus, with this point of view, university libraries are the significant position in the education role of the university students.

This research involves calculations and understanding the performance characteristics of illuminating, but the designer must never lose sight of the principle that what matters is what can be seen to make difference in the library. It is intended that a reader who follows all parts will become good at understanding human perception and library lighting.

1.1 The aim of the study

Artificial lighting design is a concept that has direct influence on space and perception. This concept is also an important field of research and interest to be applied properly by architects and designers. Lighting design of especially university libraries is among main problems in this field.

Libraries are spaces for research, sharing information and collecting resources. Most of the users are students. Students benefit libraries to study, read and research both digitally and written sources. Therefore, creating a healthy study environment for them is among primary duties of designers. User factor is the most important criterion for the designer as light does not only illuminates the space but also influence the perception, bio-rhythm and mood of the users in the space.

It was observed that the resources researched during this work emphasize these details. However, it was determined that visual hierarchy, the most significant aspect for perception, was ignored. Lighting of the space creates a visual hierarchy depending on the furniture placement and pattern in the interior space. If understood and applied successfully the designer manages to make users see whatever the designer wants them to see. Only in this way the most proper lighting design is created in places requiring high perception performance such as libraries. In this study, influence of the visual hierarchy created in the library of Yasar University on user perception is evaluated.

The aim of the study is to propose a lighting system with a better and proper lighting design after evaluation of the current one and gathering opinions of the users. Thus, users' performance will increase and a more preferable study environment may be provided with a better, healthier and more efficient lighting system.

1.2 The Limitations of the Study

In order to conduct a healthier and more accurate study there must be some limitations. In this study the limitations are the space, type of lighting and user profile. These three aspects of limitations are explained below.

Space; is chosen as and limited by the library of Yasar University and study became more specific. The space requires artificial lighting after certain hours. Type of the lighting is quite important, so the second limitation is chosen as the type of the lighting. Lighting is divided into two; natural and artificial lighting. Although natural lighting is sommonly used and preferred in libraries, the need for artificial lighting during certain hours cannot be ignored. Lighting problems caused by the architectural design of the library and wrong and insufficient lighting of the space pushed the study to focus on artificial lighting aspects of the library. Third, and the last, limitation; user profile, is very important when the artificial lighting is the subject. This is why user profile is the most important limitation of the study. User profile of the space examined in this study is limited to students only. Therefore, lighting, visual hierarchy and lighting conditions will be evaluated by means of perception of people who study, read and try to focus.

1.3 Method of the Research

This thesis focuses on researching the impacts of lighting design of library on user perception. The method of the thesis is divided into three phases; “What is lighting? How should be the lighting of libraries?”, “Evaluation of the library of Yasar University” and “Finding the right results through Dialux and ELI tools”. These three modules make up a working system if they are combined.

These are ordered in a path during the research and definition of light is one of the most important sections. First it must be clearified what light is. It is essential to understand the role of lighting, lighting tools, benefits of it and importance for human. Then lighting in libraries must be researched to evaluate library of Yasar University. Libraries must be examined and handled as interior spaces and lighting concepts of university libraries must be understood. Visual hierarchy, control of light, patterns and general lighting criteria must be taken into consideration while researching library lighting. After all these, the data gathered are justified via Dialuc and ELI programs. This modul including evaluation through Dialux and ELI is the last module of the study. The software control section, the last phase of the study will indicate the extent that the study was conducted and applied correctly and properly.

Dialux is a software that calculates if it is possible to provide the essential level of lighting depending on the functions of the space and reflection indexes of interior surfaces. First current situation of Yasar University library is evaluated through this software. It is aimed to achieve the best result by checking the five important factors including visual comfort, perception and the other factors mentioned earlier, via justification by ELI-LENI CALCULATOR software.

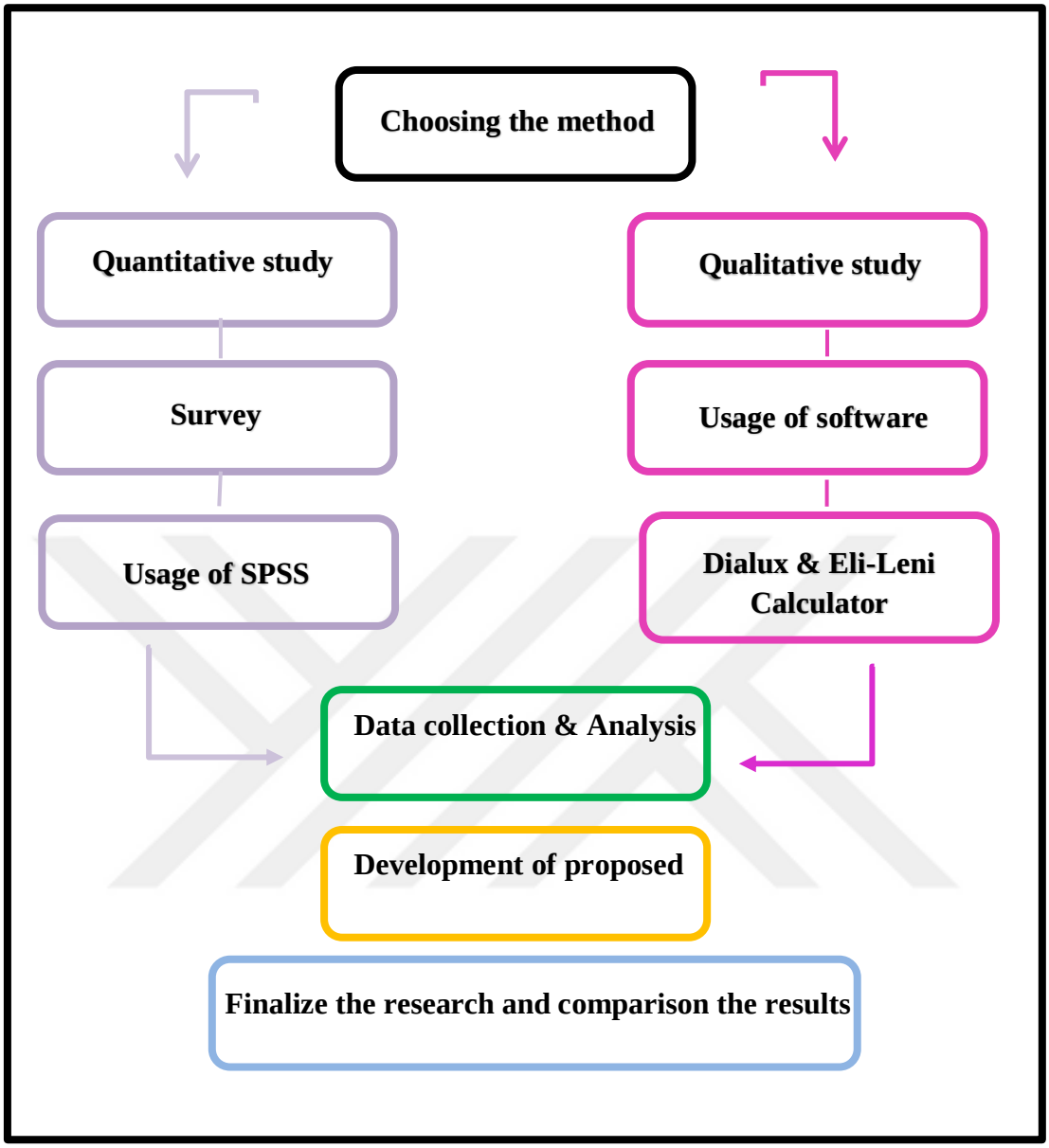

Table 1: Method of the Research as Schematic Illustration

2 LITERATURE REVIEW

The research has three main parts. These parts can be summarized as; definition of lighting design, library design and usage of software, simulations and survey.

When these main parts complete each other, the outcomes provide the right conditions for users. Artificial lighting organization of the library and type of users should be evaluated when selecting the type of lighting system of the library reply to work requirements and personal needs.

2.1 Definition of Lighting Design

In book of, **"**Light in architecture: Natural and Artificial lighting techniques that brighten our sacred spaces" which is written by Kristen McWilliams in 2008, is emphasized that structured environment around us the important of natural and artificial light. Especially, it is mentioned that artificial light is used to reawake the living environment around us. When this relationship with the light and the living environment more closely examined, the essay of "RCEP Consultation on artificial Light in the environment" which is written by Martin Margon-Taylor explains artificial lighting's effects on human health and human psychology. Usually, this study holds in its basis light's negative effects on human and how it affects quality of life.

Likewise, in book of "Lighting interior design" which is written by Malcom Innes in 2012, is mentioned to inferior space lighting and its effect on human in detail. Especially it is mentioned visual hierarchy that it taken part in many source but it has an important place in respect of lighting. Human gasps the environment with own perception. Visual perception is the greatest concept that light gives to the people. In the source of "Lighting & Human life" which is written by Dr. Anne Rialhe in 2007, is mentioned one-tone relevance between human and light. It

emphasizes that how quality of light effects to human and human behavior. When we examine this source we can see light's close relationship with living being is how much important for vital activities. "Effects of Indoor Lighting gender and Age on mood and cognitive performance" from Igore Knez and Christina Kers in 2000 tells, how lighting effects influence to mode of human and its cognitive performance in what aspects. In this source, we can discover that light approach to phenomenon of human and it influences biological rhythm and it changes biological clock. There is a good mentioning like light and human two natural phenomenons has a harmony one another.

In the study of "Influence of light fluctuation on occupant visual perception" which is written by Igore Knez and Christiana Kers in 2000, is discussed visual performance and light's change. This study explains that visual perception is influence from changing light level's fluctuation and it depends on embraceable in tolerance spaces change of light. It is a good source that should be read for visual performance in the environment can be controlled properly. In the essay of "Perception and Lighting as form givers for architecture" which is written by William M.C Lam in 1959, is mentioned to visual attention with examining the visual perception. By asking the question of "what do we look at "in this study, they mentioned visual comfort, visual effect place of lighting.

Closed spaces that used by people, are the places to be provided visual perception and visual comfort. In the essay of "Daylight and the Occupant Visual and physio-psychological well-being in built environments" which is written by Dr. Sergio Altamonte in 2009, is mentioned how will be provided natural light's comfort on commercial buildings. People's reaction of light as psychological and physiological is examined, it has advocated that even natural lighting must direct with regard to this.

In the article “The perception of light affected by color surfaces in indoor spaces” which is written by J. Lopez, H. Coch, A. Isalgue and C. Alonso visual comfort in indoor spaces are mentioned as depending on the amount and quality of light available on and space characteristics. According to this article, indoor spaces improve their visual responses for users by use of the advantage of color. “Konut yaşama mekanlarında yapay Aydınlatma: Trabzon örneği” is published by Kübra Özlü in 2008. It was mentioned artificial lighting and lighting technique are used in living environment. In this study, it is examined lighting techniques and practices which human use them in daily areas of usage.

In the book “Architectural Lighting Design” which is written by Gary Steffy in 2001visual hierarchy are mentioned as an important factor of the lighting. If designer understands and applies the rules of the visual hierarchy, the space became more meaningfull place. It separates the important one from the unimportant one and focuses the attention. After reading the essay, reader can get information about lighting techniques at interior place. Moreover, if to say something as a designer after reading this essay, designers must be more selective when to using the luminaires.

2.2 Library Design and Library Lighting

After the research on lighting, there are several research related with library in the educational fields for these informations are used correctly in the library.

“The Public Library Service” which is written by K.G. Saur with the help of IFLA and UNESCO guidelines in 2001, has a general statement on the role and purpose of the public library. In the manifesto it says ‘The public library is the local centre of information making all kinds of knowledge and information readily available to its users.’ This sentences show that the library buildings are the most important indoor spaces for users. According to the thesis of “Daylight and the Occupant, visual and physio-psychological well-being in built

environments" written by Dr. Sergio Altmonte in 2009 to substantiate an extensive use of daylight in commercial buildings is demonstraded and just providing potential energy savings can foster further benefits for both the owners and the occupants. In thesis of "Orta Doğu Teknik Üniversitesi merkez kütüphanesinin doğal ve yapay baydınlatma kriterlerinin incelenmesi" which is written by Feyyaz Ataç in 2013 is approached artificial and natural lighting's effect on human performance at library by examining lighting standard on worldwide.

The quality of artificial lighting for people here to spend most of the time in the interior is very important and if the interior is a library building, designer should give more importance to the lighting work. One of the highlights of this important work; is an essay named "Investigation of efficient system design in educational buildings at the example 'Municipal school of la tour de salvagny'" which is written by Dilay Kesten at İTU in 2016, is selected as the baseline lighting in the education buildings. According to study, visual conditions are most important in the class because all conditions in respect of psychological and physiological necessaries provide with light.

Also in book of "Lighting for Libraries" which is written by David Malman in 2001 and revised in 2005 is approached the importance of the lighting at the libraries. Good lighting design in library buildings is a technical skill and art on the part of the designer. For better lighting conditions designers should be improve themself.

In the essay of "Trakya'daki il halk kütüphanesinin binaları için optimum aydınlatma tasarımı için optimum aydınlatma tasarımı önerileri" which is published by Bahtiyar Dursun and Ahmet Altay in 2011, was made a set of measurement by laying emphasis on library lighting for to determine lighting performance at lecture room and workroom. According to taken results, it was presented some offers. Aim is that to make better to library's lighting like this thesis.

2.3 Usage of Software and Simulations

After it was examined lighting at library as an interior place, ıt was made a few more essay examination about lighting programs and survey's in order to present all of these information as a thesis subject. Some of them;

For example, Zumtobel lighting handbook which is revised in 2013. It is best source of telling program of ELI-LENI Calculator which is made by Zumtobel. Here, it is mentioned about not only software logic but also a lot of term related with lighting and subheading. Therefore, when somebody say "lighting", it is a source that can be get support technically. At the same time in the article named "Lighting quality and energy efficiency is not a contradiction" which is written by Peter Dehoff the importance of lighting quality is mentioned in order to fulfil visual tasks, enhance the architecture and to support biological functions. According to this ELI is the measure for lighting quality and allows comparing the requirement with different designed solutions.

For use in the program ELI, the survey needed and researches on the subject were done. "What is a survey" belongs to Fritz Scheuren. It tells what is questionnaire study, how does it make, which criteria should be regarded and how planning should be done in this period. If questionnaire for thesis or people who will make survey read this source, it will provide to make a correct study. In the book of "Research Methods, the essential knowledge base" which is written by William M. Trochaim, James P. Donnelly and Kanika Arora, survey research can lead to researcher properly when types of survey and survey design are made. Especially, it is fairly important to mention these like sources, this section makes thesis more statistical. According to the journal of Philips at the RAF magazine named "Dynamic Lighting" in 2006 mentione that the dynamic lighting systems is the future systems of the lighting sectory and explains the differences between daylight and artificial light, also touch upon the DALI systems usage and working principle.

When I examined the lighting design effects at a library on human perception I saw that generally there are a lot of studies about the control of accessory and sensor the light effects on human, natural or artificial lighting at the education buildings. But, I realized that there is no sufficient a study for visual hierarchy.

The important lighting in libraries are mentioned negligibly visual hierarchy's effects on human perception. Therefore, I wanted to mention this topic and find solution in my research. Thus, as it is seen from all of the sources that it will be approached from a different point of view to strong interaction between human and light.

3 DEFINITION OF LIGHTING DESIGN

Light is not only a resource and a vital substance but also a force that can create meaningful architectural experiences; the moods and the quality of an architectural space can broadly vary with its lighting conditions, transforming a sometimes dark, somble and oppressive place into a captivating, enthralling and polychromatic one.

In addition, science research has recently proven that a close relationship exits between lighting conditions, health, well-being and our perception of the environment. (van den Beld, 2001)

3.1 General Terms in Lighting Technology

Artificial lighting has become an element that has been developed and is needed by the designers. The fact that many users are interested in artificial lighting and its development made us research and learn it. Because learning the concepts and terms of lighting will lead us to better and healthier spatial designs.

3.1.1 Light

Light is power, streaming as radiation from the sun or a lamp and bouncing off all-the things around us until some of it reaches our eyes. It is a part of the electromagnetic spectrum that includes radio waves, microwaves, X-rays, infrared and ultraviolet. These are all forms of electromagnetic radiation. Visible light is visible energy.

As light is a form of energy it obeys physical rules that apply to energy, including the rules of thermodynamics. The first rule of thermodynamics states the energy cannot be created or destroyed; it can only be transformed from one kind of energy into another. Visible light can also be produced by the transformation of other kinds of electromagnetic energy, such as ultraviolet or microwave energy.

Solar cells transform the energy in visible light to electrical energy; industrial laser cutters are used to cut complex patterns in everything from sensitive paper to the hardest steel plates. But the human visual system converts light energy entering the eyes into chemical energy that is used to communicate the information received by the eye to the brain.

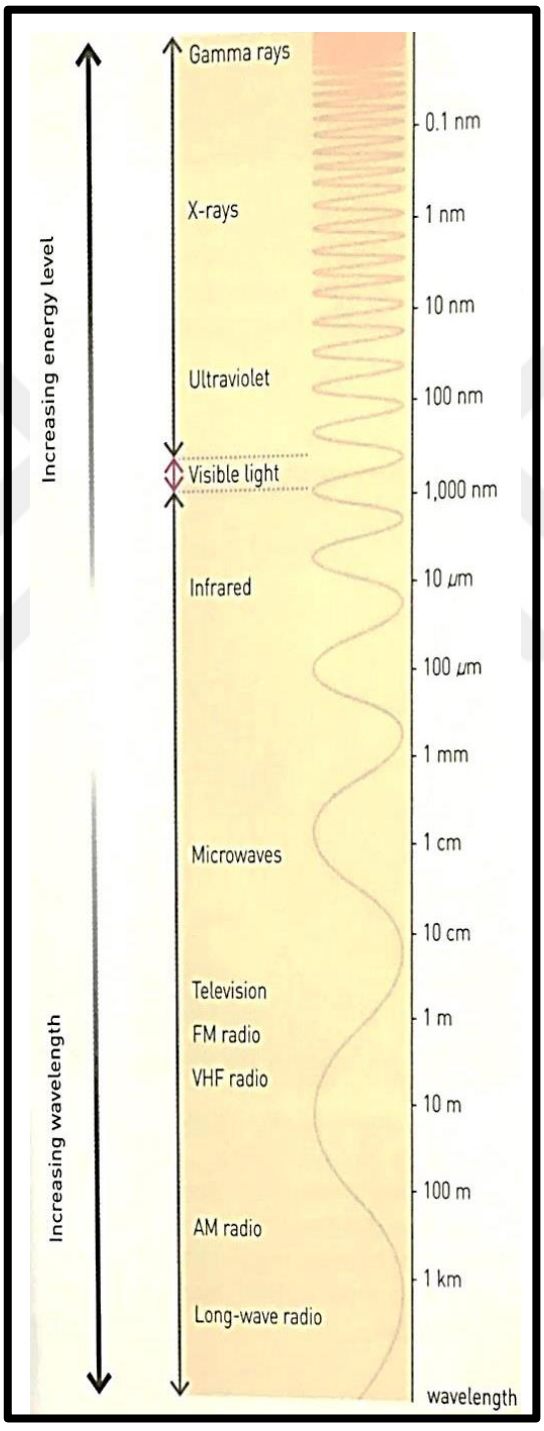

Table 2: Radiation between wavelengths between about 380 and 750 nm is the only part of the spectrum that we perceive as light.

3.1.2 Luminous Flux

In photometry, luminous flux is the measure of the perceived power of light. It differs from radiant flux, the measure of the total power of light emitted, in that luminous flux is adjusted to represent the sensitivity of the human eye. The luminous efficiency is the ratio of the luminous flux to the electrical power consumed (lm/W). It is a measure of a light source's economic efficiency. *(Zumtobel Lighting handbook, 4th edition, revised and updated: October 2013)*

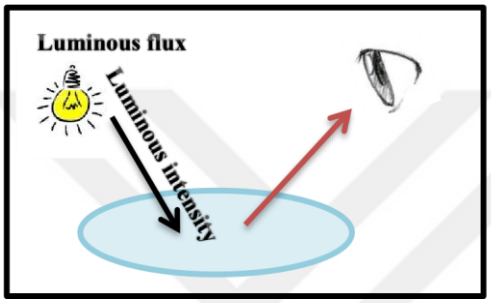

Figure 2: A Sketch of Luminous Flux

The SI unit of luminous flux is the lumen (lm). It is a description of the amount of light either produced by a source or received by a surface. Luminous flux is not a simple measurement of an amount of electromagnetic energy, it weighted to match the sensitivity of the human visual system to different wavelengths of visible light.

3.1.3 Luminous Intensity

Luminous intensity is the amount of light that falls on a defined surface and it measured in candela (cd). So candelas are the units of luminous intensity and it was imagined as very thin rays of light. Luminous intensity shows that how strong the light is in a given direction.

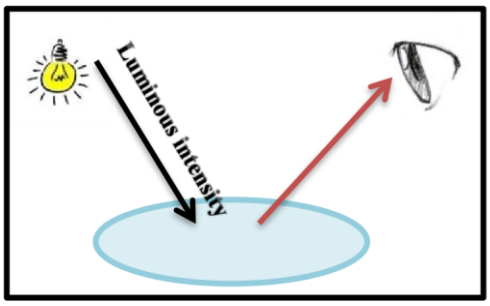

Figure 1: A Sketch of Luminous Intensity

The luminous intensity is a useful measurement for directive lighting elements such as reflectors. It is represented by the luminous intensity distribution curve LDC. *(Zumtobel Lighting handbook, 4th edition, revised and updated: October 2013)*

3.1.4 Glare

Glare is the sensation produced by luminance within the visual field that are sufficiently greater than the luminance to which the eyes are adapted, which causes annoyance, discomfort or loss visual performance and visibility. It can be disabling or simply uncomfortable. It is subjective, and sensitivity to glare can vary widely.

Visual perception is effected by glare; especially old persons are more sensitive to glare than young persons. Discomfort glare can be uncomfortable but doesn't significantly reduce ability to perform visual tasks It is influenced by brightness conditions within the entire field of vision. Disability glare reduces the ability to perceive visual information needed for task performance. It is influenced by object brightness *(Architectural Lighting, David Egan, 1983).* In the field of vision bright source called direct glare. Discomfort and disability glare can be caused by either direct light or reflected light.

Direct Glare

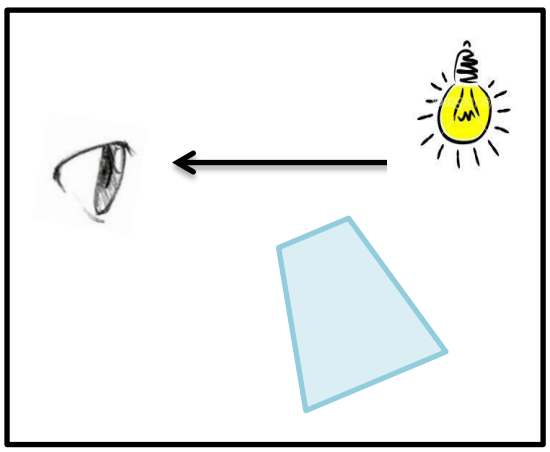

Figure 3: Uncovered light source in field of Vision

Reflected Glare

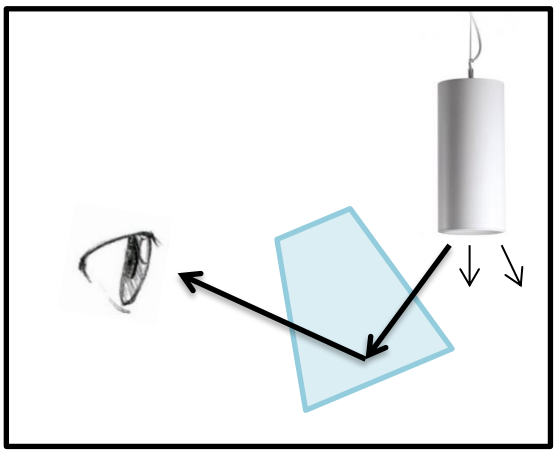

Figure 4: Image of light source overlays or 'veils' print on specular Materials

3.1.5 Brightness

Brightness is a sensation which can be expressed as bright, brilliant or light. The apparent or perceived brightness is modified by surroundings, condition of eye adaptation and other factors. Measured brightness or luminance is the amount of light reflected from or transmitted through an object expressed in foot lamberts *(Concepts in Architectural Lighting, M. David Egan, USA, 1983).* The visual system is capable of detecting objects over an extraordinarily large range of surface luminance. An object in direct sunlight may be as much as 1 million times brighter than the same object illuminated by moonlight but the human eye can perceive both. *(Perception and Lighting as Form Givers for Architecture, William M.C Lam, USA, 1977)*

The percentage of incident light which is reradiated from a surface is its reflectance. Shown below are rooms with low and high reflectance surfaces. *(Concepts in Architectural Lighting, M. David Egan, USA, 1983)*

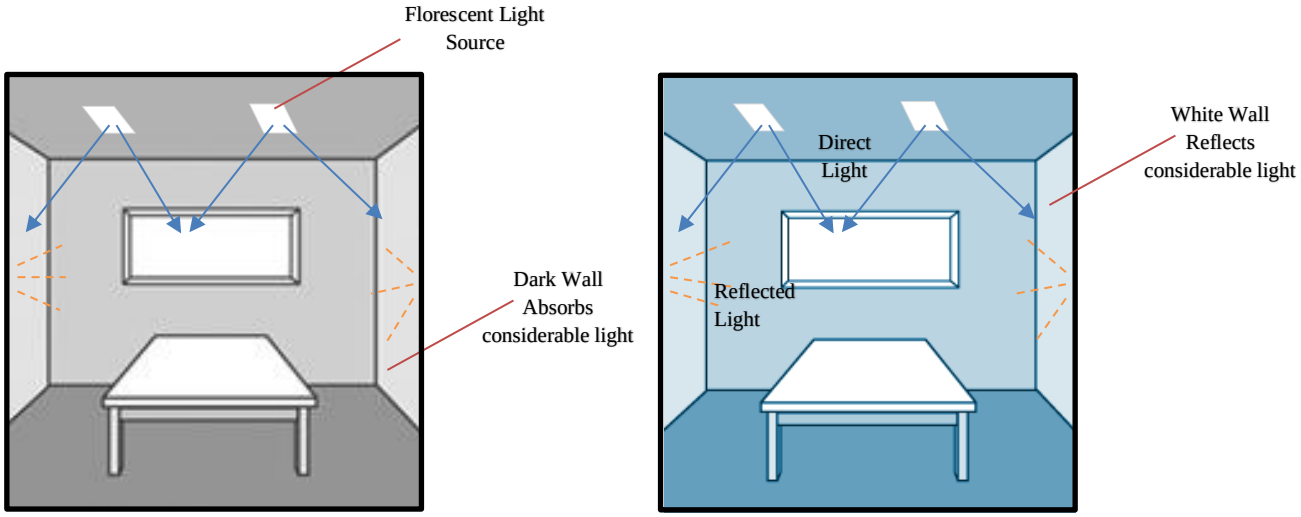

Figure 5: Low -reflectance room surfaces High-reflectance room surfaces

3.1.6 Color Temperature

Color is an incredibly important feature of our visual environment, it is still very difficult to describe what it is. At the most basic level, human respond to different wavelengths of light with the sensation of color.

Isaac Newton's discovery that white light (sunlight) contains all colors of the spectrum. For example; when the brain say a car is red, what it actually means is that under white light conditions the paint pigment on the car reflects mostly red light. This is important variance on how the brain usually describe color and objects.

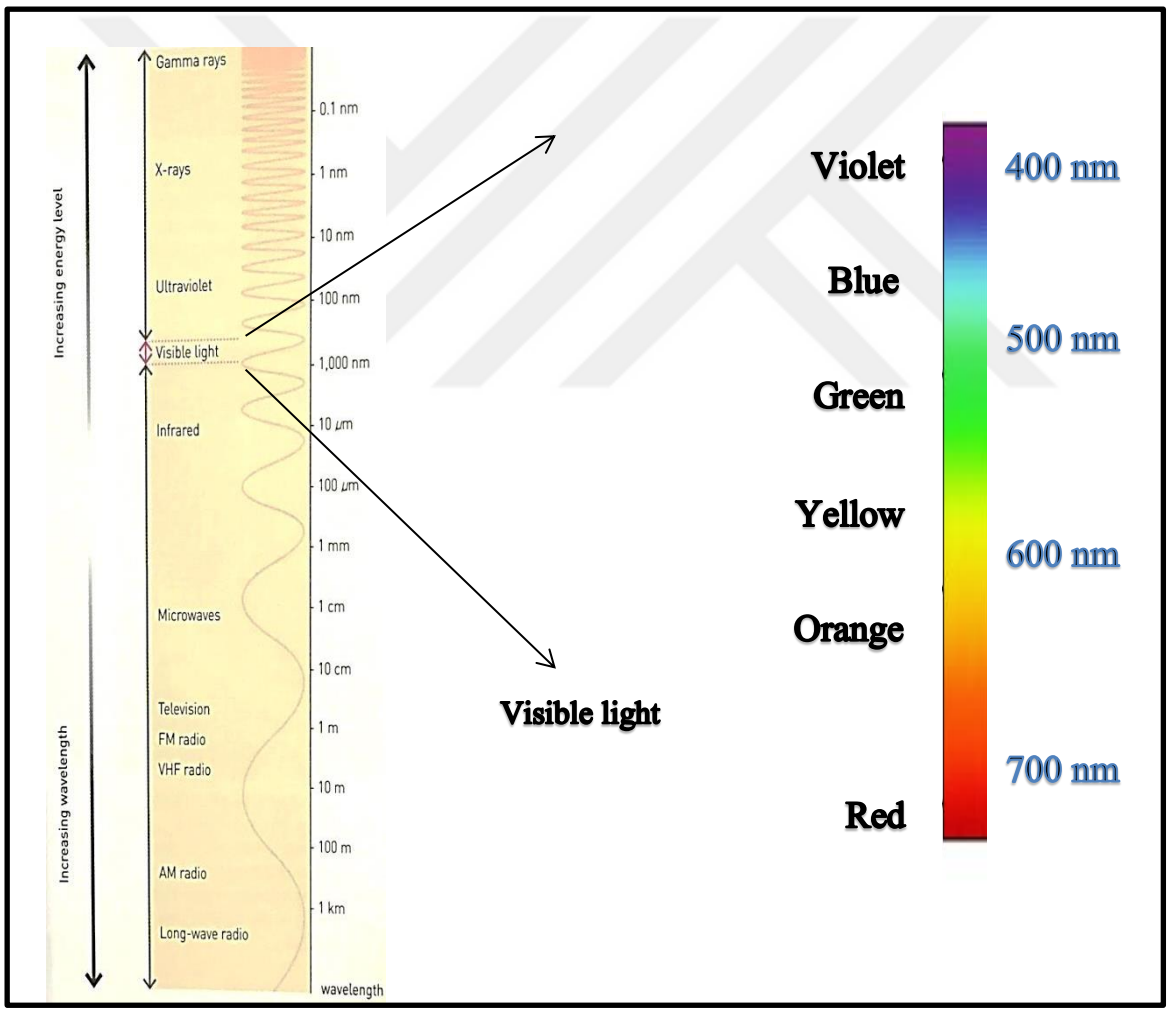

Table 3: The visible light spectrum

The whole of the electromagnetic spectrum is made up of different wavelenghts of radiation that have different proporties.

Color temperature of an electric light source express its warmth or cool not the spectral energy distribution or the physical temperature. Also it describes the actual temperature of a “black body radiator”. When an object is heated, some of its radiated energy becomes visible. Color temperature is measured in degrees Kelvin, and is designated by the capital letter” K”.

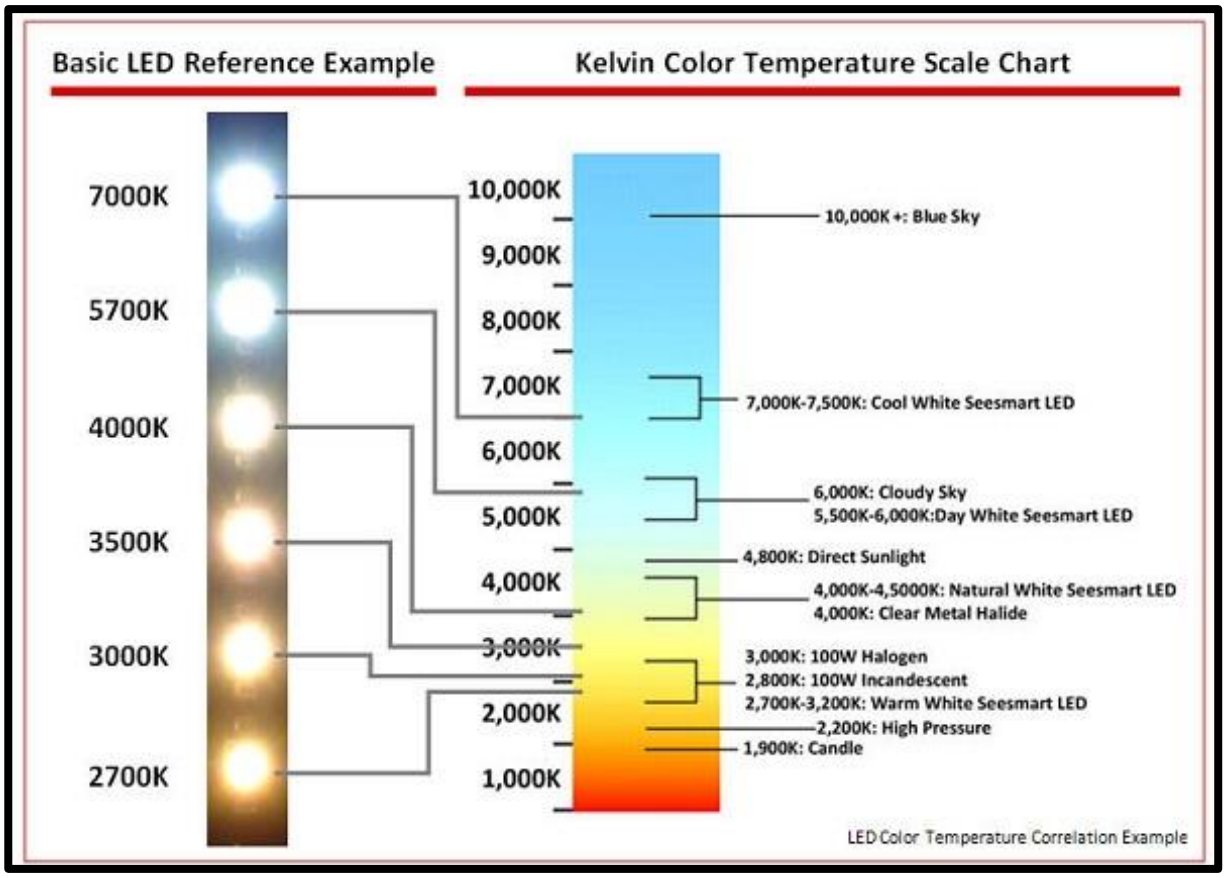

Figure 6: Color temperature chart *(Light & Rendering, Jeremy BIRN 2003)*

3.2 The Benefits of Light

The benefits of light are not limited to physical stimulus. Light is a sort of energy that influences our biological and hormone systems. This case is referred as invisible effects of light and related to light’s impact on health and use of it in medicine. The researches on the matter continue. According to the findings of the studies supported by International Lighting

Commission (CIE), light plays an active role in level of activity by influencing circadian system.

It is essential to know the light and its impacts, to apply the suggestions related to the issue in order to create more efficient living and working spaces.

3.3 Human Factors

Human factors in lighting is the study of the interaction of people and light. Human factors is important because it provides the basis for lighting practice. All application units are influenced by how people respond in terms of perfection, performance, behavior and health. Also people respond to light, how they adapt to intensity and changes in light levels and how vision works. Designer should be maximizing the visual performance and minimize the visual discomfort. So visual comfort is the most important subject for the designer in the lighting design projects.

Designed places and the life-giving lights in the environment allows people to feel relaxed and comfortable. Correct use of light has always been important for the selectivity of the people. Bad lighting tends to be produced by ignoring component guidance by an excessive concentration on one lighting criterion at the expense of others and by definition good lighting. Good lighting is produced by the thoughtful application of authoritative guidance by matching the lighting to the architecture and by sensitivity to time and place. When designing lighting, it is important to understand the physics, physiology and psychology of how humans sense light, process it and experience it *(Lighting for interior design, Malcom Innes, 2012).* Other parts explore how we respond to light and how vision works.

3.3.1 Sensing Light

The human body has many ways of understanding its environment. This happens with the stimulated by the environment. Humans are sensitive to the excitations, they perceive with their sensory organs and they always in case of stimulation by physical factors by environment. Therefore; a human begin recognizes the outside with their senses and their perception. The eye which is one of our sensory organs has a big role in the relationship between human and environment.

Sound and light are two kinds of stimulus that the body is designed to respond to. They are external and stimuli and are transmitted through the environment as waves. Waves can be described in terms of their wavelength or by their frequency. Frequency and wavelength are just different ways of describing the same information about waves. Light is a wave that can be described in terms of frequency *(Lighting for interior design, Malcom Innes, 2012).*

3.3.2 The Eye

The eye is the organ of vision. It is an incredible ınstrument and the basic effect it has on all our lives. The eyes off all living creatures are cut from the same form, but their forms are changeable forms of life. Some eyes are designed for seeing at night, some for use during the daytime and others for both.

The human eye contains around 120 million receptors, but they are not evenly distributed over the retina. The limiting factor in the resolution of an eye is the number of receptors available to capture the incoming light. Human eyes have around 200.000 receptors per square millimeter. Our visual system has evolved to deal with the visual complexity of an environment where it necessary to locate food and danger both horizontally and vertically *(Lighting for interior design, Malcom Innes, 2012).*

The human eye is an amazing confluence of features that collect the light energy that our sense of sight. It is an amazing optical device, but much of the magic of vision happens after light reaches the retina.

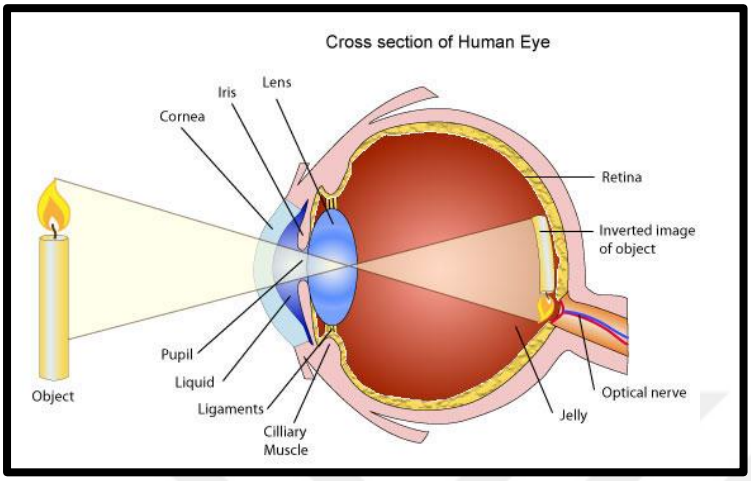

Figure 7: Cross section through a human eye

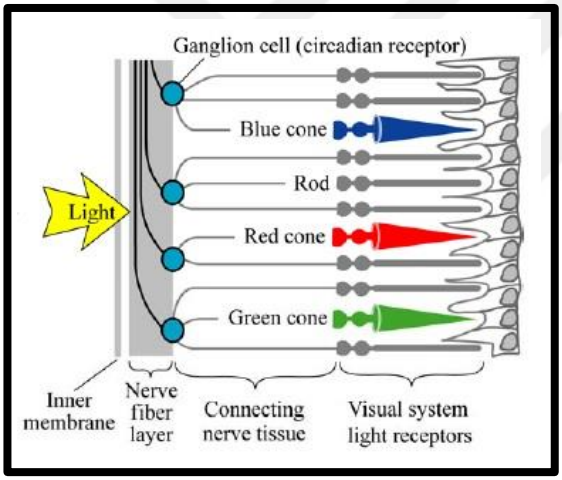

Figure 8: Schematic view of the retina including rod and cone light receptors *(from encyclopedia Britannica,1994)*

3.3.3 Adaption

It is the ability of the eye to adjust to various levels of darkness and light. If a receptor is stimulated for a prolonged time by the same stimulus it begins to decrease its rate of firing, and becomes desensitized to the continuous stimulus. This called adaptation. The process of adaptation also allows the visual system to become more sensitive.

In a dark space, we become adjusted to lower light levels over a period of time and the space seems to become brighter. During this process visual system becomes much more sensitive to light *(Lighting for interior design, Malcom Innes, 2012).*

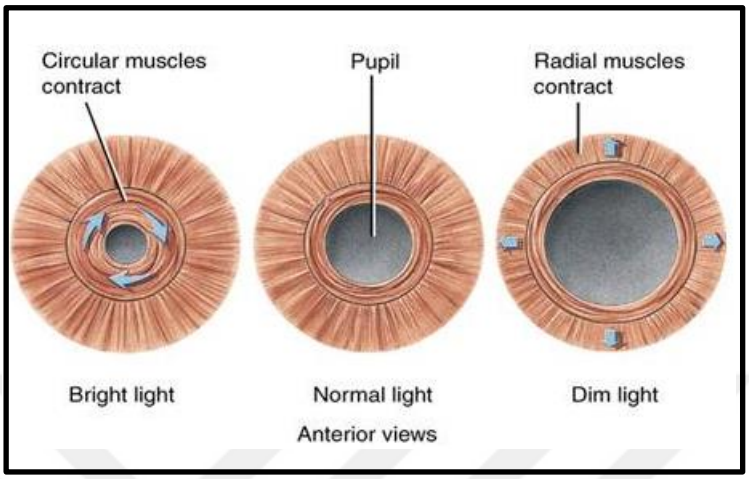

Figure 9: The inner eye muscles
(*http://paleostories.blogspot.com.tr/2014/02/piccolo-atlante-di-anatomia-di.html***)**

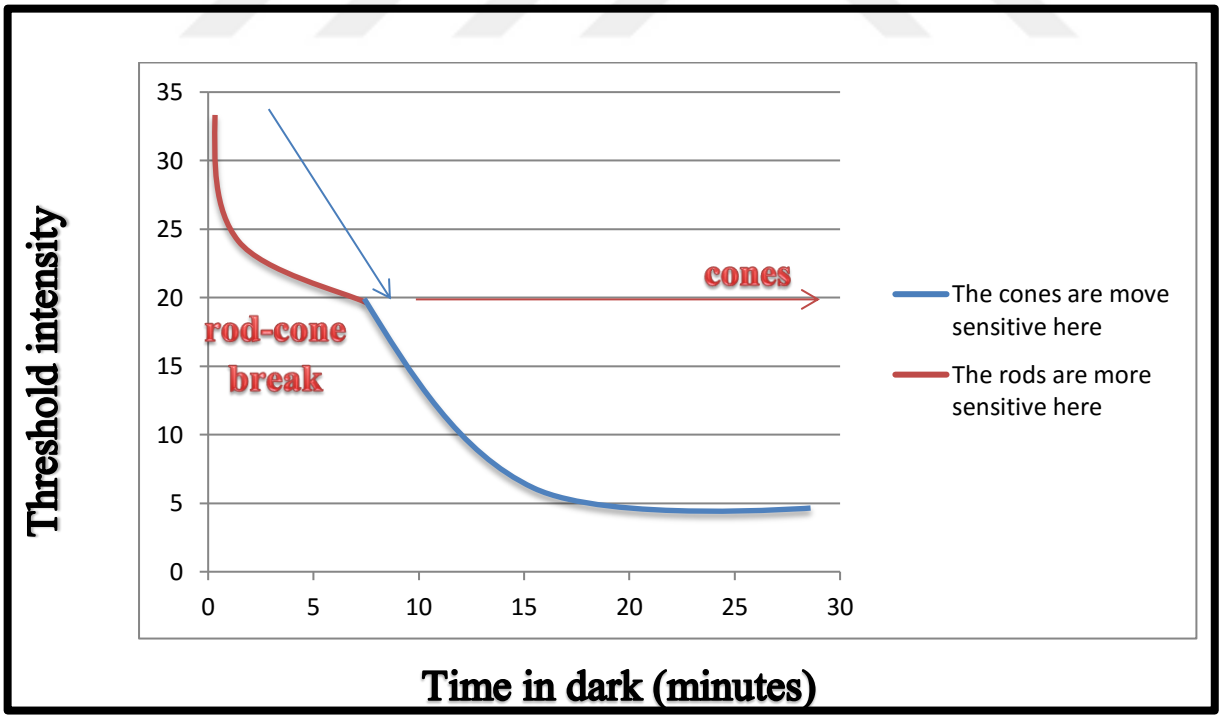

Table 4: Adaptation graphic of an eye

3.3.4 Eye Glare

Glare arises depending to the glitter of the surface in the visual environment and it happens as discomfort and disability. It should be restricted to prevent errors and accidents. Lamps or windows in volumes may create a glare discomfort, if necessary precautions are taken to prevent this failure it does not occur. Assessing glare can be made depending on the UGR (Unified Glare Rating) value.

3.3.5 Perception

Perception is the understanding of the data acquisition process which include stimulation of senses and mental processes. In other words, it is the process of obtaining information about the environment at the point where the mind and the truth meet *(Lang, 1974*).

Actually, ocular light stimuli from the retina results in signals being sent to the various glands, involving the whole of the physical, physiological and psychological aspects that together create the "process of perception" informing us about the characteristics of our surrounding environment *(Fonseca et al., 2002).* So perception affects behavior and later behavior affects perception. It is the process of making meaningful information with the interpret sensations.

Perception is being aware of the phenomenons in our perception through the senses and the recognition of environmental impression on the object. Also perception is:

- Processing the main materials of sensory.
- Conscious process.
- Sensory is physiological and simple bur perception is psychological and complex.
- Perception is subjective and relative.

A simple model of the human visual perception process is explained on Figure 14.

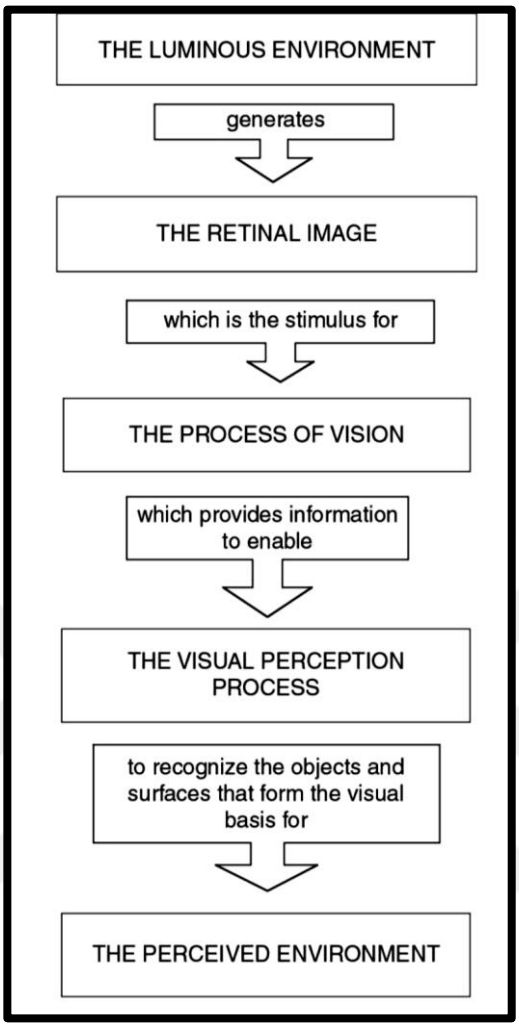

Table 5: A simple model of the human visual perception process
(Cuttle, C., 2003, p.18).

The basic features of perception are:

1) Organization
2) Constancy
3) Selectivity
4) Depth

Organization in perception

Perception represents something more than the total of sensations that make up itself. People are organized promoters as objects to brought them into meaningful wholes.

These wholes create perception to make sense. There are 4 types of organization in perception: similarity, closeness, continuity and completion.

In similarity, similar units gain perceptual integrity. As an example below similar rounds create some perceptual units.

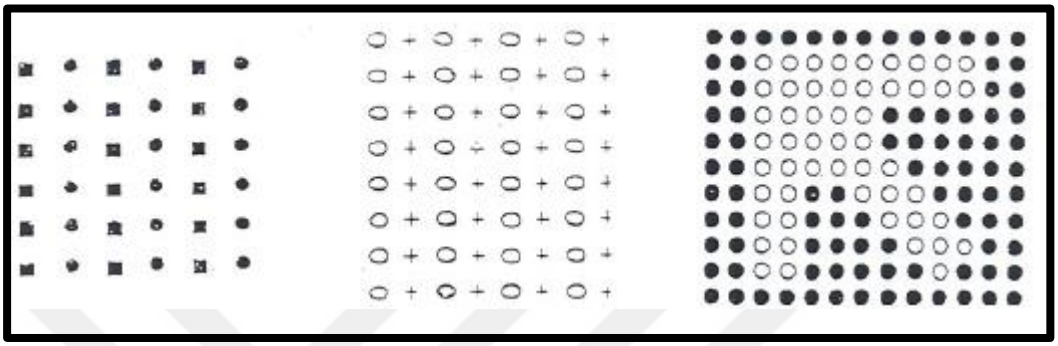

Figure 10: Describing similarity

They perceived by grouping objects that are close together and it called closeness in perception. For example, if we see some people close together in street we detected them like a group.

On the other hand, continuously perceptual stimuli create a whole that located in our field and units going in the same direction will appear interrelated. That was called continuity.

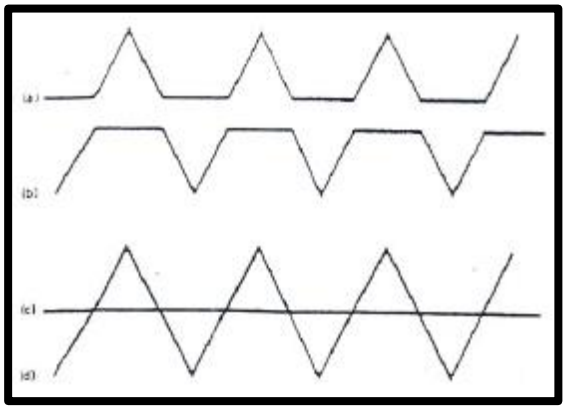

Figure 11: Describing continuity

In figure 16 two lines are separated from each other but when they imbricated with the effect of continuity rule a new perception revealed.

Finally, completion is based on old information and similarities, it perceived with a lack of stimulus to complete unity to become meaningful. For example; sometimes even heard the words of someone who is talking, it can be detected on the basis of completion rules.

Constancy in perception

Objects are previously recognized by various features, even though the view in different situations is called invariance of perception tend to perceive them with general characteristics selectivity in perception and it has 3 types; shape, size, color and brightness.

Selectivity in perception

By selecting one or more stimulus from environment and human body, it called selective perception with significantly detected.

Our brains, capacity are extremely limited to create a significant perception by processing incoming sensory data. Therefore, brain perceives constantly under the effect of certain changes. People pay attention to a few of the various events that took place at a given moment. The most important function in the perceptual choice is attention.

Depth in perception

The eye detects objects in three dimensions but falling image to the retina is a two-dimensional. As a result of environmental factors and the structure of the eye, the human brain detects three-dimensional. Depth perception is inherently feature of perception.

3.4 Relationship Between Human and Lighting

Providing a physical size of the event is seeing the light as well as a component that has a significant impact on human health. With the knowledge of the impact of light on health, feeling good, biorhythm on performance is not only physiological. It also has psychological aspects on designed a lighting system that meets the requirements.

4 PROCESS AND PRACTICE OF THE UNIVERSITY LIBRARY DESIGN

Libraries build an important part of academics' life in universities. Artificial lighting design plays a crucial role in libraries which are used not only during education hours but also after those hours. In this study library of Yaşar University and its artificial lighting is chosen as the research subject.

4.1 Existing Conditions in Yaşar Library

Yaşar University Library is the only open access library *(web news, visited on 10 May 2016,http://www.egitimajansi.com/haber/izmirin-tek-halka-acik-universite-kutuphanesi-yasarda-haberi14661h.html).* The university library aims to share, increase and pass down the information not just with its students but with all the users except the borders of university.

The Campus is located in Izmir/ Turkey. Izmir has a lot of university student population and one the most popular place is Bornova which has Yaşar University Campus. The campus has surroundings like metro station, bus station, taxi line and easy walking lines to the university dormitory. Because of this surroundings general of the students prefer this university.

It was a factory building before, but to start the education quickly owners change this factory building into a university campus, therefore they cannot change the structure they only make changes in interior and facade of the buildings. The design of the library describes a two make changes in interior and facade of the buildings. The design of the library

describes a two story building with a ground floor on 510 m^2 that greeting the users. This example was chosen because it refers to all university but it has not got enough light for users. This library started to develop that meets the needs of a modern library, including the technological advances of the information age. On the South and North side of the building, where the direct sunlight is strongest, the windows are approximately % 70 opaque glasses. There is no special material for protect books from sun's direct light. Plans of all floors are same. Due to the orientation and lack of daylight, all floors need artificial light.

4.1.1 Physical Description

The library is the revised version of the factory building. The building has two floors with an entrance which welcomes the users. When you analyze the building regarding the library design criteria, the differences can be seen between the plans of the building and existing conditions. The building becomes an inefficient place because of the deficiency in the plans and conditions.

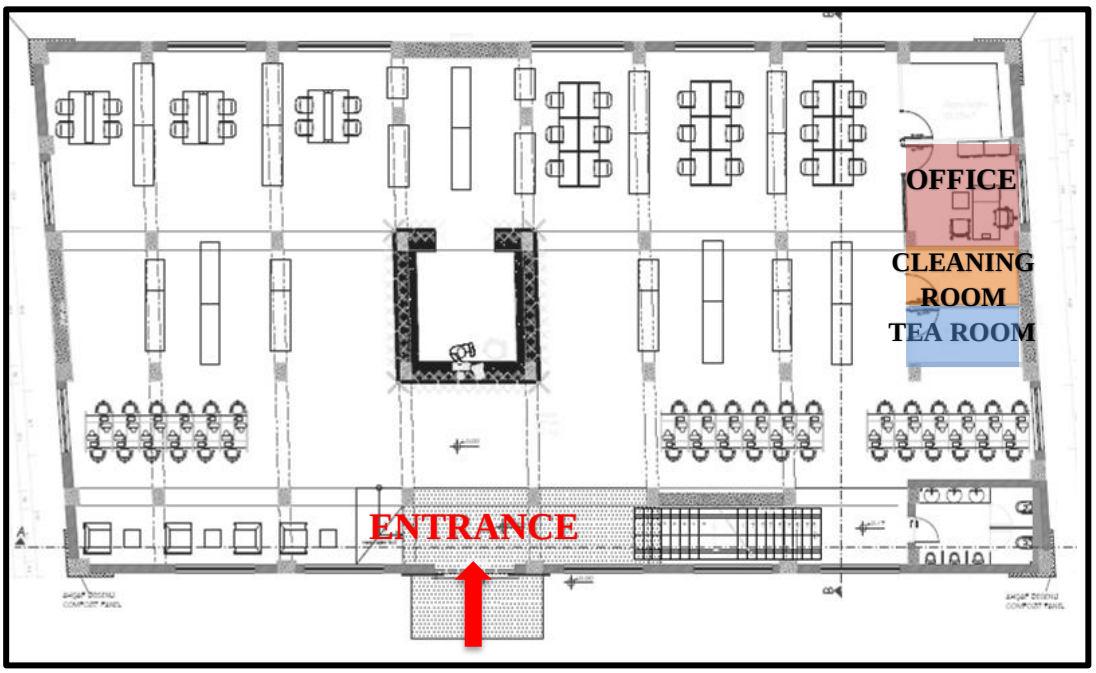

Figure 12: Ground Floor Plan

Figure 13: Existing Situation View from Ground Floor

When you view the application drawings, an office, a janitor room and a tea room are supposed to be in the first floor which are seen in Figure 12. But instead of these rooms, there are more bookshelves to increase the storage capacity. In figure 14, the second floor plan, on the right, there are rooms for management instead of workspace for students. On the left, they stick to the plan and keep the area as private workspaces with appointment system for student.

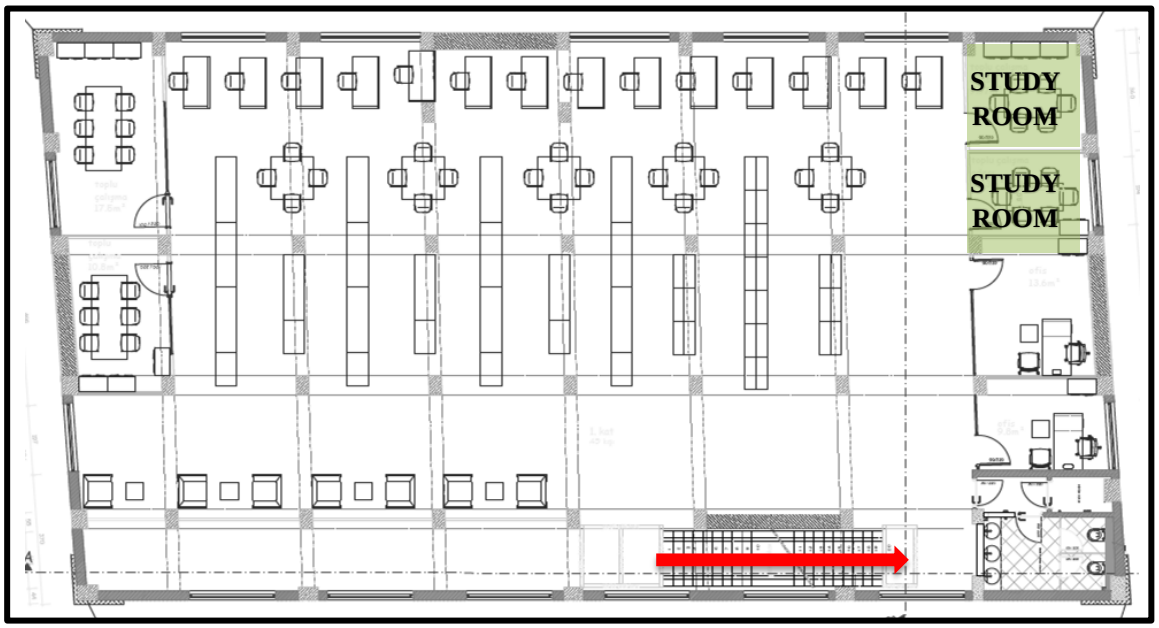

Figure 14: First Floor Plan

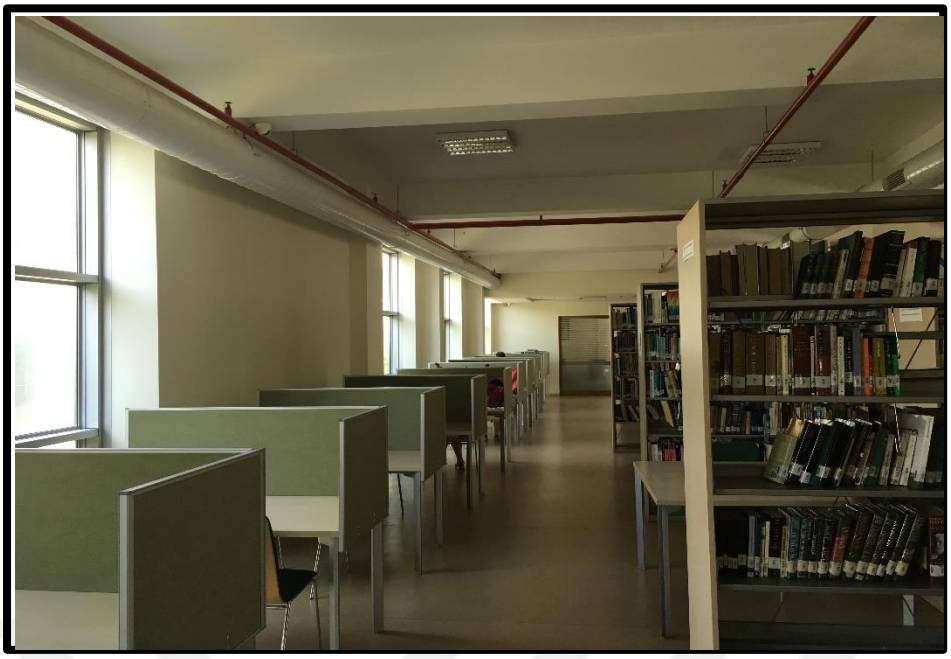

Figure 15: Existing Situation View from First Floor

In figure 16, there are differences between the plan and conditions. For example, the housing space is arranged with the bookshelves. In the plan, you need to see management, secretary and audio-visual room after housing space. But these rooms are not in use.

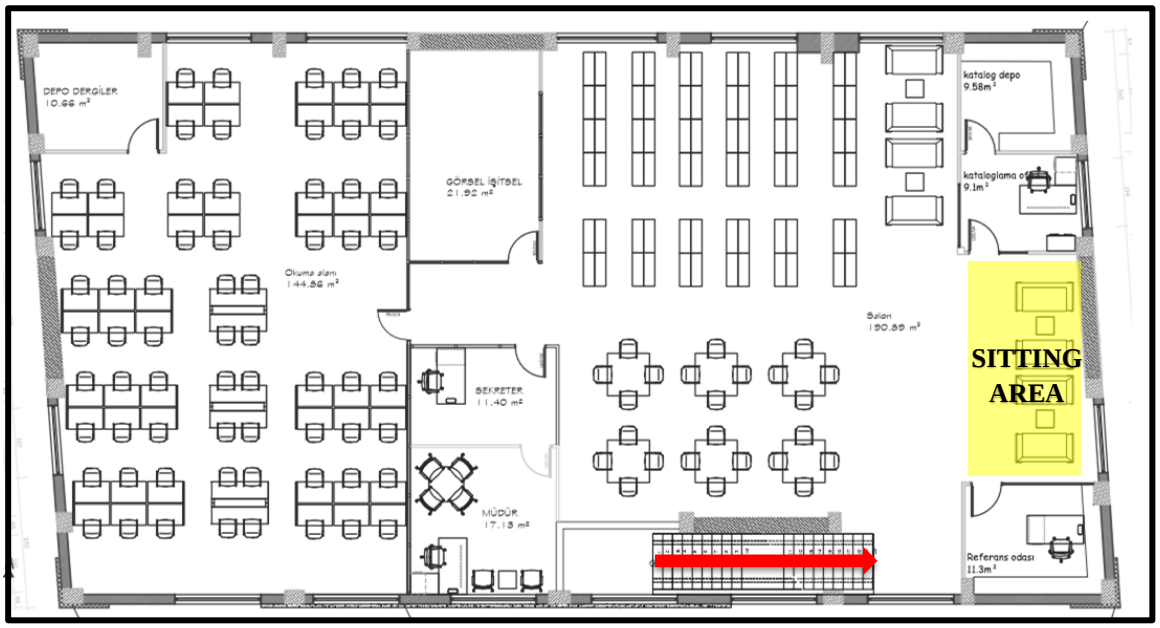

Figure 16: Second Floor Plan

Figure 17: Existing Situation View from Second Floor

4.1.2 Existing Lighting System

After reviewing the physical conditions of the library, the lighting system should also be revised. A convenient lighting system makes the library a productive workspace.

Yaşar University Library is a restoration project; therefore, it can not get the sunlight or have the appropriate lighting system. Parabolic 4x14 W recessed flourecent and 1x14 W linear fluorescent luminaires were used in lighting system. These luminaries were placed by not considering the reading space, private workspaces, bookshelves and wet floor places. And also the sunlight wasn't included into the places close to the windows.

4.1.3 Library User

The users are the students and the people who are there for research. The place should be appealed to the users, make them comfortable and provide the required conditions. Because the users are the essential elements of a place.

Some surveys were made to regulate the most efficient lighting system. The users filled the questionnaire to acquire some datas such as the glare in ELI evaluation criteria, architectural design, the disturbing reflection and feeling comfortable.

4.2 Defining Library as a space

'The library, the local gateway to knowledge, provides a basic condition for lifelong learning, independent decision-making and cultural development of the individual and social groups.' *(IFLA/UNESCO Public Library Manifesto, 1994)* UNESCO said. This chapter is a general statement on the role and purpose of the library.

Libraries are a worldwide fact and they occur in a diversity of societies, in differing cultures and at different stages of development. It provides access to knowledge, information and works of the imagination through a variety of resources and services and is equally available to all members of the community regardless of race, nationality, age, gender, religion, language and educational attainment. The basic purposes of the library are to provide resources and services in a variety of media to meet the needs of individuals and groups for education. Libraries have an important role in the development.

Harry Faulkner-Brown is an architect whose innovative ideas for libraries influenced their design throughout the world. He said that" Internal arrangements and user services vary from place to place, and from one type of library building to another, recent buildings of all sizes have several common factors which have been crystallized into the following desirable qualities." Otherwise it called by his colleagues as 10 commandments of Faulkner-Brown.

It is like this a library should be:

Flexible: with a layout, structure and services which are easy to adapt;
Compact: For ease of movement of readers, staff and books,

Accessible: from the exterior into the building and from the entrance to all parts of the building, with an easy comprehensible plan needing minimum supplementary directions,

Extendible: to permit future growth with minimum disruption,

Varied: in its provision of book accommodation and of reader services to give wide freedom of choice,

Organized: to impose appropriate confrontation between books and readers;

Comfortable: to promote efficiency of use; constant in environment: for the preservation of library materials;

Secure: to control user behavior and loss of books;

Economic: to be built and maintained with minimum resources both in finance and Staff, his "ten commandments" above are became an inspiration for the design of the libraries layout around the world. He took satisfaction in the fact that many major libraries adopted his principles.

According to these rules architects can say that library buildings play an important part in library provision. It should be designed to reflect the functions of the library service and librarians should ensure that library buildings are used and managed effectively to make the best use of the facilities for the benefit of the students. The most important design issue in libraries is lighting. In the work of the lighting design first library buildings come to mind as an examined.

There are several reasons. Libraries are day-long places so they need sufficient and properly distributed natural light. But artificial lighting should be used where it is not enough natural light, at the same time users also need to provide space for visual comfort.

4.3 Lighting Principles

Libraries existed long before electricity and therefore had to function without the use of the lighting systems like today. In those days most libraries depended on sunlight to provide adequate lighting. Flamed lighting was not an option in most libraries because it was too risky. Even a small accident could burn the entire library to the ground because almost all the materials in libraries were made of paper.

The gaslight did come into existence before the light bulb, but most libraries did not use this technology because of the risk of carbon dioxide poisoning and the risk of explosions.

The invention of electricity and the light bulb solved all the above problems and meant that libraries did not just have to be open during daylight hours. Not only did electric lights ensure that library lighting was safe, but it also enabled users of libraries to have a greater access to all kinds of information. While the light bulb does solve a lot of problems in terms of keeping libraries from being dark, there continues to be new developments in this area to illuminate libraries in better and better ways *(www.libraryarchitecture.com visited on 16.12.15 15:00).*

Installing the lighting fixtures is not only to bring the light to the space. The quality of light is very important in architecture and interior design projects as mentioned in the IALD's (International Association of Lighting Designers) sentence "Quality lighting is a powerful tool can greatly impact and enhance an architectural and interior design project."

The most important thing in the libraries is reading. Proper lighting is very important to the overall success of a library. Good lighting design in library buildings is the result of both technical skill and art on the part of the designer. IALD said that; in newer buildings where visual tasks are more diverse and technology poses new types of lighting requirements. Book stacks must be lit adequately so users can find books and also so staff can spend long hours shelving books without visual discomfort. There needs to be an even illumination across the book stacks rather than a pointed amount of lighting in any particular area. Especially, the lighting level should be at a 64.5 Lux minimum. There are a few different methods for illuminating the book stacks of a library. The parallel scheme, perpendicular scheme and the indirect scheme.

Parallel Scheme

This is where a single row of one-lamp linear fluorescent fixtures is centered above each aisle. These lighting fixtures can be recessed in the ceiling, suspended below the ceiling, or even attached to the stacks themselves.

Any of these options are viable; however, it does depend on how high the ceilings are, what the ceilings are made of, and the makeup of the ceiling grid. The important thing is that the lighting fixtures will evenly distribute light amongst the book stacks.

Figure 18: Example for parallel scheme from www.slideshare.com

San Francisco main library

Perpendicular Scheme

This is where rows of two-lamp linear fluorescent lighting fixtures run at right angles to the book stacks. The lights do not need to be centered between the aisles, so it is easy to imbed this scheme into the ceiling grid that is already there in the library.

Perpendicular lighting schemes work very well with compact shelving. It also uses less lighting fixture than the other schemes, so it is probably the most cost efficient to install.

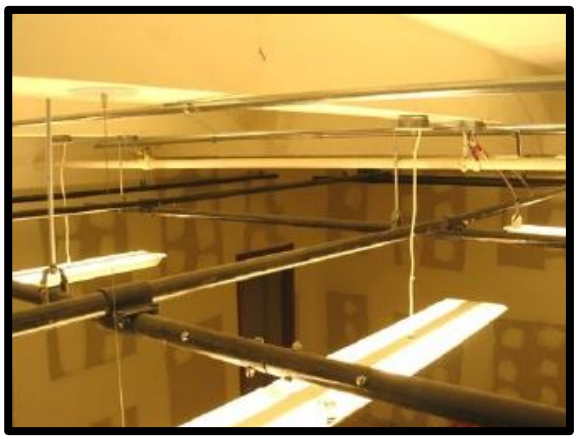

Figure 19: Example for perpendicular scheme *(www.slideshare.com)*

Indirect Scheme

This is where lights are either place on the bookshelves or directly above the bookshelves. Users receive light in the stacks by means of light reflected off the ceiling. This scheme illuminates the stacks with very soft light, but also uses a lot of energy.

Figure 20: Example for indirect scheme (*www.isgforum.biz/calismayeriniaydinlatma*)

Indirect Lighting

Indirect lighting is a technic with using indirect luminaires (fluorescents or metal halide lamps) to up light a light color ceiling. The resulting reflected light is naturally very

soft, shadow-free and low-glare. Indirect lighting works well for both paper-based and computer tasks in rooms where the ceiling height is at least 2 meter and preferably more than 3 meter.

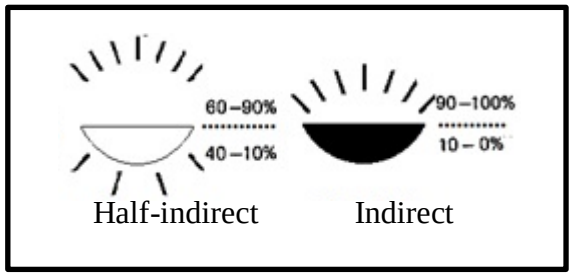

Figure 21: Showing the Half-indirect and Indirect Lighting

Direct Lighting

Direct lighting is when a light source is coming specifically one side and it uses down lights to illuminate the reading tables. Compact fluorescent or metal halide lamps and parabolic cones, or they can be linear or rectangular fluorescent fixtures with parabolic louvers.

The parabolic shape of the cones and louvers prevents seeing the lamps at shallow viewing angles and re-directs the light so it is less likely to be reflected in computer screens. The parabolic cones or louvers should be made of aluminum not plastic and they should have a semi-specular finish to reduce the visibility of dirt or fingerprints.

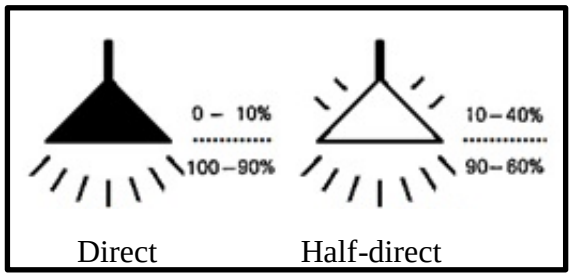

Figure 22: Showing the Half-indirect and Indirect Lighting

4.3.1 Visual hierarchy

In Lighting by Design book, Christopher Cuttle gives an example about one of his experiences about visual hierarchy;

"Howard Brandston was a colleague of mine for some years at the lighting research center, and on several occasion I witnessed him sitting through a student presentation of a lighting design proposal where the student would give a detailed explanation of lamps, luminaires and controls. After a pause, Howard would ask, 'What is that you wish me to see?' his aim was to stimulate the student to make a critical examination of the design issues. It implies that, in any situation, the lighting designer has options to cause some things to be noticed more than others. In order to direct people's attention purposefully, the designer establishes the concept of a visual hierarchy that is responsive to the overall design intent. For this to happen, the designer must be able to visualize the situation. The design concept has to develop as a clear and detailed image in the designer's mind. It should become a three-dimensional entity in which the designer is able to undergo the visual experience of the space, and above all, to see the lighting clearly."

As in the quotation, a hierarchy of things to be seen is determined and selection is made of object characteristics to be revealed. It is this selection that determines the characteristics of the lighting to be provided. Visual hierarchies are quite appropriate to signify varying degrees of importance among various areas, surfaces and objects. Using light to help identify the visual hierarchy intended by the owner and other team members is crucial to the effectiveness of these hierarchies. Figure 22 illustrates one such application of visual hierarchy with light to help direct users' attention into and around a space.

Focal centers are specific objects or elements that are a special feature of the environmental setting. Enhancing these focal centers with light is almost always a must and this can contribute to several design goals already discussed, spatial order, visual hierarchy and circulation *(Architectural Lighting Design, Second Edition, Gary Steffy, LC, IES, FIALD, 2001)*.

Figure 23: Focusing on reception (*www.uygunhotel.com, visited on 03.05.16, 16:00pm)*

However, the focal center is developed specifically for visual interest, visual identity and eye muscles relaxation. As a design goal those focal centers that are important and necessary to add interest or identity to an area should be identified. Chromatic contrast can also be used to advantage in establishing visual attraction and visual hierarchy. Surface color and colored light offer great, largely untapped resources for visual attraction.

Though, the mixture of colored light onto colored surfaces can result in disaster if not carefully understood and planned. Alternatively, when carefully studied some visually powerful effects results with colored light on colored surfaces. This is achieved through tests and mock ups. So the lighting designer has options to emphasis some things to be noticed more than others. In order to people's attention purposefully, the designer establishes the concept of a visual hierarchy that is responsive to the overall design plan and must be able to visualize the situation *(Architectural Lighting Design, Second Edition, Gary Steffy, LC, IES, FIALD, 2001)*.

First, the design concept has to develop as a clear and detailed image in the mind. It should become three dimensional entities to see the lighting clearly before its done.

4.3.2 Surfaces and textures

Light is about surface. Without a surface to capture and reflect the light, human begins will see nothing. Visualizing yourself in a space and "seeing" which surfaces are most important and prominent will help you to decide where the lighting should be positioned.

Surface itself is about texture. Materials can be smooth, rough, patterned, reflective or matt. The combination of textural qualities should guide the designer's choice of light source and locations to ensure that the designer can enhance or conceal the texture or so that the designer can avoid glare from reflective surfaces but still create enough sparkle to prevent them becoming dull and lifeless *(Lighting for Interior Design, Malcom Innes, London, 2012)*.

Figure 24: Patterns have been revealed by sunlight

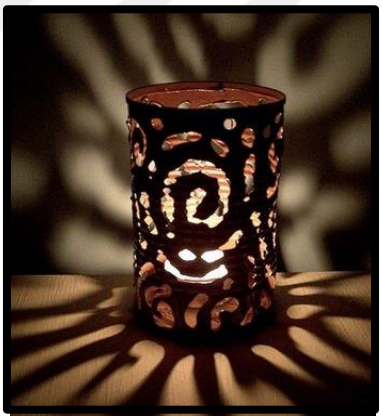

Figure 25: Pattern can be introduced with light

Figure 26: Without light, the three-dimensional quality could be lost

According to these infomations below Eladio Dieste's dictum comes to mind; "For architecture to be truly constructed, the materials should not be used without a deep respect for their essence and consequently their possibilities". That means that surfaces and textures were the clothes of the design, without wearing and showing them nothing has an identity.

4.4 Lighting Effects on Human Performance

Working performance can be defined as the extent to meet the requirements of the students work duties. Researchers use productivity (efficiency - the amount and volume of an employee made during a certain time job) as criteria for different types of studies like problem-solving, team performance, operation, such as relationships and communication style with each other. *(Konstantinou E., Silver J., Lighting, Well-being and Performance at Work, Philips Lighting and City University)*

The first phase of the main factors that affecting efficiency in the working area is to feel good, motivation and satisfaction of job. The second phase of the factors is the organizational structure, internal environment conditions, external environment conditions and systemic factors such as working facilities and services were located. During the operation of the internal environment affecting the performance of human defining the humidity, ventilation, crowded and lighting is included. There are three ways of lighting conditions can affect personal performance.

There are three ways of lighting conditions can affect personal performance. These are the possible effects on the perceptual system, visual system and circadian rhythm. The ability of the visual system is determined by the lighting conditions. The state of the circadian system is primarily affected by the light-dark cycle.

One of the many factors that affect the messages that transmitted to the perceptual system is lighting. *(Boyce P., Howlett O., Hunter C., 2003. The Biological Potency of Light in Humans: Significance to Health and Behavior, 25th Session of CIE Proceedings, San Diego)*

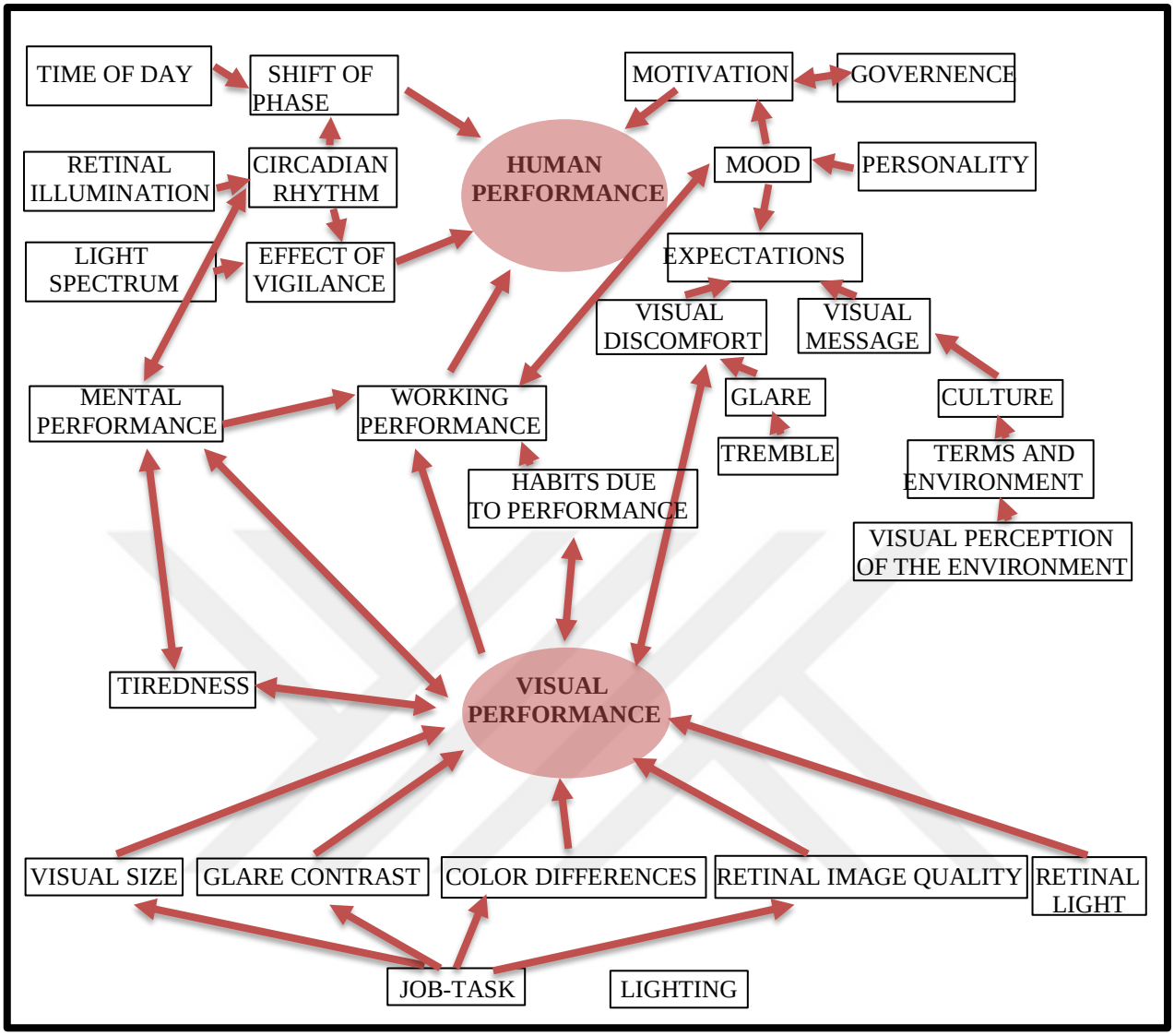

Table 6: The scheme, showing the effects of lighting conditions on human health and perception. *(Boyce P., Howlett O., Hunter C., 2003. The Biological Potency of Light in Humans: Significance to Health and Behavior, 25th Session of CIE Proceedings, San Diego)*

The quality of light is a factor that directly affects the performance of a human being in the activities. Especially in the performance expected environments like libraries, manufacturing plants, offices, etc., the right light, color of light, the angle of the coming light and the intensity of light are very important issues to be taken as a reference while designing. Psychologically relaxing lighting design in the environments where human passed long periods of time will directly affect the performance and perception.

There is a close relationship between productivity and enough illumination of the working environment. Researches has shown that with the risen of the lighting level production increases 8-27% in parallel. The bad lighting is creating a troubled working environment, weakened the eye nerves and can cause to the temporary blindness *(Sabuncuoğlu Z. ve Tüz M., 1996, Örgütsel Pskoloji; 2. Baskı, Ezgi Kitabevi.)*.

4.4.1 The Relationship Between the Biological System and The Internal Clock

Depending on changes in working conditions and hours, biorhythm of a human adversely effected, this negativity brings sleep disorders, stomach and digestive problems, blurred memory, fatigue and adaptation problems.

Finsen, has researched the impact of the light levels on the amount of hemoglobin in human blood and this researcher has determined that in the dark winter months the amount of hemoglobin in the blood is lower than the bright summer months. Also Radnot, had declared in the notification was given to the CIE in 1963, the concentration of eosinophil leukocytes which is a special kind of white blood corpuscles that changes according to the light level. Decreased density of leukocytes is an indication of the recovery of residues of human body function and efficiency. This is also an evidence been achieved optimum conditions for human to be efficient in day-light conditions at outside.

For more than twenty years, by the science of the effects of good lighting, positive effects on human health and the feeling of well-being is shown. Light is one of the cues that our biological system uses to set our internal clock.

A well-known example is the treatment of seasonal affective disorder. This condition can occur in some individuals as the days shorten in the fall and winter causing depression *(Leonardo Energy, Lighting&Human Life Dr. Anne Rialhe, AERE, Pascal Lenormand, Incub',*

Appliance&Lighting Article, July 2007). In the morning cortisol levels increase, it prepares the body and mind for the activities of the day. Also melatonin level drops and it reduced sleepiness. For good health this rhythm should not be interrupted. Bright light in the morning will help in case of disruption of this rhythm to return to a normal rhythm.

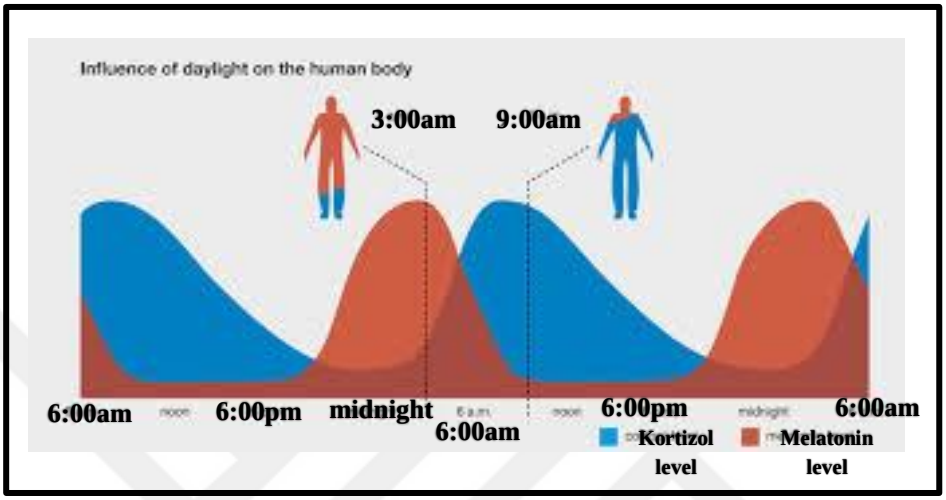

Table 7: Changes in cortisol and melatonin levels of daylight and its effect on the human body

As a result, a better performance of light causes a faster performance of business and decreases in the failure rates, safety, decrease in accident rates, feeling good and positive contributions to health.

4.4.2 Ergonomic Lighting Concept and ELI Calculator Tool

Ergonomic is the discipline that identifies the environment and human and makes the work appropriate for employees. It investigates for the human organism features and capabilities of the business people to provide the necessary conditions for the work of human harmony. To make people determine their ability and provide an effective way to avoid the impaired due to the use of excessive force while working people prove business through this adjustment. *(<http://www.ergonomi.itu.edu.tr/ergonomi.html>, visited on 11.04.2016)*

Ergonomic Lighting Indicator ELI is a software program which is measure the quality of lighting has been developed by Zumtobel Lighting and Professor Christopher Schierz (Swiss federal Institute of Technology Zurich) with an assessment program. It provides offices, educational buildings, factories, hotels, restaurants, hospitals and other services to analyses and to debate their lighting design in ergonomic way. This software program can be downloaded from the website of Zumtobel Lighting's http://www.zumtobel.com/com-en/service.html#software page with simple installation instructions.

Ergonomic Lighting Indicator provides to debate by using the five of the main lighting quality criterias in terms of quantity. The checklist used to record personal criteria and these criteria are also shown in the Kiviat chart (spider webs graphics). As shown in the figure 27 the line on the outside of the graphic indicates the point which the criteria are in the best way. *(Zumtobel Lighting handbook, 4th edition, revised and updated: October 2013)*

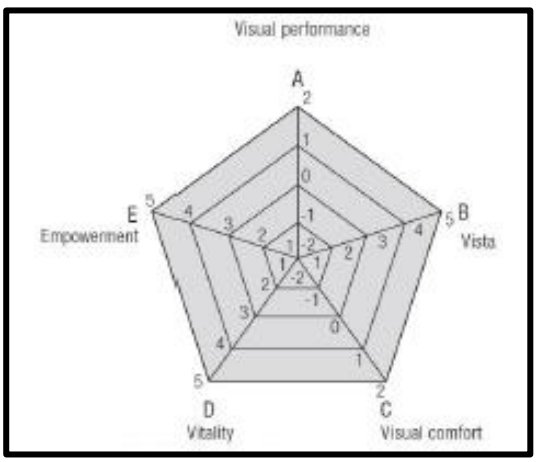

Figure 27: ELI consideration graphic with using Spider web graphic technic

Ergonomic lighting indicator criteria

The criteria of ELI are under five main headings. These are;

- Visual performance
- Vista
- Visual comfort
- Vitality
- Empowerment

The visual performance; lighting in conformity with relevant standards is decisive for ensuring that a visual task can be identified and the related activities can be carried out. Consideration of the traditional quality characteristics of lighting has a major impact on visual task performance. For example;

- Lighting level
- Uniformity of illuminance
- Color rendering
- Avoiding hard shadows
- Contrast rendition
- Physiological glare *(Zumtobel Lighting handbook, 4th edition, revised and updated: October 2013)* are the standards of visual performance.

Second part vista is in prestigious buildings, for example, light is not only needed for seeing but also enhances the looks of the interior. Light can provide guidance and make people accept the interior on account of the first visual impression they get. These are,

- Architectural design
- Mental design

- Guidance
- Hierarchy of perception
- External appearance
- Material
- Luminaires protection type
- Protection against harmful radiation *(Zumtobel Lighting handbook, 4th edition, revised and updated: October 2013)*

The third main heading is visual comfort; light is not only needed in the visual task area but also for perception in the room. Rooms should be illuminated with uniform brightness and lighting balance.

- Balanced brightness distribution
- Varying luminance levels
- Plasticity/ modelling
- Discomfort glare
- Uniform illuminance in area around visual task
- Sense of security
- Artificial lighting complement by daylight
- Use of flicker-free ballast *(Zumtobel Lighting handbook, 4th edition, revised and updated: October 2013)*

And the fourth is vitality; light significantly influences people's activity and sense of wellbeing. Moreover, it has a positive impact on their health and may even enhance or influence biological process like,

- Sense of well-being
- Activation and simulation

- Circadian rhythm
- Lighting similar to daylight
- Avoiding danger spots
- Avoiding thermal radiation
- Electromagnetic field *(Zumtobel Lighting handbook, 4th edition, revised and updated: October 2013)*

The last heading of ELI is empowerment; varying visual requirements, visual tasks or periods of use call for options to individually influence one's lighting situation. Sensors and control systems help users adjust the lighting situation to their personal needs like,

- Individual influence by switching and dimming
- Choice of lighting scene
- Presence detection
- Daylight-based control
- Choice of lighting scenarios
- Flexibility for layout changes
- Privacy *(Zumtobel Lighting handbook, 4th edition, revised and updated: October 2013)*

4.4.2.1 The Usage of ELI Calculator Tool

The software program Ergonomic Lighting Indicator ELI and Energy Numeric Indicator LENI are developed by Zumtobel Lighting and these are calculating and evaluating the results that obtained. Through the program, the remaining missing during the design or overmuch focused design criterias can be specified by comparing the values of standard requirements for ergonomic lighting and the values of the design results. So before the

practice, while in design stage the physical and psychological needs of the users will be designed in terms of quality with the changes and improvements of conditions.

In addition, calculating is possible with the software program Lighting Energy Numeric Indicator. LENI gives information about lighting energy consumption of the meter per square including battery of emergency lighting and stand-by mode of the control systems. In this calculation method, the effect of the existing daylight on lighting energy consumption is specified by identifying the external obstacle, facade, volume and window characteristics of the volumes daylight saving region. In the calculation method, improved for Turkey, this situation is taken in account and; minimum light levels (Em) depending on the function defined standards and the desired color rendering (Ra) values are intended to provide *(EN 12464-1: Light and lighting – Lighting of work places – Part 1: Indoor work places, 2002, European Committee for Standardization).*

ELI considers the 33 different criteria that grouped under five main headings which are visual performance, vista, visual comfort, vitality and empowerment. Selecting one of five different options that provide a benchmark to what extent a result of the response to each criterion can be seen in the chart with spider web graphic. This five different options are graded from 1 to 5, 1 show that the criteria were not provided at all and 5 indicates that the criteria were provided with best degree. Apart from these options, technical data is required. For example, illuminance level less than 250 lux and more than 875 lux or using the lamp which has color rendering less than 60’ more than 95’ must be selected.

The screen will appear when the program starts as in the Figure 28 is composed of three parts. On the left side of the screen when user select the Project 1, project name, date, customer information and design informations about the person to fill forms will take place.

In Figure 29 the type of structure will be selected according to the design selection on screen. When Room 1 is selected different type of work space structure is selected and work space size information can be added. For example, structure type is selected as office after choose Room1 and click the tab “Room/Space Classification” choose more than six people in 30 square meters of open plan offices, single cellular offices, technical section and rest areas (Figure 29).

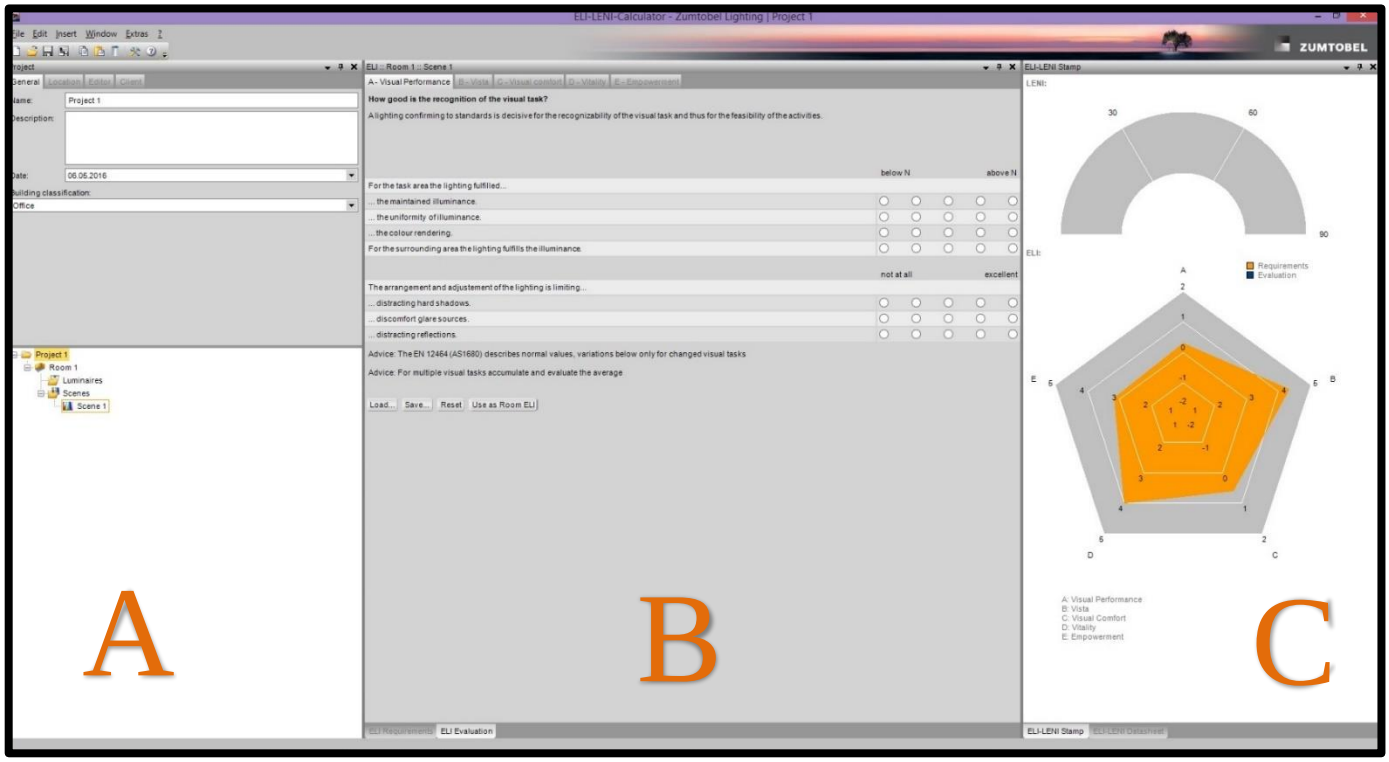

Figure 28: The Screen from ELI Calculator Tool

With the selected areas user requirements for space will changed and according to this on the spider web graphic minimum requirements representing the orange shaded area will change like in the Figure 30. While starting to the lighting design of the structure for physical and psychological needs of people the designer needs to assessed the space independently.

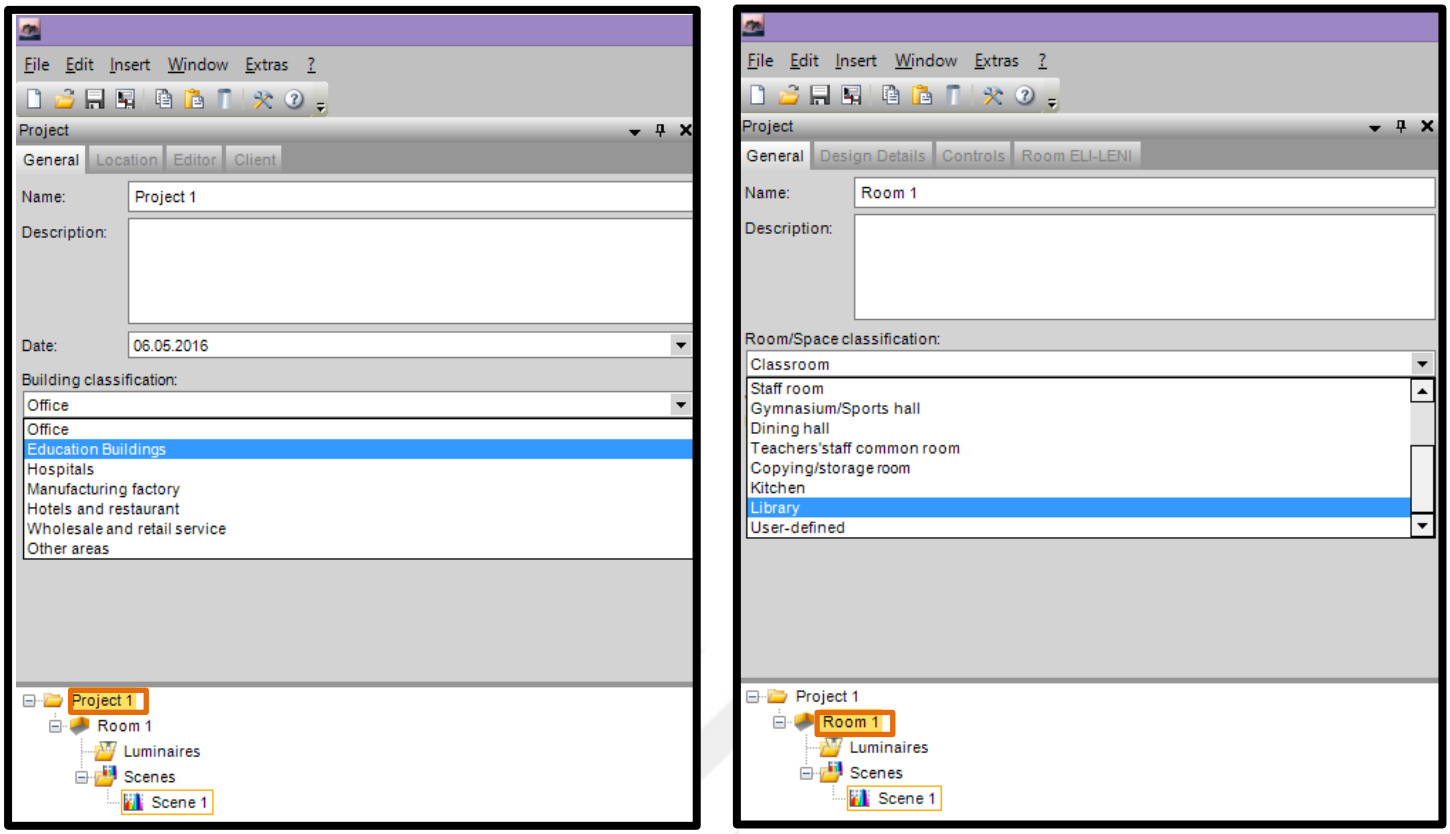

Figure 29: The project information part and structure type selection menu

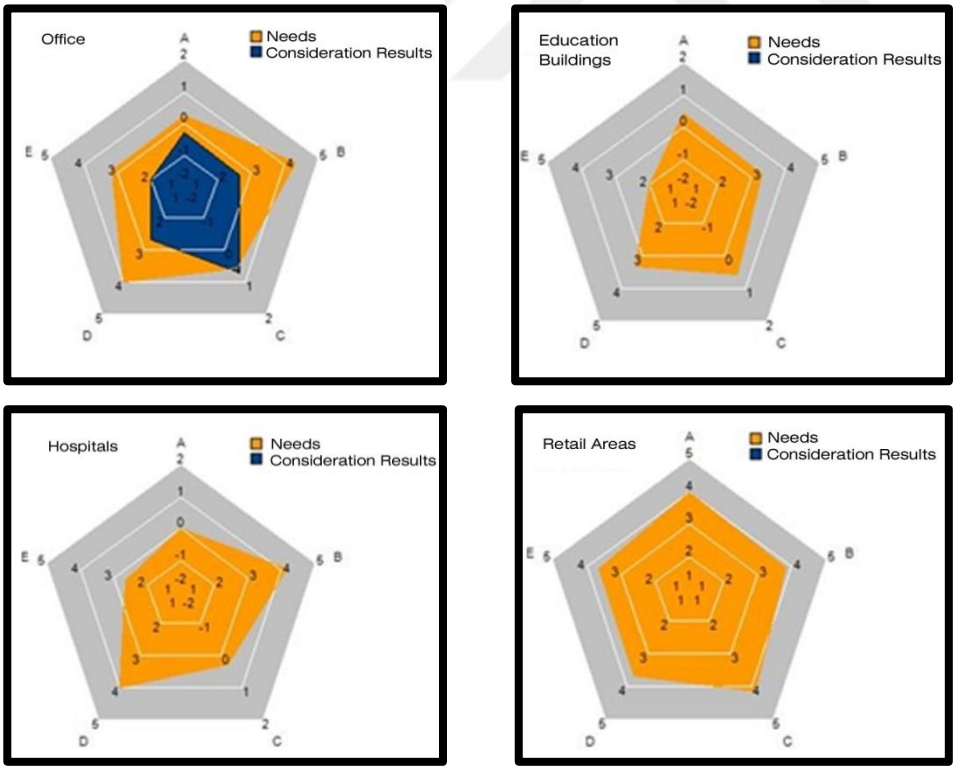

Figure 30: The ELI spider web graphic, which shows the needs of different spaces

In Figure 31, part B described under five main headings (visual performance, appearance, visual comfort, vitality and life force-authorization) which is located on the criteria section (Figure 31). This section has been described and divided as ELI requirements (In figure 28 it has been described with A) and ELI evolution (In figure 28 it has been described with B). When choosing the building type in ELI requirements section in figure 30 the graphic will be orange according to the standards that chosen, the evaluation results will appear as the blue area on the orange area based on responses to the criteria of the evolution (In figure 28/ part C).

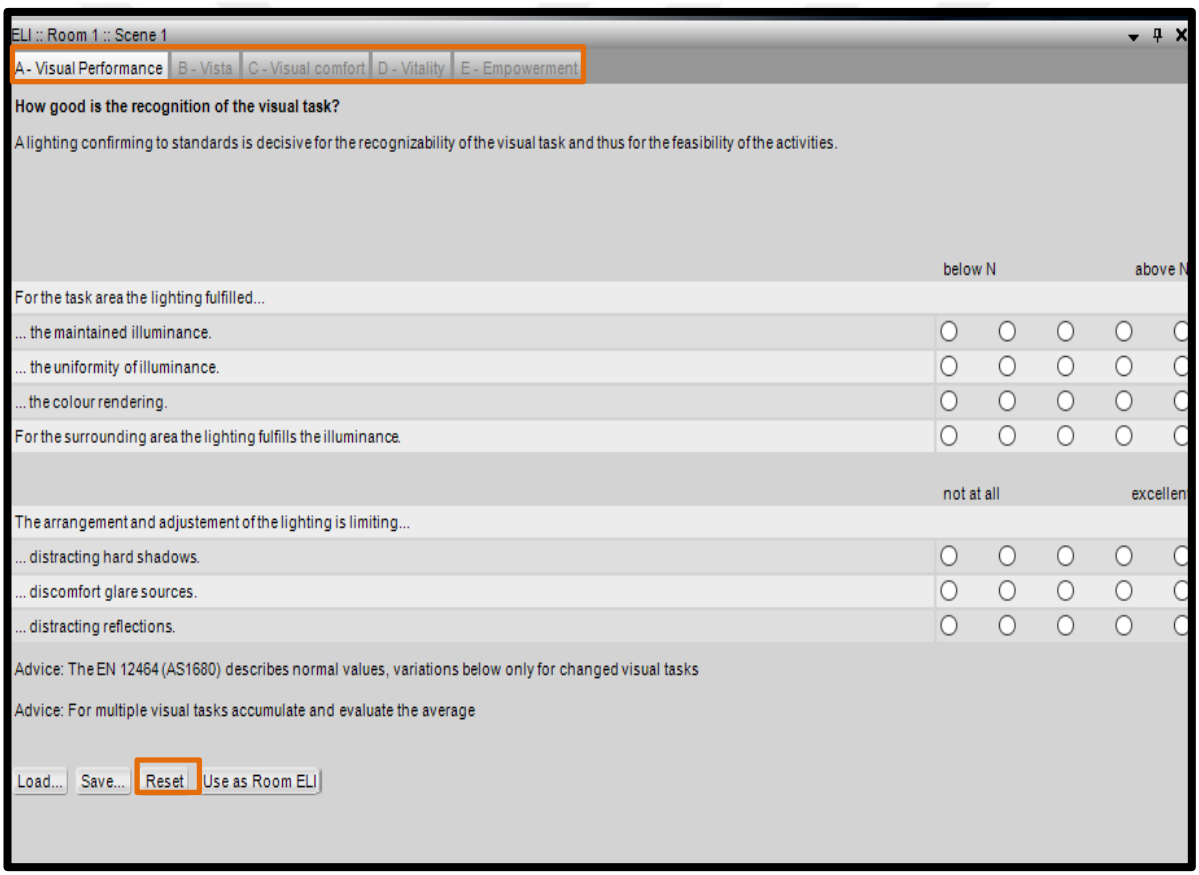

Figure 31: The screen of ELI criteria

Figure 32 shows the cobweb graphic of orange colored requirements and blue colored evaluation results. If needed, requirements section can be reset (with “reset” button shown in figure 31) and new requirements can be determined fitting for the project.

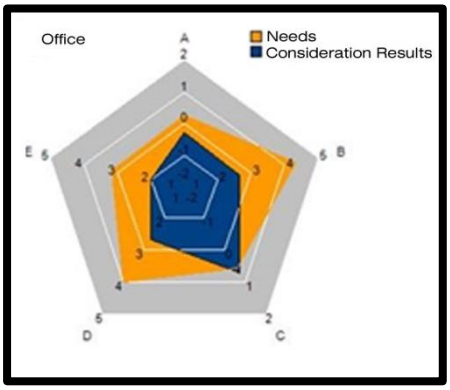

Figure 32: Cobweb indication of ELI requirements and evaluation

Although criteria are summarized in a few words, an information box with detailed information about the requirements will pop up as shown in figure 33.

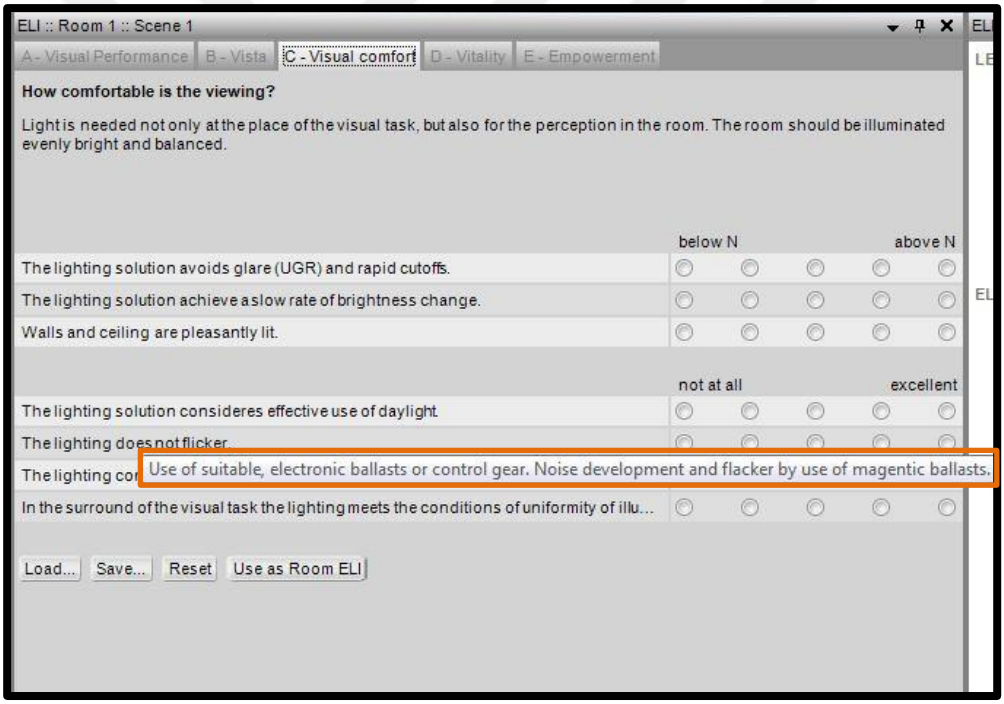

Figure 33: Information box that will pop up when mouse cursor moved among criteria

There are 5 options for the criteria one of which information box will pop up when mouse is moved over selection box (shown in figure 33).

When all the selections are made, in the third section (shown in figure 32) the evaluation scores and cobweb graphic of the results will be shown.

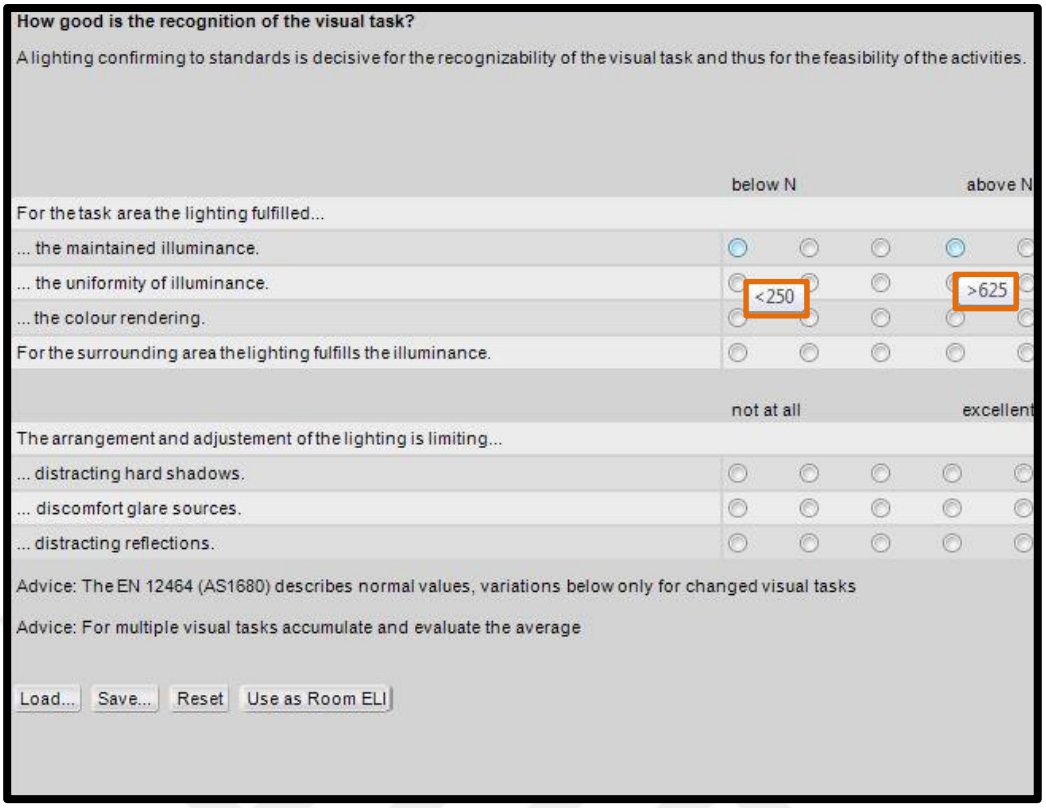

Figure 34: Pop-up information box that will be seen when mouse is moved over options of ELI criteria

4.4.2.2 The usage of ELI calculator software for library lighting

ELI is a calculating software that provides the ability to examine and evaluate the lighting design ergonomically for offices, buildings for educational purposes, factories and manufacture plants, hotels, restaurants, hospitals, wholesale and retail shops and many other interior spaces. In this section of the study library is selected among various buildings are selected to be examined by means of lighting design.

When the software is run, the screen in Figure 28 will be seen. First the project information form, can be seen in Figure 29, is filled choosing office as the sort of space.

In the second part in Figure 28, ELI requirements will be filled automatically as standards. However, new requirement conditions can be determined after cleaning the standard profile. In this paper, evaluation conclusions will be made using the standard profile.

Evaluation of Visual Performance Section

Lighting meeting the standards is determinative at recognizing the visual tasks and the feasibleness of the activities. Visual Performance section includes evaluation of the design with regards to 7 criteria, as seen in figure 36.

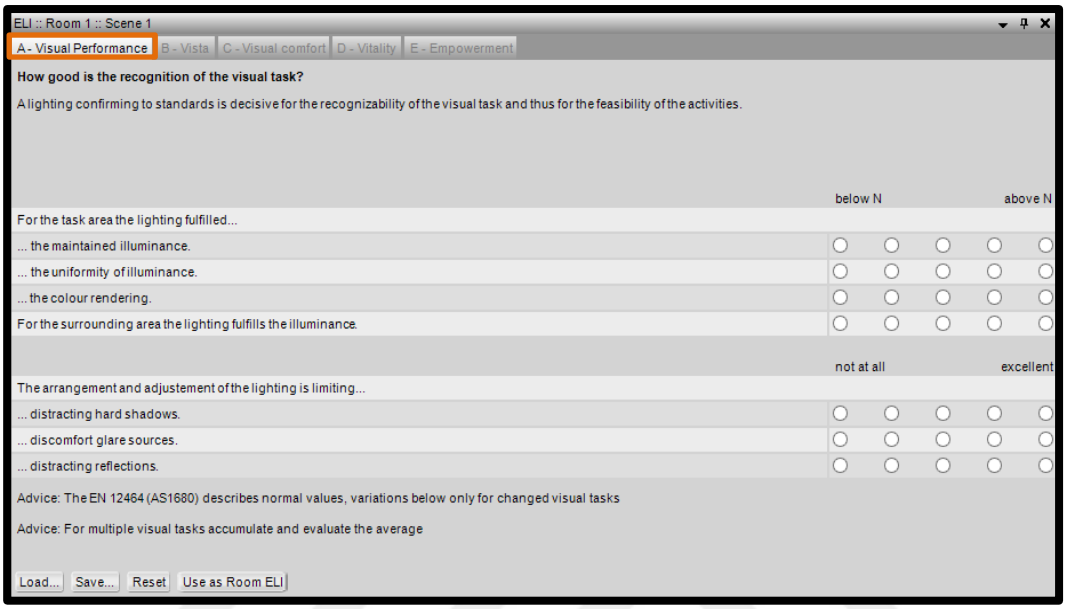

Figure 35: Criterion for evaluation of visual performance

Criterion 1- Level of luminousness in the task environment

1. 250 lux
2. >250 lux
3. 500 lux
4. >625 lux
5. >875 lux The level provided by the design must be selected among these options. Minimum luminousness levels are described according to EN12464-1 depending on the type and function of the structure.

Criterion 2- Smoothness provided in the task environment

1. <0.3
2. >0.3
3. >0.6

4. ≥0.7
5. ≥0.8 The smoothness level provided by the design must be selected among these options. Smoothness is the ratio of minimum luminousness level on the surface to average luminousness (EN12464-1)

Criterion 3- Color rendering of the lamps used in the illumination of the task area

1. <60
2. 60-79
3. 80
4. >80
5. >95 Color rendering level provided by the design must be selected among these options.

Criterion 4- Level of illumination provided for the surrounding of the task area

1. <175
2. >175
3. 300
4. >400
5. >625 Level provided by the design must be selected among these options.

Criterion 5- Drastic shadows can be narrowed down by arrange able and adjustable lighting. Drastic shadows on work area and furniture in the area can be reduced through directing or arranging the lighting tools. For this purpose, ratio between the illumination levels of calculating points around the area (RILCP) may be reviewed.

1. RILCP; 1:5
2. RILCP; 1:4
3. RILCP; 1:3

4. RILCP; 1:2
5. RILCP; less than 1:2 Ratio provided by the design must be selected among these options.

Criterion 6- Uncomfortable glare sources can be narrowed down by arrange able and adjustable lighting.

1. Often existing by 4000cd/m²
2. Rarely existing by 4000cd/m²
3. Cut-off angel is between 1000-4000cd/m²
4. Rarely above 1000cd/m²
5. Is not above 1000cd/m² Option suitable for the design must be selected among these options.

Criterion 7- Disturbing reflections can be narrowed down by arrange able and adjustable lighting. Reflection values of arrayed or grouped tools in the direction of view are critical. This is why contrast rendering factor (CRF) is described for visual tasks. CRF is a factor described as the ratio of contrast of a task under a certain level of luminousness to contrast of the same task under the reference level of luminousness *(Ganslandt R., Hofmann H., 1. edition 1992, Handbook of Lighting Design Erco Lighting Edition*).

1. CRF class III
2. CRF class between III and II
3. CRF class II
4. CRF class between II and I
5. CRF class I The class provided by the design must be selected among these options.

Evaluation of Appearance Section

This section involves evaluation of other visual impacts of light in addition to illumination, with regards to six criteria.

Criterion 1- Whether lighting design is complement with the architecture of the space; suitable option among 1 to 5 must be selected. In this criterion, the lighting tools are evaluated to the extent it contributes to architectural features of the space with its location, direction and height. 1 means the tools do not contribute to architectural features or/and not related to furniture of the office. While 5 refers to very successful fitting with the design.

Criterion 2- Suitable option among others, ranked from 1 to 5 to extent that lighting design fulfills the expectations of the user, must be selected. 1 means that user expectations were ignored and/or are not satisfied while 5 means expectations were satisfied fully or almost fully.

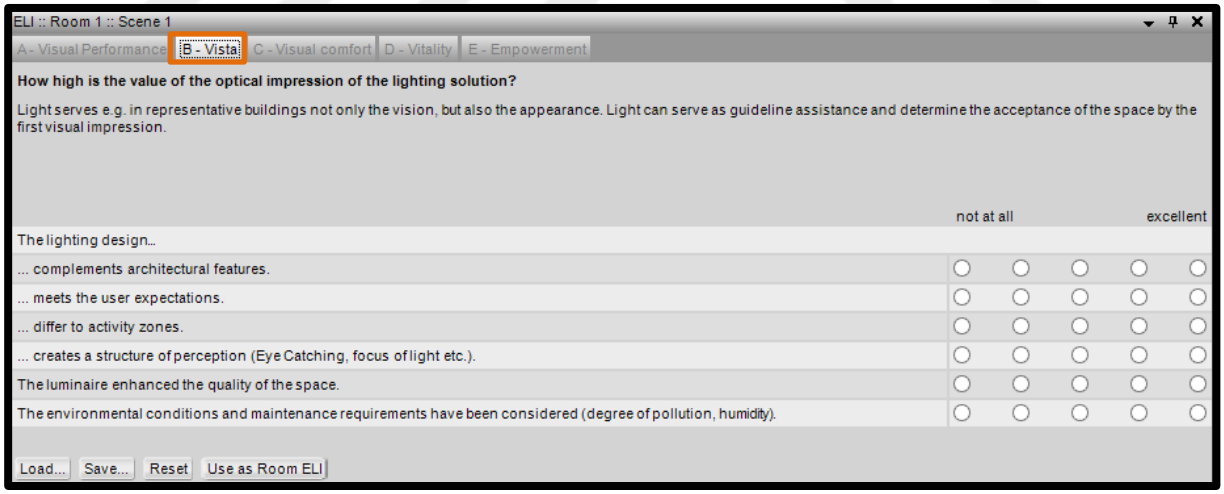

Figure 36: Criteria for evaluation of appearance section.

Criterion 3- Light routes help adapting the space and moving in the space thanks to light lines on the ground and areas. With this criterion, it is examined if there are differences between the efficiency of the design on various activity areas. The option which is provided by the design

must be selected among the options ranked between 1 and 5. 1 means that the criterion is not fulfilled whereas 5 means that it was fulfilled very successfully.

Criterion 4- Light forms the first perception of a space. This is why glam and focuser lights attract the attention of the viewer. This criterion examines if the design is able to create a perception through options ranked from 1 to 5 one of which must be selected according to the design. 1 is selected if the design is not focuser and not able to create a perception. On the other hand, 5 is selected if the design is good at gaining the attention and focus of the viewer thanks to focuser lights.

Criterion 5- 5th criterion questions if the equipment used in the design increases the quality of the office. Quality of the equipment used, correct assembly of the equipment preventing wrong angles, full and right use of the equipment and the harmony with the other luminaires ordered in the same pattern are evaluated for this criterion.

1. There are wrong angles within the design
2. The angles are correct but equipment is not fully deployed and there is no harmony with the other luminaires
3. The angles are correct, managed the harmony but the equipment is not fully deployed
4. The angles are correct; the equipment is sufficient but the harmony within the pattern is lacking
5. The angles are correct, the equipment is sufficient and there is the harmony within the pattern with other luminaires

Criterion 6- The criterion examines if environmental conditions and maintenance requirements are taken into consideration within the lighting design. Details such as; cleaning of the equipment, protection of them against dust, moisture and chemicals, durability of the equipment and lamps and consideration of environmental conditions like level of exposure to

pollution and damp are subject to evaluation by this criterion. The option provided by the design must be selected among five options.

1. Protection issues and/or maintenance time are ignored
2. Protection issues are taken into consideration but maintenance period is too short
3. Environmental conditions are taken into consideration
4. Environmental conditions are taken into consideration and maintenance period is long
5. High protection classification is provided, durable, time required for maintenance is quite long.

Evaluation of Visual Comfort Section

Light is essential not only for visual tasks but also for perception of space. Share of brightness and difference of flashiness must be balanced in an interior design. Visual Comfort Section involves evaluation of 7 criteria seen in Figure 38.

Criterion1- Glaring must be prevented within lighting solutions. (Unified Glare Rating, UGR, values are given)

1. >22
2. 20-22
3. 18-20
4. 16-18
5. <16 The rating provided by the design must be selected among these options. Direct glare can be determined via UGR values in EN12464

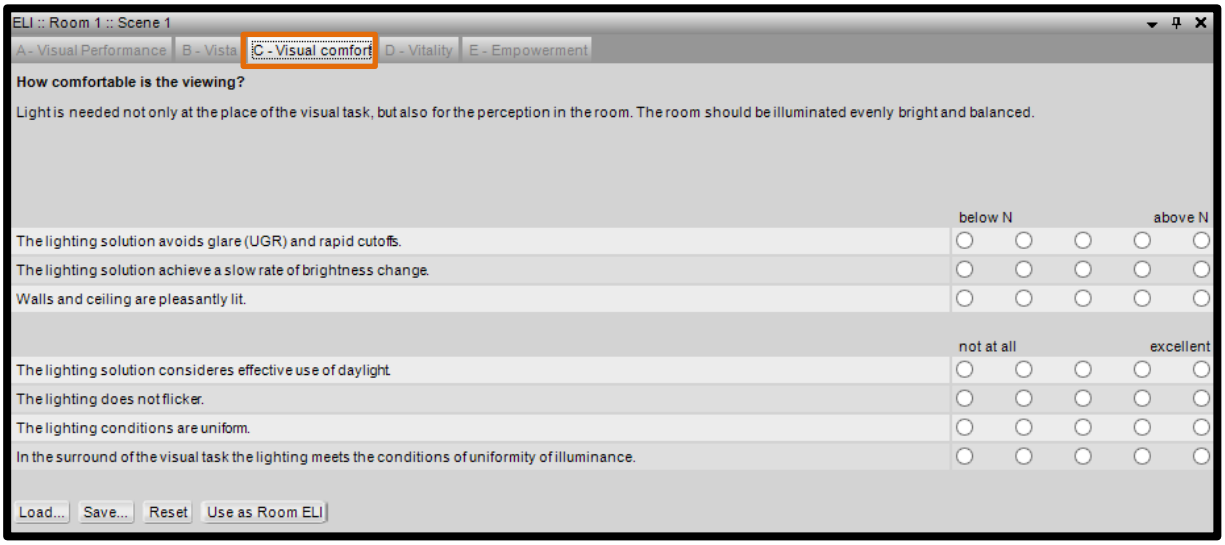

Figure 37: Criteria for evaluation of visual comfort section

Criterion 2- Lighting solutions must provide low degree of flashiness variance. Distribution of light has significant impacts on shadows on the three dimensional objects. The level may be calculated by the ratio of level of cylindrical brightness level to horizontal brightness level.

1. <0.1
2. >0.1 - <0.3
3. >0.3 - <0.4
4. >0.4 - <0.5
5. >0.5 - <0.7 The ratio provided by the design must selected among these options.

Criterion 3- A balanced illumination of the office surfaces is essential, too for a better perception.

1. Ceiling/working plane < 0.3 and walls/working plane <0.5
2. Ceiling/working plane ≥ 0.3 and walls/working plane <0.5
3. Ceiling/working plane ≥ 0.3 and walls/working plane ≥0.5
4. Ceiling/working plane ≥ 0.3 and walls/working plane ≥0.5 and ceiling reflection ≥70%

5. Ceiling/working plane ≥ 0.3 and walls/working plane ≥0.5 and ceiling reflection ≥70% and there is strong daylight. The ratio provided in the design must be selected among these options.

Criterion 4- Use of daylight must also be considered in lighting solutions. Lighting groups must be controllable separately depending on the dispersion of sunlight.

1. Neither control of the lighting equipment in the same pattern nor harmony between sunlight and artificial lights through sensors.
2. Lighting equipment is manually controllable depending on the impact of the sunlight.
3. Lighting equipment groups are manually controllable depending on the impact of sunlight.
4. Lighting equipment groups are controllable through switching, depending on the impact of the sunlight.
5. Lighting equipment groups are automatically made dim depending on the impact of the sunlight. The suitable option for the design must be selected among these options.

Criterion 5- The light provided mustn't vibrate. For preventing such a vibration, proper ballast and electronically systems must be used in the design. Magnetic ballasts causes vibration and increase in noise.

1. Magnetic ballasts are used.
2. Ballasts with less loss than magnetic ones are used.
3. Low loss ballasts are used.
4. Ballasts in the class between electronic and low loss ballasts are used.
5. Electronic ballasts are used. The ballasts used in the design must be selected among these options.

Criterion 6- Smoothness must be provided in lighting conditions. It is very important to be able to see every point of the space in order to feel safe and confident. Existence of dark and unapparent parts in a space must be prevented.

1. There are large dark parts in the space.
2. There are less dark parts in the space compared to the first option.
3. There are a few large dark parts in the space.
4. There are less dark parts in the space compared to the third option.
5. There are no dark parts in the space. The level of dark parts must be selected among these options.

Criterion 7- Illumination around the visual task must satisfy the conditions of smoothness and uniformity. The standards for uniformity around the visual task area are defined in EN12464. Illumination conditions which cannot provide uniformity causes eye-adaptation problems and tiredness.

1. <0.4
2. >0.4
3. ≥0.5
4. ≥0.6
5. ≥0.7 The uniformity level provided by the design must be selected among these options.

Evaluation of Vitality Section

Light has influences on people's mood and activities. It can also effect health, can empower or influence the biological processes. Feeling good and taking action trigger each other and they depend on the correlation of 6 criteria given in Figure 39.

Criterion 1- Controlling the direction of the light – Satisfaction; Controlling the direction of the light directly or indirectly has significant effects on feelings of people. Indirect illumination can be raised in lighting solutions. It helps people focus on the tasks.

1. There is only one of direct or indirect illumination.
2. Direct and indirect illumination are switched together (can be turned on and off together).
3. Direct and indirect illumination can be made dim together.
4. Direct and indirect illumination can be dimmed separately and the ratio of indirect to direct is 20:80.
5. Direct and indirect illumination can be dimmed separately and the ratio of indirect to direct is 40:60. The proper option valid for the design must be selected among these options.

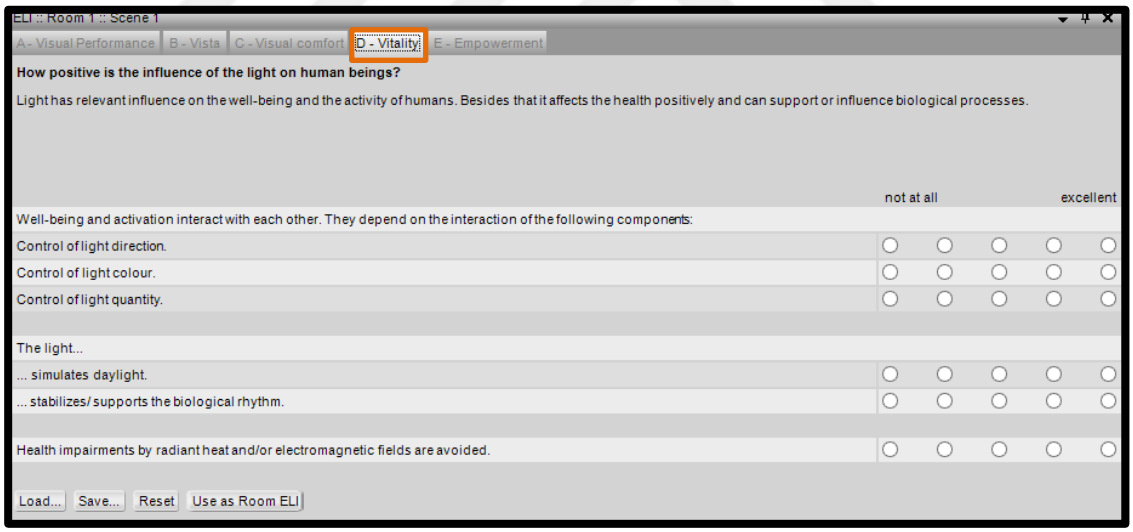

Figure 38: Criteria for evaluation of vitality section.

Criterion 2- Controlling the color of the light – Arousal; Using hot colors may prevent secretion of melatonin and increase vitality.

1. There is no change in the color temperature.
2. Different color temperatures can be turned on/off via switches.

3. Two lighting components from different color temperatures can be controlled manually.
4. Different lighting components with various color temperatures can be chosen via automatic control.
5. Color temperatures can be replaced separately and automatically. Suitable option for the design must be selected among these options.

Criterion 3- Controlling the intensity of light – High attention. Adaptation to a space has significant influence on vitality and euphoria. Different levels of light intensity may be required for different tasks.

1. Different levels of intensity cannot be obtained via switching.
2. Different levels of intensity can be obtained via switching manually.
3. Different levels of intensity can be dimmed manually.
4. Different levels of intensity can be obtained time adjusted in order to increase vigilance and attention.
5. Functional lighting components can be time adjusted and also the components on the vertical alignment can function easily if needed because of the changes in conditions. The suitable option depending on the design must be selected among these options.

Criterion 4- Light is similar to/copies the daylight. Light will seem natural if it is distributed in the space similar to daylight, light sources are not visible and if it's spectral distribution is similar to daylights'.

1. No daylight sources are used.
2. A little amount of daylight is used.
3. Color of light complies with daylight.
4. There is a better source of light by means of color and density, compared to first three options.

5. Color, distribution and source of light are similar to daylight. Option suitable for the design must be selected among these options.

Criterion 5- Light balances and supports the biological rhythm. Artificial lights can influence and support circadian rhythm.

1. Circadian rhythm is ignored.
2. Functional components vary within reasonable values depending on the density of light.
3. Direct and indirect components of light changes contrarily according to light density (direct illumination in the mornings and evenings, indirect illumination in the afternoons).
4. Functional components change the direct and indirect illumination; components with high color temperatures can be added time to time in order to increase vitality.
5. Lighting solution considering circadian rhythm, successfully compounds components that increase the sense of feeling good and functional components that provides vitality. The case suitable for the design must be selected among these options.

Criterion 6- Health disorders caused by heat dissipation and/or electromagnetic (EM) fields must be avoided. It is possible to avoid disturbing and negative effects by using disconnected transmissions, system purified of magnetic fields, specialized control systems and ballasts, UV filters and IR reflectors.

1. IR, UV and EM effects exist.
2. UV and EM effects exist; IR effect does not exist.
3. EM effect exists; IR and UV effects do not exist.
4. IR, UV and EM effects do not exist.
5. No source that has negative effects on health is used. The proper option for the design must be selected among these options.

Evaluation of Empowerment Section

Several of visual needs, visual tasks or exposure time, require control over individual influence in lighting solutions. Sensors and control system help the user to benefit the lighting solutions according to his needs. Figure 40 shows the 7 criteria for evaluation of empowerment section.

Criterion 1- Lighting can be adjusted via switch and/or dimming. Lighting solutions can be personalized by switching or dimming the equipment.

1. There is no personal intervention.
2. Lighting is switched separately for individual needs.
3. It is possible to turn on/off and dim equipment groups that are switched separately.
4. It is possible to switch and dim every single equipment.
5. It is possible to switch and dim every single equipment in the work area. Suitable option for the design must be selected among these options.

Criterion 2- Pre-arranged lighting scenarios can be chosen according to the basic activity. The scenario to be chosen must be selected considering the purpose of the user or the basic activity.

1. It is not possible to choose lighting scenario.
2. Applications with value between the first and the third options.
3. Basic activities have their own lighting scenarios.
4. Applications with value between the third and fifth options.
5. All the basic activities have pre-determined lighting scenarios. The right option suitable for the design must be selected among these options.

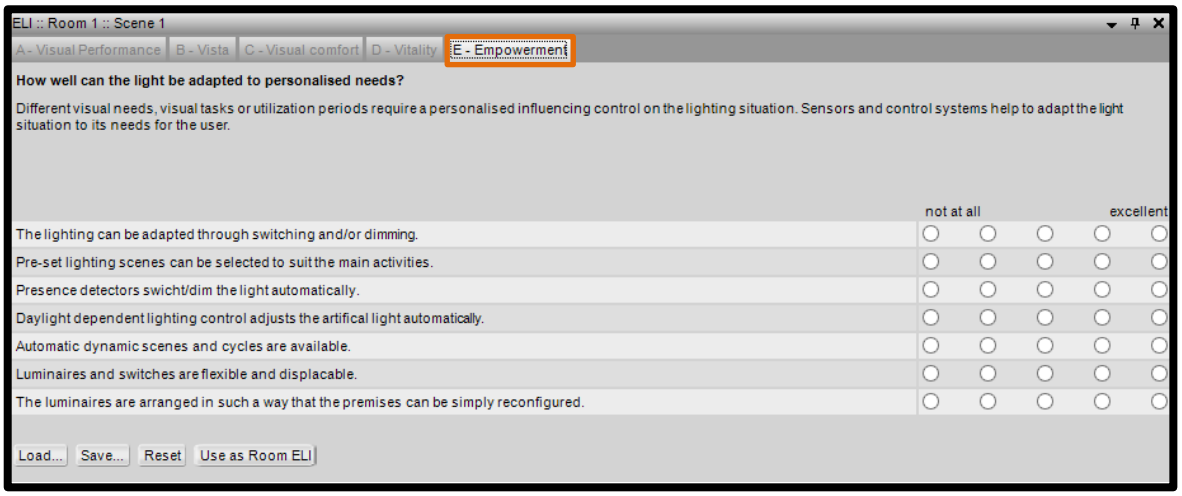

Figure 39: Criteria for evaluation of empowerment section

Criterion 3- Motion detectors turn on and off and/or dim the lights automatically. Light is needed only when there is someone in the office. Motion detectors detect the existence of people to arrange the light and save energy.

1. Lights can be turned on/off manually.
2. Lights can be turned on manually, turned off automatically.
3. Lights can be turned on/off automatically.
4. Lights can be turned off and dimmed automatically.
5. Lights can be turned on/off and dimmed automatically. The feature provided by the design must be selected among these options.

Criterion 4- Lighting control based on daylight automatically configures the artificial lights. Turning on and off and dimming can be arranged depending on the daylight via daylight detectors and light controls.

1. No light sensors are used.
2. Applications with value between the first and the third options.
3. Turning on and off is available in some areas via daylight detectors.
4. Applications with value between the third and the fifth options.

5. Daylight is fully controllable. The feature provided by the design must be selected among these options.

Criterion 5- There are automatic dynamic lighting scenarios and cycles. Light can be configured according to regulations or smart dynamic control systems based on weather conditions.

1. Time compliance light control isn't done.
2. Applications with value between the first and third options.
3. Time compliance light control is done with one lighting component.
4. Applications with value between the third and fifth options.
5. Time compliance light control is done automatically. The feature provided by the design must be selected among these options.

Criterion 6- Luminaires and switches are elastic and can be changed. Users can form their own personal equipment order and direct the light thanks to the elastic and portable equipment used in work areas.

1. Lighting components are not elastic.
2. Applications with value between the first and third options.
3. Components are elastic.
4. Applications with value between the third and fifth options.
5. Equipments, switches and user controls can be easily moved. The suitable option provided by the design must be selected among these options.

Criterion 7- Luminaires are arranged to provide ease for changes of the offices.

1. Lighting design is stable and does not allow new tendencies in the design of the space.
2. Applications with value between the first and third options.

3. Lighting design is partially suitable for new arrangements of the design of the space.
4. Applications with value between the third and fifth options.
5. Lighting design is suitable for personal arrangements of the design of the space. The suitable option for the design must be selected among these options.

5 THE EVALUATION AND IMPROVEMENT OF THE PRINCIPLES BASED ON THE SUGGESTIONS OF YASAR UNIVERSITY LIBRARY LIGHTING

This chapter describes the methodology that was used in this study to provide an understanding how the research was done. It documents steps while doing the research that explains the interpretation of the research analysis results.

To understand the methodology explaining the perception and visual hierarchy is the first step of the research. Perception is not simply a passive recording process which receives and processes all incoming sensory stimuli indiscriminately. If this were the case, our minds would have no time at all for consciously directed activity; we would be continuously enmeshed in a wild unceasing flood of sense impressions, without hope of rest or relief. We would be unable to think, to direct our attention at will, to act usefully and meaningfully *(Perception and lighting as form givers for architecture, William M.C.LAM,1968)*.

Also lighting brings the visual perception with itself when visual hierarchy and human are in relationship. Visual perception involves far more than a passive and mechanistic response to patterns of light: it is a complex, active process of information selection, filtering, interpretation and storage in which context, prior experience and expectations are combined with incoming sensory data to create meaningful perceptions *(Perception and lighting as form givers for architecture, William M.C.LAM, 1968).* A field of perception has a lot of forms which is created by visual contrast and it brings visual hierarchy. In other words, visual hierarchy influences the order in which the human eye perceives what it sees. Objects with highest contrast to their surroundings are recognized first the human mind, they are always illuminated by a combination of direct light from a multitude of directions and is reflected by clouds, plants, ground, snow, water and rocks.

To be able to use the visual hierarchy of light successfully, we need to get into the minds of the users of different kinds of space. In either case, it is imagining or visualizing the scene from both the users point of view and their mindset that makes it possible to create the most appropriate lighting solution *(Lighting for interior design, Malcom Innes, 2012)*.

In this study first aim is to understand the what is perception, visual perception and visual hierarchy is. After all, according to the observations, studies and questionnaire with the library users and stuff, values were calculated and recommended potential future activities and design suggestions for designing the university library.

Procedure

The data collection process mainly makes use of two different outfits: computer tools and questionnaire. The physical model, library floors and lighting equipment were added after the library plans were taken. After creating the model in the computer environment, the lighting calculations that should conform to a library environment in line with the research studies were made. The results obtained showed the level of lighting that should be prevalent in a library environment. But, due to the fact that this study sought to investigate to what extent the levels of lighting in the library have impact on the perceptions of the users, survey method was used.

Questionnaire is technique for collecting date through written communication. It includes a set of questions regualated for a certain purpose and in a fixed order and is generally applied to large masses. Statistical evaluations are made on the results obtained by means of surveys. As you can find attached to this study, in this questionnaire which was prepared for the library, a set of questions including what was the age range of the users and such questions that are specific to some places such as where are the places that they want to sit in here the most were asked to the participants.

The library evaluation questionnaire was applied to the students in the library, to the employees and to some law students whom I thought did and do make use of the library a lot. The results of the participants were evaluated by Statistical Package for Social Sciences (SPSS).

Following all these studies, ELI-LENI Calcualtor tool that evaluates the Lighting quality in terms of quantity was utilized. ELI evaluates the 5 main titles with the help of spidergram graphics. These titles are Visual Performance, vista, visual comfort, vitality and empowerment. Based on the statistical information and results of Dialux, ELI program which would give the most accurate answer is used. 5 main things that should exist in a library environment are indicated with the color "orange" and the results obtained from the analyses are indicated with blue with orange background. The result that come into the light proves us that the most healthy, the most accurate Lighting criteria were ensured in the library environment.

As a result, the data was collected on site by the researcher. According to drawings and questionnaire with the library users and staff, the values were calculated and recommended potential future illumination and design suggestions for designing the university library.

5.1 User Reviews

According to the questionnaire results the library building has bad lighting conditions. The questions include some specific points and helps to understand the important subjects for ELI like; privacy, personal space, territoriality, crowding & density, lighting and visual comfort.

Users answer the questions with the help of the researcher. There are 42 female and 38 male users participated in the survey and %66 of them are think that library lighting conditions should be changed. Users always prefer tho study in the library between 13:00-17:00pm.

If the topics were examined, question 1, 2, 3 and 4 are help to understand the privacy and according to the answers library has %50 privacy. Second topic is to understand personal space. The question 5, 6 and 7 shows that %46,5 of users think that there is no enough personal space to study. Third topic is about territoriality, in psychology it shows the persons own area feeling and only question 8 explains the situation. According to the answers %39 of users don't have territoriality. Fourth topic is about crowding&density and question 9, 10 gives the answer. %40 of users are unstable about this topic. Fifth one is about to understand lighting conditions in library. Questions 11, 12, 13, 14, 15 and 16 were made to understand this subject. %80 of the users are think that lighting conditions are inadequate and it is affecting the sitting preferences. Sixth and the last topic is about visual comfort, questions 17, 18, 19 and 20. %65 of users feel uncomfortable while writing, reading and studying.

As a result, this survey provides the information for ELI software to researcher about library users are required. So with the correct information the results are healthier and supports the researcher's vision.

5.2 Example implementation of the ELI calculation program in a library building and interpretation of results

In part 4.4.4 usage of the program introduced and also in part 4.4.5 for the use of library described and some information is given about the choice of criteria. The interpretations of the results evaluation were explained through an example of a library.

First of all, the lighting calculations were made ignoring the effect of sunlight as in Figure 45 and 47 of Dialux lighting program in order to obtain lighting level, UGR value, uniformity and other technical information among ELI evaluation criteria for the area where the study would be conducted. Other information such as the automation system in the library, whether the sunlight sensors do exist or not, the types of balasts used, whether bulbs with

different luminious colours were used within the devices or not was obtained from the technical personnel in the library.

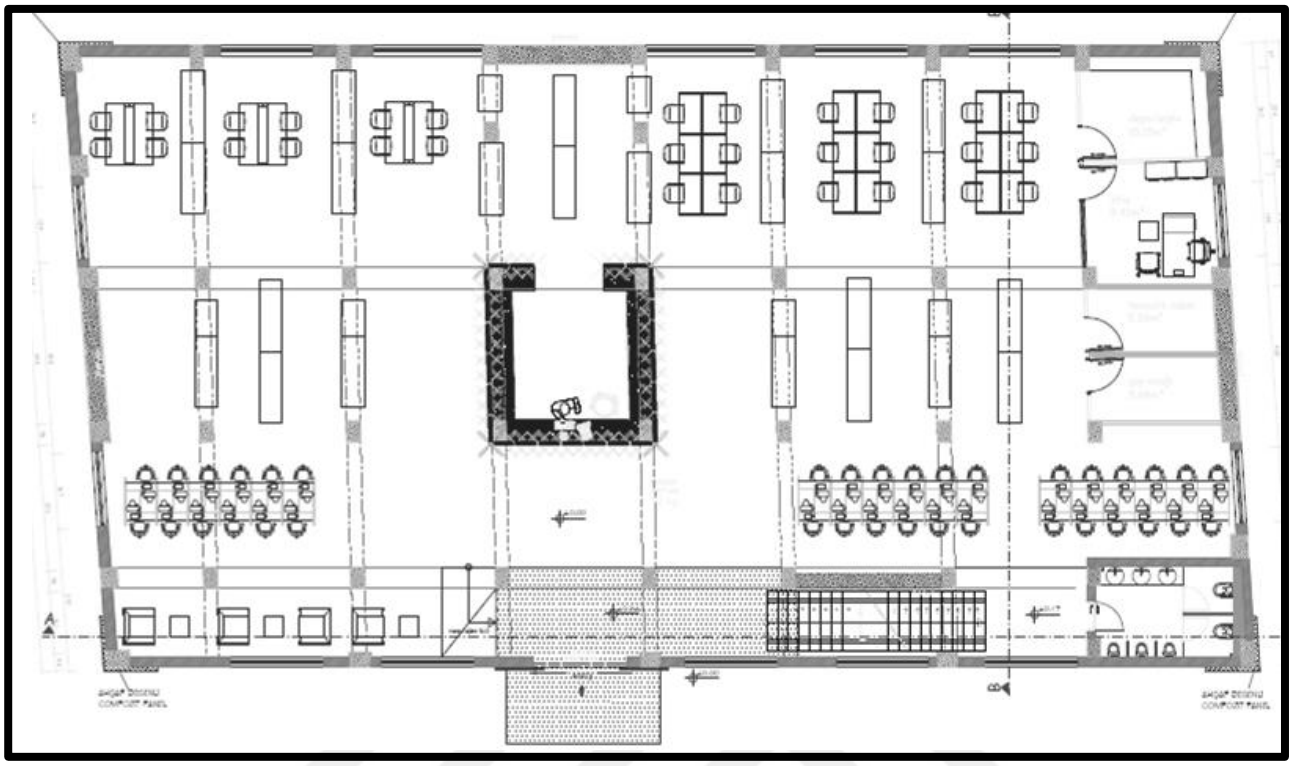

Figure 40: Discussed Library Ground Floor Plan

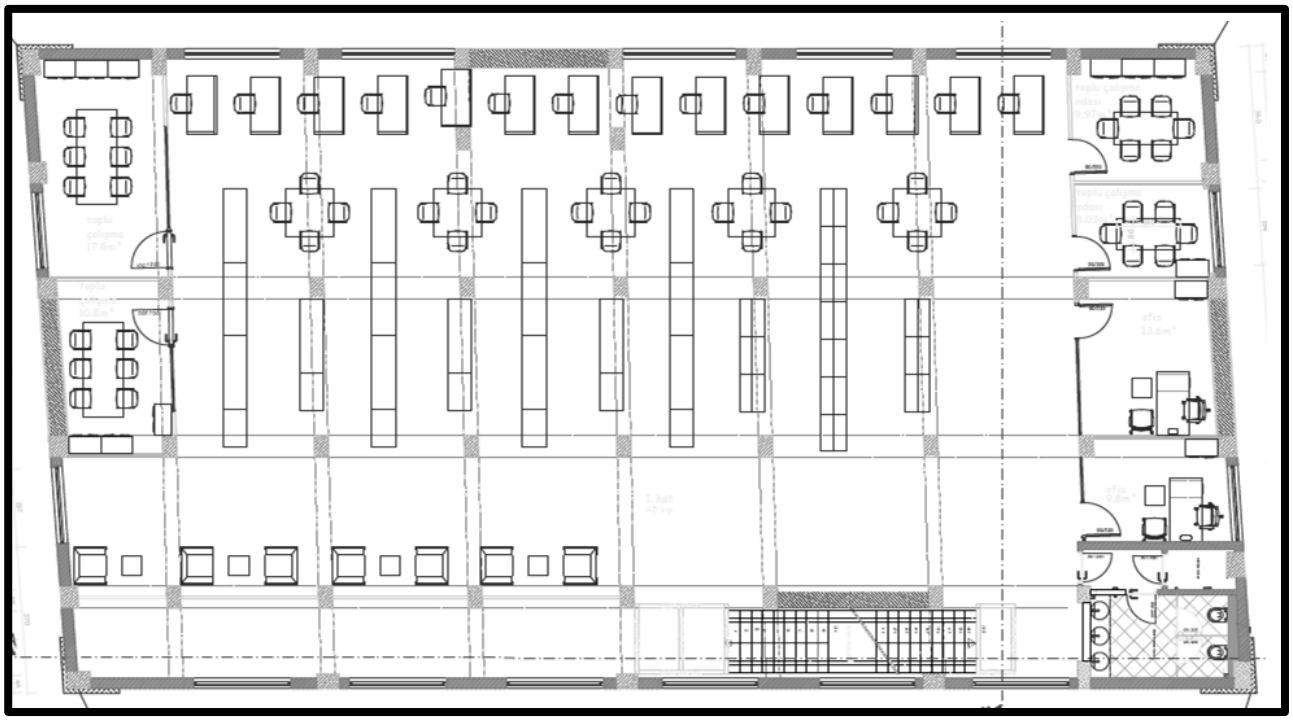

Figure 41: Discussed Library First Floor Plan

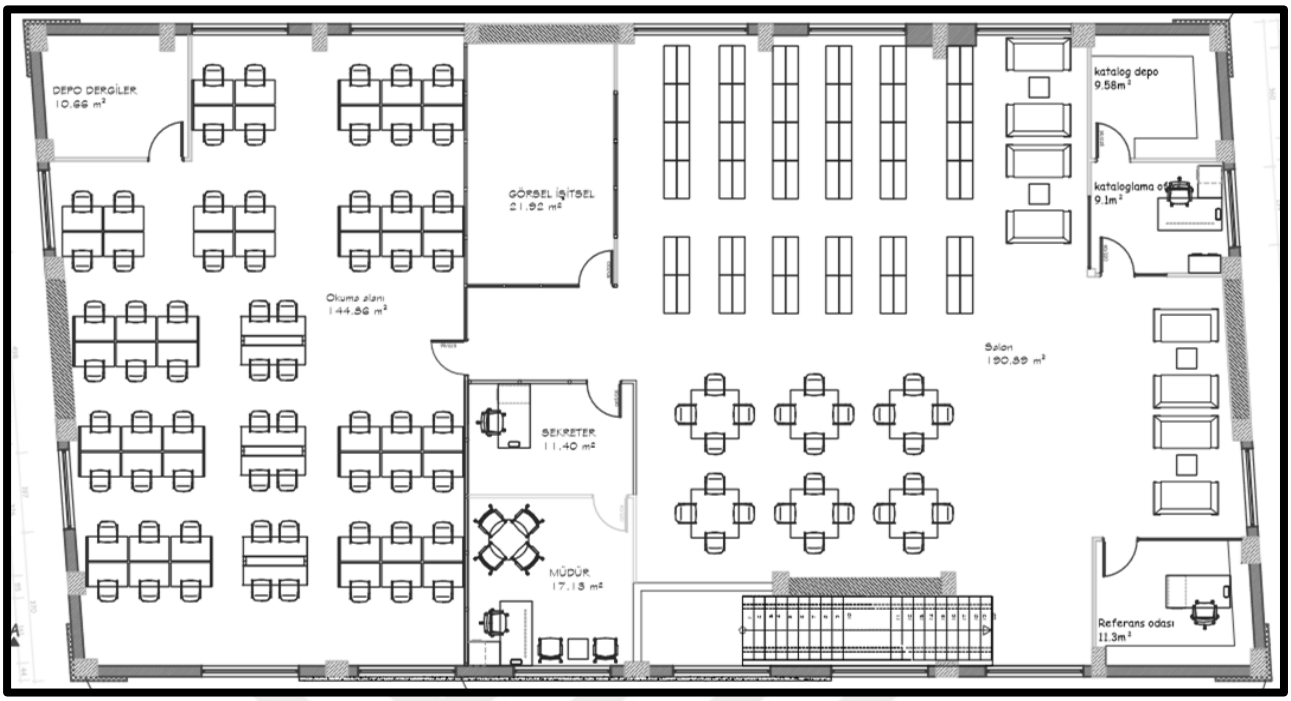

Figure 42: Discussed Library Second Floor Plan

Figure 43: Ground floor plan in 3D model from Dialux

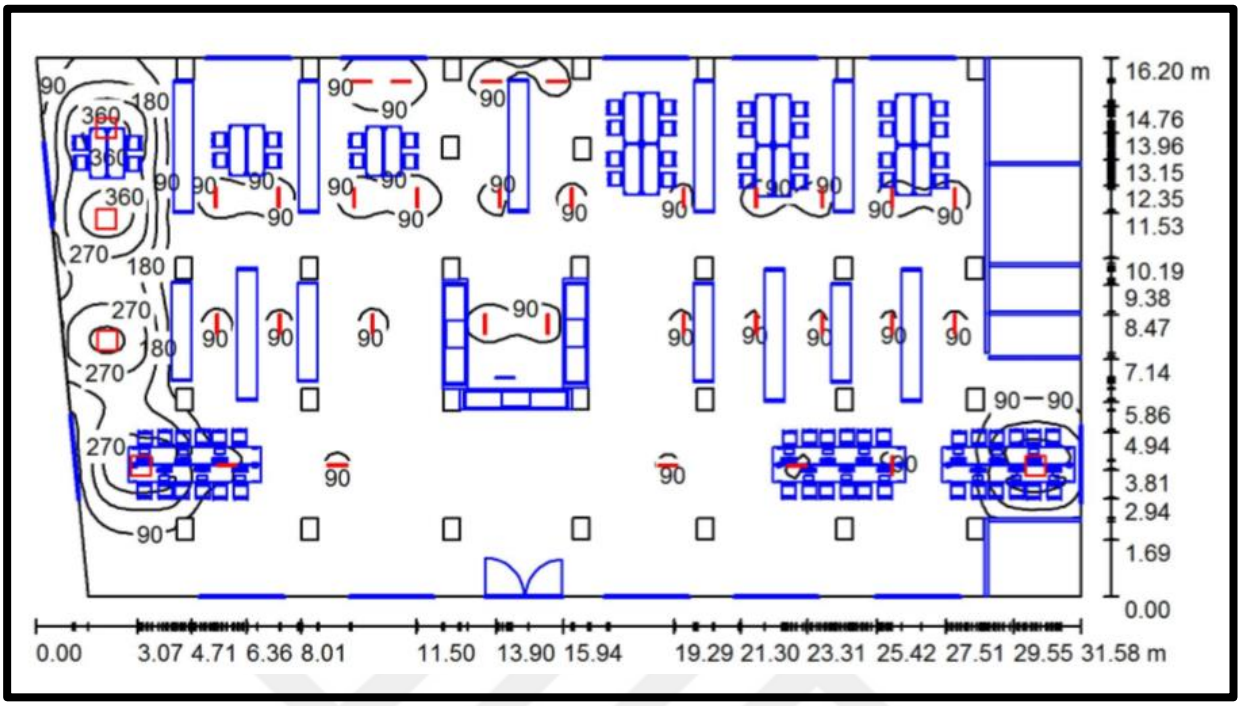

Figure 44: The results of Dialux program on ground floor by ignoring the daylight

Figure 45: First floor plan in 3D model from Dialux

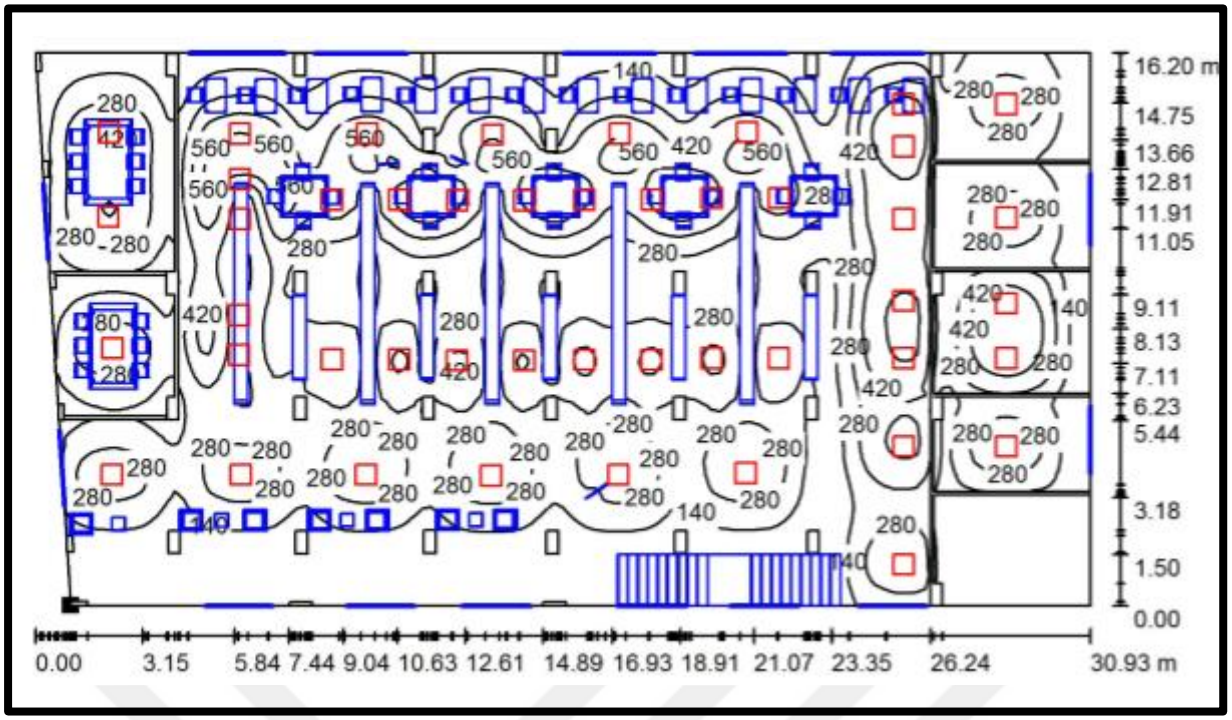

Figure 46: The results of Dialux program on first floor by ignoring the daylight

Figure 47: Second floor plan in 3D model from Dialux

In line with the information received from those in the office and Dialux lighting calculations, the following results have been obtained for each of ELI evaluation criteria;

Visual Performance

1.Criterion- The level of lighting provided in the assigned position; 256 lux

Yüzey	Ortalama Aydınlık [lx] doğrudan	dolaylı	toplam	Yansıma derecesi [%]	Ortalama Işıklılık [cd/m²]
Çalışma düzlemi	226	30	256	/	/
Hesap yüzeyi 1	231	29	260	/	/

2.Criterion- The uniformity provided in the assigned position; 0.005

E_m [lx]	E_{min} [lx]	E_{maks} [lx]	E_{min} / E_m	E_{min} / E_{maks}
256	1.33	700	0.005	0.002

3.Criterion- The colour rendering of the lamps used in lighting the assigned position; >80

4. Criterion – The level of lighting around the assigned area; 260 lux

5. Criterion - The proportion between the lighting levels of the neighbouring calculation points is less than 1:2

6. Criterion – Sparsely over 1000cd/m².

7. Criterion - values between CRF class II and I,

Vista

1. Criterion - Whether the lighting design is complementary of the architectural characteristics or not was selected as 3 among the scales from 1 to 5.

2. Criterion - Whether the lighting design meets the user expectations or not was selected as 2 among scales from 1 to 5.

3. Criterion: Lighting; was chosen as 1 among the options ranging from 1 to 5 in terms of helping comply with the place and orientation in a place with the help of directive light lines on the floor and the places.

4. Criterion: The idea of whether the lighting design created a perception or not was chosen as 2 among the options ranging from 1 to 5.

5. Criterion: The options such as accurateness of the angles, the adequateness of the devices and the relevance of the device arrangement were chosen as compatible according to other armatures.

6. Criterion: The option stating that the devices which are provided high protection require maintenance in long time periods and durable for using for many years was chosen.

Visual Comfort

1. Criterion - UGR value; calculated as 16 at maximum. 18-16 scale was selected for this criterion.

UGR-Yüzey listesi

Nr.	Belirtim	Konum [m] X	Y	Z	Büyüklük [m] L	B	Bakış yönü [°]
1	UGR hesap yüzeyi 1	16.523	8.000	1.200	26.734	16.600	0.0

2. Criterion – In line with the information below, the proportion of cylindrical lighting by the vertical lighting is selected as 0,53 >0.5-<0.7

3. Criterion - Ceiling/working plane ≥ 0.3 and the walls /working plane< 0.5. According to the calculation results, the average lighting levels are 10 lux for the ceiling, 59 lux for the working plane and 19 lux for the walls.

Oda yüksekliği: 3.000 m, Bakım çarpanı: 0.80 ... birimde değerler Lux, Ölçek 1:226

Yüzey	ρ [%]	E_m [lx]	E_{min} [lx]	E_{maks} [lx]	E_{min} / E_m
Çalışma düzlemi	/	59	0.34	422	0.006
Zemin	20	40	0.43	271	0.011
Tavan	70	10	0.62	41	0.059
Duvarlar (9)	50	19	0.86	159	/

4. Criterion - The device groups are not automatically made dim depending on the effect of the sunlight.

5. Criterion – Elektronical balast was used.

6. Criterion - The place does not have any dark area.

7. Criterion - The uniformity of the lighting around the visual assigned position; 0,253.

Vitality

1. Criterion- Only direct and indirect lighting**.**

2. Criterion - No change in the color temperature of the light.

3. Criterion - The conformity of lighting levels with the time can be provided to increase vigilance and attention.

4. Criterion - A better daylight source exists in terms of both colour and intensity according to the first three choices.

5. Criterion - The direct and indirect components of the light change in the reverse direction of the light intensity (indirect lighting part in the mornings and evenings, direct lighting part in the afternoons)

6. Criterion- No light source having a negative impact on human health was used

Empowerment

1. Criterion - Possible to turn on - turn off and make dim the seperately switched device groups.

2. Criterion - Lighting scenario can not be selected.

3. Criterion Turn-on and turn-off can be made automatically

4. Criterion - Automatical turn-on and turn-off switches were made to work using daylight sensors.

5. Criterion - No time-dependent light control was conducted.

6. Criterion - Lighting components are not flexible.

7. Criterion – Lighting design is stable and it does not allow adjustments of changes in the spatial design.

The construction type, which was primarily “Education Buildings”, will be uploaded to the ELI-LENI Stamp (graphic) screen when it is chosen as “Library” construction according to the required standard rates. Also, it will be uploaded according to the standard values as in the 21th shape and they will be in a shaded orange spider web graphic.

When the values were chosen in the design for each of the 33 criteria placed under the five main section such as visual performance, vista, visual comfort, vitality and empowerment evaluation results will appear in the ELI-LENI Stamp (graphic) section as on the orange area as shaded in blue as in the shape of example of Figure 49.

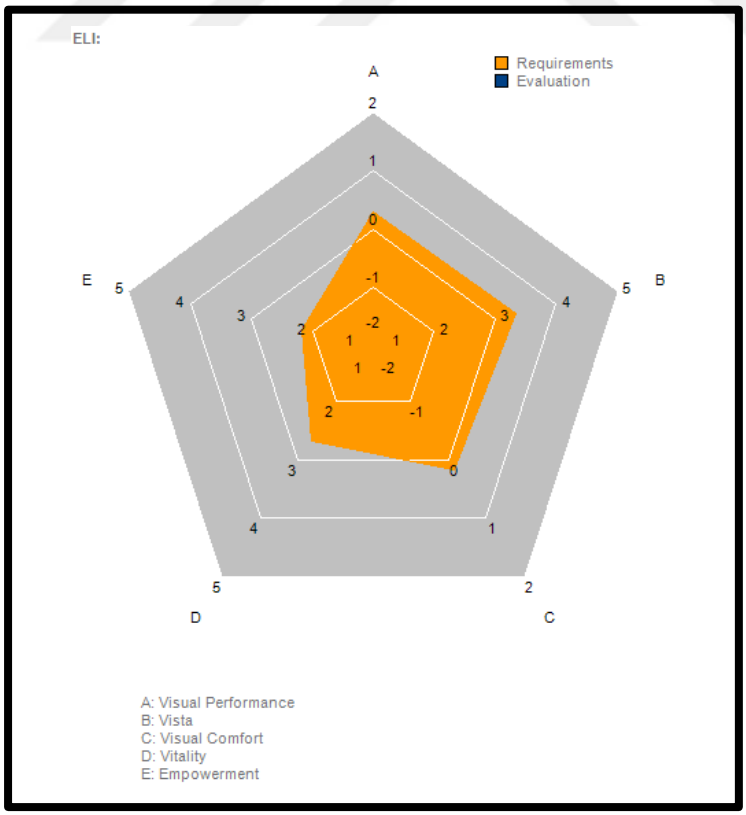

Figure 48: According to the standart datas ELI-LENI graphic screen

Figure 49: ELI-LENI graphic screen according to the standart values and evolution results

After the completion of choices about the criteria, results' demonstration on the spider web and obtained points will appear on "ELI-LENI datasheet" as showed in Figure 50.

ELI-LENI Calculator	Data Sheet
Project	
Project Name	Yaşar University
Building	Education Buildings
Room	Library
Room size	32,5 x 16,2 x 2,8
ELI	
A - Visual Performance	-1,00
B - Vista	1,83
C - Visual comfort	0,14
D - Vitality	1,67
E - Empowerment	2,14

Graphic

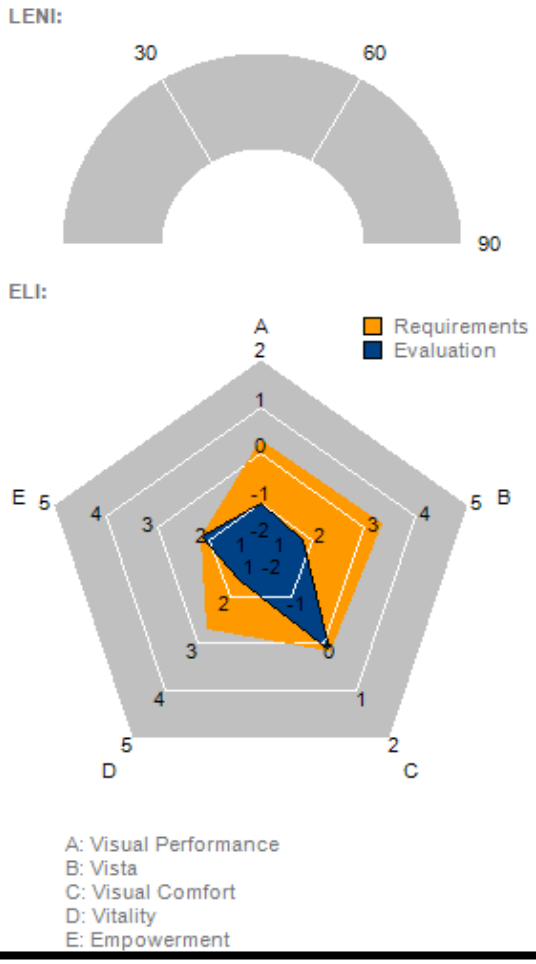

Figure 50: ELI-LENI Datasheet of existing lighting system

According to the limiting values covered by the shaded area in spidergram;

A- For Visual Performance ≥ 0.8,

B- For vista ≥ 3.5,

C- For Vista ≥ 0.85,

D- For Vitality ≥ 2.85

E-For Empowerment ≥ 2.15 olmalıdır.

The points which were calculated for choosing the rates provided in the design will appear under the ‘’ELI’’ headline in the Figure 47 data page. According to these points;

A- -1 for visual performance

B- 1.83, for vista

C- 0.14, for visual comfort

C- 1.67 for vitality

D- 2.14 for empowerment.

Regarding this survey, the results were not satisfied the expectation. And it is understood that the designer should make improvements to meet the standards.

According to European Committee for Standardization, the level of working space is supposed to be 550 lux, the brightness of bookshelves 200 lux and the immediate environment 300 lux. But regarding the results, the level of working space is 256 lux and immediate environment is 260 lux. These conditions should be reviewed and new regulations should be made to meet the standards.

For empowerment, the limit values are nearly done but this doesn't mean that the lighting system is under the control of users. It shows that there is a substructure for personal empowerment systems. Besides sunlight sensors, by using convenient lighting control systems for library conditions, the lighting solutions for different visual tasks and needs can be achieved.

When the criteria are arranged to meet the ergonomic lighting needs, both physical comfort requirements and conditions that are expected by the users can be met.

As we see in figure 50, on the date page, there is a diagram for ELI spider web besides LENI diagram. If the information about the number of the devices, the device power, sunlight, how to control the sunlight, service life, the consumed energy is added to the programme, the information of annual consumed energy can be obtained as KWh/m^2a.

In this study, the effect of visual hierarchy on perception has been researched, therefore only ELI part of the programme is discussed in detail. But these can not be considered independent of each other.

While providing ergonomic lighting condititons, energy consumption should be considered. To decrease the energy consumption, we can not dispense with the visual comfort conditions. But also the energy consumption shouldn't be increased while trying to have a design covered physiological and physchological needs of users.

5.3 Lighting System Proposal

ELI aims to design a lighting system that covers the physiological and physchological needs of users. The need for avoiding dark spaces, leading with sunlight to find the right direction, visibility of all areas are emphasized under the visual comfort and design titles. The effect of light on human is used to increase the quality and also make the life easier. This can be maintained by dynamic lighting system.

Considering the effects of sunlight on biorhytim, the dynamic lighting systems are modelled for the people who work in a workspace which is not exposed to sunlight. The system imitates the colour and location of sunlight which changes within the day. It provides a more dynamic and performance improving workspace for the users. Human Centric Lighting is one of these systems.

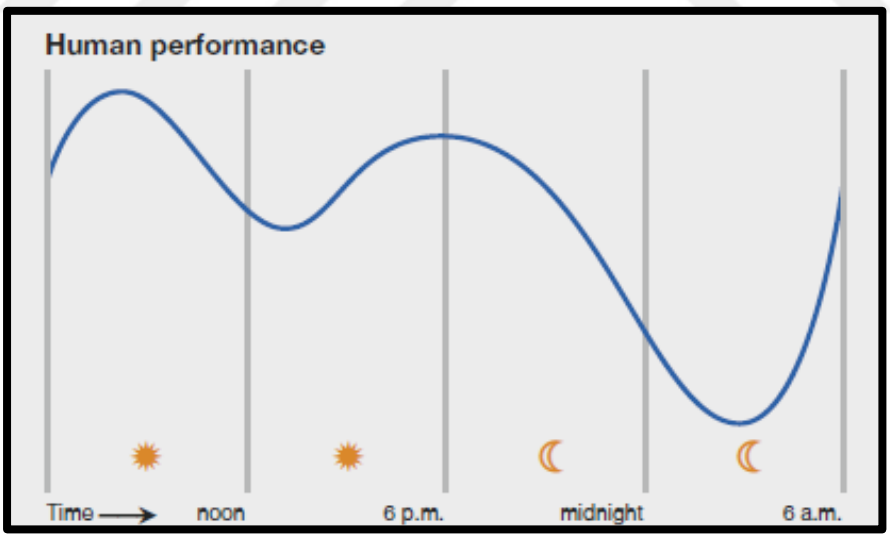

Figure 51: Human performance curve over the day *(Impact of Light on Human Beigns, licht. wissen 19, Dr. Frank Schlie-Roosen)*

As it is seen in figure 48, human body and mind are more active at 10 am and 3 pm. Human Centric Lighting can be put into use. At the same time, care must be taken to ensure that the lighting quality required is actually delivered. Workplace regulation ASR A3.4 requires that work premises should be sufficiently served by daylight and furnished with appropriate artificial lighting. DIN EN 12464-1 also stipulates that energy consumption should not be reduced at the expense of lighting quality. A good lighting installation takes account of light's visual, emotional and biological effects and is energy-efficient at the same time. Important features of lighting quality are; appearance, visual comfort, vitality and individuality.

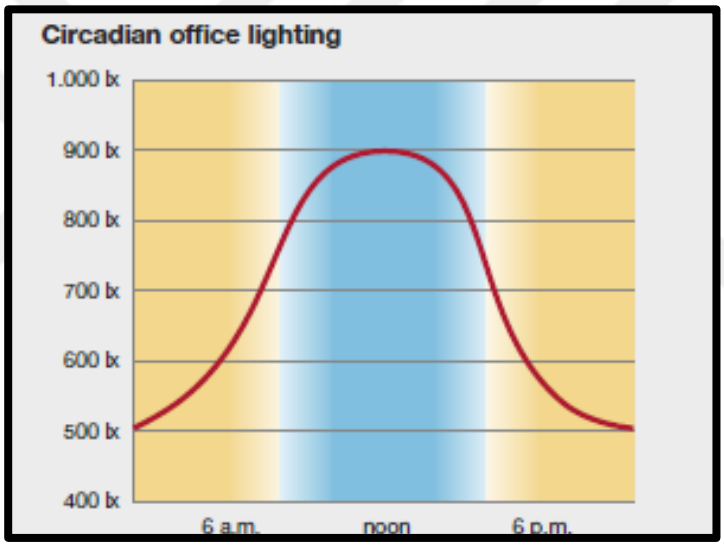

Table 8: Example of circadian-effective lighting in a working space *(Impact of Light on Human Beigns, licht. wissen 19, Dr. Frank Schlie-Roosen)*

The light color changes from warm white in the morning to daylight white at mid-day and back to warm white in the evening. At the same time, illuminance increases during to morning from 500 to 900 lux as in the Table 8. That increase in illuminance naturally impacts on the amount of electricity consumed over the year. The illuminance rises steadily to a peak at mid-day then falls again in the afternoon. So the maximum level is maintained for only a limited period.

As a result, the annual consumption of the circadian lighting is around 1,010 kWh/year, which is around 30 percent more than a modern energy efficient, non-regulated LED lighting installation. However, that is without taking account of the "maintenance factor saving" made possible in circadian lighting by lighting control and sensor technology. The new installation is designed for a setpoint value and requires significantly less electricity when it goes into service than when it reaches the time for maintenance. As seen in the Table 9 that energy saving is initially around 25 percent and decreases steadily thereafter *(Impact of Light on Human Beigns, licht. wissen 19, Dr. Frank Schlie-Roosen)*.

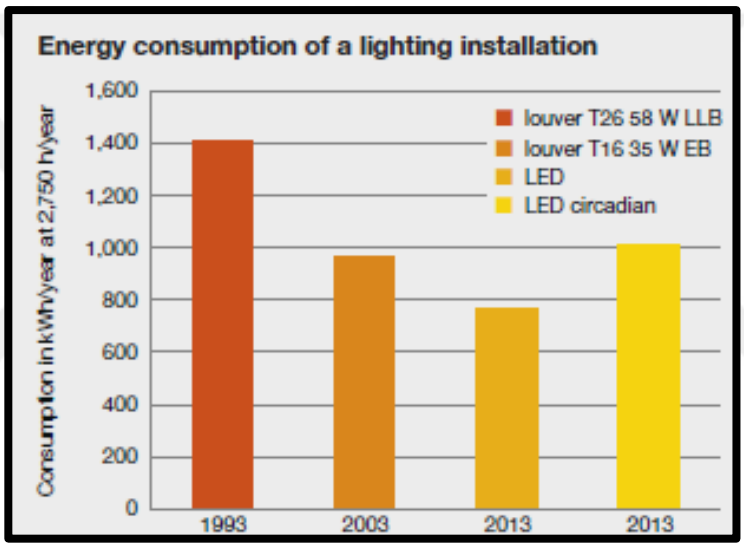

Table 9: The lighting installation *(Impact of Light on Human Beigns, licht. Wissen 19, Dr. Frank Schlie-Roosen)*

According to the results of questionnaire and the data acquired by ELI, the human centric lighting is found acceptable to make the users feel the same sunlight amount by artificial lighting.

It can be applied by adding some extra lighting elements and changing the current luminaries with special luminaries with led. There is no need to change the current lighting plan. For instance, the luminaries 40x40 cm and 4x14 W recessed flourescent luminaries can

be changed with the ones which are 40x40 cm but 3000K and 4000K, for each row, led luminaries. This change will be the essential of human centric lighting.

The system can be controlled by DALI (Digital Addressable Lighting Interface) and also arranged by considering the time when the users are more active in daylight. Location and active day light time can be entered in the system. When the artificial lighting is in use, the conditions when the users feel comfortable can be maintained.

As it shown in Figure 52, existing lighting system and renewed lighting system were compared and it was found to be detectable levels observed in the difference.

Figure 52: Comparison between existing situation and proposal application

This changes are described techniquely as mentioned in section Part 5.1 in lighting of Yaşar University Library, providing the criterias should be based on the European Committee for Standardization. These criterias are shown in figure 53 approximately, the level of working space is supposed to be 500-550 lux, the brightness of bookshelves 200-220 lux and the immediate environment 300 lux.

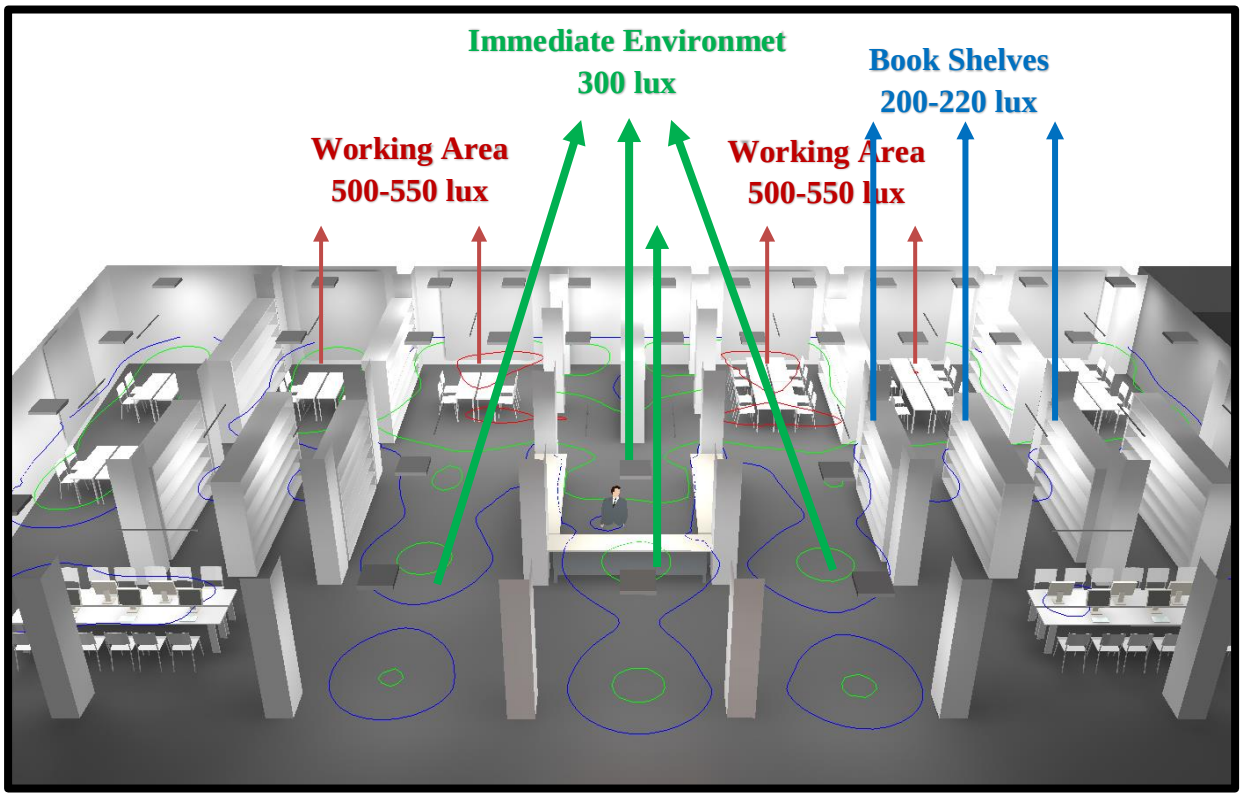

Figure 53: Lux lines are shown in the ground floor

The approximate value is given because of the structure of suggested dynamic lighting system. In the system, 2 led modules are replaced in the luminaries of 47x23 cm sizes. In the modules, there are seven rows of 2700K SMD Led and 6500K SMD Led (figure 55). The system can be switched between the colour temperatures automatically with the location and productive time. It is not possible to find a distinct answer in Dialux programme by entering one colour temperature. Color temperature unit is Kelvin and shown with letter "K". Between 2700K and 3000K light color called as warm white, 4000K and 7000K light color called as cool white.

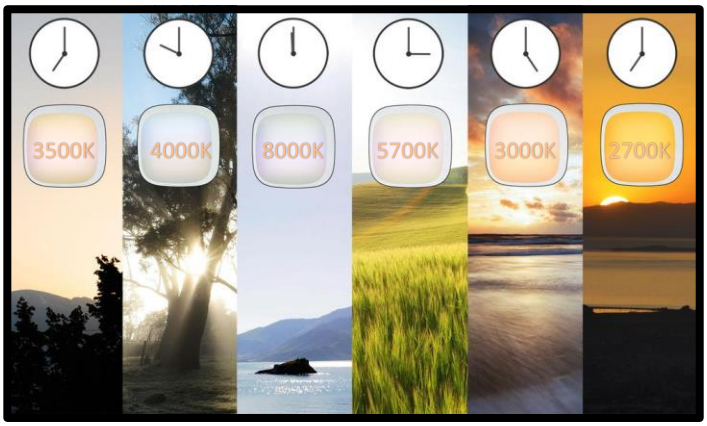

Figure 54: Kelvin table according to the daylight color temperature*(http://licht-zum-wohlfuehlen.com/pages/human-centric-lighting)*

So the approximate lux value is to found as a result. Between 3000K, 4000K, 6000K, the lumen difference is almost %10-15 and lux is lm/m2. So by using this formula, the rough values can be obtained.

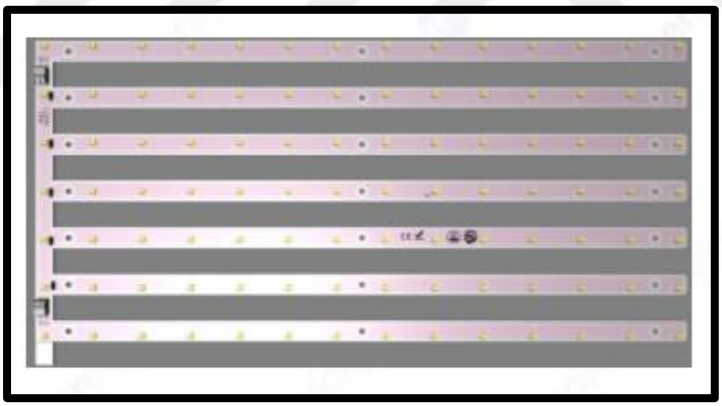

Figure 55: The Led Module

In this study, according to data from ELI for the proposed system, the library lighting conditions is shown in Figure 56. It should be given a better result.

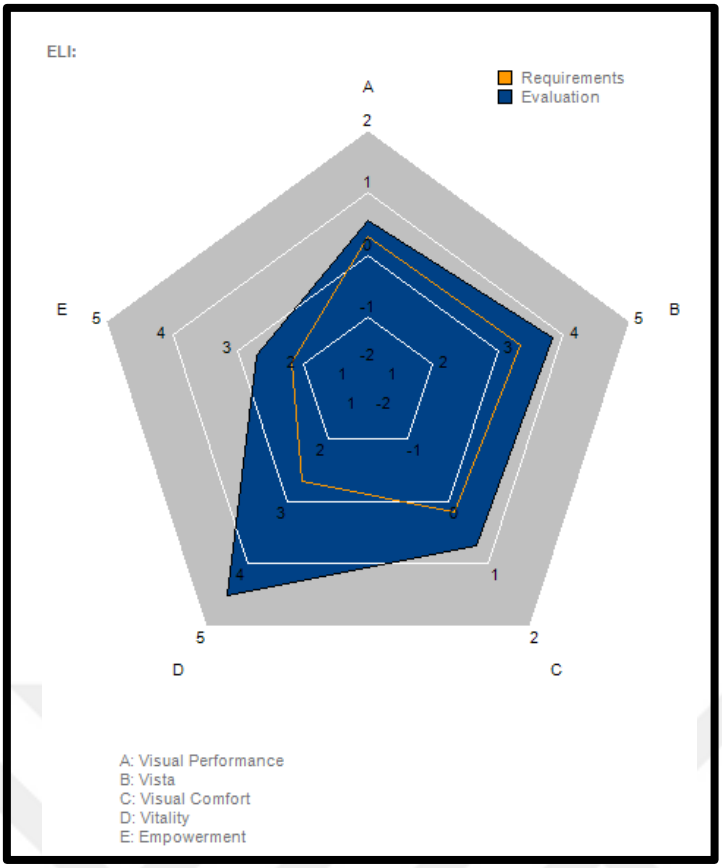

Figure 56: ELI-LENI graphic screen according to the standart values and proposal system results

ELI-LENI Calculator	Data Sheet
Project	
Project Name	Project 1
Building	Education Buildings
Room	Library
Room size	0,0 x 0,0 x 0,0
ELI	
A - Visual Performance	0,57
B - Vista	3,83
C - Visual comfort	0,71
D - Vitality	4,50
E - Empowerment	2,71
Graphic	

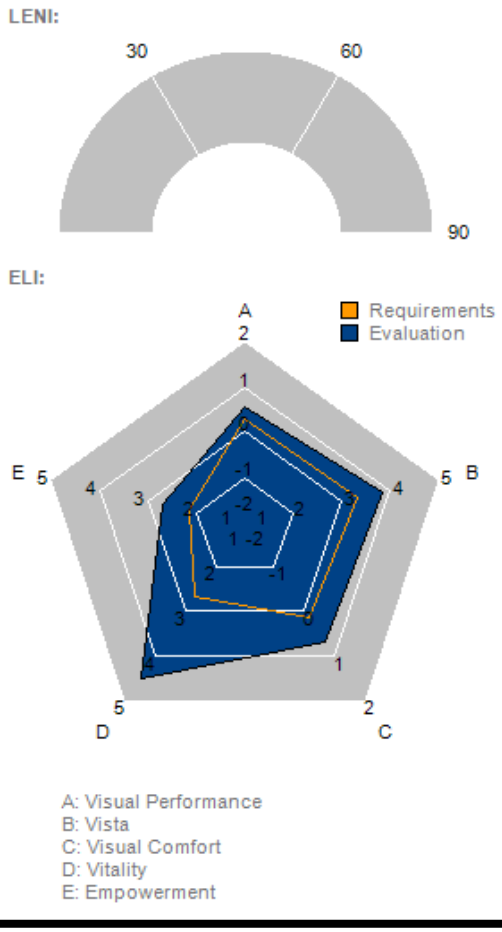

Figure 57: ELI-LENI Datasheet of proposal lighting system

The points which were calculated for choosing the rates provided in the design will appear under the ‘’ELI’’ headline in the Figure 53 data page.

6 CONCLUSION

Under the design title, it is evaluated that the design meets the needs of users and makes people feel well under the title of power of vitality and life, the lighting system covers the needs of users under the title of authorization. The common point among these three criteria is to meet the needs of users. The sunlight is the most issue in the project because of the positive effects on people. And therefore the ELI evaluation criteria make a calculation by considering these effects. In accordance with the results, the design, which has the effects of natural lights on people, is viewed under the titles of visual comfort, power of vitality and life and authorization.

In this study, the basic aim is to transmit the importance of sunlight. It is emphasized that the lighting is more important than anywhere else, especially in schools and libraries. The effects of wrong lighting system in a workspace which makes visual hierarchy on perception is examined. First, the method of this thesis is determined. This thesis has both qualitative and quantitative values so that it is supported by questionnaire and software. The results of questionnaire are used to support ELI programme. Besides, for the required calculations, Dialux software programme and Eli-Leni Calculator tools are used. One of the aims is to present the data collection and analysis which are occured by the studies of software and the correct lighting system that is supposed to be applied in here, to the users. Afterwards, the ways of progress are followed for the thesis and the results are compared to finish the thesis.

As a result, a designer who designs a library, is supposed to design the library in order to make the lighting system more productive for the users. In this study, the searcher started this with focusing human who spends her or his life in indoors and also search about importance of lighting design on human psychological and physiological needs in current libraries. According to the evaluations, special lighting systems are conceived with the knowledge and experience of the designer.

The main idea of this thesis is, light can influence much more than just users visual experience of architecture. Light find out color and it plays with texture of surface and materials. Light has also the power to influence the mood and atmosphere of space. Light can be a powerful tool to establish the kind of visual hierarchy that designers search in interior spaces. To be able to use this visual hierarchy of light successfully, so designers need to get into the minds of the users of different kinds of space.

Light can not be seen but it makes everything visible. Light is the basic element of visual perception and creates hierarchy. It separates the important from the unimportant one. It helps us to focus on something and it is a kind of natural clock for us. The changes of the daylight in 24 hours affect our bio ryhthm. Depending on the day circle, our bodies organize the time when we sleep and not. Also it provides to release the hormon like cortisol and melatonin which keep the order of this cycle. The users feel uncomfortable, tired and sleepy in the places where inefficient light. But in the places where have enough light, they feel relief and fit.

As a knowledge all human beings need light for more than just vision. There is now sound scientific evidence showing that light is actually a form of nutrition. But like the food we eat, the wrong amount can have negative effects from winter blues due to too little sunlight through to skin cancer due to too much. Artificial light at the right time with the right spectrum can make up for insufficient exposure to natural light *(Dr. Frank Schlie-Roosen, March 2014, licht. wissen 19: Impact of Light on Human Beigns, Booklet, Frankfurt).*

Also the color of light makes to perceive the place in a different way. Thus, this study is written by analyzing the spatial behaviour of the light effects, the effects on the pattern and

surface, the changes on biorythm and the perfection in schools and libraries. It is explained how the objects, their locations and dimensions affect the direction, behaviour and pattern of light. As an observer, in this study, it is shown how it affects the comment of basic question regarding the different understanding and perception of spatial concepts.

The argument in this study can formulate the visual borders as a theory. This theory makes the spatial borders visible by the lighting system and it leads the understanding to explore the spatial understanding in a clear way. The need of the places and the activities done in these places are different from each other. It is aimed to have a correct lighting system to provide physiological vision which needs to glare and the efficient light level to meet the visual needs.

One of the examples is the dynamic lighting system. Dynamic lighting will become assistive technology, used to help humans stay healthy. The advantages of dynamic lighting are shown by numerous studies worldwide and a growing number of practical applications. Modern industrial society fosters an almost 24/7 lifestyle and dynamic lighting has the ability to help us reconnect with our internal clock. The way will largely be paved by energy saving LED technology, which has the double advantage of helping reduce carbon emissions. But it would be wrong to focus exclusively on energy efficiency. Harnessing the nonvisual effects of light which were ignored in the past comes at a cost *(Dr. Frank Schlie-Roosen, March 2014, licht. wissen 19: Impact of Light on Human Beigns, Booklet, Frankfurt).* So the designers need to find a happy medium between meeting human needs and cutting energy requirements.

At this point the lighting system imitates the changing colour and location of day light which provides dynamic and productive workplaces for users. The ELI - Ergonomical Lighting Indicator-, plays a big role here. ELI, in which the lighting system gives high opinion of the user needs. ELI, is a consideration program which queries the ergonomic life, working area design, psychological needs of the users and physical needs of the users in terms of lighting. The design period of lighting system is consisting of many things. They are the function of the building, identifying the needs of the user in each workplace, architectural features, technical needs, management and investment cost, energy efficiency, and also the location and weather conditions. These things need to be reviewed and understood well.

The light, which makes everything visible by enlightening, emphasizes the spatial lighting and directing the users. This makes the users feel as if it is ambiguous, these theories can be applied by not contrasting each other. The aim is to create a more productive library environment with the new lighting system. Yaşar University library is chosen to view the effects of visual hierarchy on users. Using a flexible and testable lighting system in computer environment is suggested. So, it is planned to regain the Yaşar University Library as an ergonomical enlighted place.

Furthermore, differences were seen between architects and designers and non-professionals in the inquiries, especially in the ways they used concepts when answering a quastionnaire. The use of trained observers like designers and architects was shown to give more detailed and rich descriptions than with non-professionals.

As a result, with the quantitative and qualitative studies, this issue is approached by different ways and the findings are interpreted by questions and tests. The most important thing here is to put the results into practice. This study shows that the people need to be trained who can solve the issue and also there should be agreements on conceptual uses which need to be tested. Thus, in the future healthier, human centric, economic and ergonomic lighting system designs can be done. Also, today and future basis of architectural design phenomenon; sustainability and green environment will be supported.

7 REFERENCES

- **Gary R. Steffy, IES, IALD,** 1990, Architectural Lighting Design, United States of America, New York
- **M. David Egan,** 1976, Concepts in Architectural Lighting, Collage of Architecture Clemson University
- **Feyyaz Ataç,** 2013, Kütüphanelerde Doğal ve Yapay Aydınlatma Kriterleri: Orta Doğu Teknik Üniversitesi Merkez Kütüphanesinin Okuma Salonlarının İncelenmesi, Master Thesis, Atılım University, Social Sciences Institute.
- **Kübra Ö.,** 2008, Konut Yaşama Mekanlarında Yapay Aydınlatma: Trabzon Örneği, Master Thesis, Karadeniz Technical University, Science Institute.
- **Esra Ö.,** 2011, Doğal ve Yapay Aydınlatmanın İnsan Psikolojisi Üzerindeki Etkileri, Master Thesis, Marmara University, Fine Arts Institute.
- **Dr. Habil. András Majoros,** 2011, Artificial Lighting, Budapest University of Technology and Economics Faculty of Architecture, Department of Building Energetics and Services
- **Kristin McWilliam Bennett**, 2008, Light in Architecture: Natural and Artificial Lighting Techniques That Brighten Our Sacred Spaces, Master Thesis, The University of Utah.
- **Alpin Köknel Y., Faruk U., Feride Ş.,** 2006, Binaların Sürdürülebilirliklerinin Belirlenmesinde Aydınlatma Sistemlerinin Değerlendirilmesi, İTÜ Architecture Faculty.
- **The Royal Commission on Environmental Pollution**, 2009, Artificial Light in the Environment.
- **Jeremy BIRN**, 2003, [digital] Light & Rendering
- 1994, Encyclopedia Britannica: School and Library Subscribers, England

- Indirect schame application in interiors, 2015, Interior Lighting Design from www.isgforum.biz/calismayeriniaydinlatma (seen on December 2016, 13:42 pm)
- **Dr. Frank Schlie-Roosen,** March 2014, licht. wissen 19: Impact of Light on Human Beigns, Booklet, Frankfurt
- **Boyce P., Howlett O., Hunter C**., 2003. The Biological Potency of Light in Humans: Significance to Health and Behavior, 25th Session of CIE Proceedings, San Diego
- **Munson&Ferguson**, 1985
- **Evans,** 1981
- **Kopec,** 2006, p:60
- Zumtobel Lighting handbook, revised and updated: October 2013, 4th edition
- **David Egan**, Architectural Lighting, 1983
- **M. David Egan,** 1983, Concepts in Architectural Lighting, USA
- **William M.C Lam,** 1977, Perception and Lighting as Form Givers for Architecture, USA
- **Jeremy BIRN,** 2003, Light & Rendering
- **Malcom Innes,** 2012, Lighting for interior design
- **Fisher,** 2006
- **Lang,** 1974
- **Fonseca et al,** 2002
- **Cuttle C.,** 2003, p:18

- **Kyle Konis,** 2013, Evaluating daylighting effectiveness and occupant visual comfort in a side-lit open-plan office building in San Francisco, California, Building and Environment, USA
- **Hong Soo Lim and Gon Kim,** 2010, Predicted Performance of Shading Devices for Healthy Visual Environment, Indoor and Built Environment, London
- **M. Boubekri,** 1995, Appraisal of the Lighting Conditions in an Office Building: Results of a Survey, Indoor and Built Environment, Universty of Illnois, USA
- **Banu Manav,** 2006**,** Color-Emotion Associations and Color Preferences: A Case Study for Residences, İstanbul Kültür University, Istanbul, Turkey
- **Gökçe Erdemir,** 2014, Müze ve Sergi Mekanlarında Aydınlatma Prensiplerinin Örnek Uygulamalar Üzerinden Değerlendirilmesi, Environmental Control and Construction Technology, İstanbul Teknik University, Turkey
- The Royal Commission on Environmental Pollution**,** 2009, Artificial Light in the Environment, Book, United Kingdom
- **Dr. Habil Andras Majoros,** 2011, Artificial Lighting, Budapest University of Technology and Economics, Lecture Notes, Budapest
- Philips Lighting Academy, 2008, Basics of Light and Lighting, Netherlands
- Council on Libary and Information Resources, 2005, Library as Place: Rethinking Roles, Rethinking Space, Washington

- **Erica Marie Thum,** 2013, Light in the Landscape: Designing for Darkness, Master of Landscape Architecture, Master Thesis, Maryland
- **Dilek Şahin,** 2012, Aydınlatma Tasarımının Kullanıcı Üzerindeki Fizyolojik ve Psikolojik Etkileri Açısından İncelenmesi, Master Thesis, İstanbul Technical University, Turkey
- **Dilay Kesten,** 2006, Investigation of Efficient Lighting System Design in Educational Buildings at the Example "Municipal School of LA Tour de Salvagny", Environmental Control and Building Technology, Istanbul Technical University, Turkey
- **Robert Gifford, Linda Steg and Josep P. Reser,** 2007, Environmental Psychology, Handbook, England
- **Will Hughes,** 2008, Advanced research methods in the built environment, Journal, United Kingdom
- **Ulrika Wanström Lindh,** 2012, Light Shapes Spaces, Experience of Distribution of Light and Visual Spatial Boundaries, Book, Gothenburg
- **David Malman,** 2001-revised 2005, Lighting for Libraries, Architectural Lighting Design, California
- **Hatice Bürde Gültekin,** 2014, Light's Impact on People's Perception in Interiors, Master Thesis, Turkey

- **Fatih Us,** 2008, Mimari Mekanın Aktarımında Algılayıcı Hareketinin Önemi, Mimar Sinan Fine Arts University, Thesis of Proficiency in Art, Turkey
- **H.N. HA and P. Oliver,** 2006, Perception based Lighting Design, Informatics Research Institue, Newcastle University, UK
- **Martin Morgan Taylor,** RCEP Consultation on Artificial Light in the Environment
- Tetra Tech, 2013, Sustainable Lighting Concepts to Enhance Education Environments
- **Duff, James Mr and Kelly, Kevin Dr,** 2014, A new approach to interior lighting design: early stage research in Ireland, "SDAR* Journal of Sustainable Design & Applied Research: Vol. 2: Iss. 1, Article 3
- b,a,g & Lumitech, 2015, Human Centric Lighting, Pdf,
- **Alkistis-Zoi Skarlatou,** 2010, Light Effects in the Design Process, Thesis, London
- **Tomassoni, R., Galetta, G., & Treglia, E**, 2015, Psychology of Light: How Light Influences the Health and Psyche
- Lighting Europe German Electrical and Electronic Manufacturers Association, 2013, Human Centric Lighting: Going Beyond Energy Efficiency, Market Study, Germany
- **Stan Walerczyk, CLEP, LC,** 2012, Human Centric Lighting, Principal Lighting Wizard

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To increase my experience in the fields of architecture, lighting design and academic career. Also to work in a stimulating environment where I can apply & enhance my knowledge, skills to serve the school to the best of my efforts.

EDUCATION:

2016 – 2013: **YASAR UNIVERSITY**, İzmir/TURKEY

Graduate School of Natural and Applied Sciences (2nd year)

Expected Graduation: June 2015

2015 – 2013: **LIGHTING EDUCATION TRUST**, London/ENGLAND

in association with London South Bank University

Expected Graduation: June 2015

2009 – 2013: **YASAR UNIVERSITY**, İzmir/ TURKEY

Faculty of Architecture

2005 – 2009: **İZMİR ÖZEL TÜRK COLLEGE**, İzmir/TURKEY

Bachelor of Science

INTERNSHIP EXPERIENCES:

Summer 2012: **A Architecture**, supervised by Hale Balcıoğlu, Owner of the company

Summer 2011: A Architecture, supervised by Hale Balcıoğlu, Owner of the company

- Drawing projects such as houses and offices.

SKILLS:

Language: Turkish (native), English (%70)

Software and Tools: Autocad, Archicad, Artlantis, Rhino, Grasshopper, DiaLux, Microsoft Office Word-Powerpoint-Excel

Skills: Flexible, highly motivated, also a quick learner and dedicated to responsibilities with excellent organizational. Able to work independently and as part of a team.

SOCIAL ACTIVITIES:

Turkish National Committee of Lighting:

It is a national committee that represents our country in light and lighting platform founded in 1995. Our company is the member of this committee and I follow the meetings of this committee.

Aegean Region Chamber of Industry:

This company also has a lighting committee and accredited center. Generally, I follow the meetings of this company and try to be a part of it.

WORKSHOPS:

2013: Exterior Lighting, CIBSE/London

Interior Lighting, CIBSE/London

Daylight, London South Bank University/London

BROAD INTERESTS:

Travelling, fitness, photography.

THE LIBRARY QUESTIONNAIRE

Date:

Please circle the suitable conditions for the day of the observation.

Gender:	**Age:**	**Weather conditions:**	**Time:**
F M	18 - 22	Rainy	09:00 - 11:00
	22 - 30	Overcast	11:00 - 13:00
		Sunny	13:00 - 17:00

Please put a cross as an example is shown

1 **X** 2___ 3___ 4___ 5___

1: strongly disagree 2: disagree 3: agree or disagree 4: agree 5: strongly agree

1. The library provides enough private study places at exam times.

1___ 2___ 3___ 4___ 5___

2.Does the library have places where you can be alone if you want?

1___ 2___ 3___ 4___ 5___

3.Does the library have partitions for visual privacy?

1___ 2___ 3___ 4___ 5___

4.Does the library space provide space for you to be able to concentrate on ?

1___ 2___ 3___ 4___ 5___

5.Can you sit wherever you want in library?

1___ 2___ 3___ 4___ 5___

6.Do you usually spend your time in the library?

1___ 2___ 3___ 4___ 5___

7.Do you think that library is a comfortable place for you?

1___ 2___ 3___ 4___ 5___

8.Can you change the furniture layout in the library?

1___ 2___ 3___ 4___ 5___

9.Is library organization comfortable for you?

1___ 2___ 3___ 4___ 5___

10. Do you think the library is a pleasant for you?

1___ 2___ 3___ 4___ 5___

11. Do you think lighting (daylight/artificial light) affects your seating preference?

1___ 2___ 3___ 4___ 5___

12. Do you think that the design of the seating layout optimizes light?

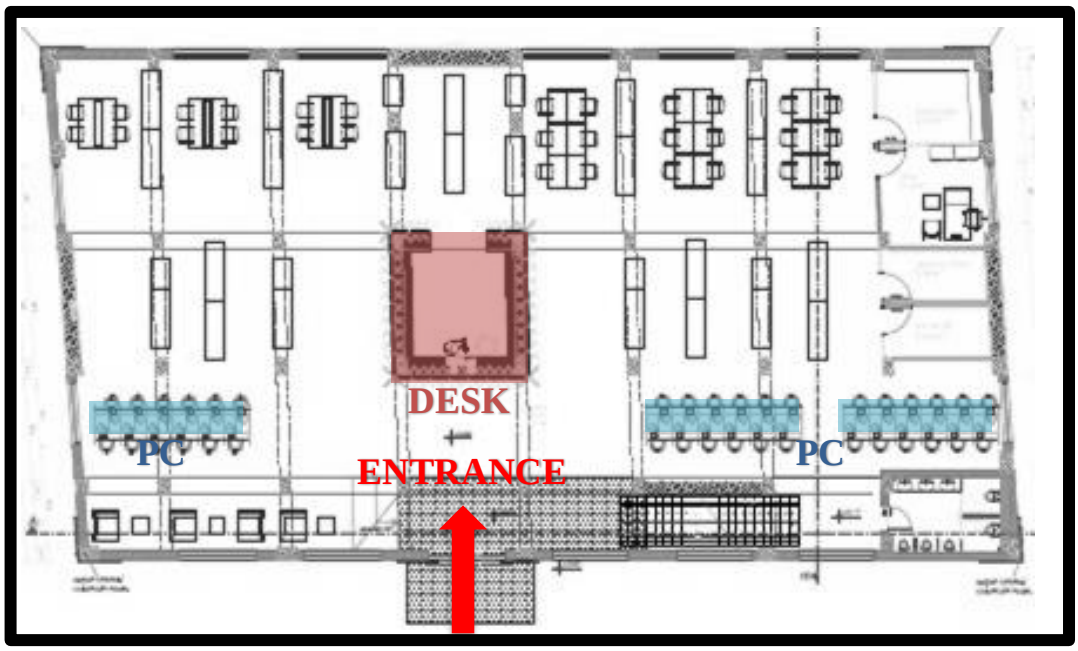
1___ 2___ 3___ 4___ 5___

13. Do you think that the design of book shelves optimizes light?

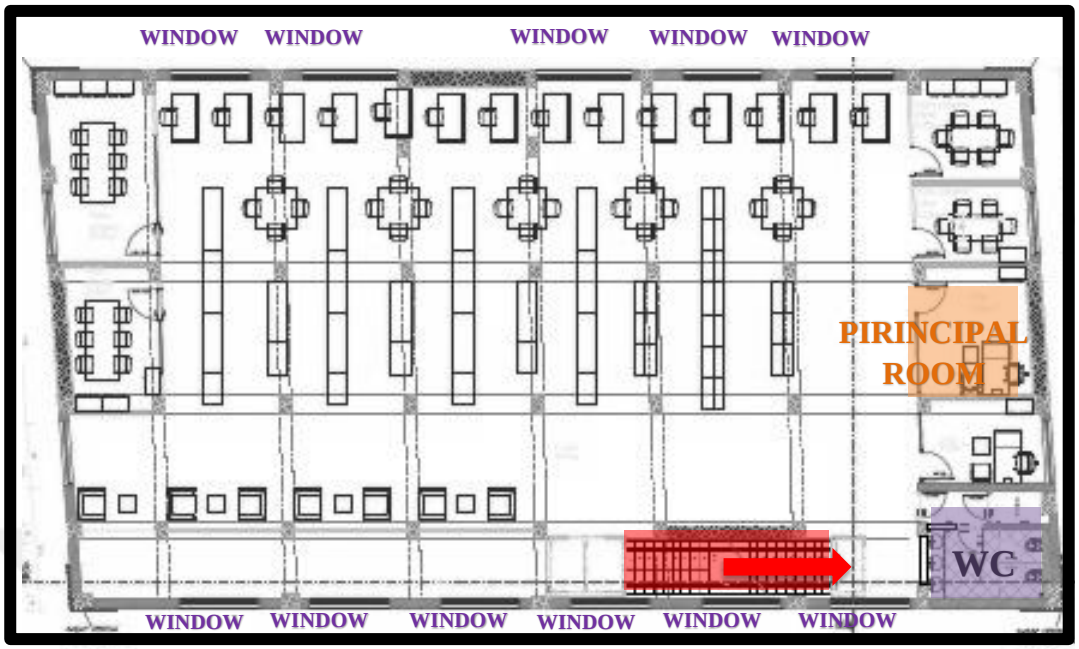
1___ 2___ 3___ 4___ 5___

14. Where do you prefer sitting between the daytime hours 09:00 – 11:00?

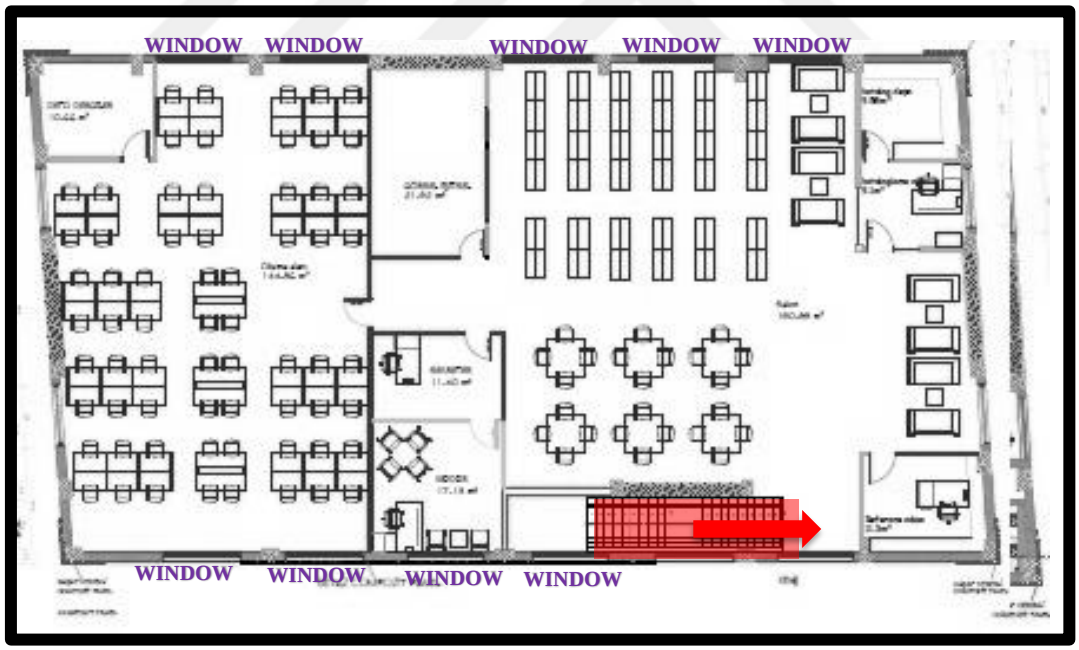
Ground Floor 1___ 2___ 3___ 4___ 5___



First Floor 1___ 2___ 3___ 4___ 5___



Second Floor 1___ 2___ 3___ 4___ 5___



15. Where do you prefer sitting between the daytime hours 11:00 – 13:00?

Ground Floor First Floor Second Floor

1___ 2___ 3___ 4___ 5___ 1___ 2___ 3___ 4___ 5___ 1___ 2___ 3___ 4___ 5__

16. Where do you prefer sitting between the daytime hours 13:00 – 17:00?

Ground Floor	First Floor	Second Floor
1___ 2___ 3___ 4___ 5___	1___ 2___ 3___ 4___ 5___	1___ 2___ 3___ 4___ 5__

17. Your impressions of the space now

Very unpleasant 1 2 3 4 5 very pleasant

Not enough light 1 2 3 4 5 too much light

1**8.**Writing, reading and paperwork at main area

A.Is light enough?

Not enough light 1 2 3 4 5 too much light

B.The brightness of this area in relation to the rest of the room?

Too bright 1 2 3 4 5 too dark

19. Computer work and looking at the computer screen

A.Is light enough?

Not enough light 1 2 3 4 5 too much light

20. There is a glare from windows

Too strong glare 1 2 3 4 5 no glare

THANK YOU FOR SUPPORTING

THIS SURVEY…