

**EFFECTIVENESS OF RETAIL LIGHTING IN
TERMS OF USER SATISFACTION AND LIGHT
QUALITY**

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ABSTRACT

EFFECTIVENESS OF RETAIL LIGHTING IN TERMS OF USER SATISFACTION AND LIGHT QUALITY

The primary purpose of lighting design is to create visuality that can perform different tasks and perceive spaces and objects it means that visual comfort conditions. Visual comfort related with the quantity and quality of light. There are some points to be considered in order to ensure the lighting design that changes/determines according to the standards of each environment: light amount, color, direction, color rendering, and uniformity of light. All these determine the quality of lighting in the environment.

Effectiveness of retail lighting related with how to design retail stores. In this study, which examines the effect of retail lighting in terms of human satisfaction and light quality, firstly what lighting is, its purposes and benefits are discussed. Then, necessary visual comfort conditions for stores, brand images and strategies, standards and requirements of lighting designs for customers are mentioned. This information was gathered by examining the main sources of lighting standards.

In the studies conducted on this subject, it has been determined that there are incomplete studies examining "different age groups, socio-cultural groups, different store profiles, daylight effects and customer/employee satisfaction". For this reason, a survey was conducted in Boyner and DeFacto stores in İzmir Westpark AVM to support the study, and it was emphasized the effectiveness of lighting designs in terms of users' satisfaction and light quality.

ÖZET

MAĞAZA AYDINLATMASININ KULLANICI MEMNUNİYETİ VE IŞIK KALİTESİ AÇISINDAN ETKİNLİĞİ

Aydınlatma tasarımının temel amacı, farklı görevleri yerine getirebilen, mekan ve nesnelere algılayabilen görsellik oluşturmak, bunu yaparken de görsel konfor koşullarını sağlamaktır. Işığın miktarı ve kalitesi görsel konfor ile ilgilidir. Her ortamın standartlarına göre değişen/belirlenen aydınlatma tasarımının sağlanması için dikkat edilmesi gereken bazı noktalar vardır: ışık miktarı, rengi, yönü, renksel geriverimi, ışığın tekdüzeliği gibi. Tüm bunlar ortamdaki aydınlatmanın kalitesini belirler.

Mağaza aydınlatmasının etkisi, mağazaların nasıl tasarlanacağı ile ilgilidir. İnsan memnuniyeti ve ışık kalitesi açısından mağaza aydınlatmasının etkisini inceleyen bu çalışmada, öncelikle aydınlatmanın ne olduğu, amaçları ve faydaları ele alınmaktadır. Daha sonra, mağazalar için gerekli görsel konfor koşulları, marka imajları ve müşteriler için aydınlatma tasarımlarının stratejileri, standartları ve gereksinimlerinden bahsedilmiştir. Bu bilgiler, aydınlatma standartlarının ana kaynakları incelenerek toplanmıştır.

Bu konuda yapılan araştırmalarda, “farklı yaş grupları, sosyo-kültürel gruplar, farklı mağaza profilleri, gün ışığı etkileri ve müşteri/çalışan algısının” incelendiği eksik çalışmaların olduğu tespit edilmiştir. O sebeple, çalışmayı desteklemek amacıyla İzmir Westpark AVM’de bulunan Boyner ve DeFacto mağazalarında anket çalışması yapılmış olup, aydınlatma tasarımlarının kullanıcıların memnuniyet ve ışık kalitesi açısından etkinliği üzerinde durulmuştur.

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CHAPTER 1

INTRODUCTION

1.1. Problem Statement

In architecture, light has an important role for designing visual environment and adequate lighting must be provided for visual comfort (Fördergemeinschaft Gutes Licht, 2008). The lighting design used when designing the interior is a very important detail especially for commercially used spaces (Moazemi, 2013). Visual comfort can be measurable for some properties such as brightness level, smoothness, glare, color of the light source or color rendering. Lighting for different designs can be provided in which visual functions by ensuring proper illumination levels determined by the standards for different activities, proper lighting of the space, and choosing the right color lamp (Şahin, 2012). It can affect aesthetics, visibility, focusing of space due to it affects human satisfaction. Recent days, one of the important parts of effectiveness in lighting on human satisfaction is 'retail lighting' which means illumination of shopping areas. Use of lighting is integrated with retail experiences.

Cuttle (2003) stated that the purpose of lighting is to make the perceived space effective for users and to provide the required level of illumination. The aim of this approach is to determine how much lux is needed for the required level of brightness. If these visual comfort requirements are met; increases eyesight, psychological visual comfort (user feels happy in the environment), a sense of security is provided (Şahin, 2012). Retail lighting related with these conditions because accurate lighting is influencing the eyesight. The visual acuity of the eye is influenced by some criteria such as contrast, shape sensitivity, and detection speed. These can be increased or optimized by accurate lighting. Quantitative and qualitative requirements, as well as the desired level of luminance, must be met for proper lighting applications. These requirements are based on the three basic needs of human being: visual comfort, visual performance, and safety (EN 12464-1, 2019). Light and color have an impact on the mood and satisfaction of a human, in the creation of the atmosphere of the space, in the perception of it as a hot or cold space. The appropriate color temperature should be selected according to the

characteristics and function of the place to be illuminated (Fördergemeinschaft Gutes Licht, 2008).

The illumination of spaces depends not only on the level of illumination, but also on factors such as light direction, shadow, and contrast. The unbalanced use of these factors may create some problems in terms of perception and visual comfort. For example, one of the lighting problems occurring in retail stores is the inability to achieve homogeneous distribution. This is usually due to excessive spot use (Ampenbergera et al., 2016). Although uniform lighting sometimes creates an effect of spaciousness to provide perceptual clarity, non-uniform lighting can also be enjoyed, and a nice ambiance can be created. However, attention should be paid to the color of the light used when designing lighting, because color inconsistency affects the appearance of the products (Hinks & Shamey, 2011). Brands target all the senses of the consumer and use lighting techniques for this purpose. Lighting directly affects people's mood and satisfaction. Retail lighting techniques affect factors such as the comfort, liveliness, emphasis, etc. of the environment (Schielke & Leudesdorff, 2014). The effects of store lighting can occur at perceptual, emotional, and behavioral levels. It deals with how the store is perceived, how people react emotionally while shopping, and how customers behave in the store environment (Quartier et al., 2014). When lighting and product qualities are used together as an architectural element, a suitable environment can be provided for the consumer. To ensure effective communication and a consistent image, it is important to implement modern lighting options with appropriate strategies. Thus, color, texture, and light play a critical role in designing space to live. The same criteria are valid for retail stores. It is clear in the literature that importance of the direction of the light from the lighting criteria, glare, brightness level, and so on. Şener Yılmaz (2018) emphasis that the lighting systems used to create an atmosphere that emphasizes the character of the store should be designed for shopping and to ensure the correct perception of the qualities of the products in that store, and to minimize glare problems. For lighting design, it is important that artificial light sources are used together with the correct color rendering index value. For example, one of the lighting problems occurring in retail stores is the inability to achieve homogeneous distribution. This is usually due to excessive spot use (Ampenbergera et al., 2016).

On the other hand, to define the impact on space some points should consider such as ambience, color temperature, and the material of the surface of the texture. In addition, color temperature, and brightness levels are important, too. If the colors are warm and

light's tones are down, it will be helping to create impressive look that is choosing to importantly lower brightness of lights. Color temperature influences the perception of quality of the product. While thinking color temperature and brightness, material types also considered. Choosing material is another important point for affecting human perception and ambience because the surface of the material may affect the illumination with the surface of the material may affect its reflectivity. That's why, while designing the lighting in a store, the level of illumination should be chosen according to the space, and if it is necessary to emphasize the importance of the material used in the spaces, light orientation should be provided in order to perceive the shape and details. Thus, all this affect the ambience of the store and users' satisfaction.

Light is the most important factor in retail lighting, especially in perceiving the space. The direction of the light in a store, its color, the texture of the materials in the environment, etc. are the spatial qualities of that store. Since perception is a visual and psychological process in seeing and understanding the space, it has an important meaning for the experiences in the space and satisfaction. The result of spatial experience can be thought of as an interpretation of satisfaction (Lindh, 2012; Gültekin, 2014).

Among the sales strategies in a retail store, lighting is of great importance because it is the lighting that provides the interaction between the customer and the space. Environmental factors should also be considered in the lighting design, which is aimed to understand the color and texture of the products correctly. For example, lighting designs can change according to the season, the color of the product displayed, and the store format (Ramachandran, 2013).

1.2. Purpose of the Study

Considering the interaction between human physiology/psychology and light, better quality and comfortable living spaces can be created for human beings with the lighting systems designed. The change in light color and level affects mood, satisfaction and emotions. The physiological and psychological effects of light on human beings are trying to be used to facilitate human life and increase the quality.

The function of the lighting design process is to take into account the design criteria such as for which activities and at what time of day, the user needs of each space in the building, architectural features and technical requirements. The illumination of

spaces depends not only on the level of illumination, but also some factors such as light direction, shadow, and contrast. The unbalanced use of these factors may create some problems in terms of visual comfort. The topics covered in this study show that lighting design affects customer satisfaction. For this purpose, considering the deficiencies in the selected examples and researches in this study, a contemporary interpretation has been brought to the subject by emphasizing how customer satisfaction changes according to the lighting criteria. Considering all the factors, this study aims to determine the effective lighting design strategy in retail and to explore its effect on users' satisfaction and light quality in the retail environment

1.3. Structure of Thesis

In the first chapter, the subject of the thesis, the definition of the problem, its purpose and structure are mentioned.

In the second part, the literature review about the subject of the thesis. Firstly, basic information about lighting is mentioned and then store lighting conditions, strategies, standards, and requirements are given. It is presented with examples from previous studies and researches.

In the third part, the lighting conditions of Boyner and DeFacto stores, where the survey was conducted, was explained. Also, the survey and participant profiles were mentioned This survey was conducted when the first pandemic case was seen and there are no restrictions in Turkey.

In the fourth chapter, the survey results and analyzes of the thesis are presented in detail and comparatively.

In the last part, the conclusion of the thesis, the studies done so far, and the data obtained are mentioned. The purpose and contribution of the study is discussed.

CHAPTER 2

LITERATURE REVIEW

2.1. Light and Vision

Light is one of the most important elements in perceiving any space or object. Senses are used to perceive anything, but there is no visual perception without light.

Light is a type of energy that affects the eye and spreads in waves, and these waves are called electromagnetic waves (Taylor, 2000). Vision begins with the entry of these electromagnetic waves (light rays) into the eye and ends with their perception in the brain.

Light emits energy at all wavelengths but appears in a different color in the range of 380-780 nm (nanometers) (Figure 2.1). This is called 'visible light' (Zumtobel, 2013).

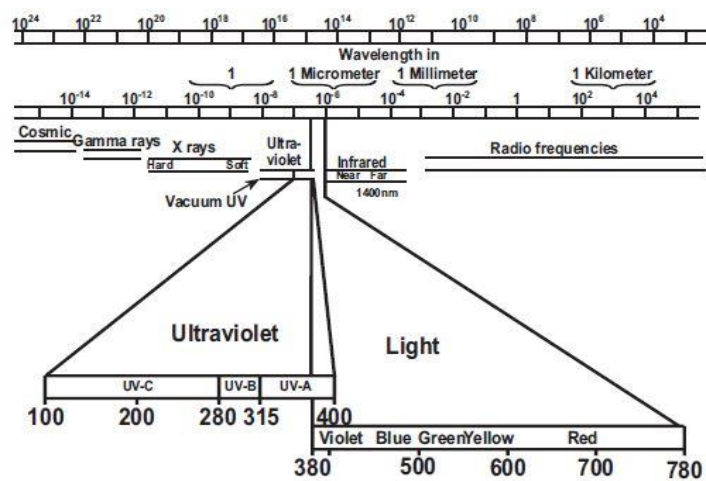


Figure 2.1. Electromagnetic Spectrum.
(Source: Taylor, 2000)

Lighting is the application of light to ensure the correct perception of the environment or objects. A simple model of human visual perception process is shown in Figure 2.2. It has three main effects: visual, biological, and emotional. In the visual function, it is aimed that the light be compatible with the relevant area, be useful, not glare and be comfortable. It is possible to say that it has a biologically stimulating and

relaxing effect. Emotionally, it is used to create perception and effect, especially in the architectural field. Therefore, good lighting has some benefits in our social life. For example, it protects eye health, improves eyesight, increases work efficiency, increases economic potential, etc. (Zumtobel, 2013).

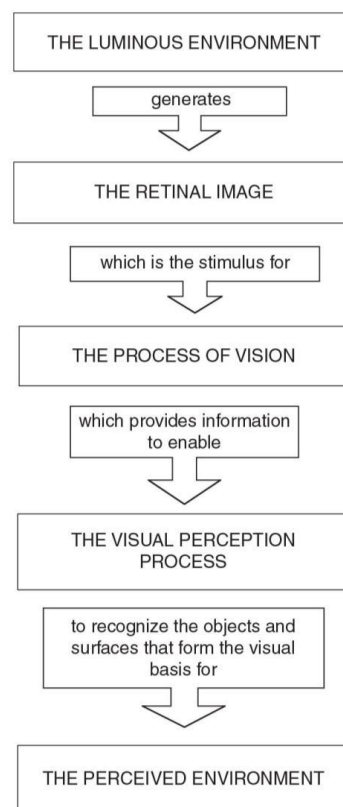


Figure 2.2. A simple model of the human visual perception process.
(Source: Cuttle, 2003)

2.2. Types of lighting according to the Aim of Lighting System

Lighting types can be categorized differently. For example, when sorted according to light sources, it can be divided into daylight, artificial lighting, integrated lighting. Natural lighting is the illumination of indoor areas with daylight. On the other hand, artificial lighting, is a type of lighting that is used as an alternative to natural lighting when there is no daylight and helps to illuminate dark places and provide visual comfort. Integrated is the lighting in which natural lighting is insufficient and used together with artificial lighting.

According to the illuminated area, it can be grouped as interior lighting and exterior lighting. While indoor lighting is the type of lighting made indoors independently of the external environment, outdoor lighting covers the lighting of the outdoor space independent of the indoor area.

In order to provide a good and correct image, it can be divided into three as physiological, decorative, and striking lighting in terms of its purpose. The purpose of physiological lighting is to provide fast perception of objects with details such as color and shape. The purpose of decorative lighting, which is mostly used in architectural sense, is not to show details, but to create aesthetic and attractive effects and increase memorability. For attractive lighting, as the name suggests, it is used in lighting, which has a striking purpose, to draw attention to the objects or objects in the space or to advertise without being concerned about detail and aesthetics. Flashing lights, high illuminance levels, etc. are used to attract attention (Şahin, 2012; Moazemi, 2013; Acar, 2017).

2.3. The Effect of Light and Color on Perception

Each light source emits different colors of light, and light color is measured by color temperature; its unit is K (Kelvin). Light and color have an impact on people's psychology and mood, as well as the perception of warm or cold space atmosphere. It is possible to say that efficiency increases when the appropriate color temperature is selected according to the functions of the spaces to be illuminated. Colors with a correlated color temperature below 3300K are warm (usually more yellow), while those with a CCT above 5300K are cool (bluer). More precisely, it is determined by the degree of Kelvin (Table 2.1) (Taylor, 2000).

Table 2.1. Light source color appearance groups.
(Source: EN12464-1)

Color appearance	Correlated color temperature
Warm	below 3300 K
Intermediate	3300 to 5300 K
Cool	above 5300 K

Color temperature can be chosen according to the quality of the product, the customer's preference, or the designer's preferences (IESNA 2011). For this reason, the use of light and color together in retail lighting design is done with the aim of increasing customer attraction (Tantanatewin & Inkarojrit, 2016).

How a space is perceived is explained by the effect of light on the space. Light, which is one of the most important factors in perception, is also an important part of the design process because it has a psychological and aesthetic effect as well as its physical dimension. For example, it has an effect on people with its relaxing/disturbing, refreshing and peaceful properties, and the factors that affect this mood also affect perception (Moazemi, 2013). Lighting, designed in harmony with architectural geometry, affects how the environment is perceived and our reactions (Aşçıoğlu, 2014).

Color, which is one of the important factors of light, provides an aesthetic feature according to the interaction of the users and the function of the space. For example, while blue and green light provide comfort and calmness; Colors such as red, orange, and yellow create a warm, active and exciting environment, allowing users to be cheerful in the space (Baker, 2002).

Since the use of light and color are important design techniques aimed at attracting customers in retail design, it can be said that they also affect the perception of space (Tantanatewin & Inkarojrit, 2016). When using color, care should be taken to ensure that the color transitions in the stores are light and smooth, because when there are sudden and hard transitions, the attention of customers can be distracted (Aşçıoğlu, 2014).

2.4. Colors

In some sources, the wavelengths of the colors are violet between 380–450 nm, blue between 450–500 nm, green between 500–570 nm, yellow between 570–590 nm, orange between 590–650 nm, and red between 650–780 nm. (Moazemi, 2013).

The color of objects is made up of the light they reflect from their surface. Accurate perception of the colors of the objects viewed or the surrounding environment is very important in terms of visual performance. This situation, the definition of the color characteristic of the light source, is related to the color rendering index. In any environment, color perception should be as sensitive as possible, it means that, correct color perception should be provided. These are the color rendering properties of the light

source and are expressed as the "Color Rendering Index" (Ra). A light source with Ra = 100 shows all colors, as well as with all their reality, and as the Ra value decreases, the correct perception of colors decreases. The CRI value of daylight is considered 100. In addition, the CRI is affected by the material and the color (e.g., optics, glass, colored surfaces) (EN 12464-1, 2019).

2.4.1. Color Psychology

In terms of positive image and reliability, cold colors are used while for excitement, it is possible to say that warm colors are effective (Bellizzi & Hite, 1992).

According to Hidayetoğlu et al. (2012) examined the effect of light and color on perception in various indoor environments. For example, the study examined the effect of yellow and purple colors, which are semi-warm and half-cold tones, in cafe/restaurant environments, and suggested that the purple environment is perceived more positively than the yellow environment. Differently, they stated that the colors on the walls in hairdressers also affect the perception, and the perception of the lilac-colored space is more positive than the colors such as cream-lilac-orange.

In summary, it is possible to say that cold colors (such as blue, purple, green) have a more positive effect than warm colors (such as red, orange, yellow) as they have a calm, unexciting and relaxing effect. (Bellizzi & Hite, 1992).

2.4.2. Spatial Effect of Colors

Lighting variables have a direct effect on all areas related to color (Hinks & Shamey, 2011). Colors of areas such as walls, floors and ceilings in the environment have an important effect on perception as much as the products on display. For example, when entering a space, observation starts from the walls, then ceilings and floors follow (Acar, 2017). Therefore, the colors used can provide effects such as depth, spaciousness, attractiveness/repelling. Acar (2017) mentioned in his study that warm colors cause the space to be perceived lower, while cold colors cause the space to be perceived higher. (Details about this study are given in the "2.7. Examples" section.)

Black, white and lead colors are neutral colors. These have a relaxing, satisfying, mature effect as well as helping to create various colors. While black is feeling depth and darkness in spaces, white creates an effect like lightness and cleanliness (Gündüz, 2016).

2.4.3. Psychological Effect of Colors

There are some symbolic meanings attributed to colors. It is possible to say that we are under the influence of these meanings, not completely, psychologically. For instance, while the “red” has meanings such as love, romance, blood, struggle, movement, fire, danger, the “yellow” has meanings such as being careful and moving. “Blue” is generally used for elements such as water and air, giving the effect of peace and calming; “green” has meanings such as nature, peace and trust. “Orange” wealth, productivity, joy; “purple” restlessness, mysticism; pink kindness, timidity; “white” purity, cleanliness; “black” seriousness, nobility, fear, darkness; “gray” can be used for many meanings such as neutrality etc. (Acar, 2017).

As a result of some studies and psychological researches, it is possible to say that colors have an effect on people's moods and perceptions. For example, in one study, warm colors are used to reintegrate patients who are detached from life in mental hospitals into society, while cold colors are used as a treatment tool for aggressive patients. In another example, it is determined that the yellow color creates a hurting effect on children, and most of the toys of the children are broken in the playroom painted with yellow color (Acar, 2017).

Another point of view, colors are related to the illuminance level of the light, and the illuminance level changes as warm and cold. While warm colored lights do not disturb people even at low levels, cold colors can be repulsive. High-level warm colors can also be overwhelming (Onuk, 2008).

2.5. Lighting in Stores

Lighting design in stores should be done considering the needs of the users. The main ones of these needs are the provision of adequate visual performance, visual comfort conditions and safety (EN 12464-, 2019).

Lighting is an effective stimulant for retail environments as it affects emotions, mood, spatial perceptions and consumer behavior (Şener Yılmaz, 2018). Many studies in this area argue that lighting design affects consumer behavior and quality perception in the store (Barati et al., 2017).

The main purpose of retail lighting is to attract attention, highlight products and provide ambient lighting. While designing lighting in stores, it should be given importance to make designs suitable for examining the characteristics of the products that emphasize the character of the store and create the desire for shopping (IESNA, 2011). In the European Standards EN 12464-1, it defines the requirements that must be complied with in order to obtain suitable lighting solutions in terms of lighting quantity and quality of interior designs. These requirements define the parameters that make up the light environment in a space: illuminance level, glare, color of light, color rendering index value, daylight, shadow, and flicker (EN 12464-1, 2019).

- **Illuminance level**

The level of illumination in a place enables the perception of that environment and enables the users to perform their movements comfortably and safely. According to EN 12464-1, the environment must be illuminated at a minimum level of 20 lx just to detect the environment. The lighting levels required change according to the characteristics of the environment. For instance, 200 lx is required for general use areas, 300 lx for office areas, 300-500 lx for retail areas, 500-700 lx for work areas, 1000-1500 lx for environments requiring fine workmanship (EN 12464-1, 2019).

- **Glare**

While designing lighting, the most comfortable design should be made for people by considering the existing international standards as well as the formal and functional characteristics of the space. While providing the desired qualities for the light environment, factors such as visual comfort and visual performance should also be considered. Considering the volume of the space, the necessary illuminance levels should be created.

Eyesight is affected by glare, so designs that increase glare should be avoided as the glare at the time of vision affects visual comfort. The reflection coefficients of the surfaces are given in Table 2.2. In fact, materials should be used considering the light reflection coefficient determined for the interior surfaces, and the designs should be made accordingly.

Table 2.2. Reflectance of Surfaces.
(Source: EN 12464-1, 2019)

	Reflectance of surface
Ceiling	0.7-0.9
Wall	0.5-0.8
Floor	0.2-0.6
Objects in work plane / space	0.2-0.7

*In addition to these, the reflectance value of transparent interior glasses is 0.1.

Glare is formed by the reflection of light from the surfaces and is divided into two as disability glare and discomfort glare. Disability Glare is caused by the scattering of light too much for the eye to see, while discomfort glare describes visual disturbance while not affecting visibility and visual performance. Glare should be controlled in order to minimize errors and avoid discomfort in the environment (EN 12464-1, 2019). Glare can be caused by luminaires without glare control as well as shiny or reflective surfaces. In order to prevent this, it may be necessary to choose luminaires that are suitable for the space and have limited brightness levels (Zumtobel, 2013). Glare coefficient and glare degree are given in Table 2.3.

Table 2.3. Glare Coefficient and Glare Degree.
(Source: IESNA, 2011)

Glare Coefficient (G)	Glare Degree
>600	Unbearable discomfort
600	Almost unbearable
600-150	Disturbing
150	Almost irritating
150-35	Distracting but not irritating
35	acceptable
35-8	Acceptable but not imperceptible
8	Almost imperceptible
<8	No glare

- **Light color**

The color of light is measured by color temperature. At the same time, it can be examined the color of light under two sub-headings as “appearance” and “temperature”.

Appearance is the color in which light is perceived after it is emitted from its source. It can be categorized the colors as warm, intermediate and cold. Colors up to 3300K are defined as warm, colors between 3300K and 5300K are warm, and colors above 5300K are cold colors. Generally, cold colored lights are preferred in hot climates and warm colored lights are preferred in cold climates. While choosing the color, designs should be made according to the effect of the color of the space and furniture on the environment, considering the psychological and aesthetic factors (EN 12464-1, 2019).

- **Color Rendering Index (CRI)**

Color rendering index is a criterion for the correct perception of colors. It is denoted by “Ra” and takes a value ranging from 1-100. Daylight has a CRI of 100, which is considered perfect.

Lamps between 90-100 CRI are considered 1A class; they are great and can be used comfortably where precise color contrast is required, and fine perception is required. Lamps from 80-89 CRI are 1B class; good and a suitable range to ensure accurate color perception. Lamps between 60-79 CRI are considered 2nd class; normal, suitable for places that require medium color rendering, but not when critical decisions about colors are to be made. It is 3rd class between 40-59 CRI; low, therefore it is suitable for use in places where color rendering and color differences are small. Finally, 20-39 CRI is 4th class, the poorest group. It can be used in environments that do not require color rendering at all (IESNA, 2011; EN 12464-1, 2019).

- **Flicker**

Flickering occurs when lamps emit low-frequency light. Therefore, the use of high-frequency light is effective in preventing physiological disorders such as headaches (EN 12464-1, 2019). Unnecessary flickers should be avoided because the human brain perceives flickers. The flashing of the light may cause false perception for people working or walking under the light. This problem is mostly seen in discharge lamps (İmert, 2008).

- **Daylight**

It is important to use daylight in store lighting in terms of not only glare prevention, but also visual comfort and energy efficiency (EN 12464-1, 2019).

•Shadow

Light falling on objects creates shadows (Figure 2.3). Although it is tiring in some cases, shadows are used to attract attention in exhibition areas such as showcases (EN 12464-1, 2019). In other words, shadow can complement lighting.



Figure 2.3. Effect of shadow on lighting.
(Source: Sirel, 2001)

Choosing the right lighting is important in retail stores, it can lead customers inside by creating the character of the store and being attractive and directing. While doing these, they should have light and color, contrast, and balance. For example, having too much emphasis means about there is not contrast, and focus. (Miller, 2014).

A well-designed store can create a positive mood for customers with the atmosphere it creates. There are different assumptions about these. For example, a good lighting design can encourage the consumer to spend more time, examine more products, and even make more purchases (Margues et al., 2013).

2.5.1. Strategies-How to Illuminate Stores?

In order to obtain a visually comfortable environment, lighting should be made in accordance with the purpose of the place, and this should be considered from the design stage. Because with lighting can be created many effects in the environment such as excitement, positive mood and orientation. Different lighting designs will not only affect shopping behaviors, but also have an important effect on the visibility of products in terms of brand identities. Therefore, there is a relationship between the perception of bright environment, perceived product quality and customer satisfaction. (Şener Yılmaz, 2018).

Some important questions should be addressed when designing lighting in stores. For example, what are the lighting design strategies, can it affect the perceptions/satisfaction of the customers, does it affect the price perception, does it affect the quality perception etc. (Şener Yılmaz, 2018).

Since shelf, cash register and counter areas are the most important places in retail stores, it is important to make lighting in these places in a way that will increase the attractiveness and emphasize the products. Glare and sparkle help the setting look lively and dynamic. In order to make this emphasis visible, 3-5 times higher light than the ambient light should be used, and color temperature and CRI values should be considered. (Contechlighting, 2017; Custers et al., 2010)

2.5.2. Lamp Types and Luminaires

Luminaires can be classified according to their different characteristics:

- Lamp type (incandescent, tungsten halogen, FL, CFL, HID, LED, etc.)
- Structure (direct, indirect, general etc.)
- Application and Installation (downlighting, wall washing, accent light, spotlight etc.) (recessed or surface mounted, wall mounted etc.) (Halonen et al., 210)

Lamp types are tools that produce light with electricity. The lamps, that provide illumination, can be divided into 3 main categories as incandescent, discharge and solid-state. While incandescent lamps give light with the heating and glow of the filament in the lamp, discharge lamps provide illumination by ionizing the gas inside. Solid-state lamps, on the other hand, use "electroluminescence" to produce light from electrical energy (Taylor, 2000).

2.5.2.1. Incandescent lamps

Incandescent lamps make the filament incandescent using electric current and contain noble gases such as nitrogen and argon. There are also some that contain xenon, although rarely, and they are also called 'xenon lamps' (Taylor, 2000).

Halogen lamps are like incandescent lamps, but they contain halogens such as iodine and bromine, not noble gases. There are some differences between incandescent lamps and halogen lamps: for example, while the vaporized gas in the incandescent lamp

accumulates on the wall of the bulb, it accumulates in the filament in halogen lamps, so halogen lamps are cleaner. At the same time, halogen lamps have a longer life. Since it has a higher color temperature than incandescent lamps, it produces cooler/white light (Taylor, 2000). Halogen lamps, which can be used not only in retail areas, but also in homes, even for decorative purposes, have an excellent CRI value compared to incandescent lamps (Zumtobel, 2013). Typical incandescent lamp construction and common shapes of incandescent lamps are shown in Figure 2.4 and Figure 2.5.

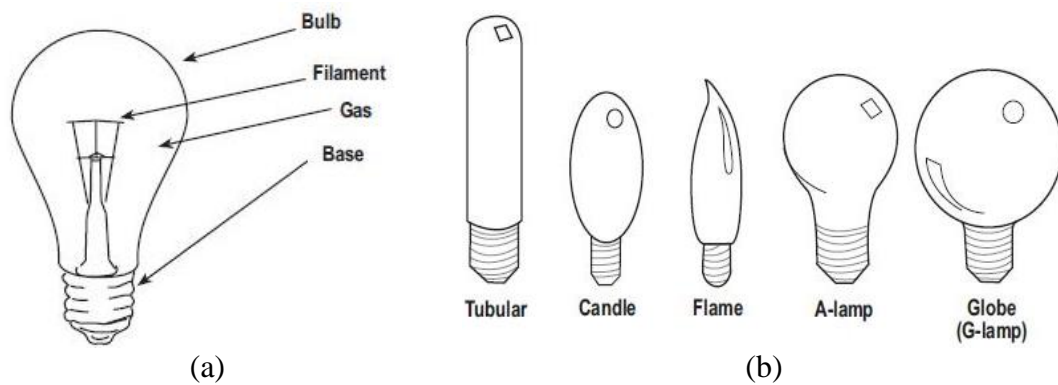


Figure 2.4. (a) Construction of a typical incandescent lamp; (b) Common shapes of incandescent lamps (Source: Taylor, 2000).



Figure 2.5. Examples of halogen incandescent lamps. (Source: Zumtobel, 2013)

2.5.2.2. Discharge Lamps

Lamps that emit light from ionized gases with the effect of electric current are called discharge lamps. It is divided into two as high-intensity and fluorescent lamps.

High-intensity lamps (HID) are also divided into four: metal halide lamps, high-pressure sodium lamps, high-pressure mercury-vapor lamps, and xenon lamps (Taylor, 2000).

Metal halide lamps are halogen-containing mercury-vapor lamps. It is called 'metal halide' because it contains metal components to increase color and light efficiency. The material contained in metal halide lamps determines the luminous quality (Zumtobel, 2013). High pressure sodium lamps contain mercury and sodium vapors. These lamps, which are generally used in outdoor lighting, have high luminous efficiency. It is light yellowish in color and has a long usage time (Zumtobel, 2013). In high-pressure mercury-vapor lamps, the light is produced with the help of gaseous mercury. Finally, xenon lamps, unlike others, contain xenon gas, and xenon gas is a gas kept at a pressure of several atmospheres (Taylor, 2000). Examples of metal halide lamps are shown in Figure 2.6.

Fluorescent lamps operate with magnetic and electronic ballasts and contain small amounts of inert gas and low-pressure mercury vapor (Taylor, 2000). Its CRI values are very good, and it has very high luminous efficiency (Zumtobel, 2013). (Figure 2.7)



Figure 2.6. Examples of metal halide lamps.
(Source: Zumtobel, 2013)



Figure 2.7. Examples of fluorescent lamps.
(Source: Zumtobel, 2013)

2.5.2.3. Solid-state lamps

The most well-known are LED lights. In other words, light emitting diodes. Small and durable, LEDs are solid-state semiconductors and convert electrical energy directly into light energy. LEDs, which produce light in different colors, have a lifespan of approximately 100,000 hours (Taylor, 2000).

LED lighting can be used for both general lighting and special purpose lighting because it can produce multiple colors (Gündüz,2016). Unlike traditional light sources, LED lights offer designers the flexibility to change, thus creating different moods in the store. In fact, it helps to provide a pleasant shopping environment by improving the colors and textures of the products.

The most preferred reasons for LED lighting are that they consume less energy and last longer. At the same time, it emits about seven times lighter and emits less heat than incandescent lamps, so the light given by a 100-watt incandescent lamp which can give 13-watt LED light. It can be said that it is quite advantageous as it contains less mercury and does not vibrate compared to fluorescent lamps (Gündüz, 2016; Sherburne, 2018). In summary, LED lights provide many gains such as efficiency, color, size, long life. (Sahin, 2012). Examples of LED lamps and luminaires are shown in Figure 2.8.



Figure 2.8. Examples of LED lamps and devices.
(Source: Zumtobel, 2013)

The color rendering index of each lamp type is different from each other. Table 2.3 shows the CRI value of each lamp type.

Table 2.4 CRI values of lamps.
(Source: Zumtobel, 2013)

Color rendering Index (Ra)	≥90	80-90	70-79	60-69	40-59	20-39
Daylight	✓					
Halogen lamps	✓	✓				
Metal halide lamp	✓	✓				
High pressure sodium lamp		✓				
High pressure mercury lamp						
Fluorescent lamp	✓	✓				
LED	✓	✓	✓			

2.5.2.4 Fiber Optic Lamps

Unlike conventional lights, it transmits light via fiber cables (hence glass surfaces) and is positioned quite far from its source. They can be used for both enlightenment and aesthetic purposes. Since they do not carry heat, they can be positioned close to the products as they will not cause any deterioration on the products. Fiber optic lamps, which can reach many points from a single source, are suitable for use in hard-to-reach areas, since the components attached to the cable ends are quite small (Şahin, 2012).

Fiber optic lamps consist of 3 components: the light source, the fiber harness, and the terminator (the component attached to the end of the wiring harness) (Figure 2.9). They are generally used in window lighting. (Sahin, 2012; IESNA,2011)



Figure 2.9. Fiber Optic Components.
(Source: Şahin, 2012)

2.5.2.5 Structure of Luminaires and Lamps

When designing lighting in any space, lamps and fixtures are often used together, because fixtures also have an impact on the lighting design. For instance, it helps to provide aesthetics and comfort by preventing glare while physically protecting the lamp. At the same time, the type of luminaires is one of the most important elements affecting the lighting. Since the chosen luminaire affects the light distribution, it is also directly effective in lighting design (Aşçıoğlu, 2014; IESNA, 2011).

Different lighting styles have emerged due to the structures of the luminaires used in these lighting designs that provide visual comfort conditions. These are: direct lighting, semi-direct lighting, mixed lighting; semi-indirect lighting is indirect lighting (IESNA, 2011; Moazemi,2013). Table 2.5 shows the classification for indoor luminaires.

-Direct lighting: It is the illumination that occurs when the light is directed downwards from the luminaires 90%-100%. More efficiency is obtained with less energy. However, since the light comes directly, it creates harsh shadows and can cause glare. To prevent glare, the lamps can be placed deep into the luminaires, or the number of luminaires can be increased. This lighting, which provides a high level of illumination, is mostly preferred in places with high ceiling heights (such as factories, hospitals).

-Semi-direct lighting: 60-90% of the light is downwards, and 10%-40% of the light also illuminates the ceiling and upper walls with a small component inside. Since some of the light comes by reflecting, sharp shadow boundaries do not occur, it is softer. It is preferred in places such as stores and restaurants, as it partially prevents glare.

-Direct indirect lighting: Lighting that emits very little light at angles close to horizontal.

-General diffused lighting: It is the lighting system in which the light coming from the luminaires is mixed up and down. Light that reflects 40%-60% upwards and 60%-40% downwards is equally distributed from the luminaire.

-Semi-indirect lighting: It is a lighting system that emits 60%-90% upwards and 40%-10% downwards. The rays emanating from the luminaires create illumination by emitting from the ceilings and walls. The probability of reflection, glare and shadow formation is very low. For this reason, they are used in places where there is more reading such as a library.

-Indirect lighting: it is a lighting system that directs 90%-100% of the light upwards (to the ceiling and upper side walls). There is almost no possibility of glare from the beam reflecting off the surfaces. It is used in places that do not require much light, such as night places. (IESNA,2011; Moazemi,2013; Acar 2017)

Table 2.5. Classification for indoor luminaires.
(Source: IESNA, 2011)

Luminaire type	% Upward flux distribution	% Downward flux distribution
Direct	00 - 10	90 - 100
Semi-direct	10 - 40	60 - 90
Direct-indirect	40 - 60	40 - 60
General diffuse	40 - 60	40 - 60
Semi-indirect	60 - 90	10 - 40
Indirect	90 - 100	0 - 10

2.5.2.6 Application of Luminaires and Lamps

Controlling the light flow is the most important feature of a luminaire. There are some situations that should be considered when choosing a luminaire. These; the place where the application will be made (indoor-outdoor), the type of lamp, the type of installation, the lighting features, and the dimensions of the place. Many types are available for designers; combination of these, such as downlight, ceiling recessed / mounted / suspended, wall washer, spotlight, wall mounted (IESNA, 2011).

-Downlight: Emits light at an adjustable angle downwards. Thanks to its adjustable angle, it increases visual comfort by limiting glare (Sahin, 2012) (Figure 2.10).

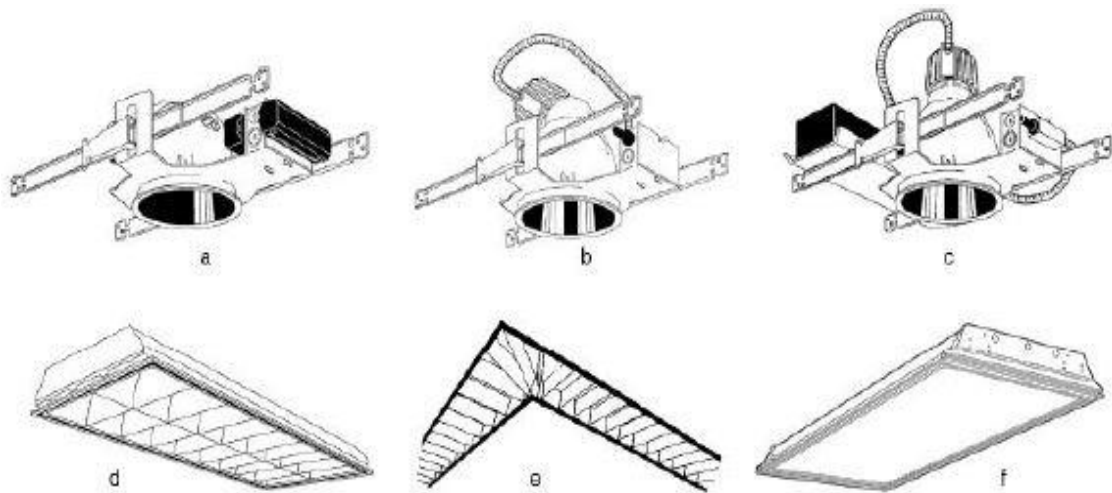


Figure 2.10. Examples of downlight luminaires using (a) compact fluorescent, (b) incandescent, and (c) metal halide lamps; (d) fluorescent lamp recessed troffer with parabolic louvers; (e) continuous linear; and (f) fluorescent lamp recessed troffer with prismatic lens (Source: IESNA, 2011).

- **Recessed in the ceiling:** These devices, which are generally chosen as tube and compact fluorescent, are used in long rectangular, square or circle shapes (Sahin, 2012) (Figure 2.11)

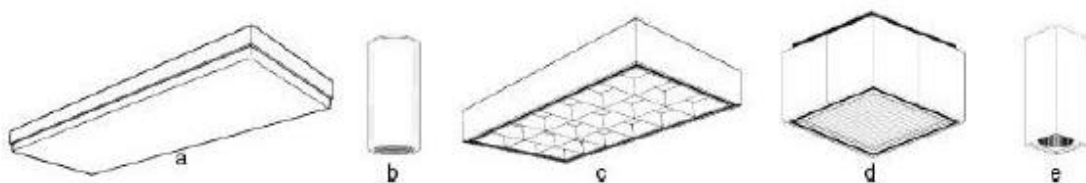
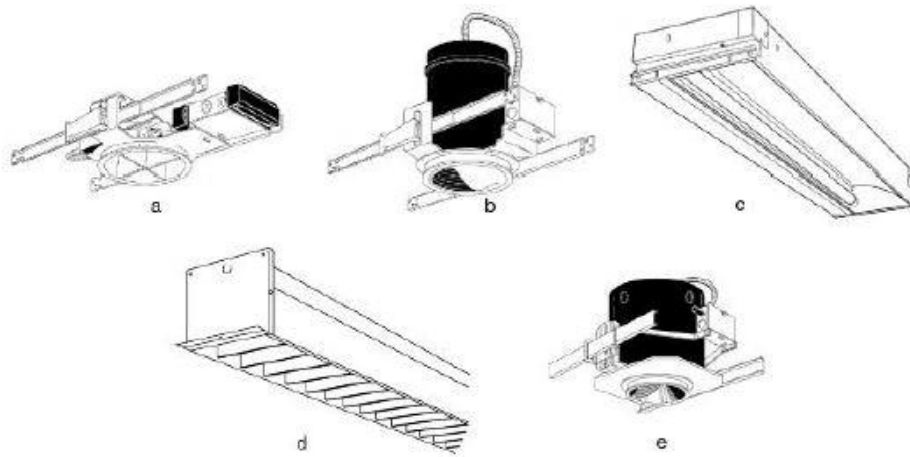


Figure 2.11. Examples of ceiling surface mounted luminaires; (a) wrap-around lens, (b) incandescent lamp downlight, (c) troffer, (d) metal halide lamp area light, and (e) metal halide lamp downlight (Source: IESNA, 2011).

- **Wall washer:** They are wide-angle and have asymmetrical light emitting feature to provide homogeneous illumination. It is often preferred in shop lighting as it helps to accentuate the vertical surface (Figure 2.12).



Figures 2.12. Examples of wall-wash luminaires: (a) compact fluorescent lamp luminaire with baffles, (b) incandescent lamp luminaire with eyelid, (c) recessed linear fluorescent lamp, (d) continuous linear fluorescent lamp with baffles, and (e) incandescent lamp wall washer with spread lens (Source: IESNA, 2011).

-Rail and spot: These devices, which have both electrical and mechanical connections, are mostly used for accent lighting. Even if the interior design changes, they can be used by changing the location, direction and angle, and the desired emphasis can be added or removed. Spotlights can be used by rotating 10°-30°. Lenses, filters, etc. can be used to prevent glare (Figure 2.13) (Erco, 1992; IESNA, 2011) .



Figure 2.13. Examples of track luminaires: (a) close-up of multicircuit track, (b) and (c) track-mounted luminaires with optical control, and (d) and (e) track luminaires for holding and aiming lamps (Source: IESNA, 2011).

-Wall-mounted: Devices that can be used decoratively, to contribute to general lighting, can emit narrow/wide, symmetrical/asymmetrical light (Figure 2.14).

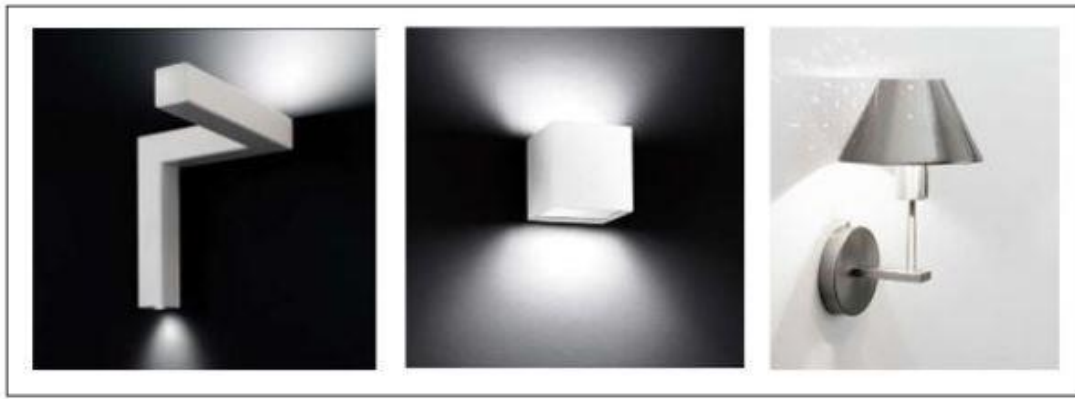


Figure 2.14 Examples of wall-mounted devices.
(Source: Şahin, 2012)

2.5.3. Lighting Types According to Aim

There are 4 types of light layers commonly used in retail lighting, these are: general (also called ambient), task, ambient and decorative (Contechlighting, 2017).

General lighting is the main lighting in the space and has a uniform lighting level. It helps to define the stores and to perceive the whole. Perceptions such as visual comfort and direction can be achieved with vertical lighting tools. In ambient lighting, uniform luminaires that emit light directly or indirectly are used.

The purpose of task illumination is to provide illumination for the task in some focused areas. For example, the most important task in stores is sales. The last place that customers interact with in the store is the cashiers and cashiers. Therefore, it is important to use task lighting in such areas.

The purpose of accent lighting is to provide a striking perception on a product or object. By maintaining the light setting of the environment and providing contrast, the desired features of the products should be emphasized, but emphasizing everything is one of the biggest mistakes in store lighting. In accent lighting, spotlights are generally used and are done by providing a higher light level than the environment to highlight a certain object or object. It emphasizes the shape, color, texture, and structure of the products.

Decorative lighting is more about the use of tools such as sconces, pendants, chandeliers used to enhance the appearance of the space and provide decor. (Contechlighting, 2017; Miller, 2014)

2.5.4. Standards and requirements

When lighting retail areas, many factors should be taken into consideration, such as the products on display, the size of the space, and the demands of the brands etc. In order to ensure a successful design, it is very important to use basic factors such as color, reflection, and contrast correctly. There are two purposes in feature shelf lighting: the first is to fully illuminate the goods, and the second is to ensure the correct perception of color and texture. (Contechlighting, 2017)

Since shopping places that are focus on convincing and influencing users, the relationship between the place and the customer is very important. The efficient progress of this communication is related to the design of the space. The design of the spaces is not only as interior; all of the factors such as marketing, lighting and sales organization should be considered together. Lighting design in shopping places can vary according to the type of places, customer portfolio, and products sold. Illumination levels and smoothness values according to store types are given in Table 2.6. The important thing in lighting is the design of the exhibition areas and the showcases at the entrance. The colors, materials and signs seen with the effect of the light to be used in these places are the most important elements in the design of the stores (Aşçıoğlu, 2014).

Table 2.6. Illuminance levels and smoothness values by store types.
(Source: IESNA, 2011)

Store type	Average Luminance level (lx)	Illuminance uniformity (Uo)
Clothing	300	0.66-0.83
Boutique	200	0.16-0.33
Discount shop	500	0.33-0.66
Jewel	400	0.16-0.33
Furniture	200	0.16-0.33

In shopping areas where general lighting and accent lighting are used together, lamps with high CRI values should be preferred in terms of ensuring correct color perception and visual comfort. If an emphasis is to be placed on any product, the overall illumination level in the environment is reduced and the emphasis is increased, and while doing this, care should be taken to use warm colored lamps. From a different perspective,

it can be said that it is possible to attract the attention of users by creating contrast through luminaires (Aşçıoğlu, 2014; IESNA, 2011). The lighting requirements of the shopping areas are shown in Table 2.7, and the required illumination levels and smoothness values according to the areas in the store are shown in Table 2.8.

Table 2.7. Lighting requirements of shopping venues.
(Source: EN 12464-1, 2019; Zumtobel, 2013)

Field	Illuminance level (lx)	Glare ratio	Color rendering index (CRI)
Sales area	300	22	80
Payment point	500	19	80
Packing area	500	19	80
Storage	300	25	80

Table 2.8. Required illuminance levels and smoothness values according to the areas available in the store (Source: EN 12464-1, 2019; Zumtobel, 2013).

Field	Luminance level (lx)	Illuminance uniformity (Uo)
Sales area	300	0.40
Payment point	500	0.60
Fitting room	300	0.66

In summary, the objectives of lighting design and the points to be considered can be listed as follows:

- Attracting customers to the store safely and effectively.
- Creating an impression of the store/brand image,
- Creating an aesthetically pleasing ambiance for customers,
- Preventing glare and improving color/texture perception while displaying products,
- Reducing energy costs (Contechlighting, 2017).

2.5.5. Examples of Retail Lighting with Lamps and Luminaires

As mentioned in the previous sections, lighting designs in stores can change according to brands, types of spaces, customer portfolios and products. In this section,

the lighting systems of some stores are examined in terms of the color temperature of the lamps used, the color rendering index and the luminaires used.

Nike Store, AnkaMall (Ankara,Turkey)

In the store, where spotlights with rail adapters are used in all general lighting and display areas, LED light with a color temperature of 3000 K and a color rendering of CRI 95 is used in order to perceive the colors closest to reality. The product was used at different angles considering the ceiling height and the features of the exhibited product (Lamp83.com).

In order to prevent glare in store entrances and changing cabinets, directional downlights with deep light sources are used. Accent lighting is used in wall writing and images, and it is provided with a steerable linear profile. LED pendant lights are used in corridor transitions (Lamp83.com). Figure 2.15 shows the lighting design of Nike Store and the fixtures used.



Figure 2.15. Nike Store, AnkaMall (a) General view of store; (b) Spotlight with rail adapter; (c) Linear profile; (d) LED pendant; (e) Downlight (Source: Lamp83.com).

14 oz. Store (Berlin, Germany)

LED spotlights were mostly used in the 14 oz store in Berlin, which aims to make shopping an event that customers will be satisfied and enjoy and designed its lighting accordingly. It has completed the modern enlightenment concept with the necessary change in luminaires. For instance, neutral white LEDs are used as cooler light is required to highlight jeans, while warm white light is used for leather goods (Erco.com). Figure 2.16 shows the lighting design of the 14 oz. Store and the fixtures used.



(a)



(b)



(c)

Figure 2.16. 14 oz. Store (Berlin, Germany), (a) General view of store; (b) track and singlets; (c) Luminaires for track (Source: Erco.com).

Lanificio di Tollegno & Ragno (Milan, Italy)

In this example, where the products of two different brands are exhibited in a single store, two different lighting designs were created by using different color temperatures in the same fixture. In the store where the rail system spotlight is used, Tollegno brand emphasizes the warm wood tones with 3000K warm white light creating a traditional atmosphere, while Ragno has used 4000K diffused and cold light for a more elegant environment. Thanks to the LED light used, optimum illumination is provided for the various color and texture palettes of the products (Erco.com). In Figure 2.17, Lanificio di Tollegno & Ragno stores and their interior views are given.



(a)



(b)

Figure 2.17. Lanificio di Tollegno & Ragno (Milan, Italy), (a)Outside view of store; (b)Inside view of store (Source: Erco.com).

2.6. The Effect of the Material Used in the Stores on Perception

Each element that makes up the interior consists of a different material. Materials are one of the auxiliary factors in understanding light (Rodop, 2014; Gültekin, 2014). The characteristic of each material is different: colour, texture, reflective properties, durability etc. Therefore, materials can change the perception of the space in which they are used (Aşçıoğlu, 2014).

The correct determination of the materials will be useful in providing the desired visual effect. The most important feature of a material is its texture (Rodop, 2014). Since it affects how the light is reflected according to the texture and roughness, it affects the lighting and therefore the perception. The direction of the incident light determines the direction of the reflected light in materials with glossy surfaces such as mirrors and glass. In matt surface materials such as plaster, paint, raw marble, raw wood, the properties of the material can be easily perceived when the light hits the surface. Polished materials or materials with glossy surfaces, such as tiles, can also cause glare as they reflect. Since there will be diffuse reflection in materials such as fabric and leather, the image becomes clearer as the brightness of the surface increases (Gündüz, 2016; Gordon, 2003).

The reflection of the light changes according to the surface it hits. For example, if it hits an opaque surface, it partially reflects light. Fabric etc. materials cause diffuse reflection. For this reason, the reflection that changes according to the material affects the illumination in the environment (Millet and Barrett, 1996). Different reflection levels of some materials are given in Table 2.9.

Table 2.9. Different reflection levels of some materials (Source: IESNA, 2011).

Room Surface	Reflectance Value
white acoustic-tiled ceilings	70 to 80%
light-colored walls	40 to 60%
Carpeting	15 to 30%

In summary, the material can create effects such as frequency, sparsity, warmth, and calmness in the perception of the space. Considering the environment and function, it is important to choose the material appropriately for the environment to be created correctly (Rodop, 2014)

2.7. Examples Research Studies About Retail Lighting

Şener Yılmaz (2018), conducted a study to establish a relationship between lighting designs and human factors in retail environments. He provided visual comfort conditions by creating different lighting design scenarios for a simulation-based sample retail environment and tried to conclude with a survey study. Some of the survey questions are about customers and the other part is to understand the importance of lighting for retail environments and physical comfort conditions in stores. According to the results of the study, it has been observed that the lighting design strategies are effective in the price and quality perception of the customers. It was emphasized that the physical comfort conditions (such as thermal, visual, acoustic) of the environments are important for the customers and that the indoor conditions should be provided at a sufficient level in order to increase the satisfaction. In addition, it is possible to say that showcases, sales areas and dressing rooms are important for customers in terms of lighting design in retail stores. Because providing the right color perception in the sales areas, homogeneity and glare control are the most important factors for customers. While the most important factor in providing correct color perception is "color rendering" and the most accurate perception can be achieved with daylight, it was found interesting that customers thought that daylight was the least important factor. As a result, in this study, it has been determined that the lighting design affects the perception of the customer in retail environments and that different lighting designs can create different perceptions.

Acar (2017) talked about the effects of colors on the perception of space. For instance, she mentioned that the use of 'warm colors' and 'dark values' on the ceiling in a high ceiling space causes the space to be perceived as lower, on the contrary, when cold colors and light values are used in low ceilings, it is perceived as higher. In the same way, he said that when these cold colors are used on the side walls, the walls are perceived farther from each other, and when warm colors are used, he perceives them closer. He even summarized the spatial perception of colors as in the Table 2.10 below.

Table 2.10. The effect of colors on the perception of space (Source: Acar, 2017).

	Ceiling	Wall	Floor
Warm color Dark value	gloomy, threatening	surrounding, jarring	holder, solid, secure
Cold color Dark value	concealer, covering	colder	durable
Warm color Light value	spiritual pressure	motivating	higher, lifter
Cold color Light value	higher	cool, router	straight, encouragement to run

Gündüz (2016) mentioned different lighting conditions for different types of stores in his study. For example, in markets, the aim is to make the products on the aisles and shelves look good. Recessed fixtures are generally used in corridors between departments. For first class markets, Lamps with an average illuminance of 300 lx and a warm color (2700-3300 K) should be used. Lamps with $Ra \geq 80$ should be preferred for good color separation. Local lighting elements can be used to increase the attention of customers in important parts. For second class markets, an average of 300-500 lx light level should be obtained and lamps with cold color values should be used (4000K). Lamps with $Ra > 80$ should be preferred for good color separation. A lower number of local lighting devices are used compared to first-class markets. For third-class markets, lamps with an average illumination level of 500-1000 lx and a cold color value (4000 K) are used. Lamps with $Ra \geq 80$ should be preferred for good color separation.

The purpose of glassware stores is to show the product on display live and in detail. It is very important that all pieces are visible in terms of form and texture, especially when illuminating multi-piece dinnerware. Such stores are also illuminated at different levels of illumination according to their classes. While 100-300 lx brightness level is provided in first class glassware stores, this value is 300-500 lx in second- and third-class stores. $Ra \geq 80$ is also an important factor.

Gültekin (2014) studied the effect of light on human perception in the interior. In her work in which he describes different lighting designs for different places, she also made experiments on 1/10 scale lighting models to measure the psychological effects of

lighting by considering space, people, and light together. She tried artificial lighting scenarios by changing factors such as the location, direction, intensity, and light color of the light source. She preferred the wall, floor, and ceiling color is dark beige which is a neutral color. In her experiment for warm and cold color temperature, she saw that warm color temperature provided relaxation.

According to research, since the material has an effect on the light distribution in the interior, it has created a new scenario by changing the material type of the walls in the spaces it creates. She saw that the wall on which he used polished paint reflected the light more than the wall on which he used wallpaper. In the literature reviews, it is known that in a place where artificial lighting is used, non-homogeneous and warm light tones have a relaxing effect. To test this theory, she provided lighting with wall stamps to emphasize the surface texture. To test the light intensity, she looked at the effect of low- and high-intensity rays and shadow together and found that high light intensity weakened the effect of shadows while the wall illuminated the area (Gültekin, 2014).

Demarco (2001) in his study, which includes the ideas of store owners about lighting, states that most designers improve the image of stores when they combine ambient and Accent lighting, providing good color rendering, low temperature, and long-lasting designs. They emphasized that in order for the shadows not to be too long, the spotlights should be placed at an angle of 30-40 from the vertical, in this way, they prevent the glare from coming into the eyes and disturbing people. Because consumers avoid being in environments where they are not comfortable in terms of visual comfort (Demarco, 2001).

Tantanatewin and Inkarojrit (2016), focused on the effect of lighting designs and environmental elements (such as light, color and sound) on the purchasing behavior of customers in retail environments. While the environment with warm white light was more appreciated by the customers, they found the yellow-colored environment more spacious. In addition, it is possible to say that in environments with different lighting designs, environments where general and accent lighting are used together are perceived more spacious and attractive than environments with only general lighting. In the study in which general and accent lighting designs and color difference are compared, the results emphasize that lighting conditions and different color preferences have a significant effect on perceiving the identity of the store, increasing the perception of quality and customer satisfaction.

CHAPTER 3

THE PROCEDURE

In this chapter, the physical characteristics, lighting conditions and user profiles of the selected stores as well as the methods used in this study are presented.

3.1. Description of the Stores

This questionnaire was carried out in "Boyner" and "DeFacto" stores in İzmir Westpark Outlet Mall. Westpark is an urban shopping center with a food court, cinema, and aquarium, as well as a baby room and children's playground (Figure 3.1). Boyner and DeFacto stores are among the clothing stores in this mall (Figure 3.2).

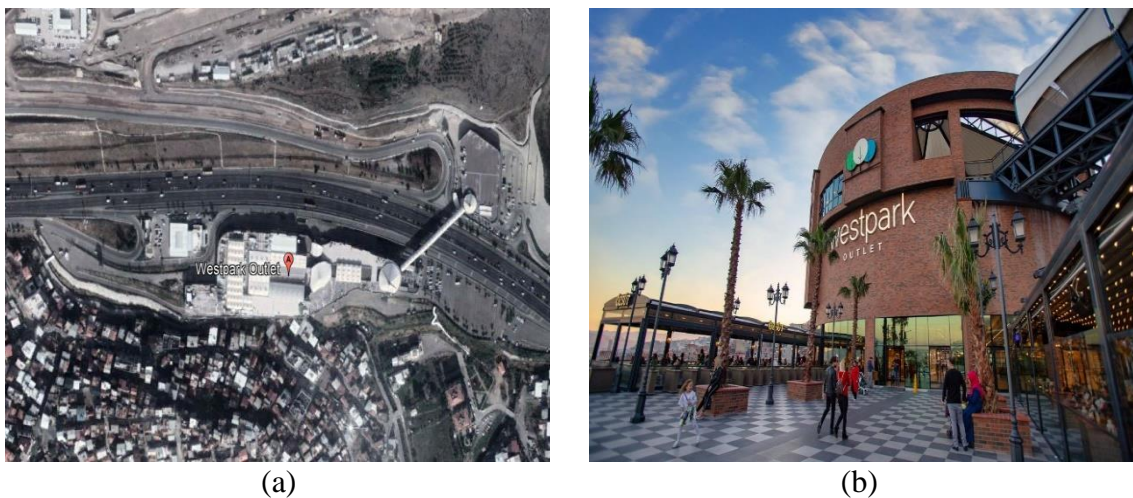


Figure 3.1. (a) Location of Westpark Shopping Mall (Source: Google Earth.); (b) its photograph (Source: İzmirinrenkleri.com).



(a)



(b)

Figure 3.2. (a) Boyner; (b) DeFacto.
(Photo by Duhan Ketencioğlu)

'Boyner' and 'DeFacto' are stores that mainly sell clothes and shoes. Boyner is located on the ground floor. DeFacto has two floors and there is a women's and children's department on the ground floor and a men's department on the upper floor.

3.1.1. Physical Attributes and Lighting Conditions of the Stores

When we examine, the lighting design of the Boyner store (Figure 3.3), it is possible to say that it is illuminated with 'general lighting'. The purpose of general lighting is to increase the visual capacity of people. In this type of lighting, luminaires can be used as wall or ceiling fixtures, recessed or rail system. In Boyner, the luminaires are embedded in the ceiling and placed in a regular/sequential manner. However, 'accent lighting' was used for the products on the edge of the store. The purpose of accent lighting is to attract attention, which is also used as decorative. Accent lighting is used to provide more illumination at the point of focus or where the general lighting around it is insufficient. Since it is inside, it cannot benefit from daylight.

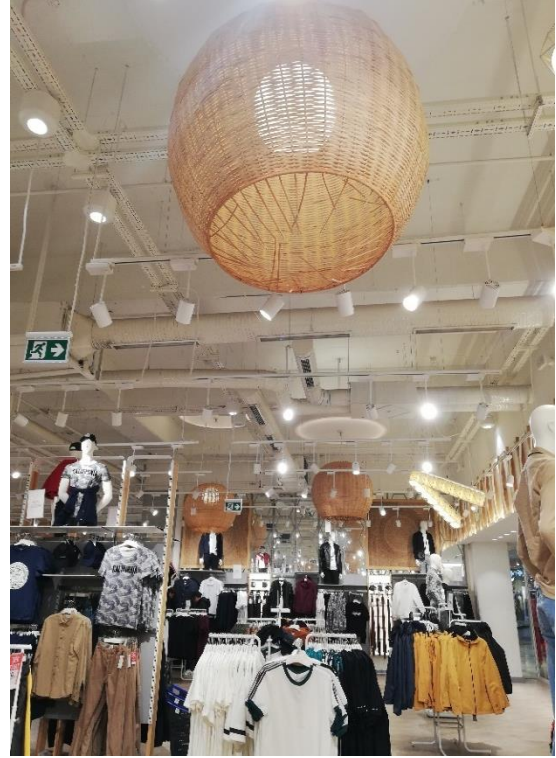


Figure 3.3. (a)General Lighting in Boyner; (b) Accent Lighting in Boyner.
(Photo by Duhan Ketencioğlu)

When we examine the lighting design of the DeFacto store (Figure 3.4), it is possible to say that it is illuminated with 'accent lighting'. Accent lighting needs about three times as much light as general lighting. For this reason, when we examine it in detail, we can see that the luminaires are placed in less number and frequently in the DeFacto store. At the same time, 'task lighting' was also used in DeFacto. The purpose of task lighting is to avoid glare and shadows. We can also say that task lighting is used both for this reason and for decorative purposes. Also, there is no daylight in both two floors of this store.



(a)



(b)

Figure 3.4. (a) Accent Lighting in DeFacto; (b) Task Lighting in DeFacto
(Photo by Duhan Ketencioğlu)

3.2. Survey Design

The purpose of the survey is to observe how the lighting used in retail stores affects human perception and ambiance. The survey aims to understand the effects of lighting conditions in stores on visual comfort and satisfaction levels for customers by examining users' perceptions from their own perspective. To understand how different lighting conditions, affect the perception and emotions of users, a survey study was conducted in two different stores, which are Boyner and DeFacto, and the data results were examined comparatively.

Before starting the questions, the participants were informed that this questionnaire will be used for the master's thesis on Architectural Lighting at the Department of Architecture at İzmir Institute of Technology.

The questionnaire used in the research was created as a result of the literature review on the visual comfort and satisfaction levels of lighting conditions and consisted of previously verified items.

The questionnaire consists of 15 questions, including yes-no questions and multiple-choice questions. The questions can be divided into 4 main parts. In the first of the parts include general information such as gender, age, and educational status. The second part is to learn the general views of the participants about the stores and shopping. The third part of the questionnaire contains questions related to the store to survey. In the last part, it is aimed to understand whether environmental factors (such as the color and material used) affect the existing stores.

Since the survey was conducted face-to-face in the shopping mall, Excel software was used in the process of analyzing the data obtained from the questions. The data obtained from the questionnaires were transferred to Excel to prepare bar-charts. It is possible to compare and discuss the respondents' answers through these graphs.

CHAPTER 4

RESULTS AND RESEARCH FINDINGS

In this section, the data obtained from the surveys will be analyzed and explained. A survey was applied to customers at Boyner and DeFacto stores. The questionnaire consists of three parts: personal information, perceptions of lighting conditions, visual comfort and satisfaction levels, and in-store questions.

While analyzing the data, the results were transferred to Excel, and statistics were expressed using the number of people and percentages.

4.1. Survey Item 1: Customer Profile

30 people participated in the survey. 15 of them were Boyner and 15 of them were DeFacto. 17 women and 13 men participated while 10% of them are between the ages 18-24, 30% are between the ages 25-32, 27% are between the ages 33-40, 27% are between the ages 40-50, and 6% are between the ages 50-60. Also, 30% of the participants are graduated from high school, 67% are undergraduates, 3% are masters.

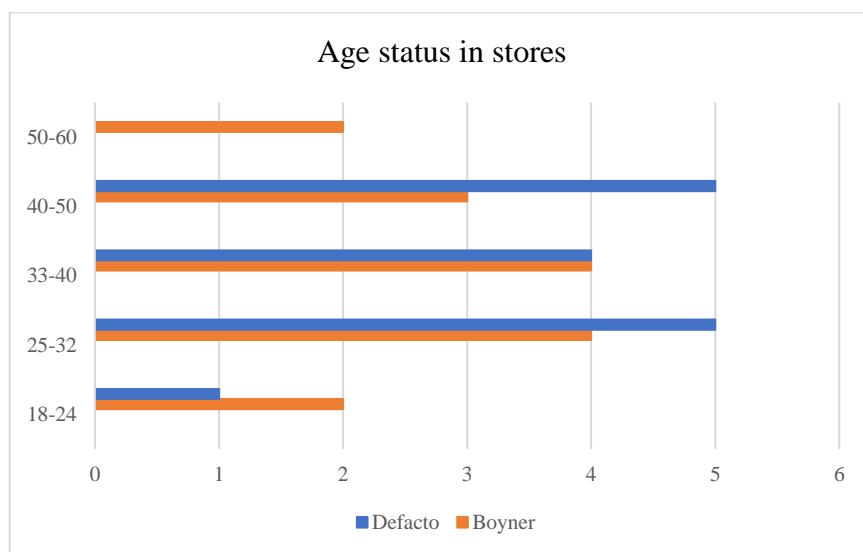


Figure 4.1. Age status in stores.

Customers from all age groups were encountered at Boyner. While no one in the 50-60 age group participated in the survey in DeFacto, only 1 person in the 18-24 age group was surveyed. However, 4 people participated in the survey in the age range of 25-32 and 33-40 in Boyner. In DeFacto, 5 people who aged 25-32, 4 people who aged 33-40, and 5 people who aged 40-50 participated in the survey.

4.2. Survey Item 2: Customers' Ideas on Retail Lighting

In this section, questions were asked to learn what customers' priorities are in shopping, how much they pay attention to lighting conditions, and how lighting conditions affect them.

Q1- How often do you go shopping?

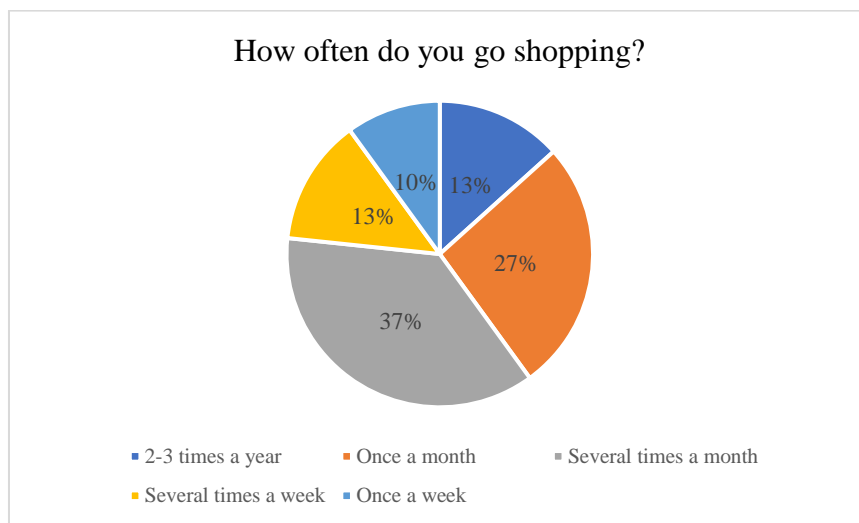


Figure 4.2. Frequency of participants going shopping.

While about 37% of people (11 people) say that they go shopping a few times a month, it is possible to say that the number of people who go out once a week is the least with 3 people. The number of people who go out a few times a week and 2-3 times a year is equal, and there are 4 people from each. Finally, with 27%, 8 people stated that they go shopping once a month.

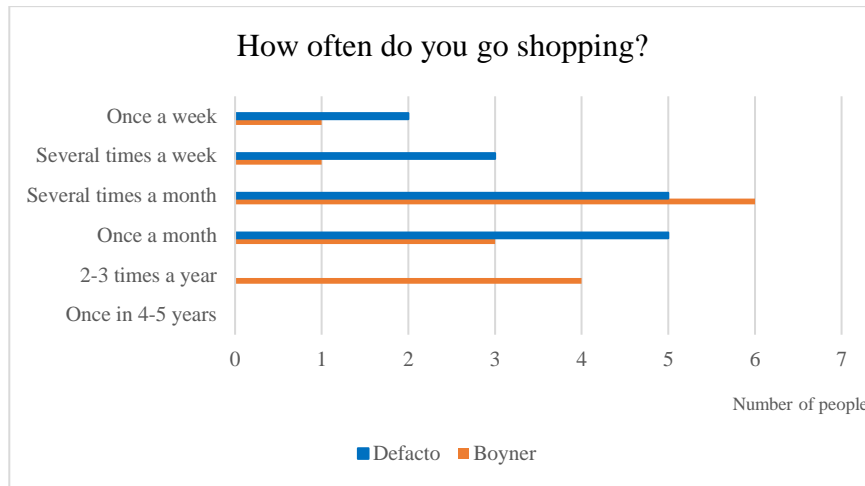


Figure 4.3 Frequency of going shopping in Boyner and DeFacto stores.

Explaining the graph, it can be said that people shop more often from the DeFacto store. For example, while the number of people who go shopping once a week is 2 in DeFacto, it is 1 person in Boyner. Likewise, the number of people who go shopping several times a week and once a month is higher in DeFacto store than in Boyner store. While the number of people who go several times a month is 6 in Boyner, it is 5 in DeFacto. While the minimum frequency of shopping at DeFacto is once a month, in Boyner even customers who go out 2-3 times a year have been encountered.

Q2- What are your priorities in shopping?

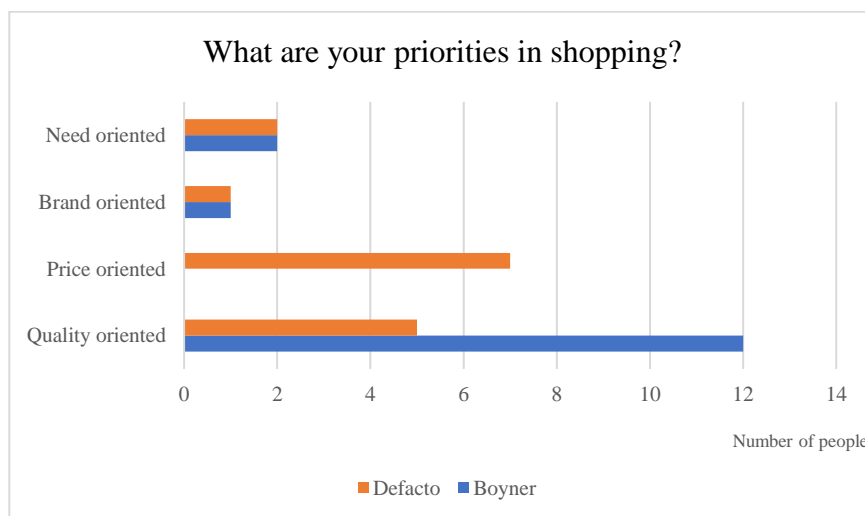


Figure 4.4. Shopping priorities of customers in Boyner and DeFacto stores.

While 12 of the 15 people in Boyner store stated that they are quality-oriented, 2 people said that they are need-oriented, and 1 person said brand-oriented. While the majority in DeFacto say that their priority in shopping is price, the number of those who say that they are shopping based on needs and brands is the same as Boyner. The number of people who say that their priority is quality in shopping is very few compared to Boyner, and this is 5.

While 57% of people are focused on quality in shopping, this rate is 23% for price-oriented, and this is only observed in the DeFacto store. While only 7% of customers say that they shop with a brand focus, 13% of them shop according to their needs.

When customers are asked to prioritize, there are 17 people who say that their first priority is quality, there are 7 people who say “price”, 2 people who say “brand”, and 4 people who say “need”. However, while the second priority of 14 people was “price”, 11 people said that their second priority was “quality”. While this figure is 5 for the “brand”, no one's second priority has been a need. While 19 people out of 30 said that the brand is the 3rd most important, 26 people said that the last priority in shopping is the need.

Q3-Which is more important to you when considering the lighting conditions of any store?

When asked people ‘Which is more important to you when considering the lighting conditions of any store?’, it can be observed that the ‘accurate color perception’ is chosen most with 37% and then ‘adequate lighting’ options with 33%. Whether or not it contains daylight is the least consideration of the customers with 7%. The purpose of asking this question was to measure how much people consider the lighting conditions while shopping, and how conscious they are when paying attention to lighting.

In general, customers say/complain that they perceive a product in a different color when they come home after buying it at the store. They attribute this to the fact that the stores are not adequately illuminated and that luminaires that will not provide the correct color perception are not used.

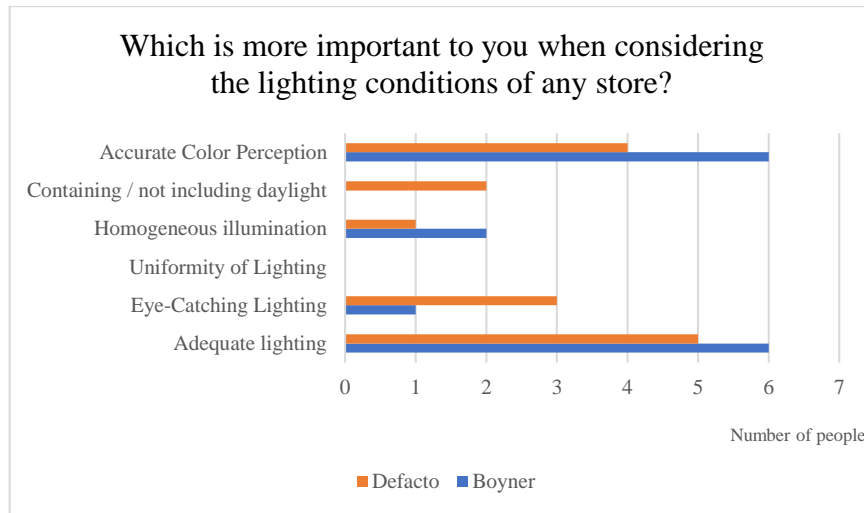


Figure 4.5. Lighting conditions of Boyner and DeFacto Stores.

When we examine the answers separately for Boyner and DeFacto stores, it is possible to say with the answers given that the customers in Boyner are more conscious than the customers in DeFacto. While no one chose the option to be 'uniformly of lighting' in both stores, they only stated that daylight had an effect in the DeFacto store. At the same time, it is possible to say that the number of customers in the DeFacto store who attach importance to the 'eye-catching lighting' is more than Boyner. On the other hand, in Boyner, homogeneous lighting is given more importance than DeFacto.

Q4- What are your expectations from the lighting design in any store?

The purpose of this question, which has the same infrastructure as the previous question, is to understand the missing/incomplete criteria in the stores, but which are the expectations of the customers, considering the current lighting conditions.

Considering the lighting design expectations of the customers in the stores, it can be said that 50% attach importance to the 'accurate color perception'. However, the least expectation is that the lighting is 'uniformity of lighting' at 3%. Being 'homogeneous' and 'containing daylight or not' have the same value, which is 7%. The most important design expectation after the correct color perception is provided is that it is 'adequately illuminated' with 20%.

It is possible to say that providing the accurate color perception is the most important criterion for customers for DeFacto and Boyner as clothing and shoe stores. While answering the questions, some participants said that even though they found it

more important that is adequately illuminated, they said that their expectation from the store was the accurate color perception, because customers complained that their biggest problem was the difference between the color which they see when they buy the product in the store and the color which they see when they come home. Considering all these, it can be said that the first important factor in this type of clothing stores is the accurate color perception.

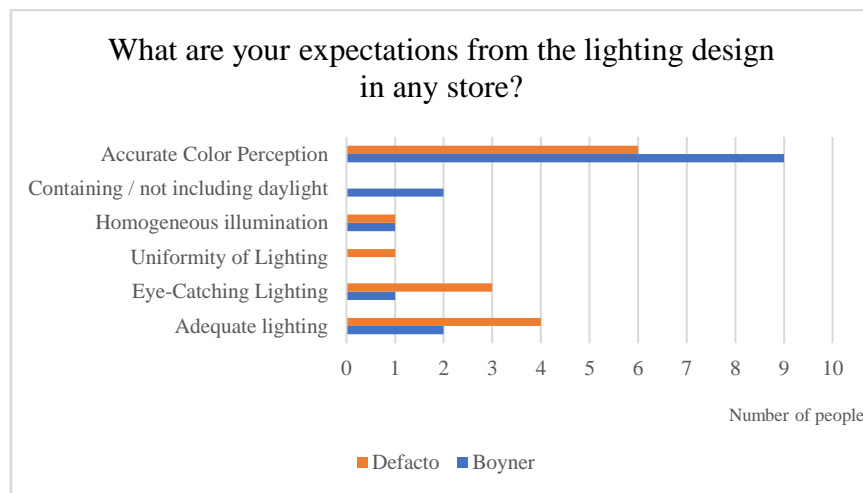


Figure 4.6. Expectation of lighting conditions in stores.

Compared to the previous question, the number of customers choosing the 'accurate color perception' increased by approximately 50% to 6 people for DeFacto and 9 people for Boyner. In addition, while 2 of the customers in Boyner store expect to see the effect of daylight in the stores, only 1 person in DeFacto said that they expect uniform lighting. However, 3 people in DeFacto and 1 person in Boyner said that they expect the stores to have eye-catching lighting designs. The number of people who expecting be homogeneous is 2 person and this is one for each store.

Q5- How important are physical comfort conditions (visual comfort / acoustic comfort / thermal comfort) in any retail store? (Can you score from 1 to 5)

The purpose of this question is to understand how much people consider environmental factors when they are shopping.

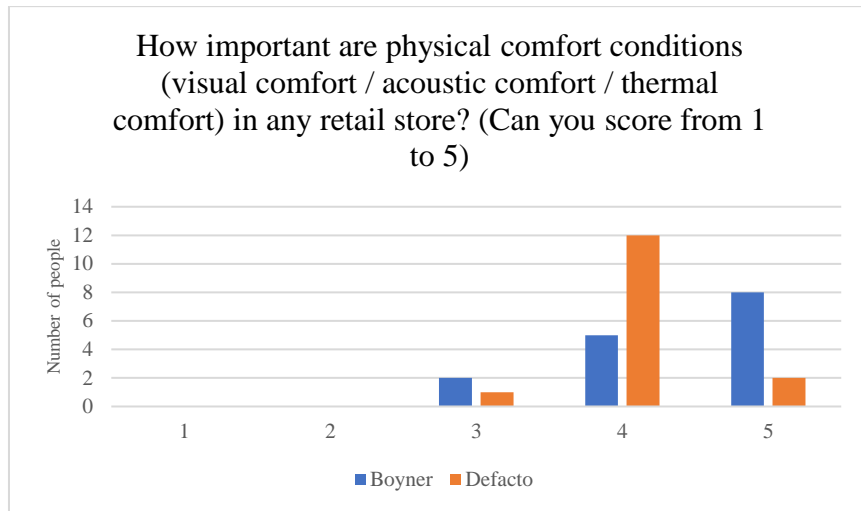


Figure 4.7. Importance of physical comfort conditions in stores.

Considering the physical comfort conditions, 12 out of 15 people in the DeFacto store give 4 points from 1 to 5; however, majority of customers gave 5 points in Boyner store. While answering questions, some customers stated that uneven shelves, loud music, hot and stuffy fitting rooms are bothering them.

In general, for 30 people, 57% gave 4 points, 33% gave 5 points and 10% gave 3 points, and no one used 1 and 2 points. From these results, it is possible to say that people are affected by environmental factors while shopping.

Q6- Which lighting conditions are more important to you in any store?

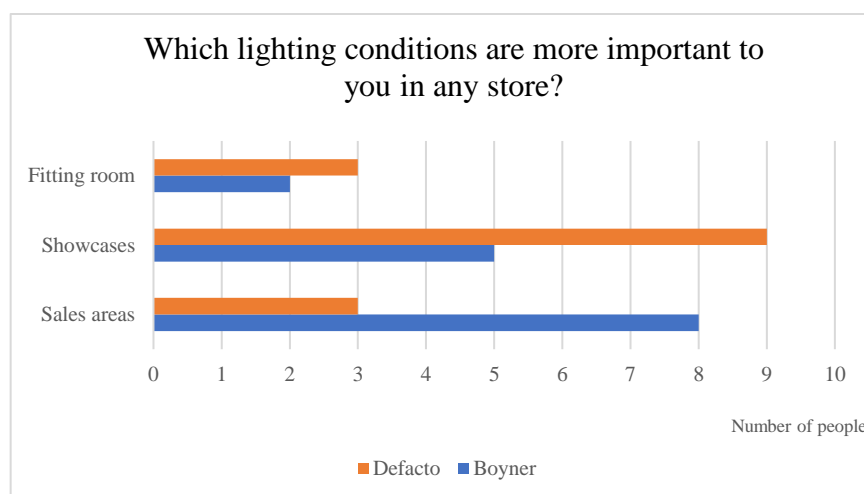


Figure 4.8. Importance of lighting design of spaces in stores.

In general, stores consist of sales areas, showcases and fitting rooms. Each lighting style is different. The purpose of this question is to understand which of the customers find the lighting conditions more important.

While the customers in Boyner store found the lighting conditions of the sales areas more important, the customers in the DeFacto store emphasized that the showcases were more important; because they stated that they look at the showcase before entering any store, and if they find it interesting, they enter the store.

In stores, showcases, sales areas, fitting rooms are illuminated differently. While most of the people in the DeFacto store attach importance to the show cases; in the Boyner store, people say that they attach more importance to the lighting of the sales areas. However, in general, about 47% find the lighting of the showcase more important, 36% find the sales areas, and 17% find the lighting in the fitting room more important.

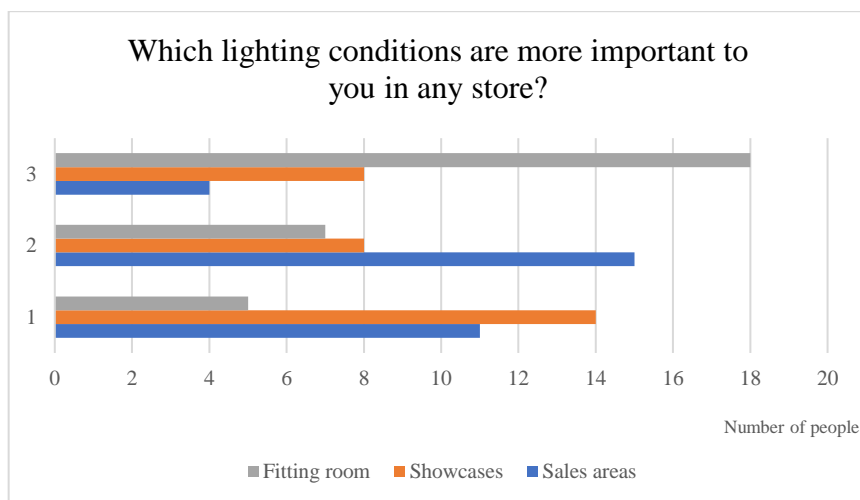


Figure 4.9. Priority order of the importance of lighting design of spaces in stores.

When customers are asked to create a priority order for sales areas, showcases and fitting rooms, the number of people who say that the 1st important area is showcases is 47%, while this value is 47% for sales areas and 16% for fitting rooms. When the second area of attention is 15 people (50%) with sales area, 8 people (27%) with showcases and 7 people (27%) for fitting room. It is possible to say that the order of importance of the fitting rooms are third for 60% for 30 people, so that the fitting rooms are at the end for customers.

4.3. Survey Item 3: Customers' Evaluation of Existing Stores

In this section, questions are asked for DeFacto and Boyner stores specifically, not for general stores.

Q7- Which one do you think is better in lighting design of this retail store?

In general, since surveys are conducted in stores whose lighting design is not so bad, the aim of this question is to try to understand what causes the visual quality in the store to be good (color of the light used, tone of the light used, emphasis of the light used).

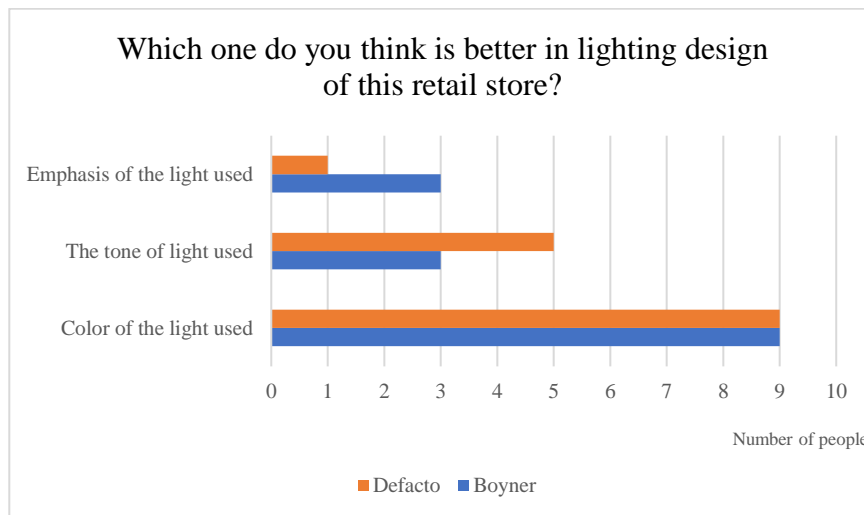


Figure 4.10. Comparing the color, tone, and accent of the light used in stores.

While most of the participants thought the color of the light used in Boyner and DeFacto stores as the best factor for the store. However, some participants said that the tone of the light used in the DeFacto store was better, and some said that the emphasis of the light used in the Boyner store was better.

The color temperature determines the color of the light. Since the choice of light color is one of the factors that determine the quality, it is possible to say that the participants found DeFacto to be of higher quality. All these are the reasons why the lighting design looks successful.

Q8- How is the luminous quality of the store which you are in?



Figure 4.11. Luminous quality of stores.

Most of the participants (83% of 30 people) found the lighting quality of Boyner and DeFacto stores sufficient. However, while 2 people found Boyner dim, 2 people said DeFacto was very bright.

In fact, the reason for this is related to the lighting systems in the stores. While general lighting and accent lighting were used together in the Boyner store, accent lighting and task lighting were used together in the DeFacto store. As mentioned in the previous chapters, since the purpose of accent lighting is to provide 3-5 times more light than general lighting, the DeFacto store was perceived as brighter than the Boyner.

Q9- How is the general visual quality of this store? (Can you score from 1 to 5)

'Luminous quality' refers to the quality of light in the environment, that is, the level of illumination. 'Visual quality' is related to the perception of the visual content (such as color, shape, texture) in the environment, considering the light quality.

While 67% of 30 people found it sufficient for the general visual quality of the stores, 17% found it average and 10% found it very good. While there is no one who thinks it is 'too bad' for both stores, we can say that 2 people from Boyner store found the light quality dim.

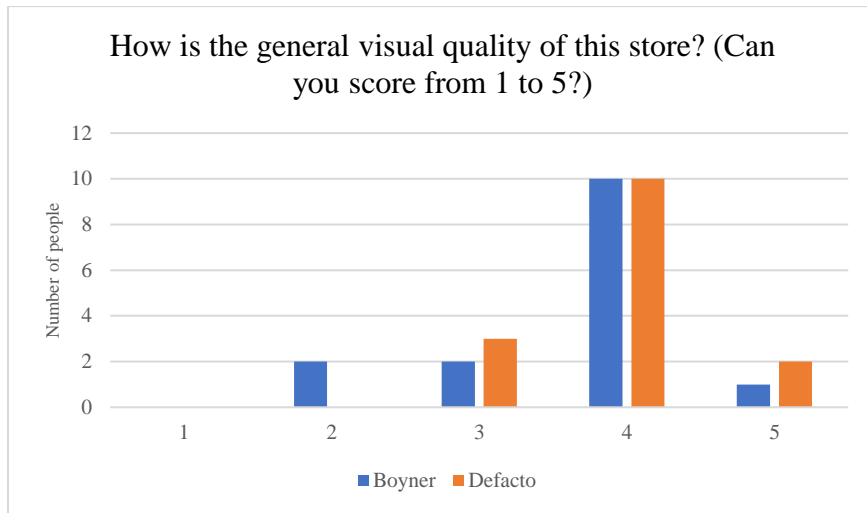


Figure 4.12. Visual quality of stores.

Participants who find the visual quality of the DeFacto completely sufficient are 7% for 30 people, while those who find it sufficient despite some deficiencies are 33%. Number of 3 % participants thought that Boyner is insufficient than DeFacto.

Q10- How effective is the color of light for you in this store? (Can you score from 1 to 5?)

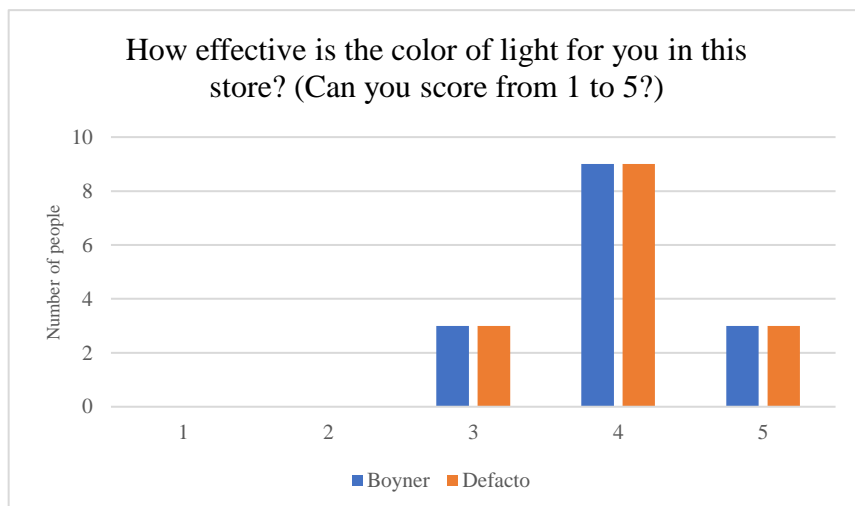


Figure 4.13. The effect of the light color of the stores.

When asked how the color of light in the store affects the customers, it is possible to say that the answers given in both stores are the same. While 60% of 30 people say that they affect, it is possible to say that 20% of them are not sure whether they affect it or not, and that 20% of them quite affect it. In general, the intensity of those who give 4 points, and 5 points shows that the color of the light affects the customers.

4.4. Survey Item 4: Effects of Environmental Factors for Customers

Q11- If you want to evaluate the lighting quality in the stores, what would you look for?

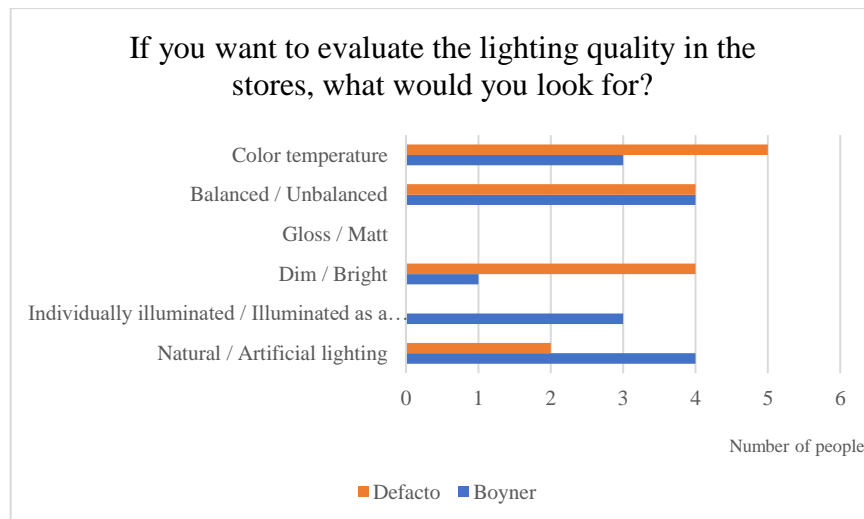


Figure 4.14. Evaluation criteria for lighting quality in stores.

In Boyner and DeFacto stores, balanced/unbalanced light goes head-to-head, while color temperature is the most important factor for customers in DeFacto. While nobody cares about the gloss/matt of the environment, its dim/brightness is more important for the customers at DeFacto. While no one at DeFacto chose it to be illuminated separately/as a whole, 3 people chose it in Boyner.

In summary, while customers at the Boyner store pay more attention to natural lighting and balanced/unbalanced lighting; The color temperature in the DeFacto store is more prominent, then comes the dim/bright and balanced/unbalanced factors.

When customers are asked about the criteria they look at when evaluating the quality of light in stores, it is possible to say that they pay more attention to the color temperature and its balanced/unbalanced, and this ratio is 27%. However, while it is the lowest criterion to illuminate Individually illuminated / Illuminated with 10%, as a whole, we can say that 20% also want to see natural lighting in stores.

Q12- Does the type of material of the exhibition areas (shelves, hangers, etc.) used in the stores affect you? (Glass, wood, steel, etc.)

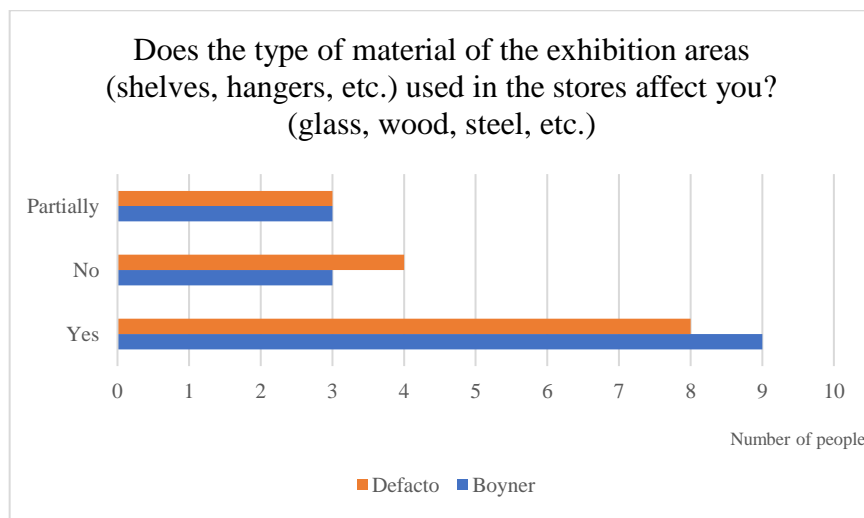


Figure 4.15. The effect of the type of material of the exhibition areas used in the stores on the customers.

The purpose of this question is to measure whether affect and the awareness the customers for products used in the stores, as well as the lighting design. Because, as mentioned before, the eye sees the light reflecting after it hits the surface, and there may be differences in visual quality and comfort depending on the reflection coefficient of the materials used.

When asked the types of materials used in the shelves, hangers, etc. used in stores whether or not affected customers. It is possible to say that the number of people who said they were affected in Boyner store is higher than in DeFacto store.

Overall, 57% of 30 people said it affected, while 23% said it did not. 20% of people partially answered. We can say that this uncertainty indicates that it can actually affect the situation.

Q13- Are you affected by the material's color / tone of the exhibition areas (shelves, hangers, etc.) used in the retail stores?

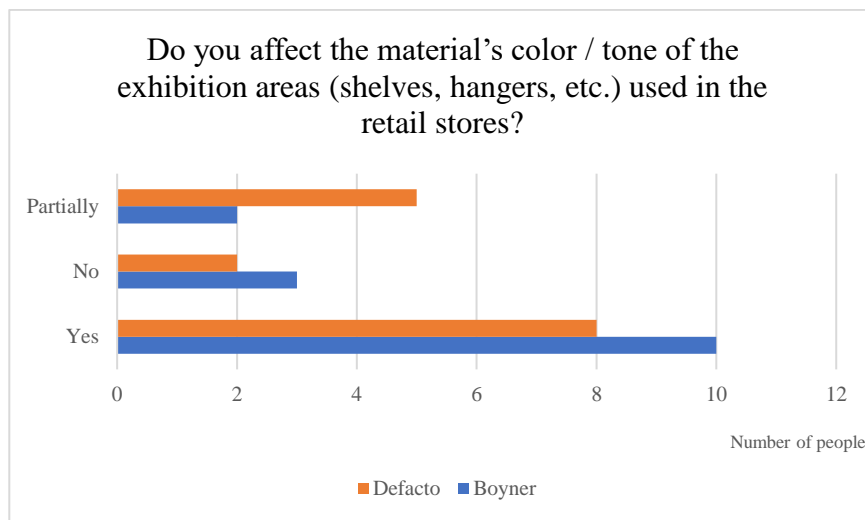


Figure 4.16. The effect of the color of the material of the exhibition areas used in the stores on the customers

The materials used in the exhibition areas may be different, but even if the materials are different, it can be created the same perception when covered with same color. Therefore, the purpose of this question is to measure whether the color of the material affects or not.

When asked if the color of material affects you, the number of people who say yes increases in the Boyner store, while the number of those who say no decreases in the DeFacto store, compared to the previous question.

At the same time, while the number of those who said that color affects it increased by 3%, the number of those who said no decreased by 6%. In general, 60% of 30 people said that the color affected them, 23% said it partially and 17% said it did not.

Looking at the two questions above, customers actually stated that they didn't realize that the type or color of the material used influenced them until the questions were asked.

Q14- Are you satisfied with the lighting conditions in the retail stores?



Figure 4.17. Customer satisfaction with lighting conditions in retail stores.

After so many questions and awareness, when the participants were asked whether they were satisfied with the lighting designs; while most of the customers in Boyner say that they are partially satisfied, the number of customers in DeFacto who say they are "yes" and "partially" is very close to each other. In fact, while the customers answered 'partially', they stated that there were some deficiencies, but this did not affect their satisfaction much. For example, while most of the customers found the DeFacto store bright, some of found the Boyner homogeneous and expressed that it could be emphasized more.

Overall, it is possible to say that only 27% of customers are satisfied with lighting conditions, and the remaining 73% are partially or not satisfied at all.

Q15- Which type of the store's lighting conditions do you like more?

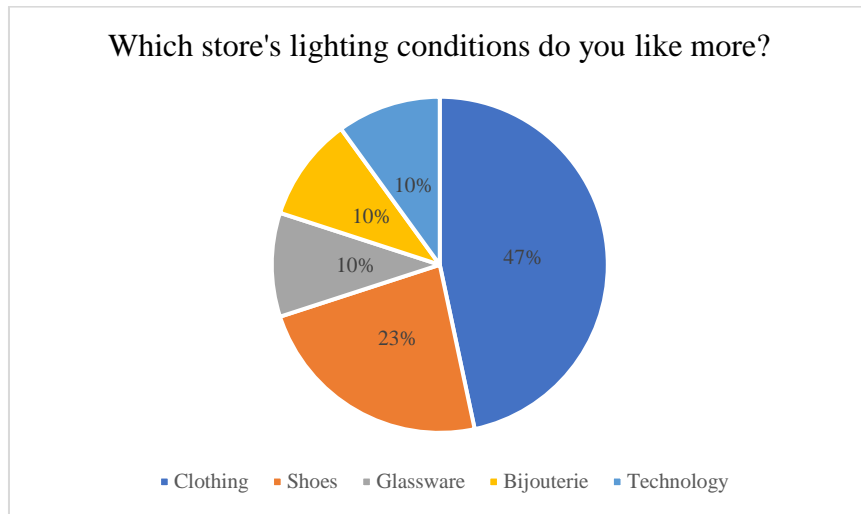


Figure 4.18. Idea for customers from the lighting conditions in different retail stores.

Since DeFacto and Boyner stores, which were surveyed, are clothing-heavy stores, customers were asked what types of stores they were satisfied with the lighting conditions. A majority which 47%, said they liked clothing stores, while they liked glassware, bijouterie, and technology stores less with 10%. They found glassware and bijouterie stores generally bright, while technology stores dim. They said that they like shoe stores almost as much as clothing stores, but they spend most of their shopping in clothing stores.

CHAPTER 5

DISCUSSION & CONCLUSION

5.1. Discussion of Key Findings on Lighting Conditions, Visual Comfort and Customer Opinions

The results obtained from the studies revealed that the lighting conditions in both stores were moderate, neither overly satisfied nor overly dissatisfied. However, considering the brightness levels of both stores, it is possible to say that in general, customers find DeFacto brighter than Boyner. The reason for this may be the type of luminaires used and the amount of use.

What customers pay attention to in store lighting and what they expect from these lightings is that they are 'sufficiently illuminated' and 'accurate color perception' is provided. Customers especially expressed that they were not satisfied with the color of the product they bought looked different when they got home.

In addition to all these lighting conditions, it is possible to say that physical comfort conditions are also important for people. In particular, they said that the conditions such as the stuffy or hot fitting rooms and loud music are the factors that should be considered as much as the lighting.

Most of the customers stated that the brightness level of the showcases is more important in the stores, which consist of three main sections: showcases, sales areas and fitting rooms. Because the more the showcase is illuminated and how the products there are perceived by the customers, the more likely the customer will enter the store. For this reason, the first factor that customers pay attention to when entering a store is the showcases, the second is the sales areas, and the third is the trial booths.

Customers generally stated that they liked the lighting conditions of the existing stores which is Boyner and DeFacto. When asked about the reason for this, they answered the color of the light used. While they find the general visual quality of the stores sufficient, the fact that the majority of those who give 4-5 points when asked about the level of effect of the color of the light on them shows that it does.

While evaluating the lighting quality in the stores, the majority state that they pay attention to the color temperature and the balanced lighting, while the fact that it is illuminated as a whole is another factor to be considered. Some customers consider the fact that many shopping malls are closed areas and that the stores are deprived of daylight as a deficiency, since they think that natural lighting has an effect on ensuring the correct color perception.

It is possible to say that the material and color of the shelves, hangers, etc., where the products are placed, affect the customers as much as the lighting conditions in the stores. The fact that the shelves are not the same color as the products and that the material does not reflect are among the factors that customers pay attention to.

At the end of all the questions, while the customers stated that they were partially satisfied with the store lighting in general, the majority still said that they found the lighting conditions of the clothing and shoe stores better.

5.2. The Effect of Lighting Conditions in Stores on Customers' Perception and Ambience

Results from customers' comments on these questions showed that daylight plays an important role in people's perceptions of the adequacy of lighting conditions. It has been determined that other factors such as the level of illumination and the color of the light are also important. The level of glare, reflection and illumination has a significant impact on the evaluation of lighting conditions. Although all these factors seem to be related to artificial lighting, the presence or absence of daylight also has an effect. Different locations require different lighting conditions. It may not be possible to provide a standard lighting level for stores because the products sell inside, and the materials used in the exhibition areas are as important as the light used. However, the inferences obtained from the comments of the customers are that artificial lighting may be insufficient. If daylight is to be used, the glare effect should not be ignored.

5.3. Solutions and Suggestions to Improve Lighting Conditions in Stores

Aşcıoğlu (2014) conducted a study by comparing the lighting conditions of store lightings in two different stores over two different lamp types. It has been determined that

the store illuminated with LED light is more beneficial in terms of energy efficiency. Similar to the results of the survey conducted in Boyner & DeFacto store, it is possible to say that the color of the light used in the store is considered important by the majority of the customers in the survey results of this study. Likewise, in both studies, customers emphasized the importance of providing correct color perception. It has been determined that the correct color perception and attractiveness are more, and the feeling of heat caused by the lamps is less in the store illuminated by LEDs.

Acar (2017) investigated the effects of lighting design in different stores on people in the study. A more elegant and attractive appearance was achieved by using bright and LED lighting in the stores it examined. It is one of the issues that the stores pay attention to that the angle of the spot luminaires used is not to disturb the visual comfort of the customers and to provide the necessary emphasis.

While designing lighting, the aim is not only to provide the necessary visual comfort conditions, but also to create environments where customers will be satisfied. The effect of physical comfort conditions on customer satisfaction as well as lighting factors cannot be ignored. It can be seen in both literature review and survey results that with the right lighting design, it is possible to increase both the image of the stores, the visual quality of the products and the satisfaction of the customers in shopping.

When designing lighting in stores, first of all, it should be decided what kind of environment you want to create (for example, warm/intimate or cold/elegant). The next thing to consider is to provide the required illumination level and color temperature in the right ratio. Customers said that while answering questions, they pay attention to the fact that the stores are sufficiently illuminated (not too dark or too bright). The average illuminance level for stores is stated in the literature as 300-500 lx.

The biggest problem of the customers was that the product they bought in the store was perceived in a different color when they came home. Some customers even said that they prefer to look at the color of the product in an environment that receives sunlight in order to perceive the color correctly. The color rendering index of the luminaires used should be high to ensure correct color perception. The CRI must be 80 for the correct perception of the colors and textures of the products in the environment, and this value is 100, which is maximum value, for daylight.

If existing stores can integrate daylight into stores without changing their form, it can also be very beneficial in terms of customer satisfaction and energy efficiency. There are some systems for this, such as daylight lighting tubes. Daylight Tube Lighting System

which is a technological system that provides comfortable lighting by taking the daylight from the outside in a controlled way, carrying and spreading it indoors, making the disadvantages of daylight advantageous thanks to its structure (Sunvia, 2021). Sunlight can be deflected in a hollow fiber, called a sun tracking mirror, and carried there for meters to where it's needed. Systematic displacement in Desired Regions is usually via a glass tube, as square light guides can also be used (Heliobus, 2021).

As we have seen in the literature and examples, if only accent lighting is used, ambient lighting may be more than necessary and cause glare, or customers may not be satisfied because there is no emphasis when only general lighting is made. If the general lighting in the environment is created with ceiling-type recessed luminaires and rail system spotlights are used, the desired product can be emphasized, and pleasant shopping environments can be provided for the customers. Raterman (2009), stated that by creating contrast, people can be directed in the store. In order to create contrast, it is necessary to make the objects in the foreground more prominent than the ones in the background, and spotlights can be used for this. Some customers have mentioned that glare occurs as a result of misdirection of spotlights used to highlight products. In the literature, it is mentioned that the angles of the spots used to prevent glare should be used between 10-30 degrees, and even the use of filters if necessary.

The material should be chosen according to the desired effect, taking into account the color and glare. Customers who answered the questions stated that glare affects their visual comfort and satisfaction. Environments with a glare rating of less than 35 are quite good for users and are not distracting.

If semi-direct lighting is used, although most of the light coming out of the luminaire is towards the ground, some of it will be reflected from the ceiling, thus reducing the risk of glare and no harsh shadows. This is important for customer satisfaction.

When we look at Boyner and DeFacto stores, which were surveyed, it is possible to say that DeFacto store is more satisfied in terms of balanced use of light, color temperature and brightness. While the use of spotlights that may cause glare in the DeFacto store is high, the luminaires used provide a cover/filter effect and prevent glare. Different from general lighting, decorative or accent lighting can be used to improve the Boyner store.

5.4. Conclusion

The aim of this study is to investigate the effect of lighting design on customers' visual comfort and satisfaction. In this context, a survey study consisting of questions for the purpose of the research was conducted in Boyner and DeFacto stores in İzmir Westpark Mall. The questions are aimed at understanding both the visual comfort and satisfaction of the customers in the stores they are in and their thoughts about the lighting designs in the retail stores in general. The data obtained in this context showed that lighting design, visual and physical comfort conditions have an effect on customer satisfaction.

It is possible to say that the most important factors affecting satisfaction are the color of light, color temperature and balanced lighting. The biggest expectation of the customers from the lighting design is to ensure the correct color perception and that the stores are adequately lit.

One of the most basic things in terms of visibility in our lives is light. For this reason, light (natural or artificial) has been the most important factor in the perception, use, etc. of any space. If the lighting design is made in accordance with the fiction and architecture of the place, it also affects human behavior, psychology, and satisfaction. In other words, it is possible to say that lighting changes the perception of space and is the most important design element with its effect on people. If the methods are used correctly, it is inevitable to provide a good visual perception, the right ambiance and customer satisfaction.

As a result of the study, it is possible to say that the visual comfort conditions (factors such as brightness level, light color, color temperature, luminaires etc.) in the stores affect the users in terms of perception and satisfaction. The points to be considered in terms of customer satisfaction and visual comfort while designing lighting in stores can be listed as follows.

- Appropriate color temperature
- $CRI \geq 80$
- 300-500 lx
- Glare < 35
- Use correct lighting types
- Contrast
- Spot angles (10° - 30°)

The importance of the study is to draw attention to the points that need to be considered in order to satisfy the customers while designing the store lighting. As a result, this study contributes to the literature as it is a guide that can be used by designers who will provide illumination by comparing the answers/comments of the participants and the information in the literature. For future studies, in addition to this study, more comprehensive studies can be done to better understand with adding effect of daylight.

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APPENDIX A

SURVEY

General Information

Gender: Female / Male

Age: 18-24 / 25-32 / 33-40 / 40-50 / 50-60

Education: Primary Education / High School / University / Master / Doctorate

1- How often do you go shopping?

- a) Once in 4-5 years
- b) 2-3 times a year
- c) Once a month
- d) Several times a month
- e) Several times a week

2- What are your priorities in shopping?

- a) Quality oriented
- b) Price oriented
- c) Brand oriented
- d) Need oriented

3- Which is more important to you when considering the lighting conditions of any store?

- a) Adequate lighting
- b) Eye-Catching Lighting
- c) Uniformity of Lighting
- d) Homogeneous illumination
- e) Containing / not including daylight
- f) Accurate Color Perception

4- *What are your expectations from the lighting design in any store?*

- a) Adequate lighting
- b) Eye-Catching Lighting
- c) Uniformity of Lighting
- d) Homogeneous illumination
- e) Containing / not including daylight
- f) Accurate Color Perception

5- *How important are physical comfort conditions (visual comfort / acoustic comfort / thermal comfort) in any retail store?*

- a) 1
- b) 2
- c) 3
- d) 4
- e) 5

6- *Which lighting conditions are more important to you in any store?*

- a) Sales areas
- b) Showcases
- c) Fitting room

7- *Which one do you think is better in lighting design of this retail store?*

- a) Color of the light used
- b) The tone of light used
- c) Emphasis of the light used

8- *How is the luminous quality of the store which you are in?*

- a) Dark
- b) Dim
- c) Sufficient
- d) Bright
- e) Very bright

9- *How is the general visual quality of this store? (Can you score from 1 to 5?)*

- a) 1
- b) 2
- c) 3
- d) 4
- e) 5

10- *How effective is the color of light for you in this store? (Can you score from 1 to 5?)*

- a) 1
- b) 2
- c) 3
- d) 4
- e) 5

11- If you want to evaluate the lighting quality in the stores, what would you look for?

- a) Natural / Artificial lighting
- b) Individually illuminated / Illuminated as a whole
- c) Dim / Bright
- d) Gloss / Matt
- e) Balanced / Unbalanced

12- Does the type of material of the exhibition areas (shelves, hangers, etc.) used in the stores affect you? (Glass, wood, steel, etc.)

- a) Yes
- b) No
- c) Partially

13- Do you affect the material's color / tone of the exhibition areas (shelves, hangers, etc.) used in the retail stores?

- a) Yes
- b) No
- c) Partially

14- Are you satisfied with the lighting conditions in the retail stores?

- a) Yes
- b) No
- c) Partially

15- Which store's lighting conditions do you like more?

- a) Clothing
- b) Shoes
- c) Glassware
- d) Bijouterie
- e) Technology

Anket

Genel Bilgiler

Cinsiyet: Kadın / Erkek

Yaş: 18-24 / 25-32 / 33-40 / 40-50 / 50-60

Eğitim: İlköğretim / Lise / Üniversite / Yüksek Lisans / Doktora

1- Ne sıklıkla alışverişe çıkarsınız?

- a) 4-5 yılda bir kez
- b) Yılda 2-3 kez
- c) Ayda bir kez
- d) Ayda birkaç kez
- e) Haftada birkaç kez

2-Alışverişteki öncelikleriniz neler?

- a) Kalite odaklı
- b) Fiyat odaklı
- c) Marka Odaklı
- d) İhtiyaç odaklı

3-Herhangi bir mağazanın aydınlatma koşulları göz önüne alındığında hangisi sizin için daha önemlidir?

- a) Yeterli aydınlatılmış olması
- b) Dikkat çekici aydınlanmış olması
- c) Tek düze aydınlanmış olması
- d) Homojen aydınlatılmış olması
- e) Gün ışığı içermesi/içermemesi
- f) Doğru renk algısının sağlanmış olması

4-Herhangi bir mağazadaki aydınlatma tasarımından beklentileriniz neler?

- a) Yeterli aydınlatılmış olması
- b) Dikkat çekici aydınlanmış olması
- c) Tek düze aydınlanmış olması
- d) Homojen aydınlatılmış olması
- e) Gün ışığı içermesi/içermemesi
- f) Doğru renk algısının sağlanmış olması

5-Herhangi bir mağazadaki fiziksel konfor koşulları (görsel konfor/ akustik konfor/ termal konfor) sizin için ne kadar önemli? (1'den 5'e kadar puanlayabilir misiniz?)

- a)1
- b) 2
- c) 3
- d) 4
- e) 5

6-Herhangi bir mağazada hangisinin aydınlatma koşulları sizin için daha önemlidir?

- a) Satış alanları
- b) Vitrinler
- c) Giyinme Kabinleri

7-Bulduğunuz mağazanın aydınlatma tasarımında hangisi açısından görselliğinin daha iyi olduğunu düşünüyorsunuz?

- a) Kullanılan ışığın rengi
- b) Kullanılan ışığın tonu
- c) Kullanılan ışığın vurgusu

8-Bulduğunuz mağazanın aydınlık kalitesi nasıl?

- a) Karanlık
- b) Loş
- c) Yeterli
- d) Parlak
- e) Çok parlak

9-Bulduğunuz mağazanın genel görsel kalitesi nasıl? (1'den 5'e kadar puanlayabilir misiniz?)

- a)1
- b) 2
- c) 3
- d) 4
- e) 5

10-Bulduğunuz mağazada ışık rengi sizin için ne kadar etkili oluyor? (1'den 5'e kadar puanlayabilir misiniz?)

- a)1
- b) 2
- c) 3
- d) 4
- e) 5

11-Mağazalardaki aydınlatma kalitelerini değerlendirmek isterseniz nelere bakarsınız?

- a) Doğal / Yapay aydınlatma
- b) Ayrı ayrı aydınlatılmış / Bir bütün halinde aydınlatılmış
- c) Loş / Parlak
- d) Parlak / Mat
- e) Dengeli / Dengesiz
- f) Renk sıcaklığı

12-Mağazalarda kullanılan sergi alanlarının (raf, askı vb.) malzeme türü sizi etkiliyor mu? (Cam, ahşap, çelik vb.)

- a) Evet
- b) Hayır
- c) Kısmen

13-Mağazalarda kullanılan sergi alanlarının (raf, askı vb.) malzeme rengi / tonu sizi etkiliyor mu?

- a) Evet
- b) Hayır
- c) Kısmen

14- Mağazalardaki aydınlatma şartlarından memnun musunuz?

- a) Evet
- b) Hayır
- c) Kısmen

15- Hangi mağazanın aydınlatma koşullarını daha çok beğeniyorsunuz?

- a) Giyim
- b) Ayakkabı
- c) Züccaciye
- d) Bijuteri
- e) Teknoloji