Sanat&Tasarım Dergisi, 12 (2), 2022: 617-630

EFFECTS OF RETAIL LIGHTING ON PRODUCT COLOR PERCEPTION AND USER SATISFACTION

Özge DİLGEN*
Prof. Dr. Deniz HASIRCI**

Abstract: Light source color properties in retail applications are among the most important factors affecting the user satisfaction in shopping places. A lighting design with a low color rendering value and an unsuitable color temperature can create a difference in the color perception of the product which may affect customers purchase decision or cause dissatisfaction resulting in the return of the product. In this study, it is aimed to evaluate the effects of lighting on product color perception and customer's feedback on the color difference. In order to fulfill this aim, the color differences of the chosen products are examined in three different key areas of a chain clothing store in Izmir, Turkey and compared with the color under daylight. Moreover, the user feedback is taken via a questionnaire to discuss the relationship between color display and user satisfaction/dissatisfaction. The collected data shows that although people do not realize the color differences inside the store, if they experience it after their purchase it may result in the return of the product. As a result of the study, it is suggested that retail store designers and lighting engineers should collaborate to ensure that the consumer perceives what the product designer intended as accurately as possible.

Keywords: Retail lighting, Color rendering index, Color temperature, Color perception, User satisfaction.

Received Date: 14.03.2022 Accepted Date: 23.06.2022 Article Types: Research Article

*İzmir University of Economics, Graduate School, ozge.dilgen@std.izmirekonomi.edu.tr, ORCID: 0000-0003-0045-2069
**İzmir University of Economics, Faculty of Fine Arts and Design, Dept. Interior Architecture and Environmental Design, deniz.hasirci@ieu.edu.tr, ORCID: 0000-0001-9928-6077

Sanat&Tasarım Dergisi, 12 (2), 2022: 617-630

ALIŞVERİŞ MEKANLARINDA AYDINLATMANIN ÜRÜN RENK ALGISI VE KULLANICI MEMNUNİYETİ ÜZERİNE ETKİLERİ

Özge DİLGEN*
Prof. Dr. Deniz HASIRCI**

Özet: Alışveriş mekanı aydınlatma uygulamalarında ışık kaynağının renk özellikleri, kullanıcı memnuniyetini etkileyen en önemli faktörlerin başında gelmektedir. Düşük renksel geriverim değerine sahip bir aydınlatma tasarımı ve uygun olmayan bir renk sıcaklığı, ürünün renk algısında farklılık yaratarak müşterilerin satın alma kararını etkileyebilir veya ürünün iade edilmesi ile sonuçlanan memnuniyetsizliğe neden olabilir. Bu çalışmada, aydınlatmanın ürün renk algısı üzerindeki etkisi ve bu duruma bağlı müşteri memnuniyeti/memnuniyetsizliğinin değerlendirilmesi amaçlanmıştır. Bu amaç doğrultusunda, İzmir, Türkiye'de bulunan zincir bir perakence mağazasında seçilen ürünlerin renkleri mağazanın üç farklı kilit alanında incelenmiş ve gün ışığındaki renkleri ile karşılaştırılmıştır. Ayrıca, sergilenen ürünün renk algısındaki farklılıklar ile kullanıcı memnuniyeti arasındaki ilişkiyi tartışmak için müşterilere bir anket uygulanmıştır. Toplanan veriler, müşterilerin mağaza içerisindeyken renk farklılıklarını fark etmeseler de, satın aldıktan sonra böyle bir deneyim yaşamaları durumunda ürünün iade edilmesiyle sonuçlanabileceğini göstermektedir. Çalışmanın sonucunda, kullanıcıların ürünü tasarımcının amaçladığı renge olabildiğince yakın algılamasını sağlamak için perakende mağaza tasarımcıları ve aydınlatma mühendislerinin işbirliği yapması önerilmiştir.

Anahtar Kelimeler: Alışveriş mekanı aydınlatması, Renksel geri verim, Renk sıcaklığı, Renk algısı, Kullanıcı memnuniyeti.

Geliş Tarihi: 14.03.2022 Kabul Tarihi: 23.06.2022 Makale Türü: Araştırma Makalesi

*İzmir Ekonomi Üniversitesi, Lisansüstü Eğitim Enstitüsü, ozge.dilgen@std.izmirekonomi.edu.tr, ORCID: 0000-0003-0045-2069
**İzmir Ekonomi Universitesi, Güzel Sanatlar ve Tasarım Fakültesi, İçmimarlık ve Çevre Tasarımı Bölümü, deniz.hasirci@ieu.edu.tr, ORCID: 0000-0001-9928-6077

1. INTRODUCTION

In today's world where consumption is increasing day by day, shopping areas has gained importance, and various design criteria have been determined in order to attract users to the store and to ensure that they have a good store experience. One of the most important elements of shopping area atmosphere is lighting. Many studies in the past have shown that the impact of lighting design on quality perception and user behavior in retail spaces is undeniable and with the right lighting design, it is possible to attract the customer to the store and to spend more time in there. According to Custers et al. (2010), lighting has an important role on store atmosphere and user behaviors. Quartier et. al. (2014) claim that color and light are the key factors on store design that affect space perception and emotion. Lighting can change the store atmosphere and has an effect on store experience. Summers and Hebert (2001) show that accent lighting was found to be more time spending. Research of Baumstarck and Park (2010), Custers et. al. (2010) and Durak et al. (2007) suggest that lighting levels have an effect on customer's perception and response. Similarly, Quartier (2011) studied the influence of lighting on space perception and showed a significant relationship. Kan Kilic and Hasirci (2011) have studied lighting and its effects on the psychological condition, perceived and visual comfort, and satisfaction. According to Brengman and Willems (2009) and Schielke and Leudesdorff (2015) lighting design in retails can affect brand image, quality perception and price levels. There are also researches that examined the effect on lighting color, color rendering index and color temperature which showed that warm lighting exposes more positive perception compared to cool lighting (Hidayetoglu et al., 2012; Knez, 2001; Park and Farr, 2007). However, when the literature is examined about the effect of lighting on product display, it is seen that the focus is more on highlighting the product and increasing customer's attention and not many studies were found on the effect of lighting on the color display of the products and its effects on the user.

The lighting decisions in retails are generally based on emotional responses from consumers or aiming to reduce energy consumption. However, the aim of the lighting in retails is not only to draw customer's attention but also allow them to browse and to render the product features as closest to the targetted. According to a research done within the National Lighting Product Information Program, light source color properties in retail applications are considered more important than any other light source criterion, including energy efficiency. Because one of the most important factors affecting the purchasing decision in shopping places is the product itself.

A successful design that takes into account not only consumer desires but also product requirements and limits can result in considerable improvements in a product's production, handling, and retail marketing (Sanger, 2007). For this reason, it is necessary to display the product correctly for the sales activity. Color of a product is one of the most important factors when it comes to evaluate a product. The textile and garment business significantly rely on color because it must produce rapidly shifting seasonal trends and because people use clothing color to convey their internal states (Chae & Lee, 2021). Despite a high level of color and lighting control during the design and production of the product, variability in store lighting may cause the color of a product in a store to be seen drastically differently than that intended by the designer (Cardenas et.al, 2009). Store lighting should display the texture, color and quality of the product in accordance with the product

designer's original design.

The lack of studies on the relationship between lighting and textiles and not giving enough importance to this factor on store lighting design increases the possibility of encountering consumer dissatisfaction. The color of the product that the user decides to buy under store lighting may differ from the color intended by the designer and the manufacturer, and moreover, the color difference encountered under different lighting conditions may result in dissatisfaction of the customer and accordingly product return (Hinks et al., 2000). According to Berns (2000) and Collishaw (2004) an illuminant metamerism occurs because an object has a different color when viewed under different illuminators. Illuminant metamerism in textiles has been the subject of a small number of studies. Jeong and Lee (2010) used red, yellow, green, blue, and purple lights to photograph seven different colored materials with two distinct reflective characteristics. The images were then printed, and the fabric colors were measured to see how each hue of light affected them. Choi et al. (2007) exposed five different colored materials to lights with correlated color temperatures (CCT) of 2800, 4200, and 6500 K in another investigation. Participants ranked how comparable the colors of materials were under the experimental lighting settings compared to natural light. Studies have looked into the impact of light sources on the color of specific fabrics, as well as how the light sources interacted with the textiles' reflecting characteristics. However, none of these research provided explicit, defined numbers for evaluating the degree of these effects to indicate how color appearance changes under various lighting situations, such as CIELAB RGB and HSL (Chae & Lee, 2021).

In this study, it is aimed to evaluate the effects of lighting on color perception of the products and to determine the effects on customer satisfaction. In order to fulfill this aim, the colors of the products are examined in three key areas of a retail store (displays, fitting rooms, purchase counters) via Color Grab color detection tool. The illuminant metamerism is intended to determine through RGB data provided by the Color Grab tool and the results are compared with the color values under daylight which has a CRI value of 100, being the best color rendering value. Also, the user ideas on color perception differences of the products are taken through a questionnaire to discuss the relationship between color display and user satisfaction/dissatisfaction.

2. LIGHT AND COLOR

There are many definitions of color and light on the literature. The most common definition is light being a kind of energy and color being an impression on human brain as a result of seeing function under a light source. Berns (2000) define the color as "a certain kind of light, its effect on the human eye, or the result of this effect in the mind of the viewer" There are three main elements essential to color perception; an object, a light source and an observer (Berns, 2000; Harold, 2005). The perceived color of an object could be described as the spectrum of light that is reflected of transmitted from an object to the observer's eye and interpreted by the human brain (Rea, 2000). "In general, the eye sees light that reflects from the surfaces of an object. As such, the color appearance of any object will be the same as the spectrum of the light source, minus whatever wavelengths of light are absorbed by the object (Laski et al., 2000)." As a result of color being perceived under a light source, color perception of an object will differ under different lighting conditions. The color perceived will change if the light source is changed. There might be conditions which humans perceive the color different than targeted. Perceiving the wrong color is called illuminant metamerism (Yaoyuneyong, 2007).

The lighting industry primarily uses two metrics to define light source color properties that affect the color perception: correlated color temperature (CCT), which is commonly used to indicate the apparent "warmth" or "coolness" of the light emitted by a source, and color rendering index (CRI), which is used to determine a light source's ability to make illuminated objects appear natural (IESNA 9th Edition). According to Mukthy, Vik, and Vikova (2022), there are studies that found that the intensity of lighting also has an effect on color perception. Lights reflected from surfaces and the environment in the background of the product can also affect color perception (Hinks & Shamey, 2011).

2.1. Color Temperature

The color of the light emitted by a light source is expressed by its color temperature. The unit of color temperature is Kelvin. Light sources with a low color temperature, such as incandescent lamps, are described as 'warm' and have a yellowish appearance. Light sources with a high color temperature, such as some types of fluorescents are defined as 'cold' and have a bluish appearance (Custers, 2008). It is mentioned in the study of Epps and Moore (1989) that the change in color temperature affect the color difference.

The color temperature also affects the perception of store image. As the store profile progressed from low budget to exclusive, it is typical to see that the color temperature of the light source in retails change from cool to warm (Ticleanu, et.al. 2013). In retail stores with low volume, the color temperature is between 3500-5000 K, neutral and cool. Metal-halide and fluorescent lamps are used in these places (Table 1). Medium category stores also prefer lighting with a neutral color temperature. In select stores with a high volume of goods, incandescent and fluorescent lighting between 2700-3000 K and with a warm color appearance are used (IESNA 9th Edition, 2000).

Table 1. *Color temperature values of different light sources.*

Light source	CCT
High pressure sodium	**2100 K**
Mercury vapor	**6410 K**
Fluorescent	**2940-4230 K**
Metal halide	**5400 K**
Halogen	**3200 K**
Daylight	**4500-6500 K**

2.2. Color Rendering Index

Color rendering is a measure of how sensitive the color perception is under artificial light, depending on the place of use and the purpose of view. It was created by the International Commission in 1970. Color rendering value of 100 means perfect perception, while a color rendering over 80 causes colors to be more saturated and brighter to be perceived. Lightings with a color rendering value below 60 cause a dull skin color and a non-white light perception. will tend to create (Custers, 2008). The CRI values of different light sources are shown in Table 2.

Table 2. *Color rendering values of different light sources.*

Light source	CRI
High pressure sodium	**24**
Mercury vapor	**17-49**
Warm white fluorescent	**51-73**
Cold white fluorescent	**64-89**
Metal halide	**85-96**
Halogen	**100**
Daylight	**100**

One of the most important elements in retail lighting design is color rendering. Since the product is sold, the product should be displayed

as closely as possible to its real color. Color rendering value varies according to the store concept and target market. However, the unchanging element is that the display and dressing cabinet areas should be the spaces with the highest color rendering value (IESNA 9th Edition). According to Judd and Wyszecki (1975), a critical evaluation of colored objects requires a very high general color rendering index.

3. EFFECTS OF COLOR PERCEPTION ON USER BEHAVIOR

A good lighting design in retail areas provide many advantages. Attracting the attention of the customer, displaying the product correctly, creating the desired image in the store, highlighting the elements such as security and cleanliness and providing visual comfort conditions for users and employees are among these advantages.

To achieve a visually comfortable environment, create user satisfaction and for the purchase to take place, it is important to have a lighting design strategy at the early design stage of retail environments (Boyce & Raynham, 2009). A guideline on lighting design is created by the Illuminating Engineering Society of North America (IESNA, 2001) Merchandizing Lighting Committee which can serve as an indicator on retail lighting design.

In retail stores, the first thing that catch the attention of the customer to a product is the color (Azoulay, 2005; Rea, 2000). Thus, perceiving the product color correctly is one of the most important key factors in retail lighting design in the textiles and apparel industries. Many retailers have their own color quality control department or outsource it to a third party. They want the most accurate and best-looking color for their products. They all have a color matching system, a color measurement instrument, trained observers, a color scale, and a color perception system, for example. They compare the color of their standard with the color of their product to arrive at the color that their designers envision. Unfortunately, it is not taken into consideration that the illuminants used in the retail store are not the same as the illuminants used in the quality control process (Yaoyuneyong, 2007). The fact that each different product reacts differently with light indicates that the product needs different lighting properties.

Retail lighting has tree aims, according to the Illuminating Engineering Society of North America (IESNA, 2001) Lighting Handbook (Rea, 2000): to attract customers, to allow customer to evaluate items and to simplify the sale. However, the color perception difference caused by lighting in the retail areas may have a negative effect on the customer since it effects the product evaluation and purchase decision.

3.1. Getting To Know The Product

Lighting should enable the consumer to evaluate the product. Consumer; should be able to perceive the quality, color and texture of the product, and be able to read the labels on the product. In order for the product to be evaluated correctly, the illumination of the cabinet area as well as the display and sales area is very important (IESNA 9th Edition, 2000).

Changing cabinets should be well lit and the lighting should resemble daylight. If lamps with high color rendering value are not used; The color of the product will differ outdoors and this may cause the customer to be dissatisfied with the product later (Arslan, 2004).

For this reason, lamps with high color rendering value should be used in shopping areas, which will enable customers to see the product in the most accurate color (Kucukikiz, 2007).

3.2. Purchase Decision

Purchasing behavior is the most widely studied

Table 3. *Store lighting properties.*

	Lamp Type	Color Temp.	CRI	Luminous Flux	Surface Color
Display	Halogen QR-111 Metal Halide CDM-R111	2900K 3000 K	100 84	650 Lumen 2500 Lumen	Light beige-satin paint
Fitting Room	Halogen bulb QR-111	2900 K	100	650 Lumen	Beige-textured wall paper
Cash Desk	Metal Halide CDM-R111	3000 K	84	2500 Lumen	Light beige-satin paint

finding in the literature on customer reactions to atmospheric effects (Turley and Milliman, 2000). Lighting has a significant role on consumers purchase decision at a retail store. Studies show that it is possible to create a positive impact and make a product more attractive and appealing to the customer with a well-designed lighting implementation in retails (Smith, 1989). A more visually appealing environment, motivate the shoppers to stay longer and potentially buy more. In general, the positive emotional response is beneficial in encouraging purchase decision (Erdil, 2015).

The effect of lighting on the color of a textile product is an integral part of retail design and visual merchandising. For textile products such as clothing and furniture, product color is one of the most important attributes that influence consumer's purchasing decisions. In order to realize one of the most basic functions of the shopping venue, the purchase decision, one of the most basic tasks of lighting is to perform the product presentation correctly and efficiently, to attract the user's attention and to increase the time spent in the store. The importance of lighting in affecting consumer purchase behavior, color appearance of textile products is very important in retails, including dressing areas, fitting rooms, general displays, and store windows. The differences in lighting might create a color difference problem when customers inspect the color of the apparel products in different locations. This may result with a customer dissatisfaction and the customer returning the merchandise. This problem might be solved by measuring color instrumentally under different standard illuminants including the illuminants used in the retail store (Quartier et.al, 2014).

4. CASE STUDY: A CHAIN CLOTHING STORE IN İZMİR /TURKEY

In order to determine the effects of retail lighting on product color perception and user satisfaction, a high-end chain clothing store in Izmir Turkey is chosen as a case study. In the 350 m2 area, different products from clothes to shoes, bags and accessories are offered to both men and women.

4.1. Store Lighting Properties

In the general lighting of the store, spots have been used. In these spotlights, halogen bulb QR-111 and metal Halide bulb CDM-R111 are mixed in order to bring the light color to the closest level to daylight and to break the whiteness of the metal Halide bulb. All surfaces in the store are arranged in light colors in order to reflect light (Table 3).

4.2. User Group Properties

The user group consisted of customers of the selected store who purchased a product. There are no specific age, gender and education level conditions in the user group. The only factor in determining the user group was that the user did not have an eye defect that may affect the color perception. Self-reports of the sample group

regarding eye defect were taken as basis.

4.3. Research Questions and Hypothesis

The purpose of this study is to evaluate the effects of lighting on color of products and to determine customers feedback on this issue. The research questions sought to be answered in this study are as follows:

1. How does lighting effects color perception of products in retail areas?

2. Is there difference in the color perception of products in different key areas?

3. What are the opinions of users on the difference of color perception in retails?

4.4. Methods and Tools

This study is a research based on literature review, observation and user opinions. In the study, the effects of lighting on the color perception of the product are examined through a Color Determination Application Tool downloaded to smart devices which enables to compare color properties such as RGB and HSL. Photos of the chosen products in a variety of colors are taken via Color Grab Application Tool in 3 different areas; display, fitting room, cash desk and the perceived color properties are compared to the 'real' color properties under the daylight which has a CRI of 100. While choosing the products to be tested, the purchasing preferences of the customers and the participation of different color tones in the study were prioritized. And the photos under daylight are taken at afternoon, clear sky conditions.

To evaluate the user opinion about color change, a questionnaire is applied to the customers of the store. The questionnaire consists of demographic questions and questions that will try to define user's opinion on color change, their satisfaction/ dissatisfaction of store lighting and color rendering and effect of color on their purchase decision.

4.4.1. Color Grab tool

Color Grab is a color detection tool that can be downloaded to smart devices and generally used by designers, artists, professionals, developers, scientists and color-blinds.

By pointing the camera of the smart device, it enables to capture and recognize the colors of the desired product/area. Some of the key features related to this study are;

• color metering

• color recognition (color-2-name)

• Supports most-common color models (RGB, HEX, HSV, LAB)

4.4.2. Questionnaire

In this research, a questionnaire is done to a user group of 12 customers in order to get user opinions on color perception difference in retails and to determine customer satisfaction/ dissatisfaction on the issue. The questionnaire consisted of demographic questions, 5-point likert scale and open-ended questions. The questionnaire was done after the shop experience and the purchasing act was finished. The users were asked to rate the importance of the product color on their purchasing decision, to score the store lighting in terms of evaluating the product, if they had realized any color difference of the same product in different key areas of the store and if they experienced a color difference under different lighting conditions after purchasing the product, would they keep the product or return it.

5. DATA AND ANALYSIS

The photos of the products chosen in different colors are taken at different key points in the store and under daylight and the color data provided by Color Grab Application are as follows;

The data collected via Color Grab App. show that the perceived colors of the chosen products are

different under different lighting conditions. As shown in the Figure 1 and Table 3, the yellow-colored part of the 1st product is more brownish in the display and fitting areas, more orangish on the cash desk and more yellowish under daylight. While the black part is a bluish black under the daylight, it is perceived dark grey on the cash desk. And the grey part is bluish light grey under daylight however it is a reddish light grey on the cash desk and light brown under the display lighting.

The second product which is originally perceived blue under daylight, is also perceived blue in fitting rooms and on the cash desk (Figure 2, Table 5). However, it is perceived dark blue in display areas. According to Figure 3 and Table 6, the 3rd product which is light brown is perceived the same color in all key points although there is a lightness difference in between the colors. The 4th product is a multi-colored product which consist of red, white, dark pink and light pink (Figure 4). The red part is perceived red under daylight and on cash desk while it is perceived a brownish red in display area and fitting rooms. The white part is only perceived an orangish white in fitting rooms and white on the rest of the areas. Dark pink is perceived a pinkish violet in fitting rooms but a reddish pink in other areas. The light pink part is a reddish light pink under daylight and a reddish pink in fitting rooms however a pinkish light violet on cash desk (Table 7).

When the RGB data are analyzed, it can be observed that achromatic colors such as black and white are the least effected colors from the change in the lighting, the gray and light brown products in which the RGB values are evenly distributed show little color change, but the yellow and pink colors, where the R value is dominant, show the most significant change.

Based on this data, it can be argued that the "R" value, that stands for the redness in the color, may have caused the prominent color difference.

In order to investigate the user opinion on the change of the perceived color, a questionnaire was applied to 12 customers who purchased a product from the store. The user group was all women, from different age groups and different professions. On the 5-degree Likert question about the importance of color on the purchasing decision, 5 out of 12 people stated that it was very important and 7 people find it important. 10/12 people have found the display lighting very good at enabling the evaluation of the product. 2 people found it good. For the same question for fitting rooms, 8/12 people found it very good, 3/12 good and 1 person found it average mentioning that the lighting in the fitting rooms felt a bit darker. 8/12 people said the lighting on the cash desk area was very good to evaluate the product and 4 said it was good. Only one of the users which have also mentioned fitting rooms being darker perceived a color difference in the fitting rooms. The rest of the people did not realize a color difference on the products at any key points in the store. 2 of the people purchased a product in black, 2 in white, 2 brown, 2 red, 1 beige, 1 pink, 1 blue and 1 multi-colored consist of yellow & black. On the question of what if they realized the color of the product was different outside the store, 7/12 people said they would still keep it, 4/12 would return it and 1 person said it depends on how much she liked the style. 9/12 of the user group have experienced a similar scenario before and only 3 of them ended up with returning the product.

When the overall data taken from the color determination tool and the users are examined, it can be said that although some color differences are detected at different points in the store, the users did not generally realize the difference on their color perception. This output can be defined as an example of 'color constancy' which is the human capacity to perceive colors as relatively

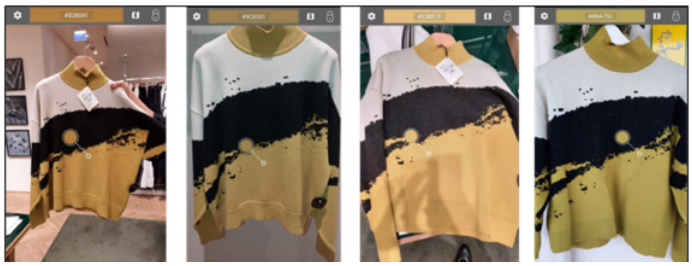

Figure 1. *Product 1 under display, Fitting room, Cash desk lighting and under daylight.*

Table 4. *Color data for product 1 provided by Color Grab App.*

Color	Area	Perceived Color	Color Name	Hex	RGB	HSL
Color 1	Display		Brown:Orange	#B38041	R:179 G:128 B:65	H:33° S:47% L:48%
	Fitting Room		Brown:Orange	#9C8351	R:156 G:131 B:81	H:40° S:32% L:46%
	Cash Desk		Orange:Yellow	#E3BE7F	R:227 G:190 B:127	H:38° S:64% L:69%
	Daylight		Yellow:Orange	#BCA75C	R:188 G:167 B:92	H:47° S:42% L:55%
Color 2	Display		Black	#110D0E	R:17 G:13 B:24	H:345° S:13% L:6%
	Fitting Room		Black	#0C1013	R:12 G:16 B:19	H:206° S:23% L:6%
	Cash Desk		Dark Grey	#373338	R:55 G:51 B:56	H:288° S:5% L:21%
	Daylight		Black:Blue	#10131D	R:16 G:19 B:29	H:226° S:29% L:9%
Color 3	Display		Light Faded Brown:Red	#CDB5B1	R:205 G:181 B:177	H:0° S:22% L:75%
	Fitting Room		Light Grey	#C0C1C1	R:192 G:193 B:193	H:180° S:1% L:75%
	Cash Desk		Light Grey:Red	#D2C5C4	R:210 G:197 B:196	H:4° S:13% L:80%
	Daylight		Light Grey:Blue	#CFD3D9	R:207 G:211 B:217	H:216° S:12% L:83%

Figure 2. *Product 2 under display, Fitting room, Cash desk lighting and under daylight.*

Table 5. *Color data for product 2 provided by Color Grab App.*

Area	Perceived Color	Color Name	Hex	RGB	HSL
Display		Dark Blue	#203D8F	R:32 G:61 B:143	H:224° S:63% L:34%
Fitting Room		Blue	#3456AC	R:52 G:86 B:172	H:223° S:54% L:44%
Cash Desk		Blue	#2249AE	R:34 G:73 B:174	H:223° S:67% L:41%
Daylight		Blue	#193FAF	R:25 G:62 B:175	H:225° S:75% L:39%

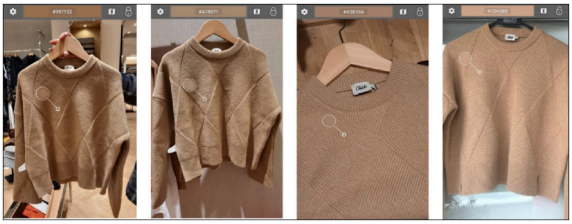

Figure 3. *Product 3 under display, Fitting room, Cash Desk lighting and under daylight.*

Table 6. *Color data for product 3 provided by Color Grab App.*

Area	Perceived Color	Color Name	Hex	RGB	HSL
Display		Brown:Orange	#997152	R:153 G:113 B:82	H:26° S:30% L:46%
Fitting Room		Brown:Orange	#A78871	R:167 G:136 B:113	H:26° S:23% L:55%
Cash Desk		Brown:Orange	#A3816A	R:163 G:129 B:106	H:24° S:24% L:53%
Daylight		Brown:Orange	#CDA58B	R:205 G:165 B:139	H:24° S:40% L:67%

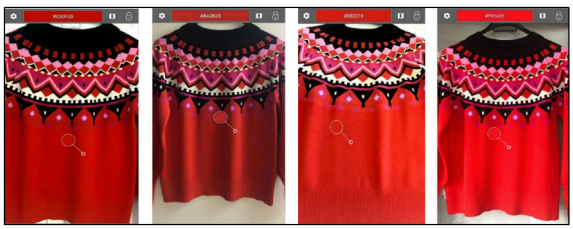

Figure 4. *Product 4 under display, Fitting room, Cash desk lighting and under daylight.*

Table 7. *Color data for product 4 provided by Color Grab App.*

Color	Area	Perceived Color	Color Name	Hex	RGB	HSL
Color 1	Display		Brown:Red	#C00F00	R:192 G:15 B:0	H:5° S:100% L:38%
	Fitting Room		Brown:Red	#BA2B25	R:186 G:43 B:37	H:2° S:67% L:44%
	Cash Desk		Red	#D82016	R:216 G:32 B:22	H:3° S:82% L:47%
	Daylight		Red	#CDA58B	R:249 G:20 B:33	H:37° S:95% L:53%
Color 2	Display		White	#FEFEE2	R:254 G:254 B:226	H:60° S:93% L:94%
	Fitting Room		White:Orange:Yellow	#EEE9DA	R:238 G:233 B:218	H:45° S:37% L:89%
	Cash Desk		White	#FDFDF6	R:253 G:253 B:246	H:60° S:64% L:98%
	Daylight		White	#FCFBF0	R:252 G:251 B:240	H:55° S:67% L:96%
Color 3	Display		Pink:Red	#AE173F	R:174 G:23 B:63	H:344° S:77% L:39%
	Fitting Room		Violet:Pink	#B82D6B	R:185 G:45 B:107	H:333° S:61% L:45%
	Cash Desk		Pink:Red	#EB3C7A	R:235 G:60 B:122	H:339° S:81% L:58%
	Daylight		Pink:Red	#DA0D55	R:218 G:13 B:85	H:339° S:89% L:45%
Color 4	Display		Light Pink:Red	#F78FB2	R:247 G:143 B:178	H:340° S:87% L:76%
	Fitting Room		Pink:Red	#C3688B	R:195 G:104 B:139	H:337° S:43% L:59%
	Cash Desk		Very Light Violet:Pink	#FEB5DE	R:254 G:181 B:222	H:326° S:97% L:85%
	Daylight		Light Pink:Red	#FA8BB9	R:250 G:139 B:185	H:335° S:92% L:76%

constant under different illuminations. Although the customers did not realize a color difference specifically in this store, most of them still mentioned that they experienced a situation like this before and some of them ended up with the return of the product.

CONCLUSION

In this study it was aimed to determine the effects of lighting in the retail business on the color perception of the products and to investigate its effects on user satisfaction/ dissatisfaction. In order to fulfill this aim, a case study was done in a chain clothing store located in a shopping mall in İzmir, Turkey. Using a color determination called Color Grab, photos of different colored products are taken under different lighting conditions of key point areas which are display areas, fitting rooms and cash points. The data provided by the application is compared to the color data taken under daylight which shows the real color having the color rendering index of 100. Based on the collected data, it can be discussed that achromatic colors such as black and white are the least effected colors from the change in the lighting, while yellow and pink colors, where the R value is dominant, show the most significant change. In order to evaluate the effects of differences in color perception on user's satisfaction/ dissatisfaction, a questionnaire was done to 12 customers who have purchased a product in this store. The survey data show that even most of the users don't realize the color differences in the store related to color constancy, when they experience a different color outside the store, it may result with product return.

To sum up, because of the variety of settings under which consumers will use acquired products, using only one illuminant for instrumental color measurement during the supply chain management process can lead to customer dissatisfaction. It is advised that the lighting used in the color quality control procedure be taken into account in retail businesses to avoid consumer dissatisfaction and other unwanted outcomes. It is critical that the illuminants employed in color measurement during production match the illumination that retailers expose their textile items to, both in shop displays and in real-world situations. In terms of supply chain management, the illuminants utilized for quality control and supply chain management must be properly selected.

As a result of this research; it is suggested that to address light quality challenges for retail displays, lamp manufacturers, color measurement vendors, retail lighting designers, and store designers should collaborate. Lighting uniformity, outstanding consumer experiences, and ultimately continuing store success will be ensured by early and ongoing partnership. Comparative research may further this study with larger samples and varying products. New technologies may help expand and enrich the understanding of the relationship between retail lighting, product color perception, and satisfaction.

REFERENCES

- *Arslan, F.M. (2004). Mağazacılıkta Atmosfer. İstanbul: Derin Yayınları.*
- *Azoulay, J.F. (2005). Color, Light and Getting It Right. AATCC Review 2005, 5: 41–45.*
- *Baumstarck, A. and Park, N. (2010). The Effects of Dressing Room Lighting on Customers' Perceptions of Self and Environment. Journal of Interior Design, 35(2), 37-49.*
- *Berns, S.R. (2000). Billmeyer and Saltzman's Principles of Color Technology (3rd ed.). New York: A Wiley-Interscience.*
- *Boyce, P., Raynham, P. (2009). The SLL Lighting Handbook. London: CIBSE-Chartered Institution of Building Services Engineers.*
- *Brengman, M. and Willems, K. (2009). Determinants of Fashion Store Personality: A Consumer Perspective. Journal of Product & Brand Management 18(5): 346–355.*
- *Cardenas, L.M., Shamey, R. and Hinks, D. (2009). Key Variables in the Control of Color in the Textile Supply Chain. International Journal of Clothing Science and Technology Vol. 21 No. 5, 2009 pp. 256-269.*
- *Chae, Y. and Lee, E. (2021). Color Inconstancy of Chromatic and Achromatic Textile Fabrics with Changes in the Correlated Color Temperature and Luminance of the Light Source. Fibers and Polymers 2021, Vol.22, No.10, 2762-2772.*
- *Choi, N.Y., Lee, J.S. and Yang, L.N. (2007). The Influence of Luminous Source Affecting on the Perception of Textile Color. Res. J. Costumec. 15, 214–220.*
- *Collishaw, P.S., Weide, S., Schamberger, R., Bradbury, M.J. (2004). Color (In)Constancy: What Is Achievable on Retailer Standards? AATCC Review. 4(9): 16-18.*
- *Custers, P.J.M. (2008). The Effects of Retail Lighting on Atmosphere Perception. Eindhoven University of Technology.*
- *Custers, P.J.M., de Kort, Y.W.A., IJsselsteijn,W.A. and de Kruiff, M.E. (2010). Lighting in Retail Environments: Atmosphere Perception in the Real World. Lighting Research and Technology, 42, 331-343.*
- *Durak, A., Olguntürk, N.C., Yener, C., Güvenç, D. and Gürçınar, Y. (2007). Impact of Lighting Arrangements and Illuminances on Different Impressions of A Room. Building and Environment, 42(10), 3476-3482.*
- *Epps, H.H. and Moore, M.A. (1989). Effect of Sample Conditioning on Color Measurement. American Association of Textiles Chemists Colorist Book of Paper, pp. 218-220.*
- *Erdil, T.S. (2015). Effects of Customer Brand Perceptions on Store Image and Purchase Intention: An Application in Apparel Clothing. Procedia e Social and Behavioral Sciences, 207, 196-205.*
- *Harold, R.W. (2005). Textiles: Appearance Analysis and Shade Sorting. Color Measurement Principles and the Textile Industry Workshop, pp. 1-21.*
- *Hidayetoglu, M.L., Yildirim, K. and Akalin, A. (2012). The Effects of Color and Light on Indoor Wayfinding and the Evaluation of the Perceived Environment. Journal of Environmental Psychology, 32, 50-58.*
- *Hinks, D. and Shamey, R. (2011). Review of Retail Store Lighting: Implications for Colour Control of Products. Coloration Technology Special Issue: Quality of Light Sources, Volume 127 Issue 2.*
- *Hinks, D., Draper, S., Che, Q., Nakpathom, M., El-Shafel and Connelly, A. (2000). Assessment of the Effect of Lighting Variability on Color Difference. AATCC Review, 32(6), 16-20.*
- *IESNA Merchandising Lighting Committee, (2000). The IESNA Lighting Handbook Reference and Applications, 9th Edition. M. S. Rea, Ed. New York: The Illuminating Engineering Society of North America.*
- *IESNA Merchandising Lighting Committee, (2001). Recommended Practice for Lighting Merchandise Areas (A store light guide). New York: The Illuminating Engineering Society of North America.*
- *Jeong, J.Y. and Lee, E.K. (2010). The Influence of Luminous Source on Fabric Chromatic Change Effects. J. Korean Home Econ. Assoc. 48, 17–24.*
- *Judd, D.B., and Wyszecki, G. (1975). Color in Business, Science and Industry (3rd ed.). New York: John Wiley & Sons.*
- *Kan Kilic, D. and Hasirci, D. (2011) Daylighting Concepts for University Libraries and Their Influences on Users' Satisfaction. The Journal of Academic Librarianship, 37(6), 471-479.*
- *Knez, I. (2001). Effects of Color of Light on Nonvisual Psychological Processes. Journal of Environmental Psychology, 21, 201-208.*
- *Kucukikiz, E. (2007). Hazır Giyim Ürünlerini Satın Almada Müşterilerin Mağaza Vitrinlerinden Etkilenme Durumları. Gazi*

Üniversitesi Yüksek Lisans Tezi.

- *Li, W.M., Lee, S.C. and Chan, L.Y. (2001). Indoor Air Quality at Nine Shopping Malls in Hong Kong. The Science of the Total Environment Vol. 273 pp. 27-40.*
- *Laski, J., Brunault, C.A., Schmidt, R. and Ryu, S.C. (2000). An Exploratory Study of Retail Lighting with Continuous Modulation of Color Rendering Properties to Influence Shoppers' spatial Range of Browsing. Journal of Business Research 111 (2020) 148–162.*
- *Mukthy, A.A., Vik, M. and Vikova, M. (2022). Color Perception Estimations of Metameric Pairs Under Different Illuminance Levels. Fibres and Textiles 29(1), 2022.*
- *Park, N.K. and Farr, C.A. (2007). The Effects of Lighting on Consumers' Emotions and Behavioral Intentions in a Retail Environment: A Cross Cultural Comparison. Journal of Interior Design, 33(1), 17-32.*
- *Quartier, K., Vanrie, J. and Van Cleempoel, K. (2014). As Real as It Gets: What Role Does Lighting Have on Consumer's Perception of Atmosphere, Emotions and Behavior? Journal of Environmental Psychology, 39, 32-39.*
- *Rea, M.S. (2000). The IESNA Lighting Handbook: Reference & Application. New York: Illuminating Engineering Society of North America.*
- *Sanger, A. (2007), "Creativity: Getting Color Right", Paper Presented at the Color Management Workshop, Raleigh, NC.*
- *Schielke, T. and Leudesdorff, M. (2015). Impact of Lighting Design on Brand Image for Fashion Retail Stores. Lighting Research and Technology, 47, 672-692.*
- *Smith, W. (1989). Trends in Retail Lighting: An Intelligent Design Approach. Retail and Distribution Management 17 (5): 30–32.*
- *Summers, T.A. and Hebert, P.R. (2001). Shedding Some Light on Store Atmospherics: Influence of Illumination on Consumer Behavior. Journal of Business Research, 54(2), 145-150.*
- *Ticleanu, C., Littlefair, P.J. and Howlett, G. (2013). The Essential Guide to Retail Lighting. IHS BRE Press: ISBN: 978-1-84806-322-8.*
- *Turley, L.W. and Milliman, R.E. (2000). Atmospheric Effects on Shopping Behavior: A Review of the Experimental Evidence. Journal of Business Research, 49(2), 193-211.*
- *Yaoyuneyong, G. (2007). Effects of Illuminants and Retail Environments on Color of Textiles Fabric. PhD thesis, Florida State University, USA.*