The Impact of Lighting Design on Perceived Architecture and Human Satisfaction in Museums.

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Dedication

I would like to dedicate this work to my father, Eng. Abd El Dayem Ahmady, who passed away in April 2019. I will always remember and appreciate his constant support in my education, research, and my entire life. I have been continuously dreaming of the time when I would be able to make him proud by seeing me earn my Ph.D. degree. May God bless his soul, forgive him, and grant him the paradise. Amen.

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Abstract

The use of light in museum design plays a crucial role in enhancing the visual experience of visitors in museums. Although atmospheric factors such as lighting design are important in enhancing the exhibition space's atmosphere, few studies have evaluated the design of these factors, and how they can affect the visitors' experience. The main aim of the research was to develop a lighting matrix that increases the understanding of how visitors perceive and respond to different kinds of exhibition lighting, and how this enhances their visual experience inside the exhibition hall. Furthermore, the study aimed to move from pure functional performance to people-driven museum lighting design.

The research utilized a quantitative approach by using a questionnaire to identify visitors' preferences regarding museums' lighting settings of two case studies. The survey was carried out in the real environment, and then in the virtual environment. A sample of 160 respondents evaluated the main exhibition hall in the Egyptian Museum in Cairo in the Real environment, and 40 respondents evaluated the Egyptian hall in the Birmingham Museum in the UK in the Real environment. Additionally, 66 participants evaluated four computer-generated scenes of the main hall of the Egyptian Museum in Cairo, Egypt, and 66 participants evaluated four computer-generated scenes of the Egyptian hall in the Birmingham Museum and art gallery, UK. Different lighting settings in each scene were adopted with the aid of virtual reality as an experimental tool using a semantic differential scaling method. Both environments were evaluated to study the effectiveness of Virtual Reality in simulating the real environment.

The survey data was analysed using SPSS, and different tests were applied to understand the relationships between the different variables using descriptive and inferential analysis. Moreover, the Spearman correlation test, Friedman test, and Chi-square test were applied. The test results showed that the more the lighting characteristics of the exhibition spaces were diverse and thrilling, the better the exhibition space was perceived, and the longer visitors were willing to stay and return. The results showed that the lighting distribution and colour could greatly affect the perception and impression of space as perceived by visitors specifically bright / dark, and colourful/ neutral tone of the lighting settings. Furthermore, the research developed a lighting matrix that could be applied to an extensive range of museum lighting settings. This lighting matrix is a contribution to knowledge that is beneficial to lighting designers, architects, museum owners, and evaluators.

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1. Chapter 1: Introduction

1.1. Background

Lighting is an important aspect of museum design that can have several impacts on the visitors' experience and satisfaction. This research focuses on the positive impacts that lighting design can have on the visually perceived architecture in the exhibition halls. These impacts include building a stronger museum's image and enhancing museum visitors' satisfaction, experience, and loyalty (Barroso et al., 2007; Beerli and Martin, 2004; Bigné et al., 2001). Furthermore, effective lighting design and visitors' satisfaction can ultimately help support and encourage heritage tourism which is defined as visiting historical buildings, artefacts, and monuments (Timothy, 2011).

Moreover, visitor's satisfaction is determined by two aspects; one is the cognitive aspect that is the outcome of the visitor's comparison process between their expectations and their actual experience. While the second aspect is the affective aspect which is more concerned with feelings (Bigné et al., 2001). The integration of both aspects provides an image of place (Martínez and Pina, 2009). Additionally, Beerli et al. (2004), demonstrated that the affective component has a stronger impact on the image than the cognitive one. In addition, several studies suggest that there should be a branch of museum research that is entirely concerned with the psychological influences of the museum architecture on visitors' experience (Bitgood, 2002, 2011). While previous research studied the importance of museum lighting design, there is still a gap in studies about the role of the lighting settings in enhancing the visitor's museum's experience (Ng, 2003).

Museums are meant to be caring for the heritage of the past yet still creating a legacy for the future (Lord, 2007). Museums play an essential role in inspiring and delivering knowledge in addition to connecting cultures and communities. During periods of economic recovery, museums can be more crucial than ever. In many instances, museums and galleries are considered deliverables of world-class public services that inspire people and, in return, attract them from all over the world. This can result in a flourishing economy and contributing to economic success (Lord, 2007).

Visitor’s experience is highly influenced by the museum’s exhibition environment (Dernie, 2006; Goulding, 2000; Macdonald, 2007). Previous research on museum visitors’ experience has mainly been concerned with the exhibition content rather than the nature of the museum’s environment itself. Moreover, theories on exhibition space design and its crucial role in enhancing the visitors’ experience have started to gain more scholarly significance in recent years (Stenglin, 2004; Roppola, 2012).

Previous research indicates that there is a direct relationship between the emotional responses of individuals and their lighting preferences. According to Baron et al. (1992), people have a more positive experience in low levels of lighting rather than in high levels of lighting. Furthermore, Kumari (1974) found that higher levels of illumination are accompanied by increased physiological arousal. Ciani (2010), also added that, when lighting design is in harmony with the furniture and accessories, the environment is perceived as more pleasant than the other environments where lighting is not in harmony with the surrounding elements. The type of lighting in an environment could have a direct impact on an individual’s perception of the definition and quality of a space, which influences his/her awareness of the physical, emotional, psychological, and spiritual qualities of the space (Ciani, 2010).

1.2. Research Problem

Although atmospheric factors such as lighting design are important in shaping the exhibition space’s atmosphere (as opposed to more specific and tangible dimensions such as the content on display), few studies were found to be concerned with the design of these factors and their potential impact on the visitors’ experience. Kottasz (2014), asserts that “Research to date has rarely investigated the impact of atmospheric cues on visitors’ responses and behaviour in museums and little is known about this important topic” (p.97).

1.2. Research Hypothesis

The more the lighting characteristics of the exhibition spaces are diverse and thrilling, the better the exhibition space is perceived, the longer visitors will stay and be willing to return thus contributing positively to the museum's brand image.

1.3. The Research Aim

Architectural design, museum branding, and the environmental psychology of visitors all represent distinct areas of practice that have sometimes struggled to speak to one another on mutually clear terms. They all have a common feature which is the desire to communicate with the visitor. The aim of the research is to develop a lighting design matrix that includes various lighting combinations that can be implemented in the exhibition space design to help enhance the visitor's experience and satisfy their needs of the visit. This study aims to consider different stakeholders from different disciplines. These include 1. the marketing discipline, that is concerned with the museum's brand image. 2. the architectural discipline which is related to lighting design and the perceived spaces, and 3. the environmental psychology discipline, which is concerned with visitor's satisfaction, preferences, and human behaviour in the exhibition halls.

1.4. Research Objectives

- To develop a lighting matrix that includes all expected lighting combinations in museums, to satisfy different stakeholders' outcome needs of the museum and contribute to a shared language among exhibition designers, museum owners, educators, and evaluators to narrow the gap between lighting design research and practice.
- To assess the potential lighting design approaches and enhance the presence of the human factor through exploring the linkage between the perceived atmosphere and the physical atmosphere.
- To evaluate the use of virtual reality as a tool to assess the different lighting settings that include different patterns of lighting distribution, brightness,

darkness, and colour in understating people’s perceptions and impressions to help in developing a lighting approach that focuses on the shift from designing lighting spaces and displays to lighting people-centric places.

- To identify the importance of the exhibition’s lighting settings in enhancing the museum’s brand image.
- To explore and compare the same exhibition’s atmosphere using different lighting settings and see how visitors perceive and respond to different kinds of lighting settings in exhibition spaces in different ways.

1.5. Research Questions

The research will address multiple research questions to find out how the research objectives could be achieved, and which methods are needed to conduct the research.

- Do changes in the lighting settings affect the perceived atmosphere and do these changes affect the visitor’s satisfaction and experience?
- What is the relationship between the lighting settings and the different emotional perceptions of Pleasure, Arousal, and Dominance?
- Does the museum’s brand image get affected by its lighting settings?
- How can exhibition lighting design enhance the visitor’s experience?
- Do participants’ levels of Pleasure, Arousal, and Dominance in the Virtual Reality environment differ from the real environment for the same lighting settings?
- Does the difference in the exhibition’s room dimensions and areas while having the same lighting settings have a different impact on people’s perception of the space in terms of lighting?

1.6. Motivation and Contribution to Knowledge

The motivation behind this work was to investigate how lighting design can have a positive impact on perceived architecture, and consequently enhancing the global image and museum loyalty, and encouraging heritage tourism. Enhancing visitors’ visual experience will help motivate them to revisit museums and encourage them to recommend the visit to others. This also helps in creating museum loyalty that encourages tourism and helps in enhancing the economy. Moreover, findings from the present study deliver a new perspective for using Virtual Reality as an assessment tool. Investigating the impact of lighting settings on people's emotional states, and the use of virtual reality simulations to assess people's visual perception in exhibition halls helped in delivering new insights and contributions to knowledge. Additionally, the development of a lighting matrix describes to a certain point the variation of visitors' emotional states in relation to different lighting settings in exhibition halls. This can provide different stakeholders with the essential data to design exhibition halls that meet visitors' visual expectations.

1.7. Summary of the Research structure

This section will include a brief description of the contents of each chapter.

Chapter 1: **Introduction**: this chapter includes the research background, aim, hypothesis, objectives, and questions in addition to the research motivation and the research contribution to knowledge.

Chapter 2: **Literature Review**: it discusses the prior research on the social, cultural and economic role of museums, the influence of museum's brand image on visitors' satisfaction, the impact of lighting on perceived architecture, and the theories' frameworks for museum's atmospherics to provide a solid background in these fields and identify the research key gaps.

Chapter 3: **Research Methodology**: it discusses the research design, justification of the methodology, methods of data collection, and data analysis.

Chapter 4: Analysis and Discussion of Findings: it includes the analysis of data collection using descriptive and inferential analysis and applying tests such as Spearman correlation test, Friedman test, and Chi-square test.

Chapter 5: Research Findings, Conclusions, and Recommendations: it discusses the research key findings, novel contribution to knowledge, future studies, and limitations.

2. Chapter 2: Literature Review

2.1. Introduction

This chapter will present a review of what previous researchers offered in relevance to the different concepts addressed in this study. Insights from the literature will be used to explore the relationships between the lighting settings in museums and perceived architecture, brand loyalty, and visitors' emotional states. Moreover, the impact of lighting as an atmospheric variable on visitors' experience in the exhibition hall will be discussed.

2.2. The Social, Cultural and Economic Role of Museums

A "museum" can be defined as a building that communicates varying images and messages to different people and displays various forms of tangible and intangible heritage (Bitgood, 2013). Some people might think of a museum as the place where fixed animals are displayed, as in the natural history museum, while others might think of the museum as the splendid steps that lead to an entrance with huge columns, designed to create a feeling of respect and admiration (Bitgood, 2006).

Furthermore, museums can facilitate a lifelong learning process and satisfy those who seek intellectual enhancement during their leisure time (Lord, 2007). Packer (2004) asserts this by describing museums as the "educational leisure settings". Museums can include various types ranging from traditional collection-based museums to aquariums, science centres, zoos, and interpretive centres Packer (2004). A study by the Australian Bureau of Statistics (ABS) showed that in year 2011, 25.9% of the Australian population aged over 15 years old visited an art gallery, 25.5% visited a museum, and 36.8% visited zoological parks and aquariums (ABS, 2011). This highlights the importance of museums in being considered the focal points for economic investment in addition to their social value as important civic institutions (Scott, 2009).

2.3. The Role of Architecture in the Museum Environment

According to Oliveira and Steemers (2008), two trains of thought are present that describe the role of architecture in the museum's environment. The first indicates that the museum building should be kept as a quiet background, so that the artefacts can express themselves. The second states that the architecture should contribute to the visual field, to enhance the experience of how the artefacts are perceived. Additionally, the artefacts should not just be seen, but it is important that the inherent meaning is conveyed through a visual interaction since, vision through lighting opens a dialogue between the artefacts and the visitor.

Over time, the forms of museums have constantly changed from historic buildings to contemporary ones and from displaying to telling (Hillier & Tzortzi, 2011). Moreover, exhibition design and museum architecture are interlinked. (Giebelhausen, 2011; Higgins, 2005). In the early 19th century, museums were characterized by their imposing entrance halls, rotunda, columns, and wings of enfilade rooms where their design was inspired from the European palaces and other monumental forms emphasizing the museum as a place of seriousness (Dernie, 2006; Giebelhausen, 2011).

In antiquity times, little attention was given to the design of the exhibitions in public museums. The organization of collections was dictated by the architecture of the museum, which was allocated into wings that were set between various levels of knowledge (Psarra, 2005). Architects at that time designed the interiors with ornamented ceilings and floors, also walls were painted in dark and rich tones. (Giebelhausen, 2011), which resulted in "dark, cluttered interiors" (Dernie, 2006). Inside the exhibition halls, the artwork was displayed on the walls of the gallery and objects were put in uniform built in display cases (Dernie, 2006; Miles et al., 1988). There was no attention paid to the needs of the visitors, with minimal interpretation. This formed exhibition spaces that "presented the lay visitor with a puzzling arrangement of objects, each carefully placed beyond his reach, with a label in a language he could barely understand" (Miles et al., 1988).

Architecture and art were highly impacted by modernism in the early 20th century which again had a high influence on exhibition design, in particular Walter Gropius and the Bauhaus, a well-known art, craft, and design school in Germany during the 1920s and 1930s (Miles et al., 1988). Bauhaus played a significant role in design education and Miles mentioned that Bauhaus's advances and contributions were one of the crucial factors that led to having exhibition design as a separate profession (Miles et al., 1988).

Moreover, in the 20th century exhibition design was influenced by the consumer culture which was practiced specifically in New York, where museums were looking for new ways to use design to draw the visitor's attention. Museums from this era show designers such as Rene D'Harnoncourt, whose 1946 exhibition Arts of the South Seas at the Museum of Modern Art adopted dramatic lighting and colour schemes in a way that opened a new door in the exhibition design. This also led to a new way of interpreting the art that was on display (Foster, 2012).

Furthermore, in this era modernism challenged the conservative limits of art, as the exhibition became not only a place where art is displayed but also a place through which art is experienced (Dernie, 2006; Lampugnani, 2011). The typical art gallery environment since then was the white cube, which put the art as the only focus while the space fades into the background (Dernie, 2006; Giebelhausen, 2011). On the other hand, the notion of the "black box" paradigm began to emerge (Toon, 2005). This notion places the visitor in an artificial environment that is created by the exhibition's designer, keeping the visitor disconnected from the outside world.

2.4. New Role of Exhibitions (Shift from Function Oriented to People Oriented Exhibitions).

In the 1960s, exhibition design gained more attention, especially in the field of organizing the visitor's experience inside the museums (Miles et al., 1988). In the same period, museum visitor research increased in status since design started to be more people- centred and driven by people's needs.

“Design is recognized more fully as an integral part of the visitor’s experience, with potentially more far-reaching implications for structuring, the very nature of that experience rather than simply providing a more or less attractive medium for presenting content” (Macdonald, 2007). Belcher (1991) classified interactive exhibitions into two main types: emotive exhibitions, and didactic exhibitions.

- **Emotive exhibitions** can be defined as exhibitions that present artistic objects for aesthetic purposes.
- **Didactic exhibitions** on the other hand are exhibitions that have educational purposes therefore, more stress is placed on the visitor’s interpretation, in order to create what is called a “three-dimensional essay” (Belcher, 1991).

Lately, this classification has differed as artistic exhibitions have started to implement more interpretation techniques while educational exhibitions are adopting more narrative and theatre techniques (Lord, 2001). Furthermore, the demanding exhibition media and increased audience expectations stress on the importance of designing the exhibition environment as a whole (Dernie, 2006; Lord, 2001; Lorenc et al., 2010; Mayrand, 2001). Lately, Dernie (2006), categorized exhibitions into three different categories as follows:

- **Narrative spaces**: They are spaces where the organization of objects and displays directs the visitor’s movement in a way that reveals intended storylines.
- **Performative spaces:** The main focus in these spaces is on action rather than on the visitor’s observation.
- **Simulated experience spaces**: These are spaces that are more concerned with immersive multimedia experiences and restorations.

All these types represent different approaches for designing exhibition halls not as spaces where there is a group of displays but as an integrated experience. ‘Experience Design’ creates a story out of the display objects in order to engage the visitor at an emotive level and help build a memory-rich experience of the physical settings (Dernie, 2006). Museums that are considered experience-based businesses focus on interactions with customers, from initial expectation and encounter to delivery and subsequent recollection. In order to enhance emotional engagement and memorability of the exhibition experience, there should be narrative techniques implemented in the design to support this notion. (Zomerdijk & Voss, 2009).

These narrative structures are achieved through a sequence of “touchpoints” or “experience clues” that take into consideration the sensory properties of the physical environment (Carbone & Haeckel, 1994; Zomerdijk & Voss, 2009). In order to achieve experience design, themed environments should be a major component (Nelson, 2009). A well-designed museum is the one that tends to support communication with visitors in a subconscious way. (Hillier & Tzortzi, 2011; Macdonald, 2007; Stenglin, 2004). Furthermore, to have a shared design language, there are some developments that should be implemented.

Roppola (2012) uses the concept of resonance to describe the interaction between qualities of the exhibition environment and the visitors. The word “resonance” in physics is used to explain “the amplification effect observed when two bodies vibrate at the same wavelength” (p.481). Likewise, exhibits and visitors can be considered as being in a resonant relationship when they are in harmony with each other. According to Roppola (2012), some environmental features such as light, colour and size tend to attract the visitor’s attention, and therefore, exhibition’s environments could be pleasant by having appealing lighting characteristics, spaciousness, or aesthetic appeal.

Museums’ exhibitions can be considered as four-dimensional media where visitors tend to move physically through them in both time and space. Roppola (2012), describes that visitors navigate through exhibition halls for more than just finding their way, it is also about how they navigate through museums physically mentally, emotionally as well as psychologically.

According to Roppola (2012), the channelling concept is concerned with the idea of how visitors perceive the environment of the museum and act accordingly. Roppola (2012), asserted that there are three different channels. These channels are divided into; spatial channels, narrative channels, and multimodal/multimedia channels. In fact, some spaces encourage people to stay while others hurry them, accordingly, narrative channels can be seen as more important to the conceptual journey of the visitor while spatial channels are important to the physical movement of people in the exhibition halls. It has been emphasized by many visitors that there should be a theme or a way to organize their journey throughout the exhibition.

Roppola (2012) uses the term Broadening to explain the visitor's engagement with the content of museums, as they negotiate "the poetics and politics of display" Examples of broadening that take place in museums include:

- "Experiential broadening: seeing or doing something you would not normally have the chance to"
- "Conceptual broadening: improving understanding of a theoretical principle"
- "Affective broadening: exploration on an emotional level"
- "Discursive broadening: considering an issue from another point of view"

Resonating and channelling, could be used to describe the relationship between the visitors and the exhibits in a way that delivers interpretive messages, that exhibits are meant to convey (Roppola, 2012). This is a new vision, as previously most museum's visitor research has taken from the point of what visitors "learn" from a given exhibition. Those terms encourage the concept of understanding the museum visitor's experience by looking at broader patterns in the relationship between the museum and the visitor instead of just being restricted to the exhibit's content (Roppola, 2012).

2.5. Atmospherics of the Exhibition Environment

The term atmospherics was first used in describing the design of retail environments, where it was defined as "the conscious designing of space to create certain effects in buyers" (Kotler, 1974; p.49). The idea behind atmospherics is that the design of an environment has the ability to influence the behaviour of people, resulting in design options that will then influence people in distinctive and anticipated ways. Kotler (1974) described atmospherics as a "silent language" a language that is similar to body language, spatial language, or temporal language.

The influence of atmospherics takes place through emotional and sensory mechanisms (Kotler, 1974), which has an impact on people's behavioural patterns, that take place on a subconscious level (Turley & Milliman, 2000). Kotler (1974) anticipated that atmospherics could be significant in cases of pleasure-based consumption. Atmospherics is now broadly recognized as an important component of quality experience in different leisure settings (Chang & Horng, 2010), and the expression is now commonly used by marketers as a way to explain the overall design and atmosphere of a leisure, retail or service environment (Baker et al, 2002). The perceived atmosphere in the consumer environment plays a crucial role in the exhibition experience, as this quotation from a recent exhibition review attests:

> ". . . The gallery has been beautifully designed and lit, creating a soothing blue subaqueous environment in which visitors swim in and out of pools of light like languid fish. Above their heads, the atmosphere twinkles, and flows" (McAdam, 2011, p. 42).

Handley (2014) added that an exhibition that lacks these elements is considered disappointing: "I expected to see the colour of blood, the brightness of fire, the vast azure expanse of the sea, but I mostly saw the same dull grey" (p.47). These examples show how atmospherics is thought of as a form of interpretation and a way of communication medium throughout the exhibition space (Kotler, 1974). The cultural sector conducted a market research which stressed on how important the environment is to the visitors' experience and satisfaction in their museum's perception and experience. In Florida, a survey was conducted of 500 visitors throughout different attractions (a museum, a zoo, an aquarium, and a performing art centre), that concluded that ambience factors that included colour scheme, lighting and signage had an important impact on the intention of visitors to be willing to return and recommend to other people (Bonn et al., 2007).

According to Bonn et al. (2007) and Kottasz (2006), atmospheric factors such as colour schemes, layout, lighting, and signage are important factors to create the overall perception of an exhibition environment as it characterizes the visitor's experience from a marketing perspective. This conclusion was also supported by an additional qualitative study, where a sequence of semi-structured interviews with museum's visitors was conducted to understand their perspectives on their visits. The comments that are concerned with the general atmosphere or ambience were included in 43 percent of the interviews (Packer, 2004). Another investigative study that used the open-ended interview technique also suggested that atmospheric factors were important factors for people to describe their visits (Roppola, 2012).

2.6. The Influence of Museum's Brand Image and Satisfaction on Visitors' Loyalty in relation to Museum's Lighting

Exhibitions are considered effective branding tools as every exhibition has its own theme and its narration that specifically reflect a museum's brand image (Wallace, 2006). According to Caldwell (2000), the impacts of a museum's brand image and visitor's satisfaction on loyalty among museum's visitors have not been profoundly analysed. It is important to identify the most effective means to make the visitors interested in heritage assets. Therefore, visitor's satisfaction is the main component of the museum's experience, and brand image is considered the significance of the museum's brand in the visitor's mind.

Word of mouth is an important factor in building a positive museum's brand image. Since positive messages of friends and family members are reliable sources, which show visitors an honest impression of the place (Simpson and Siguaw, 2008). Visitors' loyalty is also related to the repeated experiences, that imply a psychological commitment of preference (Chi and Qu, 2008). Previous literature shows plenty of research on the relationship between tourists' loyalty and their satisfaction (See Radder et al., 2013; Gallarza and Gil, 2006; Harrison & Shaw, 2004). Specifically, Radder et al. (2013), expressed that visitor's satisfaction has a positive impact on loyalty. While Yuksel et al. (2010) concluded that satisfaction is a fundamental element that leads to loyalty, however, further studies demonstrated that other factors also have a major effect on loyalty, such as the quality of the visitor's experience and destination image (Campón-Cerro et al., 2016; Wu, 2016; Radder et al., 2015).

Chen and Gursoy (2001) conducted a research in the Reina Sofia Museum, located in Madrid, Spain, to compare between the influence of visitors' satisfaction and perceived image, on visitors' loyalty. It indicated that customer loyalty is described as a relationship between the client and organization, which is in this case is the museum. Moreover, the research implied that customer's loyalty is deeper when organizations show their commitment to their customers through different marketing strategies, by initially gathering information of their customers' needs and preferences. Similarly, researchers have stated that after a museum visit, visitors can develop not only positive attitudes such as loyalty but also negative attitudes as well based on their museum experience (Tian-Cole et al., 2002; Tsai and Wang, 2016).

Loyalty has been related to different aspects, which include attitudinal, behavioural or combined intentions (Jacoby and Chestnut, 1978). Attitudinal loyalty indicates that visitors recommend the visit of the place (Bigné et al., 2001; Konecnik and Gartner, 2007). Behavioural loyalty is defined by visitors' intentions of revisiting the exhibition and repeating the experience (Lee et al., 2007; Yoon and Uysal, 2005). Composite loyalty is the combination of attitudinal and behavioural loyalty (Petrick, 2004).

2.6.1. The Link Between Satisfaction and Loyalty

For long-term business success, affective and cognitive elements of people's experiences in spaces should be measured (Del Bosque and San Martin, 2008; Mason and Paggiaro, 2012; Yoon and Uysal, 2005), and compared with their expectations concerning the visit (Agyeiwaah et al., 2016). Accordingly, the visitors will then start to make a reference framework, so that they can generate comparative judgments (Campón-Cerro et al., 2016).

Previous studies also encouraged an adequate level in the relationship between satisfaction and loyalty through encouraging revisit intentions and recommendations to others (Campón-Cerro et al., 2016; Chi and Qu, 2008; Wu, 2016). According to Polo Peña et al. (2013), visitors are more likely to be fascinated by major attractions in their first visit and tend to spend more time inside the museum, while repeated visitors, tend to visit fewer places inside the museum and spend more time at each attraction to their liking (Oppermann, 2000).

2.6.2. The impact of image on loyalty

Image is described in the tourism setting, as the mixture of impressions, perceptions and feelings which influence the decision-making process and accordingly the upcoming behavioural intentions (Chi and Qu, 2008; Del Bosque et al., 2008; Min et al., 2013; Stylos et al., 2016; Whang et al., 2016; Wu, 2016). This notion is hard to be defined, as it is determined by subjectivity which consists of two major features, cognitive aspects, and affective components (Barroso et al., 2007; Beerli and Martin, 2004; Bigné et al., 2001). To have an overall image of the place, an integration of both the cognitive aspects and the affective components should be present (Barroso et al., 2007; Beerli and Martin, 2004). Image has been analysed throughout affective elements in a precedent study by Martínez and Pina (2009) indicating that the affective component has a higher impact on the image.

It has been stated that people's revisit intentions are usually affected by their space experience. A positive experience takes place when individuals are engaged in a set of pleasurable activities and visit unforgettable places. It is also influenced by providing opportunities to satisfy a wide range of personal needs such as enjoyment, pleasure, and learning (Kim et al., 2012; Zhang et al., 2014). Moreover, potential visitors are influenced not only by images of a place in advertisements but also by the recommendations of their friends and relatives. Previous studies have indicated that there is a positive relationship between loyalty and the overall image (Zhang et al., 2014; Whang et al., 2016).

2.7. Impact of Lighting Design on Brand Image

It is shown by history that companies benefit from the architectural design and symbols to be able to communicate their brand identity (Messedat, 2005). Service businesses need to adopt consistent design strategies to assist in forming a uniform image to the consumer, to have a well-defined brand identity. Although design parameters as furniture, colour and material have been recognized more widely in the 1960s within visual guidelines (Meggs, 1983), lighting design is considered relatively new. According to the American Marketing Association (Kotler, 1974), a market brand, is considered as "a name, term, sign, symbol or design, or a combination of them, intended to identify the goods or services of one business that offer a service to differentiate them from those of competitors" (p.51). The museum's main aim is to communicate a brand strategy of the museum's brand image in the mind of the visitor as a receiver in what is called the visual identity of a brand (Kirby and Kent, 2010). In addition to the actual personality of a brand (Aaker, 1997).

In museums, the building's architectural design is considered a symbol that can communicate the place's brand identity (Messedat, 2005). Raffelt (2011), has developed an approach to consider the different design dimensions, which define the architectural expression, in addition to the brand-related response dimensions. The branding literature and connected prototypical design styles in architecture to brand impressions was also studied by Raffelt (2011). The brand personality was defined by Aaker (1997), as the "set of human characteristics associated with the brand". Raffelt (2011), assumed from literature and examined by tests a scale for empirical studies about the architectural design in Germany.

Raffelt (2011) assumed a four-factor solution to be the most adequate solution to capture the data. It explained more than 80% of the brand personality variances through temperament, competence, attractiveness, and naturalness. It was observed by Flynn (1977), that bright spaces become considerably clearer and more spacious in comparison to darker situations. Another study showed that visitors observe more displays under bright lighting unlike soft lighting which could be linked to attractiveness (Areni and Kim, 1994).

Raffelt (2011) had a hypothesis that stated if there is a change in the lighting concept from general lighting to accent lighting or another type of lighting would achieve a significant change in the brand image. Her research indicated that a bright environment could be regarded as an association to daylight and respectively to naturalness. Hence, the hypothesis is generalized for all parameters. As indicated by the first hypothesis, brightness leads to higher values for the visitor's experience and visits in addition to, temperament, competence, attractiveness, and naturalness. The first hypothesis has been examined through different lighting settings and room situations where the participants were asked to give their opinion on light and brand issues. Using a Likert scale to quantify this stimulus and subjective reactions, the light was evaluated via the following eight factors: Bright, Dark, Non-uniform light, Uniform light, Cold, Warm, Coloured and Colourless. The other hypothesis that was tested by Rafllet (2011) was that general lighting with down lights is often linked to low budget environments. Therefore, the second hypothesis stated that illumination with down lights leads to lower values for price, temperament, competence, attractiveness, and naturalness when compared to wall washing and accent lighting.

Brand classification was evaluated through a two-dimensional setting study that focuses on social status and value orientation (Becker and Nowak, 1982). Social status was evaluated using “High class” and “Low budget” terms while style as a marker for value orientation was evaluated through the two terms “Modern” and “Traditional”. Each of the four brand personality variances was evaluated with two items. For temperament, they were smart and progressive while, for competence, they were reputable and competent. For attractiveness, they were evaluated for glamorous and elegant, and lastly, for naturalness, they were evaluated for how close they are to natural. Raffelt (2011) came up after a thorough analysis of the literature, that there are four abstract store concepts for store stereotypes which are Low Budget, Minimalism, Black Box, and Colour, as shown in Figure 2.1.

Figure 2.1. Four concepts for store stereotypes (Rafflet, 2011)

The lighting for the low budget stereotype was based on a uniform lighting design with recessed down lights, to enhance a functional and simple appearance. In contrast, accent lighting and coloured projection on track-mounted luminaires created effect lighting for the colour shop concept. The black box design was based on grazing and accent light by track-mounted luminaires to create an intense contrast. Additionally, the minimalistic concept used recessed down lights and wall washers for an even illumination of the surfaces. Also, a qualitative study showed that exhibition layout and spaciousness can evoke a "spatial feeling" in visitors, which helps leave a lasting impression of the museum's experience (Schorch, 2013). These conclusions support the concept of how important the atmospheric dimension of a museum's experience is to a large percentage of visitors.

To balance Kotler's model for atmospherics, Baker (1987) developed a typology for the museum environment's that categorized space atmospherics into three elements. Ambient (temperatures, sounds, odours), and design elements (layout, colour, interior design), and social elements (the presence of visitors and employees). It is the design elements of the exhibition's atmosphere that are of interest to this study as it is related to lighting design.

Existing research on both museum atmospherics and visitors' experience have been strongly influenced by theories and techniques associated with environmental psychology (Bitgood, 2002, 2011; Ng, 2003). Environmental psychology is the study of the interplay between people and their environment, where the environment is understood to comprise both physical and socio-cultural elements (Holahan, 1982; McAndrew, 1993). In environmental psychology theory, the person and environment are both considered as a holistic integrated whole (Holahan, 1982). The environment simultaneously comprises multiple contexts across different scales. Psychological responses to this environment are either perceptual, cognitive, or affective which mutually interact with and affect behaviour. These responses in return influence the environment, creating a reciprocal person-environment relationship. In this transactional model of environmental psychology, the person-environment interaction is the main subject of study, and one cannot be fully understood in the absence of the other (Bitgood, 2002; Holahan, 1982). Applying these principles of environmental psychology to the museum environment, the visitor-exhibition dynamic can be considered to progress in space and time as the visitor perceives, processes, responds to, and interacts with the exhibition's environment (Bitgood, 2011, Falk, 1997, Holahan, 1982). This research considers museum's visitors as active participants not just passive recipients of environmental stimuli and therefore, the research will try to provide a better understanding of how the exhibition's environment is perceived. It also aims to provide further insight into how exhibition lighting design can enhance the visitor's experience.

Shannon (1948) first developed a model of the basic system of communication that indicates how the message planned by the museum is delivered to visitors. This was later adapted by Crilly et al. (2004), and involves the source, transmitter, channel, receiver, and destination. First, the information source produces a message, which is converted into a signal and transmitted across a channel. The receiver decodes the signal, and the message arrives at the destination. According to Crilly et al. (2004), the design team is the source of the message, while the displays and artefacts are the transmitters. The environment in which the visitor interacts with the museum's displays is considered the channel. Lastly, the visitor's perceptual senses are regarded as the receiver of the message and their responses are regarded as the destination. Visitors' responses can be divided into three aspects: cognition, affect, and behaviour. This communication process is described in Figure 2.2.

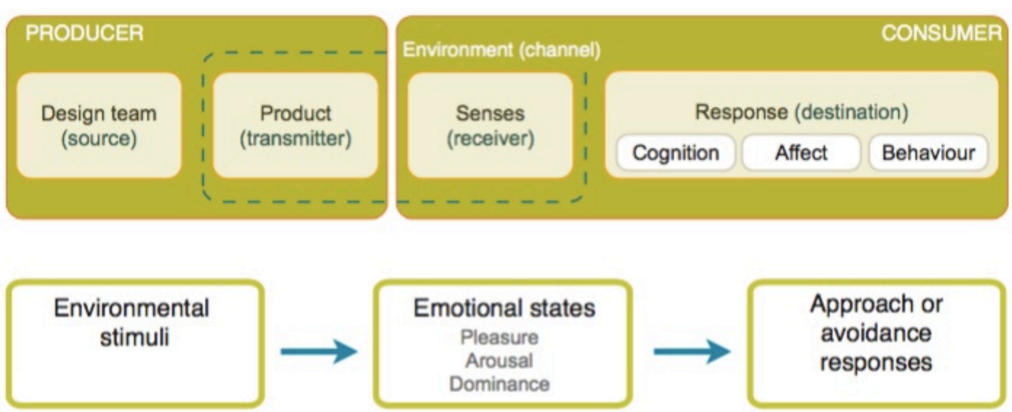


Figure 2.2. Communication Model (Crily et al, 2004).

Following the theory of Bitner (1992), the environmental stimulus is the exhibition environment that consists of people-related and space-related aspects. The space-related aspects are the focus of the current research. These aspects can be classified as aesthetic, functional, and atmospheric aspects. Functional aspects determine whether an exhibition is effective or not, while the aesthetic and the atmospheric aspects determine the experience and address the visitor's five senses. One of the five senses is the vision, which the research will study since it studies the effect of lighting on the visitor's visual experience in the exhibition hall. According to Quartier (2008), to understand the whole experience of the exhibition's space, the link between the visitor and the environment should be well understood. Therefore, both behavioural and emotional responses should be considered and measured.

2.8. Similarities between Museums Atmospherics and the Retail Settings

The research attempted to understand the retail environment and benefit from it in characterizing the museum's visitor experience. Several studies of the retail environment show that there are similarities between the museum and the retail contexts (Bitgood, 2011). Furthermore, there is a history of exchange between the retail and the museum design (Henning, 2006). Additionally, museums and retail have been under the leisure sector, in which the customer or the visitor is the main focus. Accordingly, experience is considered a way to position the museum or the retail setting in the marketplace (Falk, 2006; Gilmore & Pine, 1999). Underhill (1999) addressed various main characteristics of behaviour in store and how little changes to design and layout can affect purchasing. For example, customers have specific behaviours when entering a store, as they categorize the store's entrance as a "transition zone", in this transition zone customers are unlikely to focus on noticing products, but they focus more on adjusting to their new environment. Underhill (1999) stated that when some items were moved further into the store, more customers picked one up, enabling more purchases. Same as in the museum environment, design decisions like positioning specific displays shows a huge influence on the visitor's direction; in addition to, which and how many exhibits that visitors will be willing to visit (Bitgood, 2011; Goulding, 2000; Klein, 1993).

Although the retail and the museum environments are similar in certain areas (Bitgood, 2011), there are still other important differences as well. The main difference is the way in which success is defined. In retail environments the main objective is to maximize sales (Uzzell, 1995). However, in museums' environments, the aim is to create settings where visitors feel comfortable and in control which will consequently maximizes the possibilities for learning, entertainment, and visitors' satisfaction (Packer, 2004; Rui Olds, 1994). The main difference between both is the measure of success.

2.9. Visitor's experience and Behaviour in Museums' Exhibition.

Museum visitors' experience and behaviour can be greatly affected by the design of the exhibition spaces. According to Tregenza and Lawson (2006), room brightness for instance is highly connected to people's previous experience of alike places. This is because people's memory builds anticipations of the physical environment. According to Falk et al. (2008), in the Florida State Museum of Natural History, it was observed that adults' behaviour is constant and almost predictable in the initial 30 to 45 minutes of their visit. As visitors at the beginning spend the first two minutes in finding their direction inside the exhibition. Afterwards, when exhibits are found, there is a higher level of attention given, which remains constant for almost 30 minutes. Then after 30 to 45 minutes, "museum fatigue" takes place. Visitors at this stage start to be more selective about when to stop, and when to cruise inside the hall. Research asserts that visitors in museums behave in predictable patterns. Therefore, to provide a better experience for the visitors, a better understanding of what controls these behaviours is needed.

2.9.1. Visitor's Circulation

According to Bitgood (2006), chaos is what describes the visitor's movement at the beginning of his/her visit to the exhibition hall, afterwards it was found that they tend to turn right at a specific point of choice. According to Shettel (2008), it has been assumed that the movement pattern of visitors through museums is influenced by two aspects. The first aspect is known as agenda, which is related to what the visitor brings to the museum, such as, previous knowledge, perception, and interests. The second aspect is the design of the exhibition itself which includes the exhibited elements, and the museum's physical environment. The visitor's circulation through museums can be described as a relationship between the benefits that satisfy specific needs, and the costs which include the time and effort (Bitgood et al., 2006). It has been argued that the experience is evaluated as a ratio between the benefits and the costs. The higher the costs the lower the value of experience and vice versa. Bitgood (2006) came up with some basic assumptions regarding visitors' circulation. Firstly, people's choice to view or not view exhibited elements is highly affected by the benefits divided by the costs. Secondly, choice is interpreted to be a measure of "value." Benefits and Costs could either be perceived or actual.

2.9.1.1. The Tendency to Walk in Straight Lines.

According to Melton's study (1935), it was found that in the New York Museum of Science and Industry the majority of people went straight ahead rather than turned right as they entered the gallery (Recall that in Melton's other studies, there was a strong right-turning bias.) It is possible that inertia was the reason, but it is also possible that attraction of a landmark object or exhibit of special lighting setting influenced the straight-ahead movement in this case. This shows that lighting can play an important role in influencing people's circulation inside exhibition halls.

2.9.1.2 One-sided viewing

According to Weis and Boutourline (1963), there is a tendency for visitors to move along only one side of a path through an exhibition. When exhibits or objects are displayed on both sides of a path, there is a competition for visitors' attention between the two sides and one or both sides will have a lower rate of attention and/or approach. They noted that visitors rarely cross from side to side within an exhibit hall unless they detect the presence of landmark exhibits on opposite sides, so lighting could be a way to attract visitors' attention to turn from one side to the other across the exhibition hall.

2.10. Different Visitors' Groups and their Needs

It is important to identify the range of visitors that the museum is targeting (actual visitors), and who the museum wishes to attract in the future (potential visitors) to understand their preferences and needs. Every individual can be categorised by different criteria and fall into different groupings (Foster, 2012). It is important to note that the groups described below are not the only groups and that one individual could fall into one or more groups at the same time.

- **Leisure visitors:** Those visitors who come on onsite unscheduled. Leisure visitors could be groups of families and friends that comprise the largest museum audience. Leisure visitors are heterogeneous groups, often comprised of multi-generational members (Foster, 2012).
- **School groups:** Another large segment of the museum audience includes school groups that differ substantially from the leisure visitor (e.g., Bitgood, 2002). School groups are usually guided by teachers and/or parents and generally focus on specific content areas (usually associated with their relevance to the school curriculum). Unlike the usual visitor, school groups also have supplementary educational material sometimes presented in the formal classroom or workbook-type of tasks to complete within the museum. College/lycée level and higher education groups which often include art students who should have the opportunity to use portable tools for sketching.
- **Non-visitors:** There are also times when non-visitors are selected. Non-visitors are studied to attempt to understand why many people do not visit or to identify differences in leisure values or demographics between visitors and non-visitors (Foster, 2012).
- **Individuals:** This type of visitor would probably have an agenda for their visit and could be to see a particular collection or exhibition, or with could have a specific research interest at either an academic level or for a personal pleasure. They could be independent learners who want to have detailed information on the items or collections or given guidance to other sources. (Foster, 2012).
- **Family groups:** This group of visitors have a wide range of needs due to the range of ages and interests. Encouraging families means that the museum is

encouraging interest in museum visiting at an early age and creates a pattern of social behaviour for life. Family groups include adults who may return on their own at another time. A successful museum will aim to greet family groups rather than just tolerate them (Foster, 2012).

2.11. Visitor Variables:

To fully understand why people, perceive, and how they perceive the museum's environment, there are different variables that have to be taken into consideration as environmental and visitor variables invariably interact.

2.11.1. Demographics and leisure values

As one might suspect, age, gender, educational level are important variables in understanding the museum environment. According to Foster (2012), leisure values are strongly correlated with the visits' patterns.

2.11.2. Social influence

Most of the visitors come in groups usually with families or friends unless they are part of a school group. Therefore, museum visits are, to a large extent, a social experience. Groups typically approach an exhibit together and discuss the exhibit, point to exhibit elements, and try as a group to make sense of the displays (Foster, 2012).

2.11.3. Culture and Perception

Culture appears as the way in which people live and interact with each other. It provides the foundation for social organization, norms, values, and traditions. These components together give different groups their social identity, which is a means of defining themselves in relation to others. Therefore, cultures around the world can be quite different, holding different perspectives, and having different effects on how people perceive the same environment.

According to Hofstede (1991), culture is identified by five dimensions: Power Distance (PDI), Individualism versus Collectivism (IDV), Masculinity versus Femininity (MAS), Uncertainty Avoidance (UAI), and Long-Term Orientation (LTO). According to De Mooij and Hofstede (2010), the individualism/collectivism dimension is the most suitable indicator of cultural differences in behavioural research studies among the five dimensions of culture, especially when studies are conducted between Western and Eastern cultures. Western cultures are usually described as individualistic, meaning the stress is more on the individual, while Middle Eastern cultures are generally viewed as collectivistic as the stress is more on the notion of the group.

De Mooij (1998) argues that culture is closely related to perception. He defined perception as the way by which each individual selects, organizes, and evaluates the external environmental stimuli to have an interesting experience. Thus, indicating that these perceptual patterns can be acquired and culturally determined. Moreover, differences in perception according to culture have been recognized as an important factor to acknowledge in research in the field of design and atmospherics (De Mooij, 1998).

A study conducted by Kuller et.al., (2006) indicated that the indoor lighting colour and lighting settings had an impact on the mood of people. A survey questionnaire was sent to 988 employees in four different countries, Argentina, Saudi Arabia, Sweden, and the United Kingdom (UK). The results showed that the light and color of the working environment had an influence on all employees. The study also showed that the employees were in their lowest mood when the lighting settings were described as either too dark or too bright. Furthermore, employees who come from countries near the north of the equator had significant psychological mood swings in relation to seasonal variation.

Similarly, Park and Farr's (2007) conducted a cross-cultural study between Caucasian-Americans and South Koreans that showed that lighting color preference can affect the emotional states, perceptions, and behavioral intentions of people. Participants of the experiment had different reactions to certain lighting effects. According to Park and Farr (2007), Americans described lighting as more arousing than Koreans. Additionally, Americans preferred the lighting settings of a higher color-rendering index (95 CR) and they viewed it as more pleasurable; while Koreans preferred the lighting settings that had a lower color rendering index (75 CR) and considered it as more pleasurable.

In a cross-cultural study done by Park, Pea, and Meenely (2010), cultural preferences in relation to lighting were studied in a hotel guestroom. These preferences were assessed based on three variables: preference, arousal, and pleasure as the dependent variables. These variables were measured against three independent variables which were two culture groups, two lighting colours, and two lighting intensities. Results indicated that North Americans preferred the hotel guestroom with low lighting intensity and warm colour lighting; while the Korean preferred more the high lighting intensity and warm colour lighting. Bright lighting was perceived by the Koreans as more arousing than dim lighting, while dim lighting was perceived as more arousing than bright lighting by the North Americans.

Generally, the study by Park, Pea, and Meenely (2010) provided further insight into the preferences in lighting settings in relation to the cross-cultural differences. The study showed that cultural differences may indicate different preferences and perceptions. Also, this study offered a description of perception in relation to culture by referring to perception not only as an interpretation of a particular view but also taking into consideration the cultural implications that accompany the adopted judgment. Additionally, the study indicated that the atmospheric variables such as lighting settings, and colour can have an impact on moods and feelings in individuals of different cultures. These cross-cultural differences can dramatically affect the overall perception and experience of individuals inside architectural spaces (Park, Pea, and Meenely, 2010).

2.12. Lighting in Museums

According to Meerwein et al., 2007, lighting has become a benchmark in museum quality, as well as for other building types. Moreover, good museum lighting not only meets the requirements of the visitors, but also of the curators and operators. Additionally, lighting concepts that meet these criteria contribute to preserving the cultural heritage of humanity for future generations.

In fact, lighting can play an important role in museum's spaces and displays' expositions since it is an essential variable in the visual perception of the exhibition's environment. Previous studies by Mehrabian (1995), Rook and Fisher (1995), and Markin et al. (1976) on display perceptions in actual exhibition environments propose that lighting changes displays' perception in effective ways that can enhance visitors' experience and behaviour. Mehrabian (1995), observed that lighting can possibly increase the time visitors spend in front of displays leading to an enhanced overall experience.

Mehrabian (1995), also suggests that lighting is an extremely important determinant of the environment. He stated that brightly lit rooms are more arousing than dimly lit ones. Additionally, Rook and Fisher (1995) suggest that high arousal facilitates impulse buying in retail settings, while Markin et al. (1976) recommends the use of soft lighting to reduce the level of stimulation and hence slow down the pace of the people through the space to enjoy their experience.

While lighting has been determined to have a positive effect on the perceived atmosphere (Mehrabian ,1995), there is little knowledge about this effect. Therefore, the present study will focus on how lighting can enhance the exhibition atmosphere. It will also discuss precisely which lighting effects can change people's responses and enhance their satisfaction levels.

2.13. Museum Atmospherics

Extending from the concept of the service environment which relate to the style and appearance of the physical surroundings and other experiential elements encountered by visitors including ambient, design, and social elements, theories from environmental aesthetics and light/colour appraisal, provide an alternative way of characterizing the visual cues of a space-based on perceptual properties (Baker, 1987). Environmental appraisal theories have highlighted the role of information, coherence, and perceptions of safety in the environment, articulated as novelty, mystery, complexity, coherence, spaciousness, and enclosure (Kaplan, 1987; Stamps, 2005b, 2007). Light and colour are also important contributors to the visual appraisal of a scene, particularly in an indoor context (such as within an exhibition) (Boyce, 2004; Meerwein et al., 2007; Singh, 2006; Vogel, 2008; Yüksel, 2009). Consolidating these variables creates a potential taxonomy of atmospheric variables for the exhibition environments:

- Design Appearance: Encompassing the visual elements that cannot be articulated in tangible spatial descriptions such as size or layout: for instance, colour, lighting, and overall mood conveyed by an environment.
- Spatiality: Space and layout variables that can be expressed in terms of architectural properties of a space, for instance the level of enclosure and overall coherence of a space (incorporating coherence, spaciousness, and enclosure).

2.14. Museum Atmospheric Variables

Some of the main atmospheric variables in museums are colour, spatial forms, light, scent, and sound. These interior variables can enhance museum visitors' experience and affect the museum's brand image.

2.14.1. Colour and Light Variables

The visual atmosphere of a space is defined by the presence of the two variables which are light and colour. Colour helps in the visual assessments and accordingly affects the subconscious responses of a given space (Meerwein et al., 2007; Singh, 2006; Yüksel, 2009). Although light affects how colour is perceived, its role is still underestimated as it is registered subconsciously in the context of a wider visual assessment (Boyce, 2004; Custers et al., 2010; Meerwein et al., 2007).

Colour and light are considered key elements in interior design as they have a direct effect on space perception and emotional states (Bellizzi et al ,1983; Quartier et al, 2014; Wardono et al, 2012; Yildirim et al, 2012). It has been agreed that the use of light and colour can increase a museum's brand awareness, quality perception and recognition (Babin et al, 2003; Brengman & Willems, 2009; Schielke & Leudesdorff, 2015). Research has illustrated that lighting affects people's perception and allows ambience illumination that develops contrast and makes products or displays appear more attractive and interesting (Areni & Kim, 1994; Custers et al, 2010). It was also found that Colour affects the perception of time, crowding, taste, temperature and size (Gohar, 2008; Mahnke & Mahnke, 1987; Yuksel, 2009). The colour of the environment and how it is lit can change people's attitude towards displays or products depending on the nature of the space (Babin et al, 2003; Bellizzi & Hite, 1992). This concludes that light and colour have an interlinked influence that may not be clear if each is studied solely. Prior research concluded that the presence of light and colour is important in contributing to the overall visual perception of an exhibition environment and subsequently the whole visitor experience (Bonn et al., 2007; Kottasz, 2006; Roppola, 2012; Stenglin, 2004).

2.14.2. Colour and Spatial Perception

Colour from the architectural perspective influences the overall feeling of a space's ambience and size (Bellizzi et al., 1983; Wardono et al., 2012; Yildirim et al., 2012). According to Meerwein et al. (2007), brighter colours are perceived as lighter in weight than darker colours; for example, a ceiling in a dark colour will seem lower than one in a lighter colour. In addition, saturated and dark colours reduce the perceived size of a room. The positioning of colours in a room may stir up different feelings; for example, dark ceilings can seem harsh but the same shade on the floor may give a feeling of security and support (Meerwein et al., 2007).

According to Gorton (2017), an experiment was conducted on two similar rooms using blue and red colours. Visitors in the room that had the red colour felt anxious and didn't stay for a long time. However, the blue room had a calming and appealing effect on visitors. Pictorial examples of the Art Science Museum in

Singapore are shown in Figure 2.3. to demonstrate the effect of different colours on a space. Mahnke (1987), who is concerned with colour and environmental design proposed a list of different emotions to describe colours' impression. "Where, red being seen as aggressive or fear, orange as warm or luminous, yellow as exciting or irritating depends on hue's saturation, green as secure and clam, blue as cool, inspiring, purple as subduing, grey as neutral or boring, white as neutral, empty, or non- energetic, and black as threatening and worrying" (p.67-70).

Figure 2.3. Exhibition rooms at Art Science Museum in Singapore of different ambient colours. (Source: Developed by the Author).

2.15. Lighting and Environmental Perception

Research on lighting has focused more on the functional requirements, such as task visibility and how to avoid fatigue and visual discomfort rather than the psychological requirements, especially the effective impact of artificial lighting as it has been left as an unexplored field (Boyce, 2004).

Although lighting influences the perceptions of interior spaces, the contribution of lighting to create an overall atmospheric mood is still less well researched (Custers et al., 2010; Turley & Milliman, 2000). In spite of these complications, it is commonly accepted that bright light has a more arousal effect than that of soft light, and cool white light is considered to be more arousing than warm white light (Mahnke & Mahnke, 1987; Park & Farr, 2007). Moreover, cool white light is considered to be brighter than a warm source at the same illuminance (Park & Farr, 2007). Likewise, perceptions can be influenced by different ways through changed lighting. For example, while peripheral indirect lighting creates a sense of spaciousness, non-uniform lighting can lead to complexity and generate focal points of interest (Custers et al., 2010; Flynn, 1988). Lighting from the atmospheric viewpoint is considered as a “micro” environmental characteristic that combines with other micro characteristics to give a specific or “molar” sense of atmosphere (Quartier et al., 2008).

2.16. Impact of Light on People

There is a direct relationship between light and architecture as mentioned by Frank Lloyd Wright: "More and more, so it seems to me, light is the beautifier of the building." Architecture is meant to use light to work with some other elements like colours which can make spaces more dynamic, add beauty to the space, and stands out to be an important element in the architectural design. Since, vision is an important sense to reveal spaces; light is an important element as it is the medium that shows the beauty of form, texture, and colour (Custers et al., 2010).

There are a lot of factors that affect the indoor atmosphere; one of them is light which is considered the most important factor (Custers et al., 2010). To give a sense of mystery; for example, it is difficult to use bright light illumination. Light is needed in architecture to create a different order and rhythm that will lead to a change in the spatial effect; consequently, giving a different atmosphere (Portoghesi, 1994).

Shadows are crucial in perceiving the space’s ambiance. They can either be strong or soft. Although the right shadows could give a pleasant feeling of spaces, while imposed shadows can destroy the whole atmosphere. Also, the colours of the materials can play an important role in changing the atmosphere. This issue should be designed from the very beginning and not after the whole architectural process is conducted (Pauly,1997).

2.17. Relation between light and architecture

This section of the literature review discusses the works of Le Corbusier, Louis I. Kahn, and Tadao Ando. It is intended to point out the role of these three architects in using light inside the architectural buildings.

2.17.1. Le Corbusier

Pauly (1997) listed the work of Le Corbusier and described it in a way that light became the language expressed in his architecture. He quotes Corbusier, ‘As you can imagine, I use light freely, light for me is the fundamental basis of architecture. I compose with light.’ Although, light sources have been used in a controlled way yet still, Le Corbusier paid attention to their placement to define the interior volumes.

2.17.2. Louis Khan

Louis Kahn considered light as the base of every architectural effect. He added, it is the spirit that provides character to a space. Spaces that are created by Khan could be defined as a meeting between light and silence. He created spaces from carved out volumes and used the light to put them into function (Portoghesi, 1994).

“The room is the start of architecture; it is the place of mind. The room with its dimensions, its structure, its light, its spiritual aura responds to its character. The structure of the room must be clear in the room itself. ‘’ Structure, I believe, is the giver of light” (Kahn, 1975).

2.17.3. Tadao Ando

“When we are less aware of the darkness, we forget the spatial impacts and the subtle patterns created by light and shade. When this happens, everything is uniformly illuminated, and the object and form are limited to simple relations. ’The remedy to this situation is a restoration of richness to space” (Ando, 1995). This quote shows the struggle of Tadao Ando’s approach in architecture, as he aimed at rebuilding the fine relation between light and darkness and giving more depth to space through the formation of perceived shadows. The freedom of the structural element in modern architecture led to the use of structural glazing, thus allowing light in the interior spaces. Artificial light started to be hardly differentiated from natural light in terms of a uniform luminance pattern inside a spatial enclosure. Tadao Ando’s projects can be seen to serve as innovative design solutions.

The perception of the tangible (concrete) and the intangible (light) elements of design, as expressed in his works, can be done in various ways. But a more holistic approach is to understand the underlying design issues in relation to the overall perception of the built form. This is to analyse the role of form; geometry and the way light is made to interfere with physical objects. Tadao Ando's states that light has the power to transform an ordinary space into a space that invokes a strong response from the user (Ando,1995).

2.17.4. Kimbell Art Museum

Louis I. Kahn was commissioned to design Kimbell Art Museum in 1966 and was one of the last buildings he witnessed completing. The museum building was designed as a series of narrow rectangular vaulted elements with light and simplicity of enclosure as key design elements. The emphasis was on providing natural day lighting to the viewing galleries in a manner that the artwork in the display was not affected. For this, aluminium reflectors were designed to bring in soft and controlled amounts of light from the slit at the vertex of the vault. The principal source of natural light to the galleries are 2'-6" wide linear roof skylights. From the beginning of the design, the roof was planned as a series of parallel channels or half cylinder shapes and these skylight slits were located at the top edges of the spanning shapes as shown in Figure 2.4. Roof forms were aligned from north to south and the building's entrance was located on the west at the edge of a park. This orientation is most efficient for gathering the sunlight though most of its arc and avoids sun angles' differences between summer and winter.

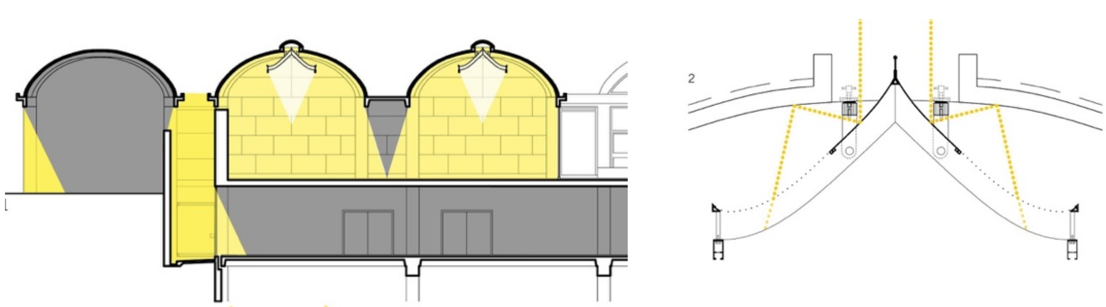


Figure 2.4. Section of Roof Skylight in Kimbell Art Museum (Gill, 2004).

Kahn in Kimbell Museum went beyond just focusing on paintings by natural lighting and he successfully integrated both task lighting and ambient light. Ambient lighting in museum galleries was the natural lighting that originated in the skylights, and he used incandescent fixtures as direct task lighting to the works of art as shown in Figure 2.5. These fixtures were close to the illuminated objects and produce such a controlled intensity that viewer's attention was focused on the works only. Natural light contributed to wall lighting, but importantly it did not distract the viewers by the intensely illuminated art. The achievement of this design reconstituted natural lighting in a controlled enclosure without either destroying its essence or overwhelming the art on display (Hawkes, 2008).

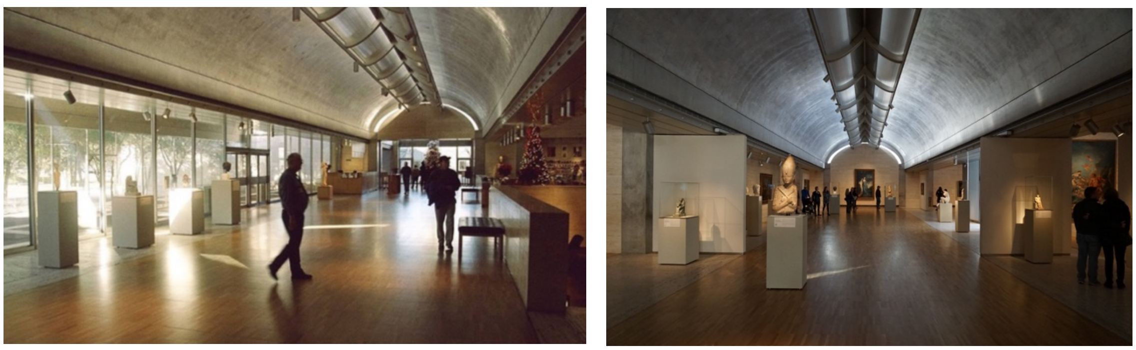


Figure 2.5. Kimbell Art Museum (Gill, 2004)

2.17.4.1. Piano Pavilion at the Kimbell Art Museum

The program for the museum expansion integrated daylight and electric lighting while supporting the conservation and exhibition requirements for art, including the following daylighting criteria (Brownlee and Long ,1991).

1) To provide a condition where daylight is the primary source of light for the display of art.

2) To have the ability to tune daylight transmission, and therefore change the mix of daylight and electric light within the gallery,

3) To be able to reduce daylight levels within the gallery to allow the display of sensitive objects requiring 50 lux or less.

4) To reduce daylight in the galleries to a minimum when the museum is closed.

According to Brownlee and Long (1991), additional qualitative and experiential daylighting goals for the expansion were clarified by the architect Onur Teke to make people not feel as if they are just in a closed box and create a visual connection between the outside and inside.

The most important architectural element in the pavilion was transparency and openness. In fact, the structure of the roof and light can be seen as shown in Figure 2. 6. The architect wanted to minimize the visual distinctions between the inside and outside to adopt an open expansive sense of space (Hawkes, 2008). The pavilion as shown in Figure 2.7. is like a roof flying above the ground, open, accessible, visible, and transparent. The two buildings work in a complementary way. Kahn is more introverted, and the pavilion is more extroverted.

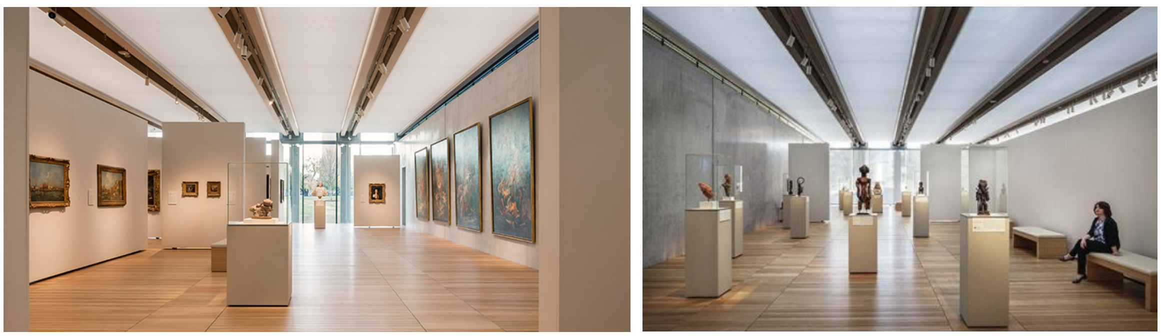


Figure 2.6. Interior of Piano Pavilion at Kimbell Art Museum (Gill, 2004).

Figure 2.7. Sections showing the lighting in the interior of Piano Pavilion (Gill, 2004)

2.18. Museum Lighting Design

This section in the literature review will consider the different studies that are related to lighting in a museum environment, by starting with a general discussion on some lighting terminologies and theories.

There are different variables that describe the overall museum's environment, such as, light distribution, light intensity and lux levels, colour rendering properties and colour temperature (Custers et al., 2010; Vogel, 2008). Visual appearance in a museum is evaluated through the relation between displayed objects and the ambience, in terms of illuminance and brightness contrast. In terms of illuminance, as a benchmark; "50 lux is considered to be a minimum for displaying objects that require more detailing and colour" (CIBSE,1994).

2.19. Lighting Characteristics.

To understand and evaluate the lighting settings, some terminologies and characteristics should be defined and studied, such as Brightness, Correlated Colour Temperature (CCT) and spatial distribution etc.

2.19.1. Brightness.

Luminance and brightness are considered to be closely related since brightness is a result of the impression of the display of luminance (DiLaura et. al., 2011). An object's brightness depends on the perception of the human observer, while the luminance of the display object is referred to as the independent measurement of a photometer. According to IESNA (2000), brightness is defined as "The perception response to luminance and is associated with the luminous power of a surface or object and varies from bright to dim". A study by Cayless and Marsden's (1983) illustrated that the brightness of a surface depends on two factors its luminance and the luminance of the near surroundings that results in forming the visual environment. Furthermore, many other factors contribute to perceiving brightness such as object luminance, surrounding luminance, adaptation of the eye, size, gradient, and spectral composition (DiLaura et. al., 2011).

2.19.2. Correlated Colour Temperature (CCT).

CCT is defined as "the absolute temperature a blackbody has when it has approximately the same colour appearance at the source and is measured in kelvin (K)" (DiLaura et. al., 2011). Practically, Correlated Colour Temperature gives an indication of how cool or warm the light output of a light source appears. Colour temperatures of less than 3500 K are commonly named as warm white. The lower the correlated colour temperature of a light source, the warmer the appearance; and the higher the colour temperature, the cooler the appearance of the light source.

According to Chen et al (2015), visibility is highly correlated with illuminance and warmth is highly correlated with CCT. It was suggested that all emotional scales could be reduced to two components which are visibility and warmth, which will be influenced by the illuminance and CCT parameters, respectively.

A unique aspect of incandescent sources is that as the light source is dimmed, colour temperature shifts and tends to get warmer. This characteristic has been regarded as a disadvantage in the museum and gallery lighting since reduced lighting intensity often will have a negative impact on the lighting tone and quality. Light Emitting Diodes (LEDs) eliminate this issue by providing dim light without a shift in the colour temperature (Chen et al., 2015).

2.19.3. Spatial Light Distribution.

According to Boyce (2004), spatial light distribution refers to the way light is distributed from a light source. It can affect the distribution of light in a space, which can be described as uniform or non-uniform. Spatial distribution is composed of two aspects, one is the distribution or pattern of the light and the other is the location of the light source. The degree of uniformity can be controlled by limiting the spatial distribution of light, thus influencing the way space is perceived. A uniform light effect in space is achieved when the whole space is illuminated evenly. Conversely, when the light in a space is distributed unevenly this creates patterns and zones within a space thus achieving a non-uniform light effect. Therefore, the desired effect which could either be uniform or non-uniform can be controlled by the number of luminaires, their location, and their direction for emitting the light (Boyce 2003).

The direction of light is very important as it can produce several different effects. The direction is determined by the angle from which light is emitted by the luminaire, which can be directional or diffuse as shown in Figure 2.8. Directional light produces well-defined edges, while diffused light produces shadows with softer edges. Directional lighting can be used to highlight certain aspects and add emphasis while diffused lighting is perceived as less bright compared to directional lighting with the same illuminance (Boyce 2003).

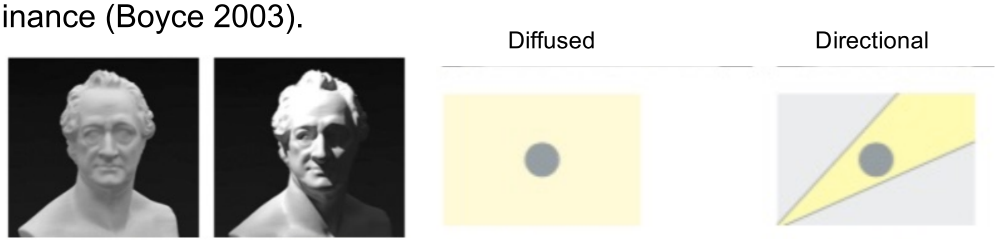


Figure 2.8. Diffused light produces virtually no shadow while directional lighting resulted in harsh contrasts (Source: Developed by the Author).

Kruithof (1941), developed a curve to visualize the values to be used in creating a pleasing lighting. Quartier (2008) concluded different results from Kruithof curve as the lighting values that are less pleasing according to Kruithof curve, produced strong pleasurable feelings and were also perceived as cosy. She found that Kruithof values are irrelevant in retailing contexts; therefore, it might be or might not be the case in museums. Hence, future research is needed as it might be interesting to study and develop a new curve, or several curves that help to visualise which lighting settings should be used in museums. The challenge lies in including, not just the objective measurements such as CCT and illuminance but also the balance between the spot and general lighting and how that impacts people's perception and quality of experience of the perceived atmosphere.

2.20. Effect of Lighting Design on a Visitors' experience

Lighting design can tremendously affect visitors' experience. It can transform the room in shape and size. It also affects the mood of the people in a room in addition to, the atmosphere of the room itself.

2.20.1. Lighting Quality

Many authorities have legislated energy codes that restrict building energy consumption for all uses, including lighting. Quality lighting systems today must keep both the environment and the resources conserved, while still meeting immediate task, social, behavioural, aesthetic, emotional, health, and safety needs as shown in Figure 2.9. Maintaining this balance is important to the building's owners, employers, and occupants. Although many of the existing lighting systems meet the energy-efficiency requirements, there are still concerns that more energy-efficient lighting design may yet result in poorer quality lighting. Veitch and Newsham (1998) proposed a behaviour-based definition of lighting quality. According to this definition, lighting quality exists when the luminous conditions are suitable for the needs of the people who will use the space. They grouped these needs into six categories:

1. Visual performance
2. Post-visual performance (e.g., reading, eating, walking).
3. Social interaction and communication.
4. Mood state (happiness, alertness, satisfaction, preference).
5. Health and safety.
6. Aesthetic judgments (assessments of the appearance of the space or the lighting).

According to Veitch and Newsham (1998), light is argued to be the most important element in architecture. Light is modified firstly by the physical surroundings; colours are added, intensity is diffused, and lighting directions are changed. Light is then subjected to a mental modification, the same light when perceived by someone in a happy mood or in a sad mood also appears to be very different.

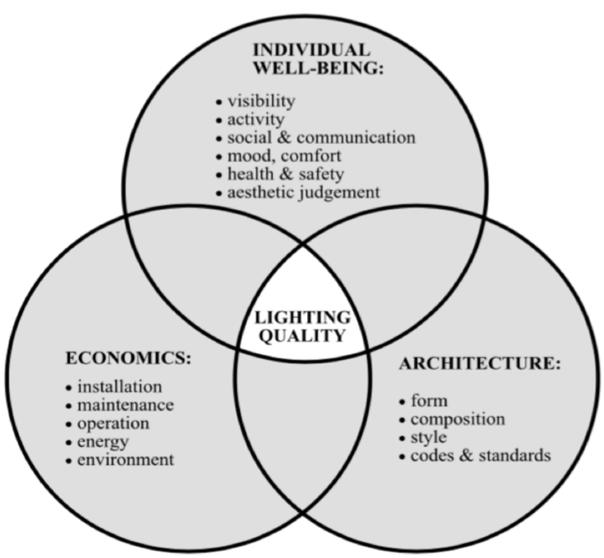


Figure 2.9. Lighting Quality (Veitch and Newsham,1998)

2.21. Theory Development

There are some models that study the different effects of the surrounding environment on human satisfaction, pleasure, and behaviour. One of these models is the Mehrabian-Russell Model (S-O-R) Stimulus Organism Response (Mehrabian & Russell, 1974a), which proposes a valuable theoretical model that studies the effects of the surrounding environment on human behaviour. It is a framework which states that the environment is a **stimulus** (S), which consists of a set of signs that cause an internal evaluation of someone (O) and then produces a **response** (R) to the museum environment. This model is the most commonly used theory in atmospherics research (Liu & Jang, 2009; Massara et al., 2010). Those models are applied to facilitate the prediction and knowledge of the effects of the surrounding environment on users (Ciani, 2010). Mehrabian-Russell model includes three elements which are stimulus classification, a set of intervening variables, and a set of responses as shown in Figure 2.10.

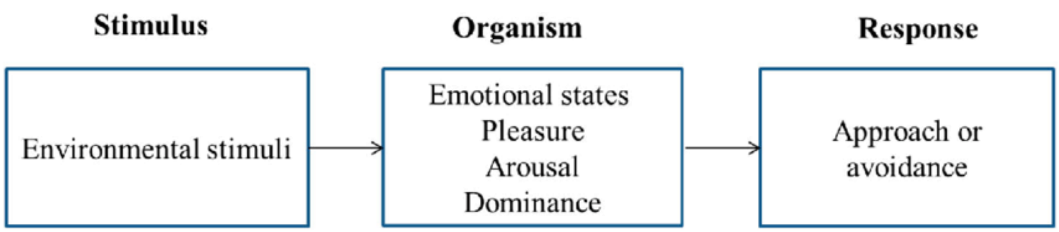


Figure 2.10. (S-O-R) Stimulus Organism Response (Mehrabian & Russell, 1974a)

The degree of a person's happiness, satisfaction, or how pleasant or content he feels is considered the pleasure-displeasure dimension. While the arousal dimension is more concerned with low levels of being relaxed, bored, or sleepy to high levels of stimulation, excitement, or arousal. Another dimension is the dominance dimension which is related to the level of dominance the individual feels either by feeling influential, in control, important or the contrary, he might feel submissive, compliant, passive, or lacking control. According to the model, positive responses to the environment are considered approach behaviours while negative responses are considered as avoidance behaviour (Mehrabian & Russell, 1974a).

The resulting behaviours could either be responding to the environment or avoiding it to different degrees.

1. A desire to physically stay in approach or to avoid the environment.
2. A desire or willingness to explore the environment and walk around or to avoid interacting with the environment.
3. A desire or willingness to communicate with others in the environment or having no desire.

2.22. Theoretical Frameworks for Atmospherics Study

These are the frameworks that describe and study the different emotional states of people in relation to the causes and the consequences of these feelings.

2.22.1. Atmospherics Variables

This present study is more concerned with the atmospheric variables that are involved in the visual appraisal of a scene. Museum atmospherics relate to the special sensory qualities of exhibition spaces, which can arouse a person's emotional and/or cognitive states that influence their behaviour. Furthermore, researchers indicated that visitors' perception of the atmospheric stimuli in an exhibition environment is highly related to the visitor's behaviour (Grossbart et. al. 1990; Spanenberg et al., 1996; Yalch & Spanenberg, 2000), thus studying the atmospheric variable is essential in understanding the visitor's cognitive and affective needs.

2.22.2. Research Approaches in Lighting

According to Kottasz (2006), PAD state (Pleasure, Arousal, Dominance) is measured using semantic differential scales, each scale intended to vary one of the dimensions while keeping the other two relatively constant. For instance, the semantic differentials originally specified by Mehrabian and Russell (1974a) included despairing-hopeful (varying pleasure); relaxed-stimulated (varying arousal), and guided-autonomous (varying dominance) (Mehrabian 1995; Mehrabian and Russell, 1974a). These studies have demonstrated a link between the atmospheric stimuli and people's behaviour or revisit intentions, and results have been consistent with the notion that affective measures of pleasure, arousal, and in some instances, dominance act as mediators in this relationship (Ezeh & Harris, 2007; Gilboa & Rafaeli, 2003; Kaltcheva & Weitz, 2006).

2.22.2.1. Limitations of the S-O-R Model

A major limitation of this model is that it does not explain much the nature of the atmospheric perceptions in-depth. Several studies have concluded that environments accompanied by pleasant and affective states likely lead to approach behaviours (Kaltcheva & Weitz, 2006). However, these studies have left the question of why a certain environment is perceived to be pleasant unexplored.

2.22.3. Cognitive Appraisal Theory in the Museum Context.

Cognitive appraisal theory is increasingly applied to consumer settings as it provides a clear framework for understanding the causes and the consequences of a particular emotional state (Bagozzi et al., 1999; Watson & Spence, 2007). According to the cognitive appraisal theory, the emotion evolved by a stimulus depends upon a subjective interpretation of the situation according to several appraisal dimensions (Sander & Scherer, 2009). It is settled that the most important dimension is how the conditions correspond with a person's needs, interests, priorities, and goals. Correspondent stimuli will lead to positive emotions, whereas the contrasting stimuli generate negative emotions. (Bagozzi et al., 1999; Sander & Scherer, 2009; Smith & Ellsworth, 1985; Watson & Spence, 2007). In the museum's context, visitors will be attracted to those exhibits and environments that fit their needs and goals, while responding negatively to those environments that confuse and frustrate them (Pekarik & Schreiber, 2012; Rui Olds, 1994).

2.22.3.1. Circumplex Model of Affect

This model is considered a derivative of the PAD dimensions that ignores dominance. According to researchers on PAD technique, dominance could be a problematic measure (Desmet, 2010; Gilboa & Rafaeli, 2003) as it is a dimension that is most culturally, and context related. In addition, Dominance has been suggested to be more cognitive rather than affective in nature (Russell et al., 1981), leaving pleasure and arousal as the principal affective components of environmental appraisal (Russell et al., 1981; Russell, 1988). This ended up with a two-dimensional circumplex model as shown in Figure 2.11.

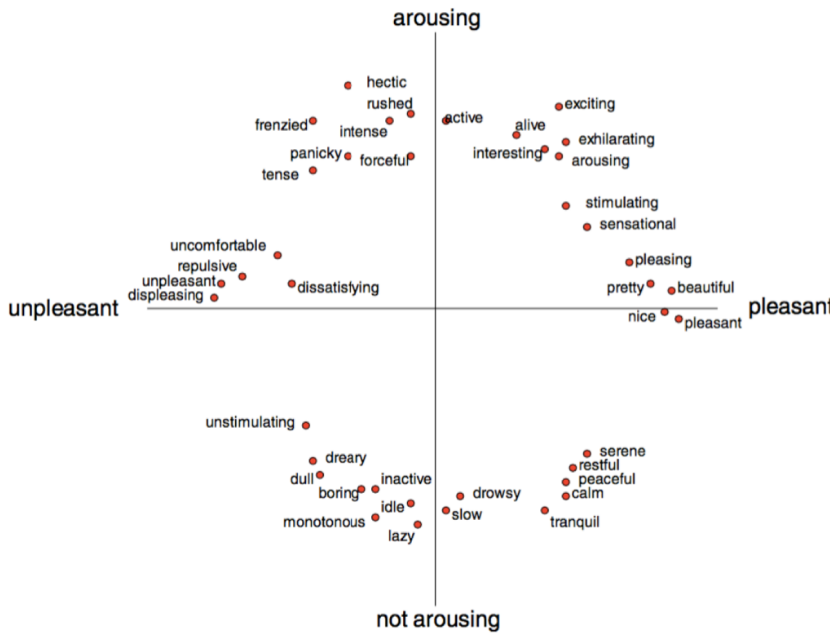


Figure 2.11. Circumplex model of affective quality attributed to environments (adapted from Russell et al., 1981).

2.22.4. Primary Emotions Theories

Both the PAD dimensions and circumplex models are dimensional models that measure affective states. They are hypothesized as being a result of varying ranks of underlying orthogonal dimensions. An alternative model is based on several primary emotions, which can be combined in different ways to produce the range of affective responses (Izard, 2002; Plutchik, 1980). Izard (2002) identified ten basic emotions which are Joy, Sadness, Interest, Anger, Guilt, Shame, Disgust, Contempt, Surprise and Fear; whereas Plutchik's (1980) model has eight: Anger, Joy, Sadness, Acceptance, Disgust, Anticipation, Surprise and Fear. Both models have been successfully used to study the emotional responses to a shopping experience (Machleit & Eroglu, 2000). Although the bias towards negative emotions in the Izard model suggests that Plutchik's model may be more relevant in the museum context.

2.22.5. Plutchik Model

Plutchik (1980) argues that primary emotions can be combined to form new secondary emotions. For example, Joy and Anticipation combine to form Optimism. Plutchik's model is frequently represented as an emotion wheel that looks like a colour wheel. Furthermore, within each emotion "colour" there is a range of intensity; for example, the spectrum of anger ranges from mild annoyance to intense rage (Plutchik, 1980). These different intensities can be represented by expanding the colour wheel into a three-dimensional space as shown in Figure 2.12.

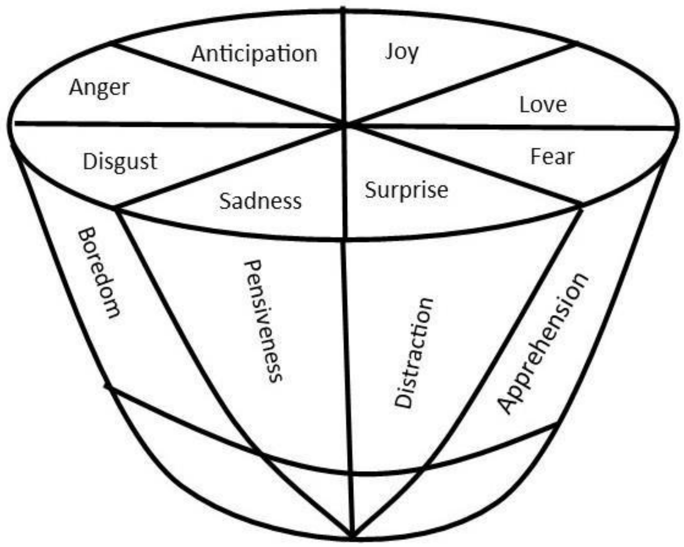


Figure 2.12. Primary emotions represented in three-dimensional space. The conical shape reflects the notion that as emotions become less intense, they are less distinct from one another (adapted from Plutchik, 1980, p. 157).

According to Vogel (2008), the emotional states can be difficult to be separated from the perceived atmosphere. The effect of the environmental variables on the perceived atmosphere is expected to be independent of people's emotions, yet many researchers do not differentiate between these variables. Vogel (2008) indicated that people can feel very stressed in a relaxed environment if they think about all of their problems. However, they will have a hard time feeling relaxed in a stressful environment. She noted that atmosphere is a more stable concept or variable to use for measuring people's experiences rather than the measures of emotions. Vogel (2008) model is regarded as further refining to the concepts explored by the M-R model (Mehrabian-Russell Model (S-O-R)) as it evaluates atmospherics, in terms of the perceived atmosphere and not in terms of emotions.

Vogel (2008) developed an atmospheric metric questionnaire to evaluate the perceived atmosphere in a lit environment. She created a list of atmospheric terms and used factor analysis to construct an atmospheric questionnaire composed of atmospheric terms using 38 semantic differential scales. Vogel (2008) concluded that the atmosphere could be described in four dimensions: cosiness, liveliness, tenseness, and detachment. These dimensions are comparable to the pleasure and arousal dimensions found by Mehrabian and Russell (1974). Furthermore, these four dimensions resemble those used by Flynn and Spencer (1977) who specify their dimensions as relaxing, tense, and spacious; in relation to, the spatial lighting distribution.

2.22.6. Flynn's Model

James Flynn is an influential lighting researcher and a retail consultant. He concluded that the lighting impacts the ways in which the brain perceives the surrounding environment. He introduced the element of subjectivity rather than assuming perception as an objective process. Flynn's (1977) research together with Flynn et al. (1977) research were considered by (e.g. Veitch, 2001) in this research field to be a fundamental research source; specifically, in examining subjectivity and various lighting conditions.

Flynn (1977) conducted an experiment regarding the participant's subjective impressions of six lighting configurations. Based on the responses, five independent dimensions were identified using factor analysis. They include perceptual clarity (e.g. clear – hazy), evaluative (e.g. pleasant – unpleasant), spaciousness (e.g. large – small), spatial complexity (e.g. simple – complex), and formality (e.g. rounded – angular). He concluded that only three dimensions (perceptual clarity, evaluative impressions, and spaciousness) showed significant differentiation between the lighting conditions. Flynn (1988) later revised his theories, suggesting that there are six categories of human's impressions that can be influenced or modified by the lighting design which are perceptual clarity, spaciousness, relaxation and tension, public versus private space, pleasantness, and spatial complexity. Flynn (1988) suggested that the lighting systems can be subjectively categorized by three main modes of lighting which are bright /dim, overhead /peripheral, and uniform / non-uniform lighting.

2.22.7. Framework Developed and Influenced by Quartier et. al (2008).

Based upon the previous theories proposed by the researchers; Mehrebian and Russel (1974), Vogel (2008) and Flynn (1977), another model was developed by Quartier (2008) to study the effects of the ambient light on consumer's perception of products. Quartier's model identified different variables as quality, pleasantness and attractiveness which are important parameters in evaluating the exhibition environment and assessing it in different lighting conditions. These theories and models will reflect then on the research, to study and measure the level of visitor satisfaction in exhibition halls according to different lighting settings.

According to Mahdavi et al. (2002), in the field of atmospherics and lighting design research, there are three different visual approaches to be conducted. One approach includes two dimensional images or verbal description, while the second approach takes place in three dimensional environments such as labs and simulated stores, and the third approach is a four-dimensional experiment in real stores with a complete experience. Each approach has its own methodological challenges Rohrmann and Bishop (2002). Experimental studies have been identified to be costly and inefficient due to lack of space, time, and money to create a physical mock-up environment (Heydarian et al, 2016). Some researchers primarily rely on the data gathered from the observational studies to predict the different occupant behaviours. Through observational studies, researchers can predict the correlations between different factors and changes in occupant's behaviour without understanding the specific cause of such behaviours (e.g., lighting influence on behaviour). Therefore, a systematic approach is missing that can effectively be used to collect and measure the changes in the occupant's behaviour. This research will adopt the second approach that takes place in three- dimensional environment and will consider the simulated atmosphere with the aid of Virtual Reality.

2.23. Summary:

Firstly, the development of exhibition design in recent decades has been discussed in the literature. Exhibition design has moved from just a place where there are some displays into a more interactive space that enhances the visitor experience.

Although the role of creating an exhibition that has a specific ambient environment is considered a crucial aspect nowadays, yet the visitors' experience is still less researched on and understood. Therefore, more studies are needed to offer ways to understand how people perceive and respond to those exhibition spaces. The scope of this research is the atmospheric dimensions that can be seized visually instead of the non-visual ambient elements of the environment. Atmospheric variables principally refer to the visual dimensions of the environment. Lighting is considered a crucial aspect of the visual perception of space and is combined within the atmospheric variables which are the interest of this study.

Secondly, this chapter discussed the different characteristics of light and what is meant by lighting quality and how it was used in previous architectural buildings. It also explained some lighting terms as Correlated Colour Temperature, illuminnace and how lighting can be distributed in an exhibition space. In addition, different architects' reviews on the impact of lighting in architecture were discussed and the concepts of how light and colour of light can transform an ordinary space into a space that stimulates people's responses.

Finally, different theories and models were studied that were important in providing the foundation for the theoretical and methodological framework of this study to measure the emotional satisfaction of people in architectural spaces. It was found that museums' spaces had not been thoroughly investigated in terms of, the use of colour and lighting of their interior spaces. Although few studies focused on the effect of the lighting arrangements on space perception, yet the use of colour in museums has not been deeply studied.

3. Chapter 3: Methodology

3.1. Introduction

The extended literature review led to the chosen methodology, that aimed to present a systematic approach where the visitors' information, that is, the lighting preferences, were collected for two exhibition spaces: one in the Egyptian Museum in Cairo, Egypt, and the other in the Birmingham Museum in the United Kingdom. To further understand the influence of the lighting factors, Virtual Reality (VR) method was used as an experimental tool to collect participants' lighting preferences and related experiences, as it allows for exploring and manipulating the computer-generated scenes in three-dimensional interactive environments (Sherman, 2003).

Based on the literature review of the theories, the study adopted a framework informed by the research of Quartier et. al. (2008) and Flynn (1977), as they demonstrate a linkage between the environmental design factors (colour and light) and the visitors' perception (museum's impression and identity). The research considered socio-cultural aspects as there were responses from the Middle Eastern and European visitors. To explain the effects of the physical environment on people's satisfaction, a conceptual framework was adopted by pairs of adjectives with positive/negative meaning such as pleasant-unpleasant, cheerful-depressing, relaxed-dramatic, attractive-unattractive, spacious-confined to measure visitors' impressions using four simulated scenes for each exhibition in each of the chosen museums using Virtual Reality. The collected data was used to improve the lighting design of the exhibition spaces and accordingly having a better visual perception of an exhibition space. The influence of the lighting preferences on people's emotional states was analysed leading to the prediction of different lighting preference profiles.

3.2. Research Design:

The research is concerned with how people feel and how they perceive exhibition halls based on the lighting as an atmospheric variable. Since the research deals with emotional states and was conducted amongst people rather than upon objects, it reflects the philosophy of interpretivism. In this research, a deductive approach was adopted. The hypothesis is based on the literature and is tested throughout the research. According to the research design, multi-methods were adopted, and questionnaires were used as the research tool to collect quantitative data by the use of Virtual Reality to visualize the exhibition hall scenes with different lighting settings.

Furthermore, the research adopted a mixed method that involved both qualitative and quantitative methods. A qualitative case study analysis was carried out in the real environment and the virtual environment. A survey questionnaire was distributed amongst the museums' visitors in two different exhibition halls, one in the Egyptian Museum in Cairo, Egypt, and the other in the Birmingham Museum in the United Kingdom in the real environment. Visitors were surveyed about their opinions towards the lighting settings in both exhibition halls. Moreover, the Virtual Reality technique was then used to visualize the different lighting scenes of each of the two exhibition halls, and participants were surveyed to collect data for the quantitative analysis about their lighting preferences, and the effect of the lighting settings on their emotional state, and visual perception. The questionnaire results were then analysed using SPSS.

3.3. Justification of the Methodology:

Quantitative data was used during the research process to have a better examination of the research and to explain in-depth, the trends and details of understating the visitors' perception and preferences of different lighting settings through statistical relationships. According to Marshall (1999), the survey method was proved to be the best choice for the suggested approach, philosophy, and objectives as it considers the individuals' experiences concentrating on the qualities, principles, feelings, and thoughts. Moreover, it is considered as a narrow-angled lens since it uses quantitative data from a study conducted in a controlled environment to test the hypothesis specified in the research and to allow for the generalization of findings.

According to McNeill (1990), a quantitative approach using a structured questionnaire reduces the probability of bias, unlike qualitative approaches, and obtains numerical data that can be statistically analysed and compared against precedent studies that have statistical significance of findings. The choice of case studies, especially one in Egypt and one in the United Kingdom, set the study in two different socio-cultural environments to have in-depth focus on the exhibition halls in their actual settings. It also allows the implementation of different methods which include surveys to closely examine the emotional states of visitors from different contexts. Virtual Reality was acknowledged by previous researchers as an effective tool in representing the actual environment (Brengman, 2002; Briand Decre & Pras, 2013; Hidayetoglu et al., 2012; Kernsom & Sahachaisaeree, 2010; Schielke & Leudesdorff, 2015; Wardono et al., 2012 and Engelke et al, 2013). Virtual Reality was chosen since the other alternative was having a four-dimensional experimental study, which would have been difficult to construct and to change the lighting settings. Additionally, the exact same Egyptian displays and the same sense of the exhibition space found in reality are difficult to attain in the four-dimensional experiment.

3.4. Data Collection:

The research data was collected using primary and secondary data. Primary data was collected through conducting questionnaires in the real environments in both museums as the first phase of research in addition to, the usage of Virtual Reality in the second phase of data collection of the research. Secondary data was collected through the literature review to identify the previous theories and relationships, and to find the current research gaps to allow for the validity and originality of the research. The phases of the research methodology are described in Table 3.1.

Table 3.1 Strategic Approach, and Phases

Methodology	Egyptian Museum in Cairo	Birmingham Museum in the UK
Phase 1	Qualitative questionnaire to collect the data in the Real environment in Egyptian Museum in Cairo, Egypt for quantitative analysis.	Qualitative questionnaire to collect the data in the Real environments in Birmingham Museum in the UK for quantitative analysis.
Sample of Real Environment Respondents	160 Respondents	40 Respondents

Phase 2 Virtual Reality Experiment	1.A model of an exhibition hall, similar in dimensions to the actual hall was designed and modelled. A 3D realistic computer rendering tool was used to generate 4 different interior scenes for the exhibition hall with different lighting settings of the interior space. 2.Conducting a Survey on the lighting preferences of participants of the 4 scenes.	1.A model of an exhibition hall, similar in dimensions to the actual hall was designed and modelled. A 3D realistic computer rendering tool was used to generate 4 different interior scenes for each exhibition with different lighting settings of the interior space. 2.Conducting a Survey on the lighting preferences of participants of the 4 scenes.
Number of Samples of the Virtual Reality	66 respondents for the Egyptian Museum in Cairo (33 questionnaires for the Egyptian Museum in Cairo for the 4 scenes that took place in Egypt and another 33 questionnaires for the Egyptian Museum in Cairo that took place in the UK).	66 respondents for the Birmingham Museum in UK (33 questionnaires for the Birmingham Museum in UK for the 4 scenes that took place in Egypt and another 33 for the Birmingham Museum in the UK that took place in the UK).
Analysis for both Museums	Descriptive information on age, gender, and educational level were included. Descriptive statistics such as the means and standard deviations of each one of the adjectives were carried out. Inferential analysis using Spearman correlation, Friedman, and Chi-square tests were applied.	Descriptive information on age, gender, and educational level were included. Descriptive statistics such as the means and standard deviations of each one of the adjectives were carried out. Inferential analysis using Spearman correlation, Friedman, and Chi-square tests were applied.

The first phase was concerned with collecting the quantitative numerical data, that was gathered using surveys in the real environment. This data was analysed using descriptive and inferential analysis. The aim of the quantitative phase was to find out any statistical relationships between visitors' emotional responses in terms of Pleasure, Arousal, and Dominance and the existing lighting settings; while the second phase used Virtual Reality to find the relationship between visitors' emotional perceptions and the different lighting settings through the different generated lighting scenes. In previous research, Virtual Reality was considered as an appropriate way of representing the physical environments. Participants in these research projects had similar feelings of presence and immersion in those environments as if they are in real-life settings (Roberts et al,2006, Slater,2009, Adi and Roberts, 2014), and they found that there were no major differences between the participants' performance, in the Virtual Reality and the physical environment. Consequently, Virtual Reality can be used as an experimental tool to gather user-related data while taking into consideration various factors of interest. Virtual Reality is a tool that can be used to mimic the real environment while drastically reducing the cost and inefficiencies accompanied by experimental studies. It also allows for having more control over different variables.

3.5. Case Study Selection:

Case study research is considered appropriate when the proposed research addresses the "how" and "why" questions or when the focus of the research is on contemporary phenomena that need a real-life context, in other words, the research needs to involve contextual conditions that is important for the study in addition to, the need of understanding a situation in depth or when a situation that is rich with information is needed (Yin, 2002). This research also adopted case study analysis since, it is concerned with people's perception on lighting settings in exhibition halls through understanding how and why different lighting settings affect people's museum experiences through data collection from real-life museums.

According to Yin (2002), case study is defined as “an empirical inquiry that investigates a contemporary phenomenon (the ‘case’) in depth and within its real-world context”. He also added that the choice of case studies is not a haphazard activity, and it is often preferable to include more than one case study as this offers strong analytical conclusions.

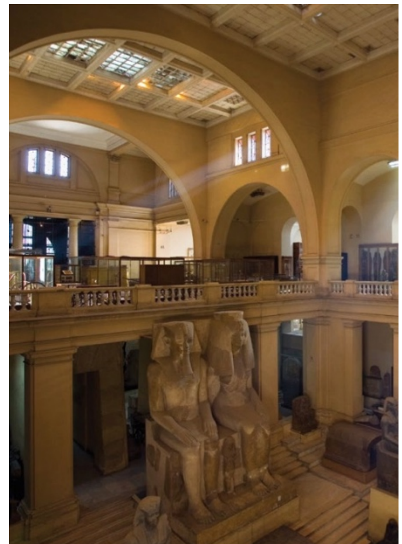
The case studies of the present research were selected according to the following criteria; firstly, the number of case studies needed; secondly, the location of the chosen case studies; thirdly, the availability of data that includes accessibility, availability of the needed information, and type of artefacts. Thus, the research adopted two case studies in different real-life contexts to increase external validity. The first case study is the Egyptian Museum in Cairo, Egypt and the second one is the Birmingham Museum and Art Centre in Birmingham, UK. These two case studies were specifically chosen since there was ease of access to both museums, as the research has been conducted in two countries which were Egypt and the United Kingdom. The management of both museums were welcoming to let the research be carried out in their exhibition halls. Moreover, the two chosen museums have ancient Egyptian displays and artefacts which were essential to unify the type of artefacts as a variable when making a comparative analysis between the two museums.

3.6. Egyptian Museum in Cairo (A Case Study in Egypt):

The Egyptian Museum was designed by Marcel Dourgnon. It has a classical style and design adopting the narrative technique to tell the story of the displays. Also, it allows visitors to feel as if they are going through a journey to enhance their museum experience. The architect created a narrow central hall that is located longitudinally through the museum. The Egyptian Museum has huge internal exhibition halls to house the massive ancient Egyptian monuments. The visitor enters the museum through an attractive porch in the center of the main facade. Two iconic columns that are decorated with the head of the goddess Isis, flanked the well-proportioned archway. The columns that are set into the wall on either side are for two high-relief female figures representing Upper and Lower Egypt (the Nile Valley and the delta). Furthermore, the facade is decorated with marble panels on which the names of prominent Egyptologists and other individuals who contributed to the preservation of Egypt's antiquities are inscribed. When visitors walk down the central hall they are welcomed by colonnades of double-height until they reach the enormous statue, 7 meters high, of Amenhotep III and his wife Tiy (Trapani, 2001, p. 187). The royal couple is located towards the end of the central hall and positioned on the same axis of the main entrance portico to highlight the powerful essence of the walking experience to the royal couple as shown in Figure 3.1. Additionally, the plan has a symmetrical form and a T- shape composition with vast internal spaces at its centre. The museum has a sequence of double-height rectangular and circular spaces from east to west, with a dome at the centre, positioned right after the museum’s main entrance. The space to be studied in the present research is the central hall that has rows of arches and columns on both sides as shown in Figure 3.2.

Figure 3.1. Interior of the Main Hall in the Egyptian Museum in Cairo in the Real environment. (Source: retrieved from www.egyptianmuseumrevival.org, 2014).

View of the statue of Amenhotep III and his wife Tiy in the central hall.



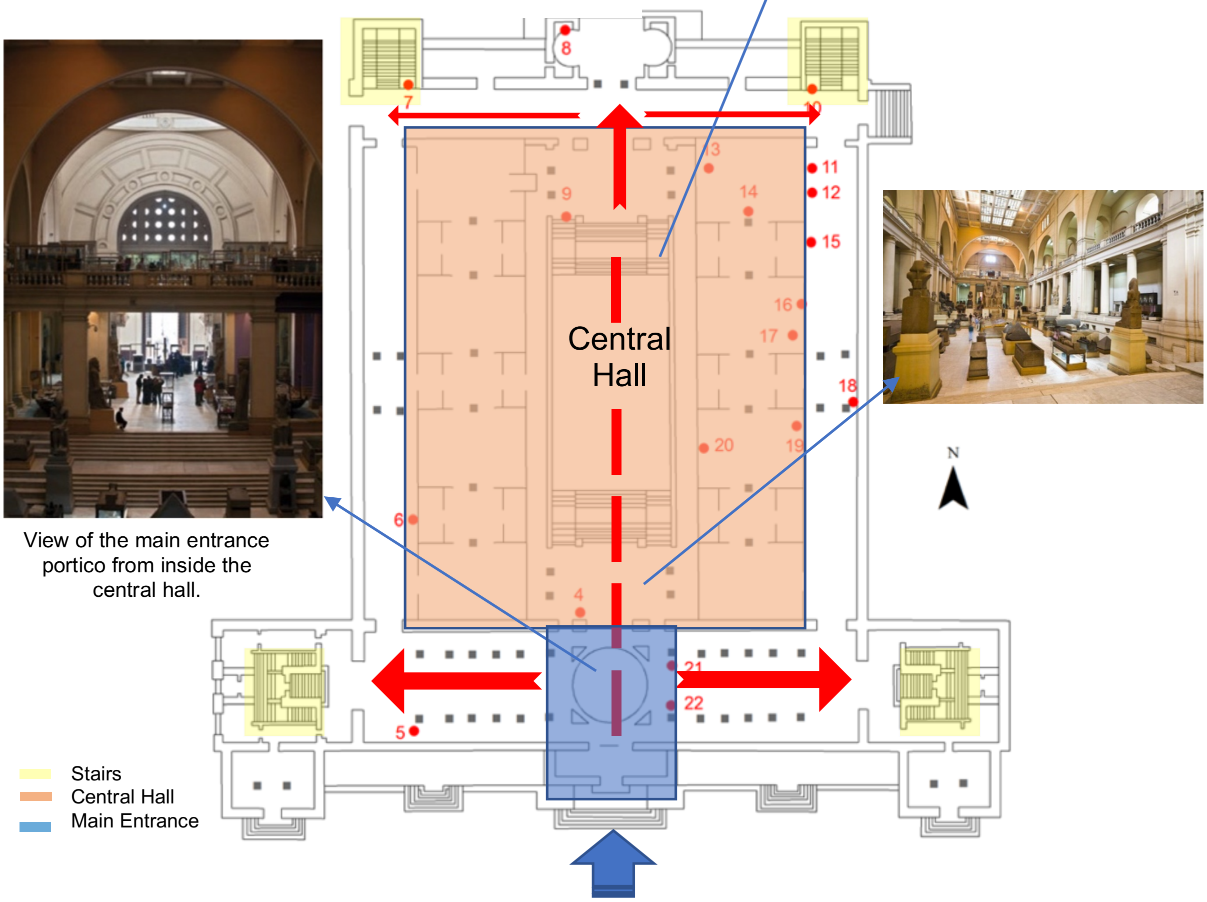


Figure 3.2. Circulation and Views of the Central Hall in the Ground Floor Plan of the Egyptian Museum in Cairo. (Source: Developed by the Author).

3.7. Birmingham Museum and Art Gallery (A Case Study in the UK)

The museum was designed by Yeoville Thomason. It has a collection of displays and exhibits of different types including ancient Egyptian antiquities. The Egyptian gallery is located on the fourth floor that has a form of a rectangular shape of approximately 23 metres by 12 metres. The exhibition hall has a courtyard in the middle and a red column placed on the floor below and extending upwards across the courtyard to be displayed in the gallery that is studied in the current research as shown in Figure 3.3 and 3.4 respectively. Moreover, Egyptian antiquities are placed in display cases on the walls of the gallery with artificial lighting suitable for the exhibition.

Figure 3.3. Interior views of the Ancient Egyptian gallery in the Birmingham Museum. (Source: Developed by the Author)

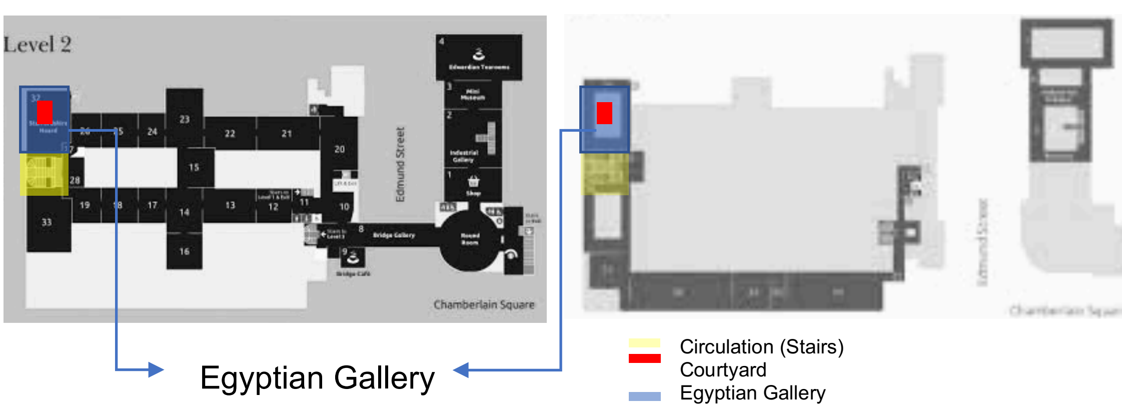


Figure 3.4.Plans of the Birmingham Museum and Art Gallery. (Source: Developed by the Author)

3.8. Procedures of the Virtual Reality Experiment

To obtain an evaluation of four different lighting settings and four exhibition views for each of the two chosen museums, a 3D model of an exhibition hall similar in dimensions to the actual hall in the Egyptian Museum in Cairo and the Birmingham Museum in the United Kingdom was designed and modelled. A 3D realistic computer rendering tool was chosen as the method to mimic the actual exhibition space and create visualizations for the chosen space. The scenes of the chosen exhibition rooms in this study were simulated using a 3D max realistic computer rendering program. In addition, different colour and lighting arrangements were tested out. Specific variables were examined in this study, which included lighting distribution (general lighting and accent lighting), colour hues and correlated colour temperatures (cool and warm) as shown in Figure. 3.5 and 3.6 respectively. These key variables were selected based on the thorough review and analysis of literature conducted on museum architecture and exhibition halls' design.

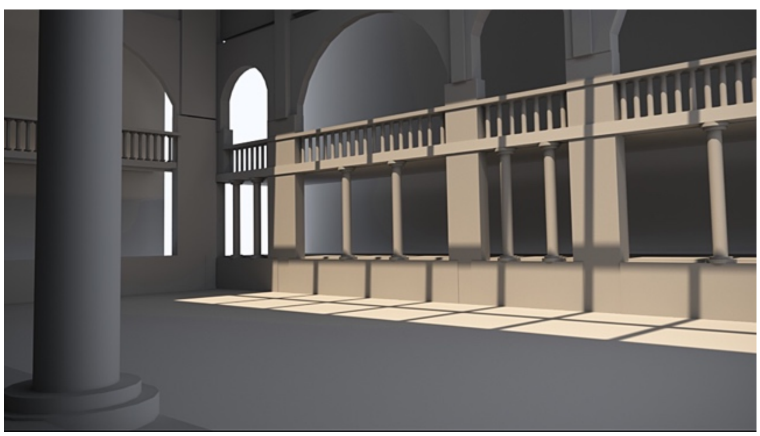


Figure 3.5. Preliminary rendered model of cool colour temperature. (Source. Author)

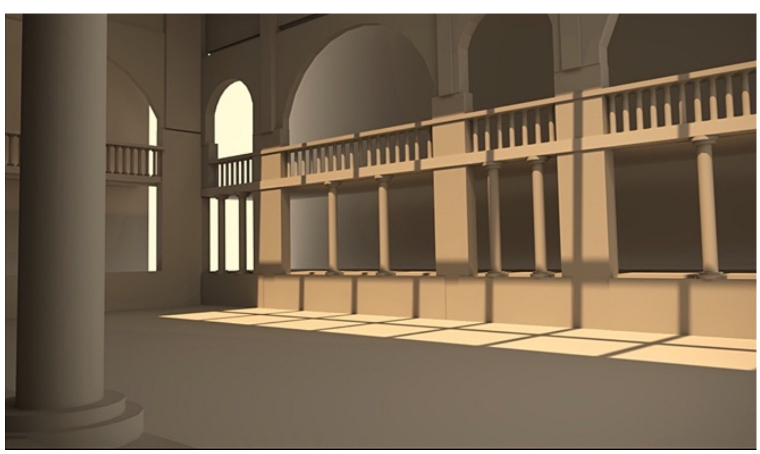


Figure 3.6. Preliminary rendered model of warm colour temperature. (Source. Author)

To create the virtual models of the exhibition halls that are similar in dimensions to the actual halls in both museums, floor plans and interior elevations with real dimensions of both museums were drawn using AutoCAD programme as shown in Figure 3.7. These drawings were then imported into the 3D max computer rendering software. In the 3D max programme drafting units of the drawings were adjusted from metres to centimetres. Walls were drawn using lines, afterwards these lines were dragged up to have floors and walls in a 3D form. Openings were created by clicking on the polygons that represent them in the model and they were then extruded. The camera was put inside the model to visualize the interior of the exhibition hall for both museums. The preliminary setup of the model for the Egyptian Museum in Cairo before the addition of the displays and the different lighting settings is shown in Figure 3.8 and 3.9. The same procedures were applied for the Birmingham Museum in the UK.

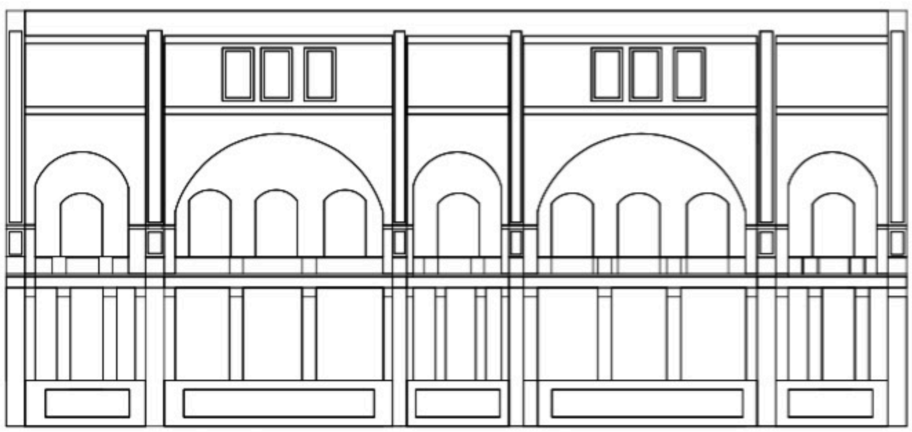


Figure 3.7. 2D CAD Drawing of the interior elevation of the Egyptian Museum in Cairo. (Source: Author)

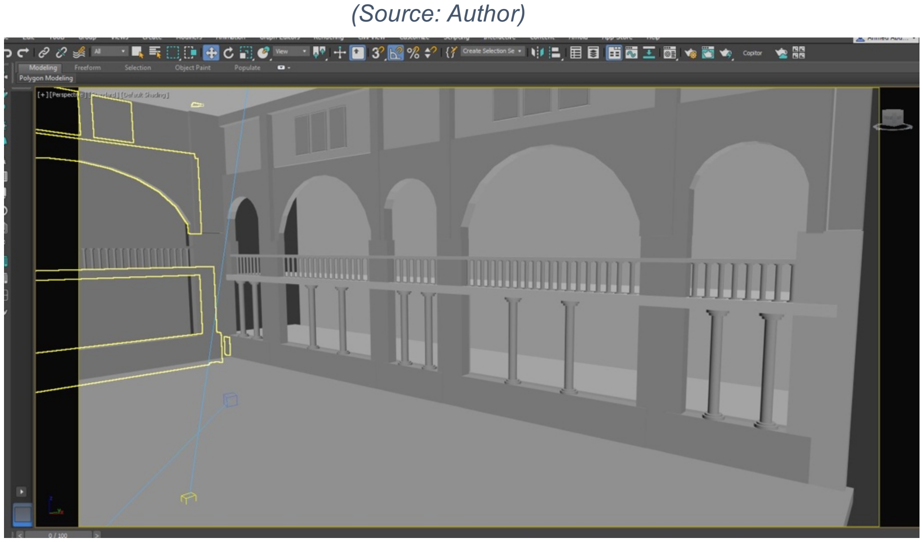


Figure 3.8. Preliminary 3D Model before blocks were added. (Source: Author)

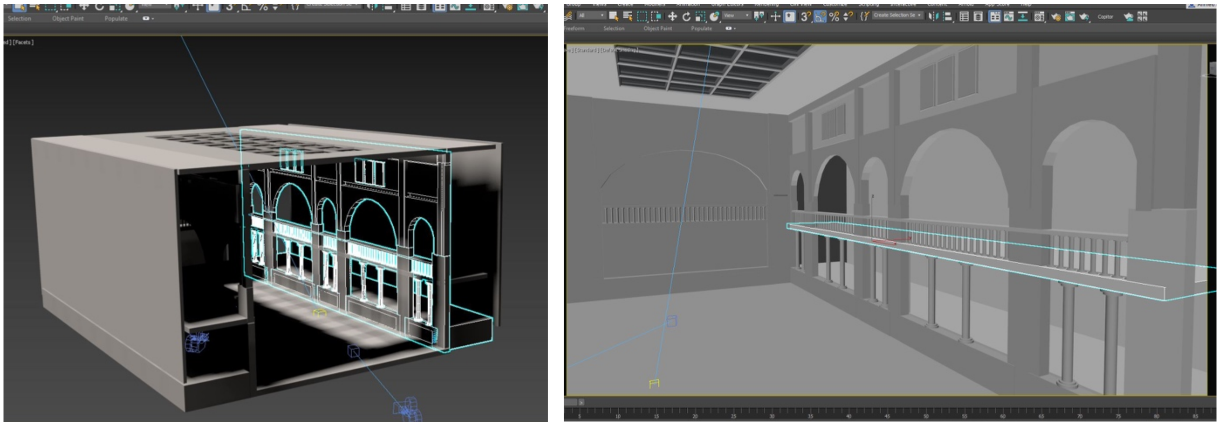


Figure 3.9. Preliminary Setup of the Virtual Reality 3D Model (Source: Author)

After the model was created in terms of floors and walls, blocks of the ancient Egyptian displays as shown in Figure 3.10. were imported to the model from the modelling library and then the rendering process was carried out. Rendering is the process of converting the 3D scene into a two-dimensional picture that simulates the light rays. V-Ray render plugin was used for rendering the interior of both museums. V-Ray is one of the most used render plugins in 3D visualization. Materials are considered the data that is applied on the surface of an object to visualize it in a particular way when the scene is rendered. The used materials were chosen to effectively reflect the lighting settings applied in each scene. Maps were used to add texture and more details to the objects in the scene. A sample of the maps applied in the 3D model is shown in Figure 3.11. UVW Map modifier was then used to adjust the size of the texture in a three-dimensional form to achieve the most desired results and the four scenes were generated for each of the chosen exhibition halls.

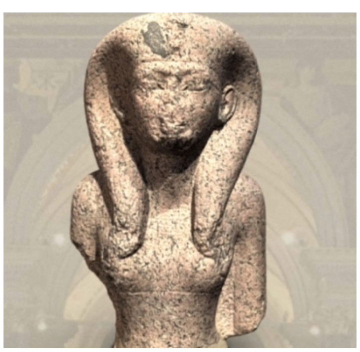


Figure 3.10. 3D Block for one of the displays in the 3D model. (Source: Author).

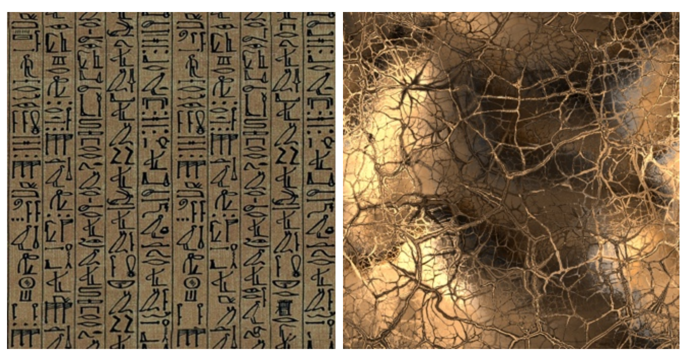
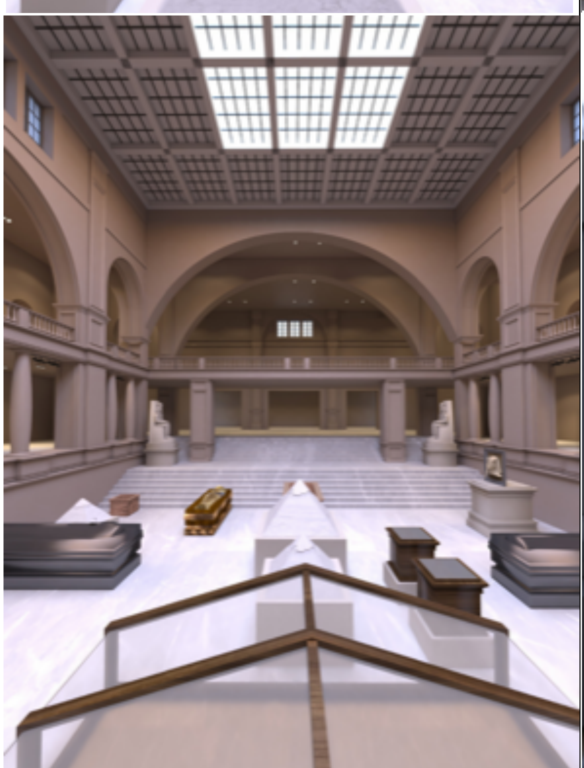


Figure 3.11. Maps used in the 3D Model rendering. (Source: Author).

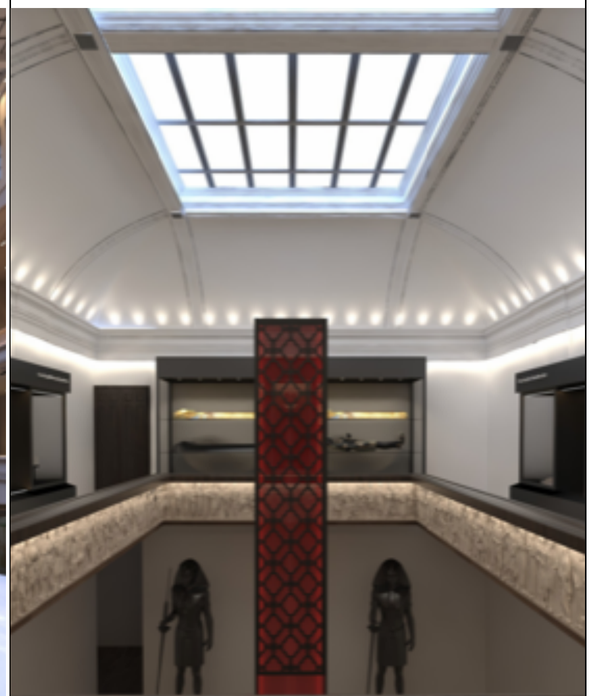
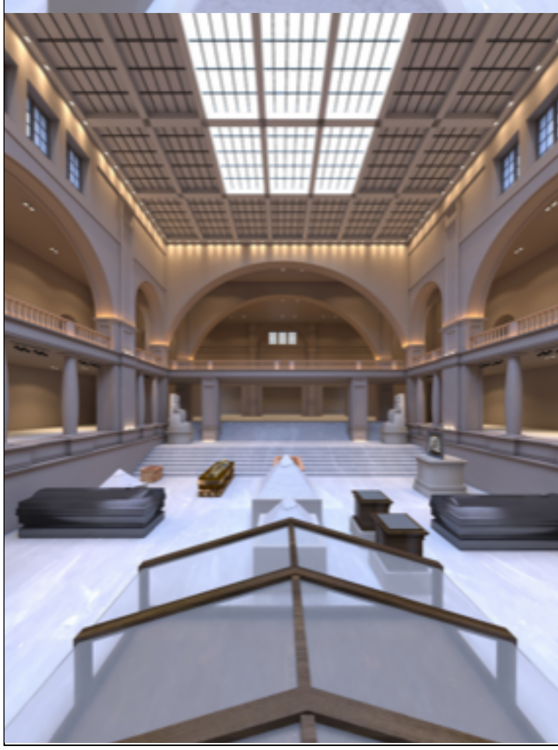
The first scene (Scene 1), which looked like the existing halls in the real environment (The Egyptian Museum in Cairo and The Birmingham Museum in the UK), had downwards (DL) and general lighting that had a uniform illumination of the vertical and horizontal surfaces as shown in the photos in Table 3.2.

Table 3.2. Two different Views for Scene 1 in Egyptian Museum and Birmingham Museum.

Egyptian Museum in Cairo	**Birmingham Museum in the UK**
	
	

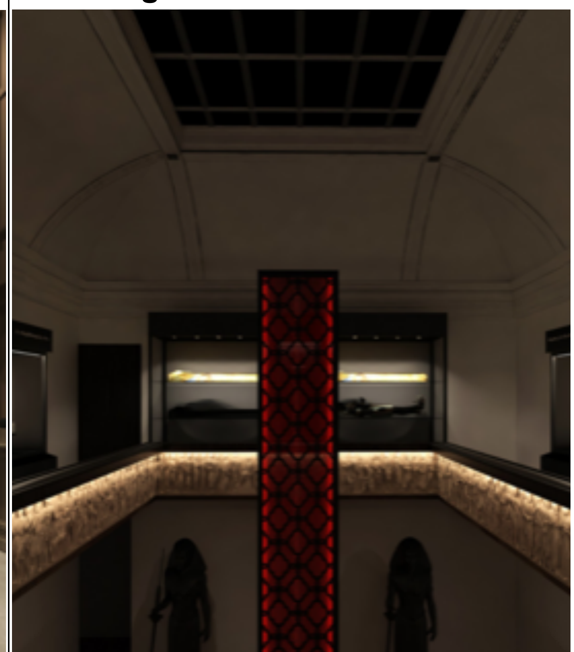
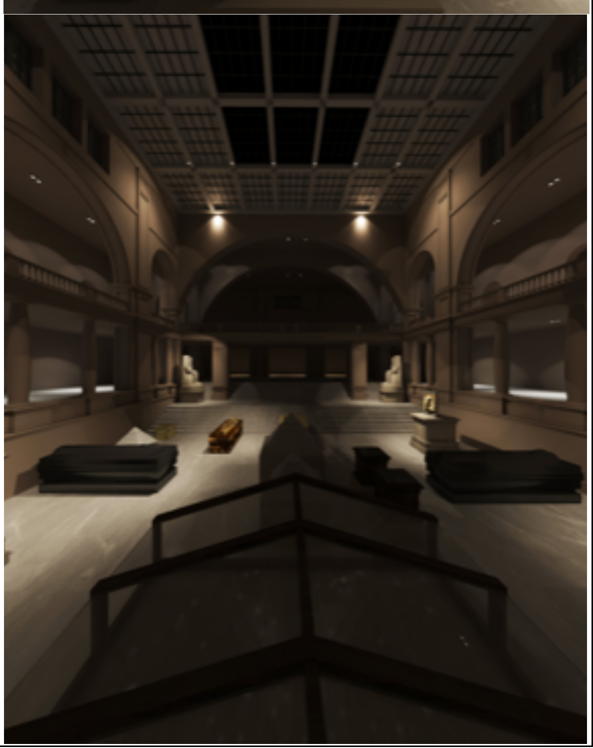
The second generated scene (Scene 2) had accent lighting (AL) and wall washers (WW). Items on the wall shared the same light and a large amount of indirect light was rebounded into space as shown in the photos in Table 3.3.

Table 3.3. Two different Views for Scene 2 in Egyptian Museum and Birmingham Museum

Egyptian Museum in Cairo	**Birmingham Museum in the UK**
	
	

The third scene (Scene 3) was dark and dramatic, which is the black box Scene, where the whole environment had a black surface and only the displays were lit. In order to create the black box design, and have an intense contrast, track-mounted luminaires were considered, and a mix of accent and grazing light (AG) was used as shown in the photos in Table 3.4.

Table 3.4. Two different Views for Scene 3 in Egyptian Museum and Birmingham Museum

Egyptian Museum in Cairo	**Birmingham Museum in the UK**
	
	

Finally, the fourth scene (Scene 4) was of a different colour hue (cool colours) using accent lighting and coloured projection (AP) which drew people’s attention and determined where people will move from one place to another inside the exhibition hall as shown in the photos in Table 3.5. It is considered a highlighting technique to specific areas in the space through projection.

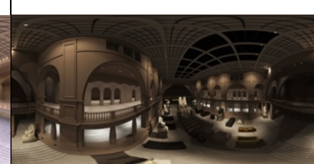
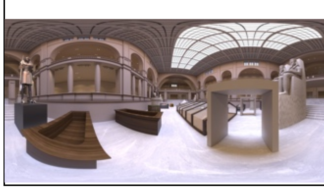
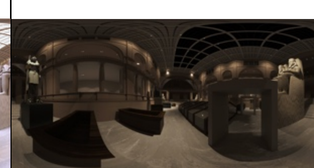
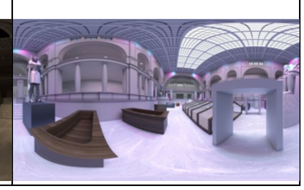
Table 3.5. Two different Views for Scene 4 in Egyptian Museum and Birmingham Museum

Egyptian Museum in Cairo	Birmingham Museum in the UK
	
	

According to Smith (1986), a bluish-purple colour has a visual difference against the other warm interior colours without producing strong irritating colour contrasts for the participants, thus this colour was used for the coloured projection.

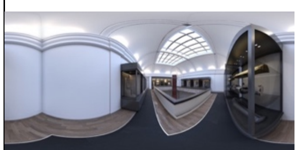
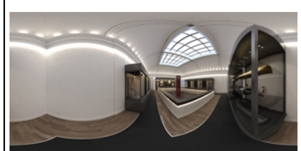
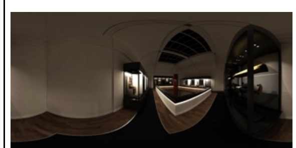
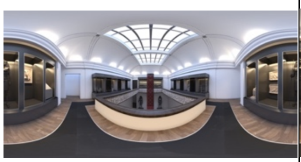
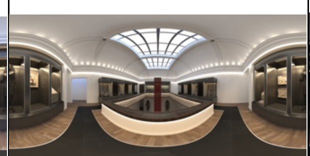
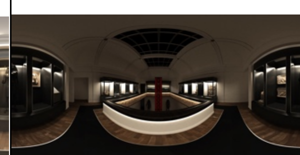
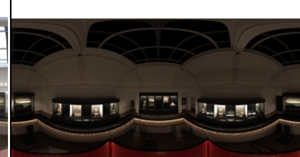
The generated lighting scenes were based on the visual perception theories and qualitative lighting design guidelines that were discussed earlier in this research. The four scenes of the exhibition halls in the Egyptian Museum in Cairo are shown in a 360-degree form in Table 3.6.

Table 3.6 Egyptian Museum in Cairo in the Virtual Environment

Scene 1 Downwards and General Lighting (DL)	Scene 2 Wall washing (WW) and Accent Lighting (AL)	Scene 3 Black Box With accent lighting and grazing lighting (AG)	Scene 4 Different Colour Hue
View 1 			
View 2 			
View 3 			
View 4 			

The four scenes of the exhibition halls in the Birmingham Museum in the UK are shown in a 360-degree form in Table 3.7.

Table 3.7 Birmingham Museum in UK in the Virtual Environment

Scene 1 Downwards and general Lighting (DL)	Scene 2 Wall washing and accent Lighting (WW) &(AL)	Scene 3 Black Box with accent lighting and grazing lighting (AG)	Scene 4 Different Colour Hue
View 1 			
View 2 			
View 3 			

3.9. Questionnaire Design

McNeill (1990) adds that a structured questionnaire if carried out in the right way could lead to having indispensable data that can be analysed thoroughly and compared against other findings. To explain the effect of the physical environment in terms of lighting on people’s satisfaction, a conceptual framework was adopted by pairs of adjectives with a positive/negative meaning. Therefore, to evaluate the perception responses of a museum environment, 16 adjective pairs based on the study of Schielke & Leudesdorff (2015) were selected and regrouped for the identification of an exhibition space's impression, lighting settings and museum identity. The semantic differential scale (1-5) was used to evaluate the computer-generated scenes of the simulated exhibition hall with different colour and lighting conditions for each question. It was indicated that 1 is considered strongly agree and 5 is considered strongly disagree at the different ends of the scale axis. The impression was measured via these adjective pairs as follows: “Good /Poor”, “Depressing/Pleasing”, “Satisfying/Disappointing”, “Spacious/Confined”, “Sleepy/Awake”, “Calm/Excited”, “Interesting/Boring”, “Controllable/Controlling”, and lighting settings were described as “Uniform/Differentiated”, “Bright/Dark”, “Warm/Cool”, “Diffused/Contrast Lighting”, “Evenly/Targeted Lighting”, “Colourful /Dull”. Branding was evaluated by a five-level Likert scale on the tendency to revisit, the tendency to recommend to others and how visitors find the image of the exhibition through lighting using ‘Strongly disagree’ and ‘Strongly agree’ at the different ends of the scale axis. The Likert scale has been widely used for experiments, and numerous studies exist, which discuss its reliability and validity.

Phase 1: The survey was designed as paper-based since it was to be carried out in the museum at a specific time. It included five-level Likert scale questions to determine branding image and (1-5) semantic differential method for visitors’ perception inside the space in terms of lighting. The surveys were conducted in the Egyptian Museum in Cairo and the Birmingham Museum in the UK in the real environment on each of the six days of the week when the museum was open. The times of the day selected were designed to make the final sample represent the attendance patterns. The survey instrument consisted of twenty-two questions, seven of which were concerned with the demographic characteristics such as age, gender, education, frequency of visits, and group size. The survey was also translated into the Arabic language to be able to conduct the questionnaire in Egypt.

Phase 2: adopted internet-based questionnaires which gave the advantage of collecting enough data during the timescale of this research for the 4 scenes for both museums in addition to, eliminating the risk of human errors during data entry which might have significant implications on the accuracy of the data analysis and findings.

3.10. Ethics Procedures

This research is designed to abide with the ethical standards since human participants were engaged. Ethical review was applied and granted by the School Ethics Review Committee. Participants were debriefed as there was a 15-minutes debriefing session prior to the test, explaining how the study will be conducted before they put on their Virtual Reality glasses and how they will fill the questionnaires afterwards to get their responses on their lighting preferences. At the very beginning of the questionnaire, there is a paragraph that states the purpose of the research and that the answers are kept anonymous and will just be used for an academic purpose. Participants who filled the questionnaire were informed to sign the consent forms which were distributed among them before conducting the survey.

Participation in the research was voluntary; the participants were informed beforehand about the nature and the purpose of the research, and they had the right to withdraw at any point as indicated in the consent form that they signed. Also, participants were no younger than 18 years old to avoid dealing with the vulnerable group issues. For the elderly extra training was held as they might be not familiar with the Virtual Reality technology, and they were accompanied by someone to answer their questions whenever they seek help in any of the procedures. The questionnaire and the research ethical forms needed are presented in Appendix 1.

3.11. Sampling in The Real Environment

The sampling technique that was adopted includes sample selection which is based on a random method in both surveys, the Egyptian Museum in Cairo and the Birmingham Museum in the UK. Systematic sampling was used as it involved selecting individuals according to a predetermined sequence such as having the fifth person to walk in to participate was chosen, which must originate by chance. One of the advantages of this technique is that the sample is free from sample bias. A sample size of 160 participants was selected in the Egyptian Museum in Cairo in the Real Environment while 40 participants were selected in the Birmingham Museum in UK; in order to assure a quality sample from which significant statistical calculations can be made that allows for the generalization of findings. This sample of 160 participants was selected in a response to a survey of literature suggesting that the sample should be based on a reasonably calculated margin of error listed as $1/\sqrt{N}$ (Lenth, 2001; Patel et al., 2003). Having this sample size of participants would limit an estimate of margin of error to approximately eight percent (Patel et al., 2003). This margin of error was applied for the sample size of the Egyptian Museum in Cairo in the Real environment, however, in the Birmingham Museum in the UK, the margin of error wasn't applied due to low people flow. After the survey procedures were completed, the collected data was entered to the computer using SPSS software for statistical analysis.

The results of the survey are reported in three sections. In the first section, a series of demographic variables are presented to provide a picture of the typical museum visitor. Following this, the responses to the contrasting statement pairs are discussed. Finally, a series of correlation analysis and accompanying figures are presented to explore the findings in depth, as the main aim of the research is to develop an approach that increases the understanding of how visitors perceive and respond to different kinds of exhibition lighting.

3.12. Virtual Reality Experiment Setting

The hypothesis of the present study is that lighting makes a significant contribution in making the exhibition spaces more vibrant and diverse which adds to the visitor’s experience in the exhibition space. Therefore, to study this relationship, the research project used a Virtual Reality tool to create a Virtual Reality environment, where a specific number of participants could experience the lighting experience in a virtual environment. Participants viewed the exhibition hall through the Virtual Reality glasses where everything in the exhibition hall scene was kept constant except for the lighting. Additionally, lighting was the only aspect to be changed in the different scenes to collect more accurate data. Virtual Reality was used to motivate and engage the participants by giving them the illusion that they were really experiencing an exhibition's visit. In addition, numerous studies have shown that immersive Virtual Reality applications can provide effective results. Virtual models of the two exhibition halls (The Egyptian Museum in Egypt and the Birmingham Museum in the UK), similar in dimensions to the actual ones, were designed and modelled. To create a realistic immersive virtual experience, the visual content included 3D scenes of different lighting settings for the same view which were modelled, textured and animated in the 3D Max software by Autodesk. This model included similar architectural features to the actual exhibition halls; that include walls, floor, ceiling, windows, skylights, material types and displays with different lighting settings using various textures and material maps.

The Virtual Reality experiment setting was chosen to be at the British University in Egypt library to be easily accessible by a various number of participants from different backgrounds. All experiments were conducted between 11:00 AM to 3:00 PM for two months (September 2018 to November 2018). In order to make sure that lighting settings in the ''3Ds Max'' modelling software were almost realistic, the 3D models were designed to reflect the same sun position at 2:00 PM from the skylight at the same location (Cairo for the Egyptian Museum and Birmingham for the Birmingham Museum) at the same time of the year (a sunny day in Cairo, and partially cloudy in Birmingham on September 5th). ''Round Me'' was the mobile software application used, in order to visualize the animated scenes on an iPhone mobile device; that is then put in the Virtual Reality glasses. In fact, a pilot study was conducted prior to the start of the experiment, to be able to identify the experimental and the procedural improvements that could be needed; in addition to, the issues related to Virtual Reality, such as the improvements in participant's interaction with the Virtual Reality glasses and interface, the rendering quality of the virtual exhibition hall, and the difficulty level that the participants might face to move from one scene to the other.

After the participants were instructed on how to use the mobile software application, and the Virtual Reality glasses, they were tutored on how to move from one scene to the other, which was attained by making the bubble on the mobile screen inside the virtual reality glasses turn green after it is positioned at the centre of vision. Each participant was instructed to look at the simulated scene for about 45s.They were then asked to remove the Virtual Reality glasses and rate his/her response on a computer-based questionnaire for their most preferred lighting settings. Afterward, they were thanked for their participation in the experiment.

3.12.1. Participants of the Virtual Reality Experiment

There were 33 participants who took part in Egypt and another 33 participants who took part in the experiment in the United Kingdom in London South Bank University for both museums to take into consideration the diversity and culture differences. The experiment took almost 4 hours, participants were either asked directly to participate or were informed through the postage of posters and banners in the library hall on the BUE campus. There was a 15-minute debriefing session prior to the experiment to explain the purpose and the nature of the research. Participants had the right to withdraw at any point, this debriefing procedure allowed the participants to become more familiar with the Virtual Reality process. After they agreed on participation, they were asked to read and sign the consent document before the experiment starts (See Appendix 2) that proved that participants were informed that the results of their survey forms would be kept confidential and is used for academic purposes only.

To avoid fatigue due to the long evaluation time taken to move from one scene to the other that took about 15–20 minutes, participants were split into two groups and swapped, one group evaluating the Egyptian Museum in Cairo while the other group evaluated the Birmingham Museum in the United Kingdom. The sequence of the lighting scenes and the application of the same lighting settings were presented in a similar way to both groups. Participants were asked to put on their Virtual Reality glasses to start the experiment. A survey was then distributed to the participants after they have seen the different lighting scenes through the Virtual Reality glasses, these surveys were then filled out and stored to be evaluated later. The obtained data from the questionnaires were then reported in spreadsheets and analysed using SPSS and different statistical tests were applied.

3.13. Types of Statistical Data Analysis Tests for Quantitative Data (Questionnaires):

These mentioned statistical tests are generally the tests used to describe the quantitative data. These tests give a numerical description of the data to draw a conclusion from the statistical analysis.

3.13.1. Descriptive statistics:

Descriptive statistics is considered a quantitative indicator and a methodology capable of describing and reporting results as it gives numerical information about data that is collected from the research questionnaires, for example, the number of males or females who took the survey etc. (Argyrous, 2005). There are three different types of data that are useful for statistical analysis:

- Ratio/ Interval: It is applied when the provided data is in the form of an order from low to high in equal intervals for example.
- Ordinal: It is used when the collected data can be ordered in a sequence.
- Nominal: It is considered when data represents different categories, instead of a scale.

3.13.1.1. Mean and standard deviation:

Mean and standard deviation are descriptive statistics that give a numerical average of a group of participants, for instance, mean is the sum of the responses divided by the sum of participants, while standard deviation indicates the level of variability in dataset. However, drawing conclusions from the means of participants only is not enough; thus, inferential analysis should be carried out (Bryman and Cramer, 2001).

3.13.2. Inferential Statistical Analysis Tests:

There should be a p-value in inferential analysis, that is the probability that varies between 0 and 1. If the probability is below a certain point, which is typically at 0.05, the hypothesis is accepted, which means that there is a significant difference and vice versa. When it is extremely unlikely to have occurred by chance, the outcome of the tests applied is said to be 'statistically significant' (Pallant, 2000).

3.13.2.1. Parametric and Non-Parametric Tests.

Parametric tests make assumptions about the population that the sample has been taken from. In order to apply parametric tests, the data should be normally distributed unlike the non–parametric technique. They are sometimes known as distribution-free tests. Although non-parametric tests are less complex, they do have some disadvantages; for instance, there are less sensitive than the parametric tests which might sometimes make it difficult to find differences between groups that are already present. On the other hand, non- parametric tests are perfect to be used when the given data is on a categorical or nominal scale. It is also beneficial to use non-parametric data when the sample is very small and when the data doesn't meet the tough requirements of the parametric tests (Pallant, 2000).

3.13.2.2. Factor Analysis:

This test is used to condense a large number of items/dimensions into smaller and more manageable factors. This is done by searching for groups of closely related items (Pallant, 2000).

3.13.2.3. Correlation Analysis:

Correlational analysis is used to describe the strength and the direction of the relationship between two variables. There are two types of correlational tests in SPSS one is Parametric, and the other is the non – parametric alternative.

- **Pearson Correlation** is a test that has often been used for parametric data (score on a measure / data in a form of an order) to show whether or not there is a relationship between two variables, and a p-value is calculated to measure the significance of the relationship (Pallant, 2000).

- **Spearman correlation** is a test that has often been used for **non-parametric** data (ranked data/ ordinal level) to show whether or not there is a relationship between two variables, and a p-value is calculated to measure whether or not the relationship is significantly relevant (Pallant, 2000).

3.13.2.4. Mann-Whitney U Non-Parametric / T- Test Parametric Tests:

Mann-Whitney U test is used to compare the differences between two independent groups when the dependent variable is either ordinal or continuous, but not normally distributed. It is often considered as the non-parametric alternative of the independent t-test (Pallant, 2000).

3.13.2.5. Friedman Test/ One Way ANOVA with Repeated Measures.

Friedman test is the non-parametric alternative to the one-way repeated measures analysis of variance when data has violated the assumptions necessary to run the one-way ANOVA with repeated measures. It is used to test for differences between groups when the dependent variable is ordinal (Pallant, 2000).

3.13.2.6. Chi-Square Test

It is a non-parametric test that is used when the study is based on categorical data to determine the relationships between the categorical variables (i.e., whether the variables are independent /related or not) (Pallant, 2000).

3.14. Choice of The Appropriate Statistical Test for Data Analysis.

The following statistical tests are the applied tests in this research. These tests are relevant to the study as the collected data are categorical data thus these non-parametric tests should be applied. The applied statistical tests are as follows:

3.14.1. Spearman Correlation

Since the collected data was in a categorical scale, Spearman correlation was used to check whether there is a link between how visitors perceived the atmosphere in terms of the different lighting settings in addition to, how they reacted in terms of Pleasure, Arousal, and Dominance emotional items and the different branding determinants.

3.14.2. Mann-Whitney U test

This test was used to compare the differences between two independent groups (The participants in Real Environment are different from those of the Virtual Reality Environment) when the dependent variable is either ordinal or continuous, but not normally distributed. It was used to compare between two categorical data of the case of Egypt and the United Kingdom in addition to, the real environment and the Virtual Reality data. This test was used to answer the following questions:

(i) Do participants' levels of Pleasure, Arousal, and Dominance in the Virtual Reality environment differ from the real environment for the same lighting scene or not?

(ii) Does the difference in the exhibition's room dimensions and areas while having the same lighting settings have a different impact on people's perception of the space in terms of lighting or not?

3.14.3. Friedman Test

Friedman test was used as the same sample of participants' responses were recorded under four different lighting conditions which were Scene 1, Scene 2, Scene 3, and Scene 4. In consideration of the fact that there is one sample of participants, evaluated under various conditions. This test was used to address the question; is there a change in the emotional scores across the four different lighting Scenes? In relation to the null hypothesis that lighting has no significant contribution to the visitor's experience in the exhibition spaces.

3.14.4. Chi-square Test

The study was performed based on categorical data that focused on the comparative assessment of the four lighting settings for Pleasure, Arousal, and Dominance experiences. In order to identify how lighting affects the emotional perception in an exhibition hall, the Chi- square test was used to examine the relationships between the categorical variables. This test was used to address the question of what is the relationship between the lighting settings and the different emotional perceptions of Pleasure, Arousal, and Dominance?

3.15. Summary

This chapter described in detail how the adopted research methodology was carried out throughout the research and the advantages of the chosen research methodology. It also provides a description of the data collection procedures, which include the different phases in the Real Environment and the Virtual Reality and the sampling techniques, in addition to the questionnaire design, ethical approval procedures, and the plan for the data analysis. Finally, different statistical terms and tests were discussed to be able to choose the most appropriate statistical test for the research analysis, knowing why and when each test is used. Also, the difference between parametric and non-parametric tests was discussed in addition to, the different test alternatives for each technique.

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4. Chapter 4: Analysis and Discussion of Findings

4.1. Introduction

During the research analysis, quantitative data was used to further analyse the research and clarify the patterns and specifics of the research questions in-depth, as using quantitative analysis contributes to a more detailed numerical analysis. The quantitative data was obtained using questionnaires, then descriptive and inferential analyses were performed on the data. The main goal of the quantitative stage was to provide statistical relationships that help to understand the perception and expectations of visitors of the various lighting settings. To provide a summary of the sample from which data was obtained, the analysis of the results was divided into two parts: descriptive analysis involving the presentation of results as quantitative indicators and techniques for explaining and summarizing data followed by inferential statistics that test the research hypothesis. The significance levels and p-values (< 0.05) were used in the inferential tests to determine whether the test results were statistically significant or not.

4.2. Survey Analysis

To see if there was a substantial difference in the results of the various lighting scenes, the results of the surveys were evaluated using descriptive analysis by comparing the mean values of the different variables. To compare the various values, tables and graphs were created. SPSS (Statistical Package for Social Sciences) statistical analysis was used to help analyse the significance levels of the variables because of their versatility in the process of evaluating data in different ways. SPSS has embedded equations for every statistical test applied, thus there was no need to encode the equations. The collected data (raw data) was inserted in the SPSS, tests were then selected from the SPSS programme tabs, and results were calculated automatically. The analysis included descriptive analysis to be a quantitative guide to describe and report results by providing means and standard deviation. This was followed by some inferential analysis tests to analyse the relationships between variables and to test the research hypothesis.

Spearman correlation is used to evaluate relationships that include ordinal variables. This test was used to check whether there is a link between how visitors perceived the atmosphere in terms of the different lighting settings in each generated scene or not. The Mann-Whitney U test is used to compare the differences between two independent groups when the dependent variable is either ordinal or continuous, but not normally distributed. This test was used to test both individual groups for the Virtual Environment and the Real Environment for both museums in the study scenario. To investigate whether the answers of the participants differed in the real environment from the Virtual Reality for the same lighting settings for the same exhibition hall or not. Friedman Test is used to test for differences between groups when the dependent variable is ordinal. It was used to compare the scores of the generated scenes under the four different lighting conditions. Chi-square test is used to examine the relationships between categorical variables. It was used to identify how lighting affects the emotional perception in the exhibition hall. Chi- square test was used at 0.05 significance level with lighting settings as the independent variable unless indicated otherwise.

4.3. Empirical Research Statistics

This chapter will report the empirical results of the research investigating the impact of lighting settings on the visual perceptions and satisfaction of the visitor using Pleasure, Arousal, and Dominance paradigm (PAD) dimensional technique. To draw solid conclusions, the interpretation of the findings is based on two forms of statistics, i.e., differential, and inferential statistics.

4.3.1. Descriptive Analysis

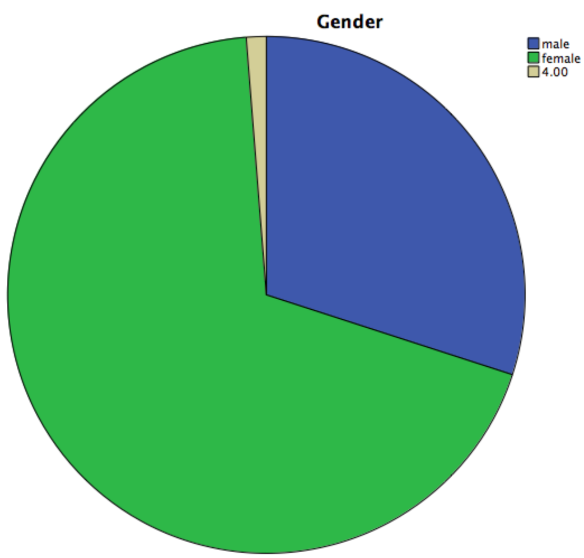
It is a quantitative indicator and a methodology capable of describing and reporting results. Means and standard deviations for the dependent variable have been reported and frequency tables have been used to present the results.

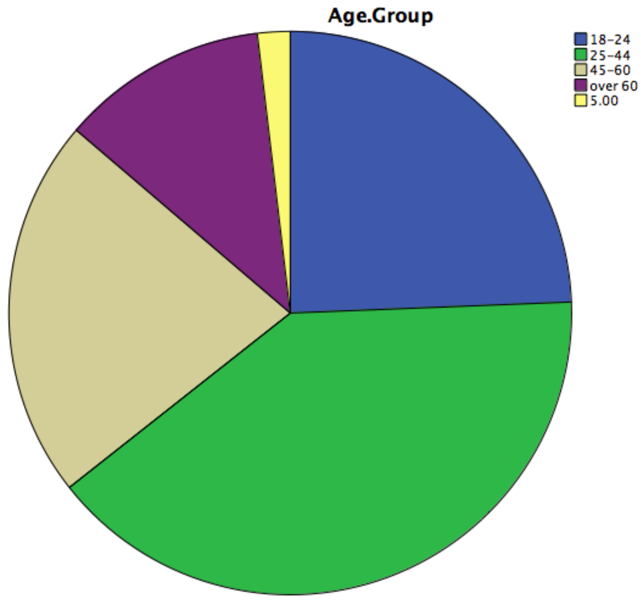
4.3.1.1. Overview of Personal Data of Egyptian Museum in Cairo participants in Real Environment:

Among the participants were 50 males (30%) and 110 females (70%). The age range of participants was mainly between the age of 25 and 44 years, which contributed to (40%) of the total number of participants followed by the age range of 18-24 years old by (24.4 %) and the age range from 45-60 by (21.9%) followed by the age range of over 60 years by (11.9 %). Participants from various countries indicated a variety of responses due to the different cultural backgrounds as shown in Table 4.1.

Table 4.1.Descriptive Analysis of the Survey in The Egyptian Museum in Cairo (Source: author)

Gender			
		Frequency	Valid Percent
Valid	Male	50	30.0
	Female	110	70.0
	Total	160	100.0





		Frequency	Valid Percent
Valid	18-24	39	24.4
	25-44	64	40.0
	45-60	35	21.9
	over 60	19	11.9
	Total	160	100.0

Country

		Frequency	Valid Percent
Valid	Australia	6	3.75
	Belgium	6	3.75
	Egypt	104	65.0
	Germany	15	9.37
	Lebanon	3	1.88
	Netherlands	10	6.25
	USA	16	10.0
	Total	160	100

4.3.1.2. Mean and standard deviation for The Egyptian Museum in Cairo in Real Environment

To measure the emotions generated by the museum; the Pleasure, Arousal, and Dominance paradigm (PAD) of Mehrabian and Russell (1974) is adopted in addition to, the framework which was informed by the research of Quartier et al. (2008). This technique measures the three key emotional dimensions, Pleasure measures the level of a person feeling happy or pleasant, while Arousal measures the degree to which a person feels active or aroused, and Dominance measures the level of a person feeling in charge of the situation. The Pleasure dimension was measured by four semantic differential items, Arousal was measured by three semantic differential items, and Dominance was measured by one semantic differential item, as indicated by Desmet (2010) to be of low importance. Each item consists of a 5-point scale with opposing emotional terms at either end. The study followed the Arabic translation of each item in the Arabic version of the questionnaire.

4.3.1.3. Egyptian Museum in the Real Environment Analysis Results

The means and the standard deviation for the different emotional states in the Egyptian Museum in Cairo have been recorded and put into tables, to understand how people perceived the exhibition’s atmosphere in terms of lighting and how lighting has impacted the participants’ mood and satisfaction. To help in understanding how the atmospheric factors specifically lighting is important in shaping the exhibition’s experience and hence affecting the emotional states of visitors. This has been less researched on in prior studies that were related to museums’ atmospherics. The means of the sixteen semantic differential scales and the lighting colour and distribution were listed in Table 4.2. and plotted using a graphical representation as shown in Figure 4.1.

Table 4.2 Mean and Standard Deviation of the Emotional Scales in the Real Environment (Source: author)

EMOTIONAL SCALE		REAL ENVIRONMENT	
IMPRESSION (PAD)	**Pleasure, Arousal, Dominance**	**MEAN**	**SD**
Good/ Poor	(Pleasure)	3.3438	1.22883
Pleasing / Depressing	(Pleasure)	2.9563	0.83438
Satisfying / Disappointing	(Pleasure)	3.2563	1.49316
Spacious/Confined	(Pleasure)	3.0563	1.18293
Awake / Sleepy	(Arousal)	3.6250	1.46124
Excited / Calm	(Arousal)	3.3813	1.09241
Interesting / Boring	(Arousal)	3.1750	1.22114
Controllable/ Controlling	(Dominance)	3.3250	1.24663
Lighting Settings		**MEAN**	**SD**
Uniform /Differentiated	(Lighting Description)	3.0125	1.34579
Bright /Dark	(Lighting Description)	3.1875	0.90552
Warm /Cool	(Lighting Description)	2.9813	1.23610
Diffused /Contrast lighting	(Lighting Description)	3.0188	0.77274
Evenly/Targeted lighting	(Lighting Description)	3.2688	1.15863
Colourful /Dull	(Lighting Description)	4.5625	0.73277
IDENTITY		**MEAN**	**SD**
Revisit / No Revisit		2.9438	0.89896
Recommend to others/ Don’t recommend to others		2.6625	1.30257
Brand image / No brand image through lighting		2.7188	1.12251

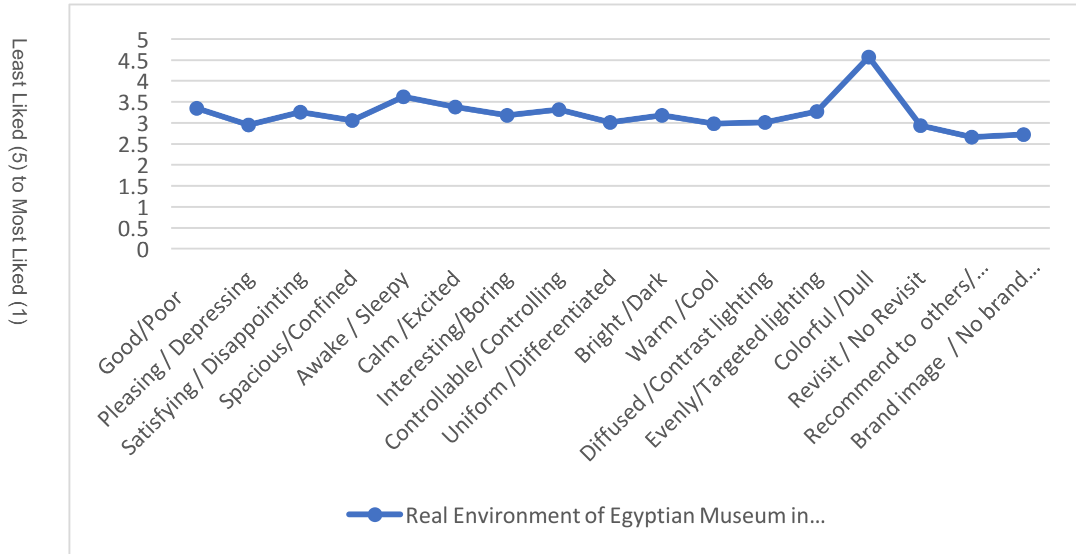


Figure 4.1. Graphical Representation of the Means of the Egyptian Museum in Cairo in real environment (Source: author)

The graph shows how people responded in terms of visual perception and satisfaction within the main exhibition hall. The results showed that visitors assessed the atmosphere generated by the lighting settings as neutral to almost all the emotional states except for the awake / sleepy item as Mean and SD have been given (3.6250 & 1.46124), indicating that the participants perceived it as a sleepy atmosphere rather than an awake one. While for the lighting settings, the participants assessed the atmosphere created by the lighting settings of the exhibition hall as a vibrant and colourful atmosphere as Mean and SD have been given (4.5625 & 0.73277).

4.3.2. Inferential Analysis

This section will discuss the different applied tests and findings regarding the research questions and objectives outlined in the first chapter. There will be a p-value for each of the inferential statistics used in the thesis. This is the probability that varies between 0 and 1. If the probability is below a certain point, which is typically at 0.05, the null hypothesis will be rejected, which means that there is a significant difference and vice versa.

4.3.2.1. Lighting Settings Versus Pleasure, Arousal and Dominance Tests.

4.3.2.1.1. Factor analysis

After conducting factor analysis on SPSS, it was inferred from the rotated component matrix that the adjectives Good/Poor, Pleasing/ Depressing and Satisfying / Disappointing could be all grouped together to form part of the Pleasure component which needs to be measured.

The other adjectives which are Awake/Sleepy, Exciting/Calm and Interesting/ Boring could be grouped together under item 2, which is the Arousal component according to the Factor Analysis test. As the table of the rotated component Matrix shows that item 4 has the strongest factor loading, while item 3 has the weakest factor loading. As items 1,2, and 3 are loaded together, they are therefore grouped together and items 4,5, and 6 are loaded together, so that they are grouped together. This is shown in Table 4.3.

Table 4.3 The Components in Factor Analysis (Source: author)

Items	Component	
	Pleasure	Arousal
1.Good/Poor	0.861	
2.Pleasing/Depressing	0.849	
3.Satisfying/ Disappointing	0.605	
4.Awake/ Sleepy		0.908
5.Exciting/ Calm		0.746
6.Interesting/ Boring		0.712

4.3.2.1.2. Spearman Correlation

The Spearman correlation is one of the analytical tests conducted to answer the following research questions, Q1; Do changes in the lighting settings affect the perceived atmosphere, and do these changes affect the visitor's satisfaction and experience? Q2; What is the relationship between the lighting settings and the different emotional perceptions of Pleasure, Arousal and Dominance? and Q3; Does the museum's brand image get affected by its lighting settings?

The test showed that there is a relationship between Pleasure and the lighting settings; in addition to, some of the items of arousal, dominance, and branding determinants. Table 4.4 shows the correlation, significance, and number of observations. In order to determine the statistical significance, the standard alpha level of 0.05 was used.

Table 4.4 Spearman Correlation Analysis for the Emotional Items (Source: author)

Correlations		**Good**	**Pleasing**	**Satisfying**	**Interesting**	**Spacious**	**Awake**	**Exciting**	**Controllable**
Uniform/ Differen-tiated	Correlation Coefficient (rho)	0.113	0.386**	-0.025	0.153	-0.066	0.141	-0.0051	0.309**
	Sig. (2-tailed).	0.154	0.000	0.750	0.054	0.410	0.076	0.526	0.000
	N	160	160	160	160	160	160	160	160
Bright/ Dark.	Correlation Coefficient (rho)	0.122	0.492**	-0.117	0.280**	0.373**	0.460**	0.121	-0.183*
	Sig. (2-tailed).	0.124	0.000	0.141	0.000	0.000	0.000	0.127	0.020
	N	160	160	160	160	160	160	160	160
Warm/ Cool	Correlation Coefficient (rho)	0.159*	0.423**	0.171*	0.390**	0.539**	0.689**	0.345**	-0.042
	Sig. (2-tailed).	0.045	0.000	0.031	0.000	0.000	0.000	0.000	0.598
	N	160	160	160	160	160	160	160	160
Diffused/ Contrast	Correlation Coefficient (rho)	-0.046	0.062	-0.014	0.239**	0.425**	0.283**	0.010	-0.233**
	Sig. (2-tailed).	0.566	0.436	0.858	0.002	0.000	0.000	0.900	0.003
	N	160	160	160	160	160	160	160	160
Evenly lit/ Targeted	Correlation Coefficient (rho)	0.079	0.042	0.160*	0.123	0.488**	0.140	0.365**	-0.017
	Sig. (2-tailed).	0.323	0.602	0.043	0.120	0.000	0.078	0.000	0.832
	N	160	160	160	160	160	160	160	160
Colourful / Neutral	Correlation Coefficient (rho)	0.456**	0.239**	0.436**	0.331**	0.642**	0.333**	0.538**	0.530**
	Sig. (2-tailed).	0.000	0.002	0.000	0.000	0.000	0.000	0.000	0.000
	N	160	160	160	160	160	160	160	160

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

According to the correlation results, **uniform or differentiated lighting** had a significant positive moderate relationship with the items Pleasing/Depressing, rho = 0. 0.386, n=160, $p<0.000$ and Controllable/Controlling, rho = 0. 0.309, n = 160, $p<0.000$ unlike other emotional items as there was no significant relationship.

The relationship between **bright and dark lighting** was a positive strong correlation in relation to Pleasing/Depressing, rho = 0.492, n = 160, $p<0.000$, positive weak relation to Interesting/Boring, rho = 0.280, n=160, $p<0.000$ and moderate positive relation with Spacious/Confined, rho = 0.373, n=160, $p<0.000$, Awake/Sleepy, rho = 0.460, n=160, $p<0.000$ as well as negatively significant in relation to Controllable/Controlling, rho = -0.183, n=160, $p<0.020$.

As for the relationship between **warm/ cool lighting**, it has been a strong significant positive correlation with Pleasing/Depressing, rho = 0.423, n=160, $p<0.000$ as well as a strong relationship with Interesting/Boring, rho = 0.390, n=160, $p<0.000$, Spacious/Confined, rho = 0.539, n=160, $p<0.000$, Awake/Sleepy, rho = 0.689, n=160, $p<0.000$, and a weak positive relationship with Exciting /Calm, rho = 0. 0.345, n=160, $p<0.000$, but it had no significant relationship with the Controllable/Controlling item.

Evenly lit/targeted had a strong significant relationship with Spacious/Confined, rho = 0.488, n=160, $p<0.000$ and moderate positive relationship with Exciting/Calm impressions, rho = 0.365, n=160, $p<0.000$. **Diffused or contrast lighting** had a weak positive relationship with Interesting/Boring, rho = 0.239, n=160, $p<0.002$, a strong relationship with Spacious/Confined, rho = 0.425, n=160, $p<0.000$, a weak relationship with Awake/Sleepy impressions, rho = 0.283, n=160, $p<0.000$ and a negative relationship and Controlling/Controllable impressions, rho = -0.233, n=160, $p<0.000$. Finally, the **colourful or dull lighting** had a highly significant relation with all the impressions' items.

The correlation to show the significant relationships between the different types of lighting and the branding parameters is presented in Table 4.5.

Table 4.5 Spearman Correlation Analysis for the Brand Image (Source: author)

Correlations		Encourage to Revisit	Recommend to Others	Gives Specific Image
Uniform/ Differentiated	Correlation Coefficient (rho)	0.143	0.159*	0.104
	Sig. (2-tailed).	0.072	0.044	0.190
	N	160	160	160
Bright/ Dark.	Correlation Coefficient (rho)	0.275**	.0169*	-0.056
	Sig. (2-tailed).	0.000	0.032	0.480
	N	160	160	160
Warm/ Cool	Correlation Coefficient (rho)	0.454**	0.003	-0.0130
	Sig. (2-tailed).	0.000	0.970	0.100
	N	160	160	160
Diffused/ Contrast	Correlation Coefficient (rho)	-0.011	0.309**	-0.042
	Sig. (2-tailed).	0.891	0.000	0.601
	N	160	160	160
Evenly lit/ Targeted	Correlation Coefficient (rho)	0.174*	0.162*	0.053
	Sig. (2-tailed).	0.028	0.041	0.505
	N	160	160	160
Colourful / Neutral	Correlation Coefficient (rho)	0.314**	0.352**	0.144
	Sig. (2-tailed).	.000	.000	.069
	N	160	160	160

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

There is a positive relationship between Bright/Dark, Evenly Lit/Targeted and Colourful / Neutral and the willingness of people to revisit the exhibition because of the lighting conditions, rho = 0.275, n=160, p<0.000, rho = 0.174, n=160, p<0.028, rho = 0.314, n=160, p<0.000 respectively. There is a strong positive relationship between recommending the visit of the exhibition hall to others and Diffused/Contrast Lighting, rho = 0.309, n=160, p<0.000 and also a positive strong relationship with Colourful/Neutral, rho = 0.352, n=160, p<0.000. All the lighting parameters had a statistically significant relationship with the willingness of people to recommend to others to visit the exhibition hall for the preferred lighting settings except for warm/Cool as the relationship is not statistically significant. This proves the hypothesis that the more the lighting characteristics of the exhibition spaces are diverse and thrilling, the better the exhibition space is perceived, thus, contributing positively to the museum's brand image.

4.3.2.2. Egyptian Museum in Cairo in the Virtual Environment Analysis

Participants of the Virtual Reality Experiment in Egypt were of different age groups, sex, and educational backgrounds to have variety in participants. The total number of the research participants in the Virtual Reality in Egypt was 33 participants, 30% of participants were undergraduates and 70% were graduates. Furthermore, 30% of participants had an architecture background; 3 % in lighting design, and 72 % came from other fields (business, dentistry and pharmacy, construction, and law etc.) which indicated that the judgment was of normal visitors without a specialization in visual fields which is most likely the case of real museum visitors. There were 23 males (70%) and 10 females (30%) among the participants. The age range of the participants was limited to be from +18 to 50 years old due to its relevance to museum visitors.

The analysis and results will help in forming an overview of how lighting can affect people's responses in relation to visual perception and satisfaction. It is important to highlight that the participants of this study evaluated the overall atmosphere generated by the lighting settings rather than the lighting on its own. The impression and the brand image produced by the lighting settings were analysed through eight pairs of adjectives for the impression and three pairs of adjectives for the brand image. Table 4.6 shows the means of each adjective in each of the four simulated scenes.

Table 4.6 Mean and Standard deviation For Scenes 1,2,3 and 4 in the Egyptian Museum in Cairo (Source: author)

EMOTIONAL SCALE	SCENE1 (DL)		SCENE 2 (AL) & (WW)		SCENE 3 (AG)		SCENE 4 Colour & (AP)	
IMPRESSION	MEAN	SD	MEAN	SD	MEAN	SD	MEAN	SD
Good/Poor	2.0606	0.89928	1.8485	0.87039	2.6364	1.43218	2.6970	1.44665
Pleasing / Depressing	2.0909	0.76500	1.9697	0.95147	2.8182	1.46745	2.6061	1.27327
Satisfying / Disappointing	2.2121	1.02340	1.9091	1.01130	2.5758	1.27550	2.8182	1.53000
Spacious/Confined	2.1818	1.07397	2.1515	1.00378	2.7576	1.39262	2.6970	1.35750
Awake / Sleepy	2.2424	1.19975	2.3030	1.13150	3.4242	1.34699	2.0000	1.22474
Calm /Excited	2.9091	1.10010	2.5758	1.25076	3.3333	1.53433	2.4242	1.39262
Interesting/Boring	2.5152	1.14895	2.0909	1.07132	2.3333	1.29099	2.6364	1.49621
Controllable/ Controlling	2.6970	1.28659	2.2424	0.93643	3.1212	1.49494	3.0909	1.52815
Uniform /Differentiated	2.5455	1.12057	2.5455	1.12057	3.1758	1.29977	3.3939	1.32144
Bright /Dark	2.0909	0.87905	2.1212	0.81997	3.9091	1.15552	1.8788	1.11124
Warm /Cool	2.7576	1.09059	2.4545	0.93845	2.6061	1.41287	3.1818	1.35680
Diffused /Contrast lighting	2.6970	1.15879	2.8182	1.15798	3.2424	1.25076	2.9091	1.46551
Evenly/Targeted lighting	2.2121	1.16613	2.2727	0.97701	3.7576	1.34699	2.4545	1.41622
Colourful /Dull	3.5455	1.17502	2.9697	1.01504	3.5758	1.14647	1.8182	1.21075
Revisit / No Revisit	2.4545	1.02342	1.4532	1.23123	2.3212	1.12324	2.3451	1.11231
Recommend/No	2.3210	1.42511	1.3278	1.09823	2.4512	1.34251	2.6512	1.23141

The results of the means and the standard deviation showed that the different lighting conditions in the exhibition halls were found to change the visual appearance of the displays. Accordingly, different impressions were given to visitors. Scene 1(DL) in terms of the lighting settings, was perceived as more of a diffused, evenly lit, and bright lighting atmosphere. Scene 2 (AL&WW) was perceived almost the same as Scene 1 except for the colourful / dull. Moreover, Scene 2 was perceived as less colourful than Scene 1. While Scene 3 (AG) was perceived as a differentiated, targeted and contrasted lighting atmosphere unlike Scenes 1 and 2. For Scene 4 (Colour & AP), lighting was perceived the same as in Scenes 1 and 2 except for the colourful/dull item as it was perceived as a more colourful scene.

4.3.2.2.1. Analysis and Comparison of the four Scenes of the Egyptian Museum in the Virtual Environment

There was a significant variation in the responses for each of the four Scenes in terms of the space impressions. Scene 1 (DL the one that resembles the real environment) and Scene 2 (AL&WW) were perceived as more pleasant and satisfying than Scene 3 (AG) and Scene 4(Colour & AP). In terms of how spacious the exhibition is according to the lighting settings, it was found that Scenes 1and 2 were perceived as more spacious than Scenes 3 and 4. The accent grazing lighting Scene was perceived as more interesting and exciting unlike the downwards, while the general lighting Scenes were found to be similar to the same result as in previous studies (Schielke & Leudesdorff, 2015; Summers & Hebert, 2001). Cool lighting and accent projected lighting had a less significant feeling of pleasure by resulting in a decrease in the level of satisfaction and pleasantness, although it was perceived as a stimulating scene. For the branding parameters, there was a higher tendency to recommend it to others and to revisit in addition to, a better brand image in Scene 2 more than the other three scenes. This is graphically represented in Figure 4.2.

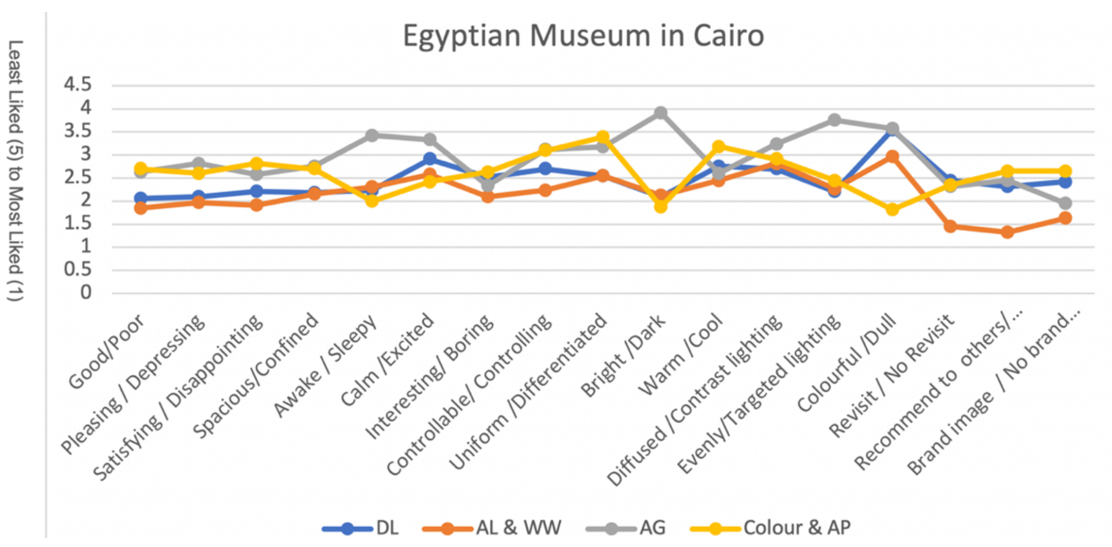


Figure 4.2. Graphical Representation of the Comparison Between the Four Scenes in The Egyptian Museum in Egypt (Source: author)

4.3.2.2.2. Egyptian Museum in Cairo Museum (Real Environment Versus Virtual Reality):

The lighting settings were presented to participants through semi-realistic simulated scenes using Virtual Reality. The means were calculated for each of the asked questions using SPSS, they were then plotted to provide a graphical representation of the subjective reactions of the lighting settings. Figure 4.3. plotted the means of the sixteen semantic differential scales and the lighting colour and distribution. The values range from 1 as being the most positive response to 5 as being the most negative response.

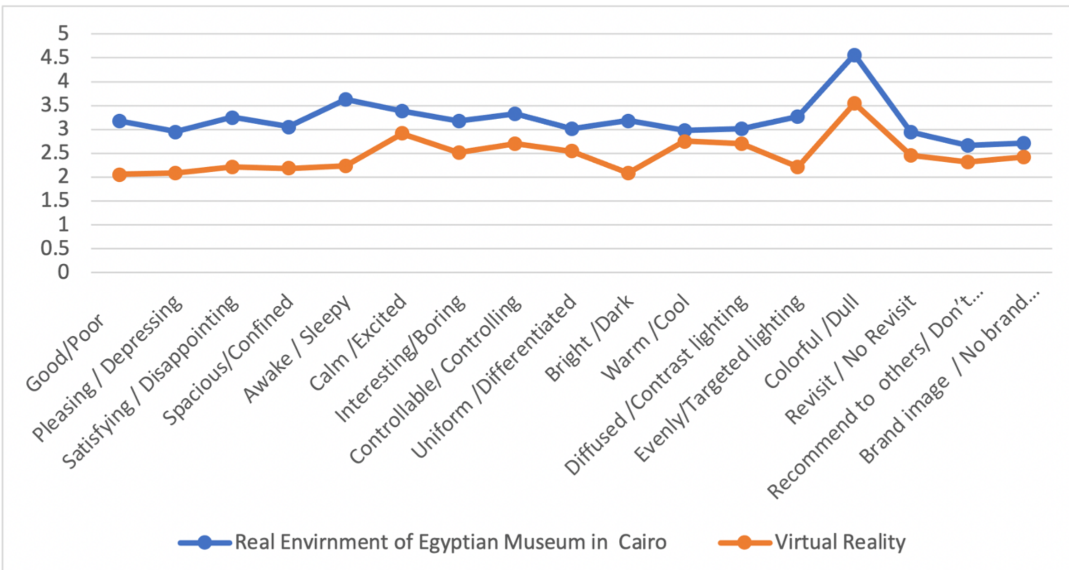


Figure 4.3. Graphical representation of the Comparison Between the Real Environment and the Virtual Reality Means in the Egyptian Museum in Egypt (Source: author).

The results of the means for the Real Environment and the Virtual Environment in the Egyptian Museum were plotted graphically as shown in Figure 4.3. The means did not vary significantly between the Real environment and the Virtual Reality. Means were all parallel for “Good/Poor”, “Depressing/Pleasing”, “Satisfying/Disappointing”, “Spacious /Confined”, “Sleepy /Awake”, “Calm /Excited”, “Controllable/ Controlling”, and the lighting settings as described “Uniform /Differentiated”, “Warm /Cool”, “Diffused /Contrast lighting”, “Evenly/Targeted lighting”, “Colourful /Dull” except for “Bright /Dark” which had higher means in the real environment. This resemblance validates the use of virtual reality as a tool to assess the effect of the various lighting settings on people’s visual perception as if they are in the real environment.

4.3.2.2.3. Real Environment and Virtual Reality Environment comparison using Mann Whitney U test:

This test was conducted to address the question of; is there a discrepancy between the answers of the participants in terms of the emotional states in the real environment and in the Virtual Reality for the lighting settings for the same exhibition hall? The test has shown that there are no major variations exist between the responses obtained from the two independent groups assessing the same lighting conditions in both environments. The p-value was not less than or equal to 0.05, which validates the use of virtual reality as a tool to imitate the real environment and present the same environment to people with nearly the same feelings. This is shown in Table 4.7

Table 4.7 Results of the Mann-Whitney U Test (1) (Source: author)

Test Statistics

Emotional Items	Good Poor	Pleasing Depressing	Satisfying. Dissatisfying	Interesting. Boring	Spacious Confined	Awake Sleepy	Exciting Calm	Controllable Controlling
Mann-Whitney U	1806.000	2128.000	1806.500	2018.000	1768.000	1814.500	2070.000	1844.000
Wilcoxon W	4017.000	4339.000	4017.500	4229.000	3979.000	4025.500	4281.000	4055.000
Z	-1.754	-.243	-1.736	-.748	-1.935	-1.698	-.511	-1.562
Asymp. Sig. (2-tailed)	.079	.808	.083	.454	.053	.090	.609	.118

Mann-Whitney test could answer the question; have people perceived the lighting in the Real environment and the Virtual environment the same or not? If yes, this means that the Virtual Reality tool has succeeded in simulating the same lighting conditions for the participants to evaluate, thus validating the use of Virtual Reality as an appropriate experimental tool. After carrying out the Mann-Whitney U test, it is inferred that there were no significant differences between the responses regarding the description of the lighting conditions from the Real Environment and the Virtual Reality that were collected from two independent groups of participants. The p-value was not less than or equal to 0.05, this is shown in Table 4.8.

Table 4.8 Mann-Whitney U Test Results(2) (Source: author)

Lighting Characteristics	Uniform Differentiated	Bright. Dark	Warm. Cool	Diffused. Contrast	Evenly lit Targeted	Colourful Neutral
Mann-Whitney U	2174.000	1960.000	2014.000	1853.000	1824.000	1902.000
Wilcoxon W	4385.000	4171.000	4225.000	4064.000	4035.000	4113.000
Z	-.019	-1.169	-.771	-1.571	-1.672	-1.427
Asymp. Sig. (2-tailed)	.985	.242	.441	.116	.094	.154

4.3.2.2.4. Friedman Test for the Egyptian Museum in Cairo:

This statistical test was used to prove the research hypothesis in the case of the Egyptian Museum in Cairo. Since the normal distribution is not given, a Friedman test was conducted for the four different scenes. The test showed that there is a significant difference across the four scenes.

By examining the median values for Scenes 1,2, 3 and 4, it was found that they were perceived the same in terms of **Good/Poor lighting** ((3, n=33) = 27.863, p < .001 and the median was 2 (Md=2). The hypothesis was proved for **Pleasing/Unpleasing** emotional item as there is a significant difference ((3, n=33) = 25.789, p < .001). The median values were 2 (Md=2) for Scenes1,2 and 4, while the median value is 3 (Md=3) for Scene 3, this indicated that Scene 3 is less pleasant that the other scenes as indicated by the participants. For **Satisfying/Dissatisfying** emotional item, the hypothesis was accepted as there is a significant difference ((3, n=33) = 23.471, p < .001). Scene 3 had a median value of 3 (Md=3) indicated that the other three scenes were more satisfying as they had a median value of 2 (Md=2). For **Interesting / Boring** emotional item, there was a significant difference ((3, n=33) = 11.805, p < .005). Moreover, Scenes 1,2,3 and 4 shared the same median value of 2 (Md=2), this indicated that the 4 Scenes were considered as interesting. For **Spacious/Confined** emotional item, there was a significant difference ((3, n=33) = 22.175, p < .001). Scenes 1,2,3 and 4 had a median value of 2 (Md=2) which indicated that the four Scenes were perceived as spacious. There is a significant difference for **Awake/Sleepy** emotional item across the Scenes, ((3, n=33) = 44.375, p < .001), the Median Value for Scene 4 is 1 (Md=1) indicated that Scene 4is the most awakening Scene, as it gave an arousal feeling while Scene 3 is considered as the sleepiest Scene with a median of 4 (Md=4). Scenes 1 and 2 gave a sleepier feeling than Scene 4 but gave a more aroused feeling than in Scene 3 with a median of 2 (Md=2). For **Exciting/Calm**, there were significant differences that took place as ((3, n=33) = 27.603, p < .001). Scenes 3 and 4 were considered more exciting with a median value of 2 (Md=2), while Scenes 1and 2 showed to be less exciting with a median of 3 (Md=3). There was a significant difference for **Controllable/ Controlling** ((3, n=33) = 23.257, p < .001). Scenes 1 and 2 were considered as more controllable with a median of 2 (Md=2), while Scenes 3 and 4 were considered as more controlling with a median of 3 (Md=3). This was graphically presented in Figure 4.4. Friedman test confirmed that evaluating different lighting settings in the same exhibition hall for four different lighting scenes has an impact on people's emotional states, that accepts the research hypothesis.

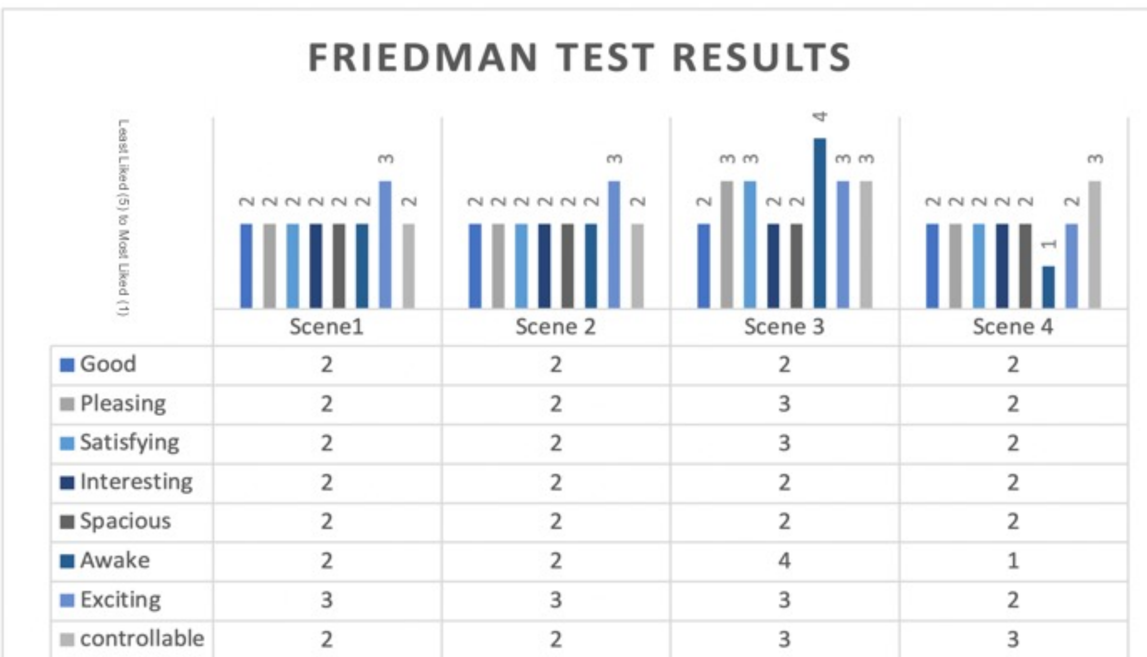


Figure 4.4. Friedman Test Results for the Egyptian Museum in Cairo (Source: author)

4.3.2.2.5. Chi-square Test for the Egyptian Museum in Cairo:

Since participants evaluated four different lighting settings, the Chi-square test was used. Chi-square analysis was conducted on the categorical data based on the comparative evaluations of the four lighting settings on the perceptions of Pleasure, Arousal and Dominance. To determine the statistical significance, the standard alpha level of 0.05 was used. This indicates that 95% of the variation found in the data could be explained by the specific variables tested while only 5% of the variation in participants' responses cannot be explained by the variables tested.

The Chi-square test was used to evaluate the collected data in regard to visitors' perception under the different lighting settings for the two different exhibition halls one in the UK and one in Cairo whilst both possess Egyptian displays and to answer the research question Q4; How exploring exhibition lighting design can enhance the visitor's experience? The reactions of participants under the four lighting scenes were gathered to identify the effect of the lighting settings on people's perception of the ambient atmosphere and space. A Chi-Square test was carried out to determine this relationship and determine people's perception of the lighting settings.

4.3.2.2.6. Scenes 1,2,3 and 4 (Good/Poor Lighting Verses Uniform/ Differentiated Lighting)

Chi-Square test was carried out to identify the relationship between Good/Poor Lighting and Uniform/Differentiated Lighting among the four scenes in the Egyptian Museum in Egypt. In Scenes 1,3 and 4 there is a significant relationship, X2 (1, N = 66) = 26.296, P = 0.010, X2 (1, N = 66) = 84.991, P = .000, X2 (1, N = 66) = 70.517, P = .000 consecutively, unlike Scene 2, there is no significant relationship as X2 (1, N = 66) = 15.641, P = 0.208 (See Appendix 3).

According to participants' responses in Scene1 (which is considered as downwards and general lighting with an even illumination of the horizontal and vertical surfaces) in the Egyptian Museum in Cairo, 24 participants (36 % of the total participants) evaluated uniform lighting as very good to good lighting. In Scene 2, 20 participants (30 % of the total participants' responses) considered uniform lighting as good lighting. While in Scene 3, 21 % of the total participants considered differentiated lighting as poor lighting. In Scene 4, 14 participants (21 % of the total participants) perceived differentiated lighting as Poor to very Poor lighting. This is represented graphically in Figure 4.5.

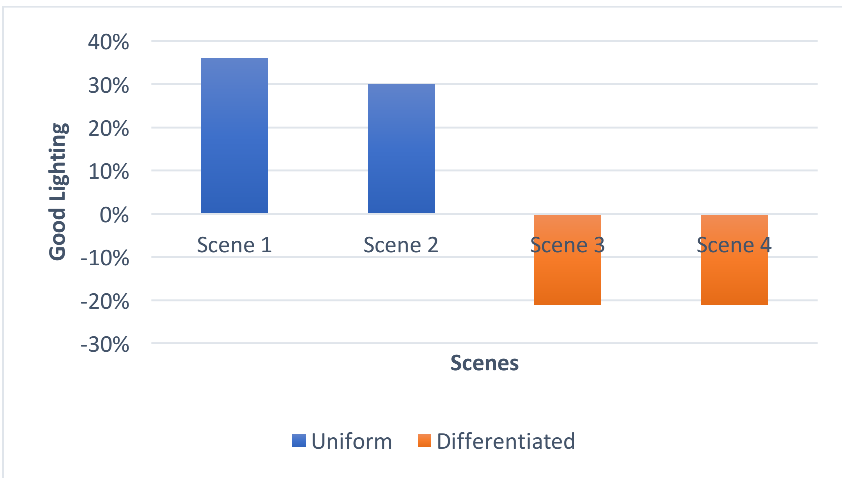


Figure 4.5. Results of Chi-Square Test (Scene 1,2,3, & 4) on Participants' Perception Between Good/poor Lighting and Uniform Differentiated Lighting (Source: author)

4.3.2.2.7. Scenes 1,2,3 and 4 (Good/Poor Lighting Verses Bright/Dark Lighting)

The relationship between Good/Poor Lighting and Bright/Dark Lighting is meant to be a significant relationship in all of the four Scenes, X2 (1, N = 66) = 30.222, P = 0.000, X2 (1, N = 66) = 64.433a, P = 0.000, X2 (1, N = 66) = 60.415a, P = 0.000, X2 (1, N = 66) = 54.028, P = 0.000 consecutively (See Appendix 3).

According to participants' responses in Scene1, 38 participants (57.5 % of the total participants) evaluated Bright lighting as very good to good lighting. Moreover, in Scene 2, 44 participants (66 % of the total participants) perceived bright lighting as good to very good lighting. In Scene 3, 16 participants (24 % of responses) considered dark as poor lighting. Finally, Scene 4 was perceived by 36% of responses as bright and good to very good lighting, unlike Dark lighting. This is represented graphically in Figure 4.6.

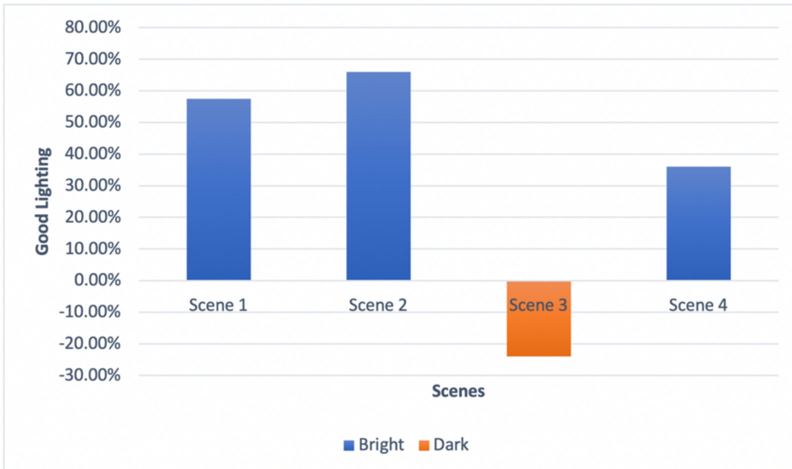


Figure 4.6. Results of Chi-Square Test (Scene 1,2,3, & 4) on Participants' Perception Between Good/poor Lighting Verses Bright/Dark (Source: author)

4.3.2.2.8. Scenes 1,2,3, and 4 (Good/Poor Lighting Verses Warm/cool Lighting)

The relationship between Good/Poor Lighting and Warm/Cool Lighting is meant to be a significant relationship in all of the 4 Scenes according to the conducted test. Consecutively Scene 1, X2 (1, N = 66) = 23.403, P = 0.024, Scene 2, X2 (1, N = 66) = 37.793, P = 0.000, Scene3, X2 (1, N = 66) = 122.57, P = 0.000 and Scene 4, X2 (1, N = 66) = 77.521, P = 0.000 (See Appendix 3). Participants' responses in Scene1 indicated that 20 participants, 30 % of the total participants evaluated warm lighting as very good to good lighting. In Scene 2, 36 responses (55 % of participants' responses) considered warm lighting as good to very good lighting. Moreover, in Scene 3, 34 responses (52% of the total replies) considered warm lighting as good lighting. In Scene 4, 20 participants (30% of the total responses) evaluated cool lighting as poor to very poor lighting in relation to warm lighting. This is represented graphically in Figure 4.7.

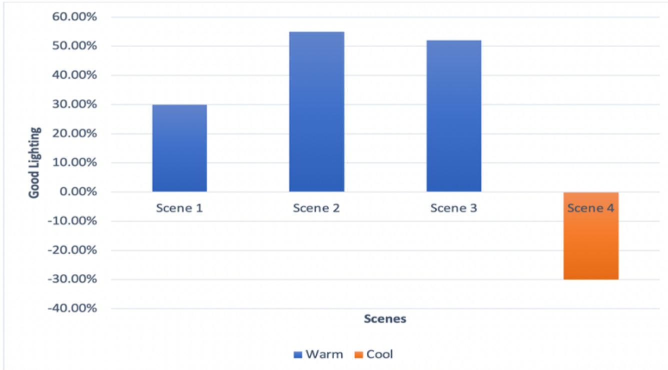


Figure 4.7. Results of Chi-Square Test (Scene 1,2,3, & 4) on Participants' Perception Between Good/poor Lighting and Warm/Cool Lighting (Source: author)

4.3.2.2.9. Scenes 1,2,3 and 4 (Good/Poor Lighting Verses Evenly Lit/ Targeted lighting)

The relationship between Good/Poor Lighting and Evenly Lit/Targeted Lighting is meant to be a significant relationship among the four Scenes. Scene 1, X2 (1, N = 66) = 37.373, P = 0.000, Scene 2, X2 (1, N = 66) = 63.107[a], P = 0.000, Scene 3, X2 (1, N = 66) = 52.194, P = 0.000 and Scene 4, X2 (1, N = 66) = 73.564, P = 0.000 (See Appendix 3). According to participants' responses in Scene1, 38 participants (57.5 % of the total participants) evaluated Evenly Lit lighting as very good to good lighting. Moreover, in Scene 2, 42 participants (63% of responses) considered evenly lit as good to very good. While in Scene 3, 22 responses (33 % of the participants' total responses) evaluated targeted lighting as poor to very poor lighting. In Scene 4, 35 responses (53% of the total responses) evaluated evenly lit as poor to very poor lighting to targeted lighting. This is represented graphically in Figure 4.8.

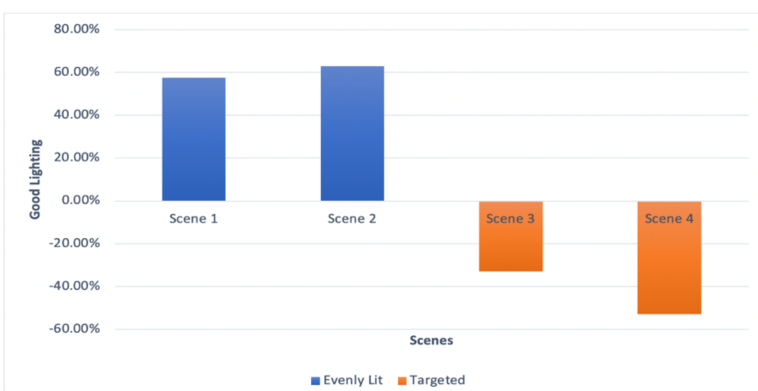


Figure 4.8. Results of Chi-Square Test (Scene 1,2,3 & 4) on Participants' Perception Between Good/poor Lighting and Targeted/Well Lit Lighting (Source: author).

4.3.2.2.10. Scenes 1,2,3 and 4 (Good/Poor Lighting Verses Colourful / Neutral lighting)

The relationship between Good/Poor Lighting and Colourful/Neutral Lighting is meant to be a significant relationship, Scene 1, X2 (1, N = 66) = 21.774, P = 0.040, Scene 2, X2 (1, N = 66) = 58.143, P = 0.000, Scene 3, X2 (1, N = 66) = 52.093, P = 0.000 and Scene 4, X2 (1, N = 66) = 56.387, P = 0.000 (See Appendix 3).

Participants responded to neutral lighting in Scene 1 as good lighting by 12 participants,18% of the total responses. In Scene 2, 30% considered neutral lighting as good to very good lighting. In addition, in Scene 3, 33% considered neutral lighting as good lighting, unlike colourful lighting. In Scene 4, Colourful to very colourful was considered as poor to very poor lighting which was indicated by 55 % of the responses. This is represented graphically in Figure 4.9.

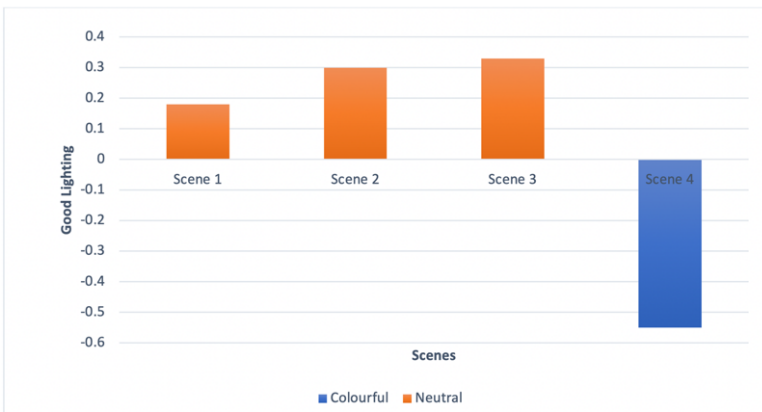


Figure 4.9. Results of Chi-Square Test (Scene 1,2,3 & 4) on Participants' Perception Between Good/poor Lighting and Colourful/Neutral Lighting (Source: author)

4.3.2.2.11. Scenes 1,2,3 and 4 (Pleasing/Depressing Emotional Item Verses Uniform/ Differentiated lighting)

The relationship between Pleasing / Depressing emotional item and Uniform/Differentiated Lighting was meant to be a significant relationship. Scene1, X2 (1, N = 66) = 16.481a, P = 0.036, Scene 2, X2 (1, N = 66) = 18.699, P = 0.028, Scene 3, X2 (1, N = 66) = 64.873, P = 0.000 and Scene 4, X2 (1, N = 66) = 65.718, P = 0.000 (See Appendix 3). According to the results that is generated after carrying out the chi square test. Uniform Lighting in Scene 1 has a more pleasing effect than differentiated lighting as indicated by 22 participants, 33% of the total of participants. In Scene 2, 22% considered uniform lighting as pleasing. In Scene3, 33 % considered differentiated lighting as depressing to very depressing lighting. In Scene 4, 21% responded that differentiated lighting is depressing to very depressing. This is represented graphically in Figure 4.10.

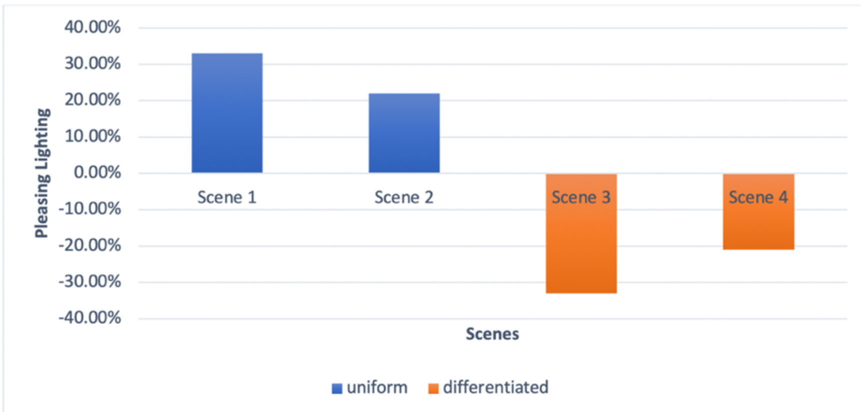


Figure 4.10. Results of Chi-Square Test (Scene 1,2,3 & 4) on Participants' Perception Between Pleasing/Depressing and Uniform/ Differentiated Lighting (Source: author)

4.3.2.2.12. Scenes 1,2,3 and 4 (Pleasing/Depressing Lighting Verses Bright/ Dark lighting)

The relationship between Pleasing / Depressing Lighting and Bright /Dark Lighting is meant to be a significant relationship. Scene 1, X2 (1, N = 66) = 13.750, P = 0. 033, Scene 2, X2 (1, N = 66) = 68.263, P = .033, Scene 3, X2 (1, N = 66) = 48.277, P = 0.000 and Scene 4, X2 (1, N = 66) = 61.921, P = 0.000 (See Appendix 3).

After carrying out the chi square test, in Scene 1, 34 participants responded to bright lighting as very pleasing to pleasing (52 % of the total of participants' responses). In Scene 2, 66 % of responses considered bright lighting as pleasing. While in Scene 3, 22 % of participants' responses considered the dark atmosphere generated by lighting as a depressing one. In Scene 4, 51% of responses considered lighting as pleasing to very pleasing in terms of brightness. This is represented graphically in Figure 4.11.

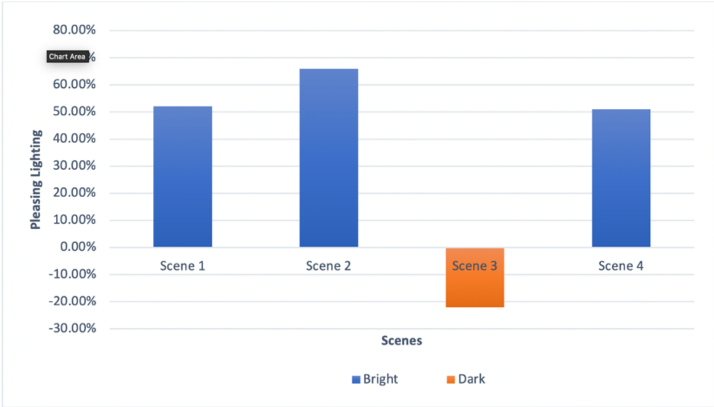


Figure 4.11. Results of Chi-Square Test (Scene 1,2,3 & 4) on Participants' Perception Between Pleasing/Depressing Lighting and Bright/Dark Lighting (Source: author)

4.3.2.2.13. Scenes 1,2,3 and 4 (Pleasing/Depressing Lighting Verses Warm/Cool lighting)

The relationship between Pleasing / Depressing Lighting and Warm /Cool Lighting is meant to be a significant relationship, X2 (1, N = 66) = 18.774, P = 0.016, Scene 2, X2 (1, N = 66) = 40.400, P = .000, Scene 3, X2 (1, N = 66) = 83.490, P = 0.000 and Scene 4, X2 (1, N = 66) = 61.267, P = 0.000 (See Appendix 3).The test indicated that in Scene 1, Warm to very Warm Lighting was considered as very pleasing to pleasing, as a result of the responses of 24 participants (36% of the total number of participants). In Scene 2, 36 participants (54% of responses) considered warm lighting as pleasing to very pleasing. In Scene 3, 42% of participants considered Warm lighting as pleasing to very pleasing. In Scene 4, 30% of participants responded that cool lighting is considered depressing. This is represented graphically in Figure 4.12.

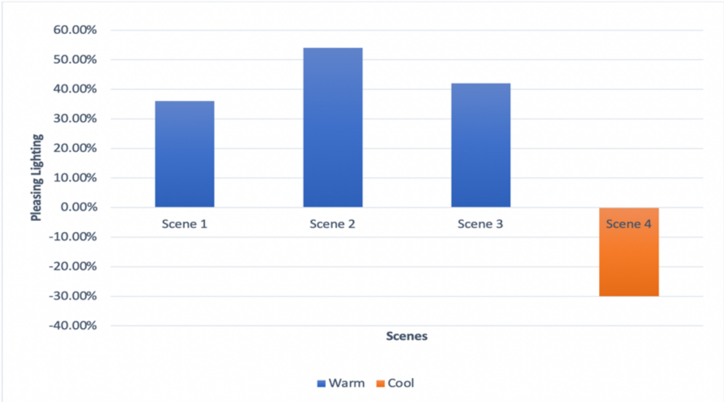


Figure 4.12. Results of Chi-Square Test (Scene 1,2,3 & 4) on Participants' Perception Between Pleasing/Depressing Lighting and Warm/Cool Lighting (Source: author)

4.3.2.2.14. Scenes 1,2,3 and 4 (Pleasing/Depressing Lighting Verses Diffused/Contrast lighting)

Among all Scenes there is a significant relationship between Pleasing / Depressing Lighting and Diffused/Contrast Lighting, X2 (1, N = 66) =19.994, P = .010, Scene 2, X2 (1, N = 66) =74.700, P = .000, Scene 3, X2 (1, N = 66) =67.595, P = .000, Scene 4, X2 (1, N = 66) =74.250, P = .000 (See Appendix 3).

According to the analysis of participants' responses of Scene 1, it showed that very diffused and diffused lighting was considered to be more pleasing than contrast lighting by 22 participants, 33 % of the total participants. In Scene 2, 39% considered diffused lighting as more pleasing than contrast lighting. In Scene 3, about 42 % considered contrast lighting as depressing. In Scene 4, 30% considered contrast lighting as depressing. This is represented graphically in Figure 4.13.

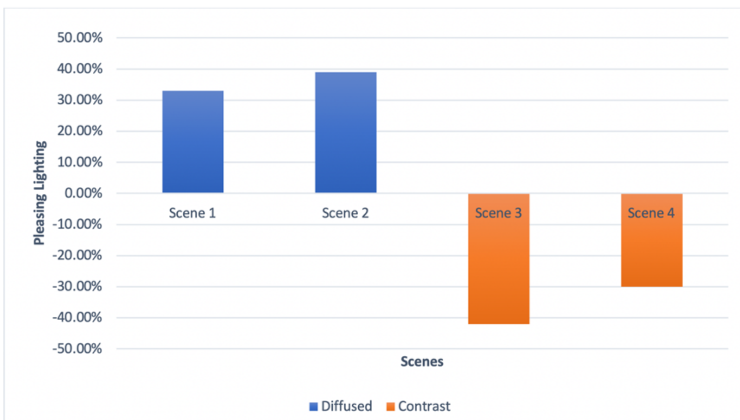


Figure 4.13. Results of Chi-Square Test (Scene 1,2,3 & 4) on Participants' Perception Between Pleasing/Depressing Lighting and Diffused/Contrast Lighting (Source: author)

4.3.2.2.15. Scenes 1,2,3,4 (Pleasing/Depressing Lighting Verses Evenly Lit/Targeted/ lighting)

There is a significant relationship between Pleasing / Depressing Lighting and Evenly Lit/Targeted Lighting among all Scenes as Scene 1, X2 (1, N = 66) =24.649, P = 0.002, Scene 2, X2 (1, N = 66) =77.787, P = 0.000, Scene 3, X2 (1, N = 66) =59.930, P = 0.000, Scene 4, X2 (1, N = 66) =69.208, P = 0.000. (See Appendix 3).

In Scene 1, Evenly Lit lighting was perceived as more pleasing to 36 participants, 55 % of the total participants and no responses indicated that evenly lit lighting is considered depressing. In Scene 2, 63%of responses indicated that evenly lit was more pleasing. While in Scene 3, 42% of participants perceived targeted lighting as depressing. In Scene 4, 51 % of participants' responses indicated that targeted lighting gives a depressing mood. This is represented graphically in Figure 4.14.

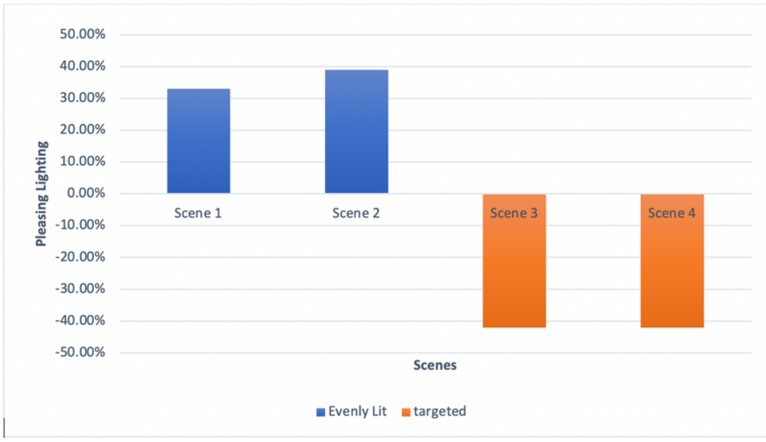


Figure 4.14. Results of Chi-Square Test (Scene 1,2,3 & 4) on Participants' Perception Between Pleasing/Depressing Lighting and Evenly Lit/Targeted Lighting (Source: author)

4.3.2.2.16. Scenes 1,2,3 & 4 (Pleasing/Depressing Lighting Verses Colourful/Neutral lighting)

There is a significant relationship between Pleasing / Depressing Lighting and Colourful/Neutral Lighting, X2 (1, N = 66) =26.845, P = 0.001, Scene 2, X2 (1, N = 66) =71.707, P = 0.000, Scene 3, X2 (1, N = 66) =52.470, P = 0.000, Scene4, X2 (1, N = 66) =69.184, P = 0.000. (See Appendix 3)

In Scene 1, it was concluded that neutral lighting that is not too colourful and not too neutral was considered more pleasing by 16 participants. Moreover, 12 participants considered colourful lighting as pleasing to very pleasing than very colourful lighting or very pale lighting. In Scene 2, 30 % of replies indicated that neutral lighting was less pleasing. In Scene 3, 42% of participants perceived neutral as depressing. While in Scene 4, 51 % of responses indicated that colourful lighting was perceived as more pleasing. This is represented graphically in Figure 4.15.

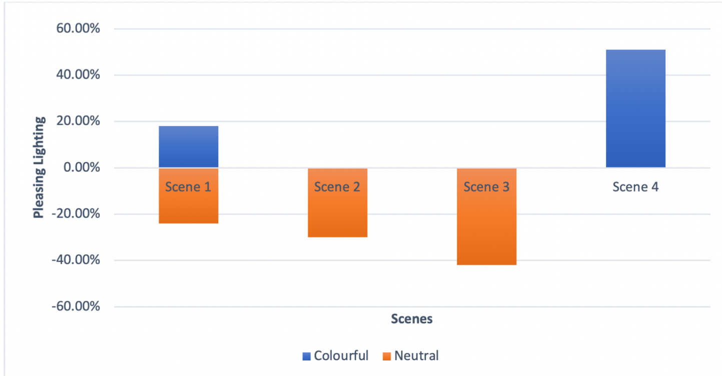


Figure 4.15. Results of Chi-Square Test (Scene 1,2,3 &4) on Participants' Perception Between Pleasing/Depressing Lighting and Colourful/Neutral Lighting (Source: author)

4.3.2.2.17. Scenes 1,2,3 and 4 (Satisfying/Dissatisfying Lighting Verses Uniform/ Differentiated lighting)

There is a significant relationship between Satisfying/Dissatisfying lighting and Uniform/ Differentiated Lighting, X2 (1, N = 66) =62.049, P = 0.000, Scene 2, X2 (1, N = 66) =20.150, P = 0.021, Scene 3, X2 (1, N = 66) = 77.970, P = 0.000, Scene 4, X2 (1, N = 66) =73.432, P = 0.000. (See Appendix 3).

In Scene 1, the relationship is meant to be statistically significant, 25 participants (38% of the total participants) perceived Uniform lighting as more satisfying. Moreover, in Scene 2, it was implied that Uniform lighting was more satisfying than differentiated lighting by 22 responses, 33 % of the total responses. In Scene 3, 42 % considered differentiated lighting as dissatisfying. In Scene 4, Differentiated Lighting was perceived as dissatisfying by 33% of participants. This is represented graphically in Figure 4.16.

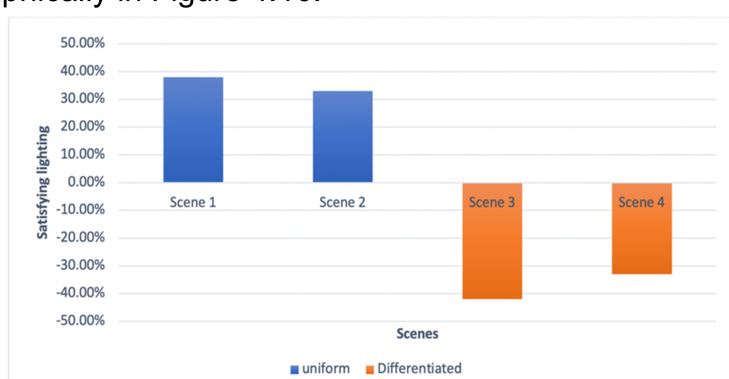


Figure 4.16.Results of Chi-Square Test (Scene 1,2,3 &4) on Participants' Perception Between Satisfying/ Dissatisfying Lighting and Uniform/Differentiated Lighting (Source: author)

4.3.2.2.18. Scenes 1,2,3 and 4 (Satisfying/Dissatisfying Lighting Verses Bright/ Dark lighting)

There is a significant relationship between Satisfying/Dissatisfying lighting and Bright/Dark Lighting in all Scenes, Scene 1, X2 (1, N = 66) =18.073, P = 0.013, Scene 2, X2 (1, N = 66) =64.433, P = 0.000, Scene 3, X2 (1, N = 66) =48.331, P = 0.000, Scene4, X2 (1, N = 66) =54.221, P = 0.000. (See Appendix 3).

The relationship between Satisfying/ Dissatisfying Lighting and Bright/Dark Lighting is statistically significant. In Scene 1, 32 participants perceived bright lighting as more satisfying, 48% of the total participants' responses. In Scene 2,66 % perceived bright lighting as satisfying. In Scene 3, 24 % considered very dark lighting as dissatisfying. In Scene 4, 51 % of participants were more satisfied with bright lighting. This is represented graphically in Figure 4.17.

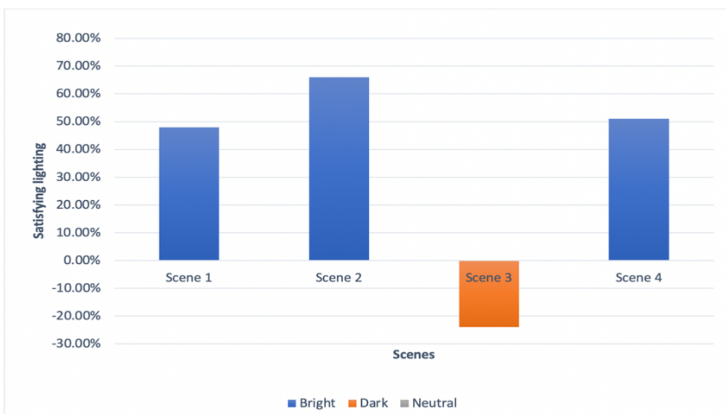


Figure 4.17. Results of Chi-Square Test (Scene1 ,2,3 & 4) on Participants' Perception Between Satisfying/ Dissatisfying Lighting and Bright/Dark Lighting (Source: author)

4.3.2.2.19. Scenes 1,2,3 and 4 (Satisfying/Dissatisfying Lighting Verses Warm/ Cool lighting)

There is a significant relationship between Satisfying/Dissatisfying lighting and Warm/Cool Lighting, X2 (1, N = 66) =46.009, P = 0.000, Scene 2, X2 (1, N = 66) =39.915, P = 0.000, Scene 3, X2 (1, N = 66) =79.381, P = 0.000, Scene 4, X2 (1, N = 66) =70.427, P = 0.000. (See Appendix 3).

The relationship between Satisfying/ Dissatisfying emotional items and Warm/Cool Lighting is statistically significant. The results showed that 20 participants perceived warm lighting as more satisfying, 30 % of the total participants. Moreover, Scene 2, implied that warm lighting was more satisfying than cool lighting by 36 participants, 55% of the total responses. In Scene 3, 42 %of participants' responses considered warm lighting as more satisfying than cool lighting. In Scene 4, Cool Lighting was perceived as dissatisfying by 22 participants, 33% of the total responses. This is represented graphically in Figure 4.18.

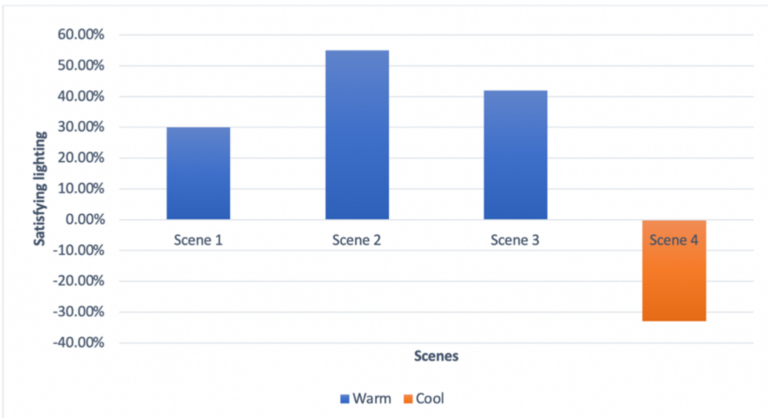


Figure 4.18. Results of Chi-Square Test (Scene 1,2,3 and 4) on Participants' Perception Between Satisfying/ Dissatisfying Lighting and Warm/Cool Lighting (Source: author)

4.3.2.2.20. Scenes 1,2,3 and 4 (Satisfying/Dissatisfying Lighting Verses Diffused/ Contrast lighting)

There is a significant relationship between Satisfying/ Dissatisfying Lighting and Diffused/Contrast Lighting among the four Scenes. Scene 1, X2 (1, N = 66) =34.190a, P = 0.005, Scene 2, X2 (1, N = 66) =81.429, P = 0.000, Scene 3, X2 (1, N = 66) =57.087, P = 0.000, Scene4, X2 (1, N = 66) =82.421, P = 0.00 (See Appendix 3).

The relationship between Satisfying/ Dissatisfying Lighting and diffused/ contrast Lighting is statistically significant. In Scene 1, 40 participants perceived diffused lighting as more satisfying (60% of the total participants). Furthermore, in Scene 2, 41 % perceived diffused lighting as satisfying. In Scene 3, 24 % considered contrasted lighting as dissatisfying. In Scene 4, 33 % were dissatisfied by the contrasted lighting. This is represented graphically in Figure 4.19.

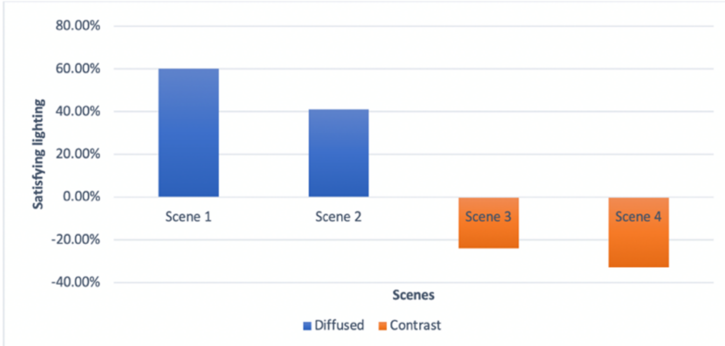


Figure 4.19 Results of Chi-Square Test (Scene 1,2,3 & 4) on Participants' Perception Between Satisfying/ Dissatisfying Lighting and Diffused/Contrast Lighting (Source: author)

4.3.2.2.21. Scenes 1,2,3 and 4 (Interesting/Boring Lighting Verses Uniform/Differentiated)

There is a significant relationship between Interesting/Boring Lighting and Uniform/Differentiated, Scene1, X2 (1, N = 66) = 40.863, P = 0.001, Scene 2, X2 (1, N = 66) =15.237, P = 0.029, Scene 3, X2 (1, N = 66) =85.800, P = 0.000, Scene4, X2 (1, N = 66) =61.292, P = 0.000. (See Appendix 3). The relationship between Interesting/ Boring Lighting and Uniform/Differentiated Lighting is statistically significant. In Scene 1, 40 participants perceived Uniform lighting as boring (60 % of the total participants). Additionally, in Scene 2, it was implied that uniform lighting was less interesting than differentiated lighting by 22 responses, 33% of the total responses. In Scene 3, 54 % considered differentiated lighting as more interesting than uniform lighting. In Scene 4, differentiated Lighting was perceived as interesting by 20 participants, 30% of the total responses of participants. This is represented graphically in Figure 4.20.

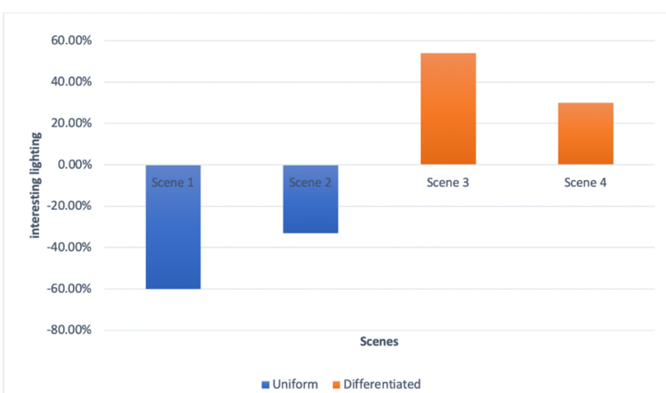


Figure 4.20. Results of Chi-Square Test (Scene 1,2,3 & 4) on Participants' Perception Between Interesting/Boring Lighting and Uniform/Differentiated Lighting (Source: author)

4.3.2.2.22. Scenes 1,2,3 and 4 (Interesting/Boring Lighting Verses Bright/Dark Lighting)

There is a significant relationship between Interesting/Boring Lighting and Bright/Dark. Scene 1, X2 (1, N = 66) = 24.390, P = 0. 018, Scene 2, X2 (1, N = 66) =61.521, P = 0.029, Scene 3, X2 (1, N = 66) =38.746, P = 0.000, Scene4, X2 (1, N = 66) =54.565, P = 0.000. (See Appendix 3).

There is a significant relationship between Interesting/Boring Lighting and Bright/Dark. In Scene 1, 45 % of participants perceived Bright lighting as more boring than Dark lighting. In Scene 2, 44 participants considered bright lighting as boring, 66 % of the total responses. In Scene 3, 27 % considered dark lighting as interesting while very dark was considered boring by 30 %. In Scene 4,55 % of participants' responses perceived very bright lighting as boring. This is represented graphically in Figure 4.21.

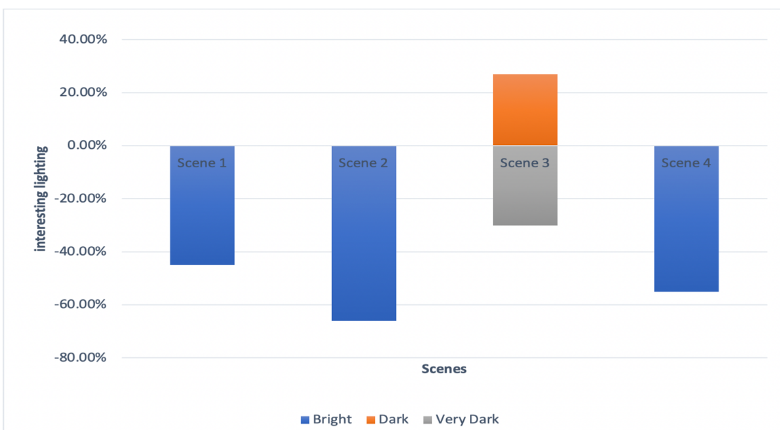


Figure 4.21. Results of Chi-Square Test (Scene 1,2,3 and 4) on Participants' Perception Between Interesting/Boring Lighting and Bright/Dark Lighting (Source: author)

There is a significant relationship between Interesting/Boring Lighting and Warm/Cool, Scene1, X2 (1, N = 66) = 41.494, P = 0.000, Scene 2, X2 (1, N = 66) =38.486, P = 0.029, Scene 3, X2 (1, N = 66) =75.756, P = 0.000, Scene4, X2 (1, N = 66) =81.233, P = 0.000. (See Appendix 3).

There is a significant relationship between Interesting/Boring Lighting and Warm/Cool as in Scene 1, 30 % of participants perceived warm lighting as more boring than Cool Lighting. In Scene 2, 48 participants responded to warm lighting as boring which is 72 % of the total responses. In Scene 3, 51 % considered warm lighting as less interesting than cool lighting while in Scene 4, 36 % perceived cool lighting as more interesting than having dark lighting. This is represented graphically in Figure 4.22.

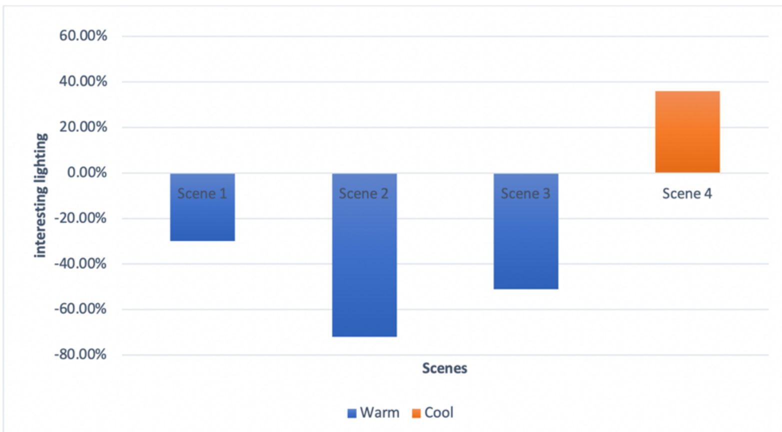


Figure 4.22. Results of Chi-Square Test (Scene 1,2,3 &4) on Participants' Perception Between Interesting/Boring Lighting and Warm/Cool Lighting (Source: author)

4.3.2.2.23. Scenes 1,2,3 and 4 (Interesting/Boring Lighting Verses Diffused/Contrast Lighting)

There is a significant relationship between Interesting/Boring Lighting and Diffused/Contrast, X2 (1, N = 66) = 49.851, P = 0.000, Scene 2, X2 (1, N = 66) =90.375, P = 0.000, Scene 3, X2 (1, N = 66) =82.830, P = 0.000, Scene4, X2 (1, N = 66) =82.343, P = 0.000. (See Appendix 3).

In Scene 1,30 % of participants perceived diffused lighting as less interesting than contrast lighting. In Scene 2, it was perceived by 39 % of participants that diffused lighting was less interesting than contrast lighting Moreover, in Scene 3, 24 participants considered contrast lighting as interesting (36 % of the total responses) and lastly in Scene 4, contrast lighting was considered interesting by 30 % of the total responses. This is represented graphically in Figure 4.23.

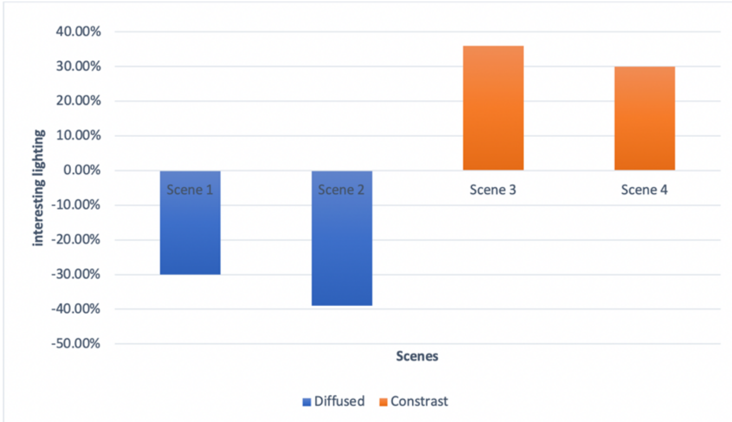


Figure 4.23. Results of Chi-Square Test (Scene 1,2,3 &4) on Participants' Perception Between Interesting/Boring Lighting and Diffused/Contrast Lighting (Source: author)

4.3.2.2.24. Scenes 1,2,3 and 4 (Interesting/Boring Lighting Verses Evenly Lit/ Targeted Lighting)

There is a significant relationship between Interesting/Boring Lighting and Evenly Lit/Targeted Lighting. Scene 1, X2 (1, N = 66) = 17.767, P = .038 Scene 2, X2 (1, N = 66) =61.564, P = 0.000, Scene 3, X2 (1, N = 66) =59.636, P = 0.000, Scene4, X2 (1, N = 66) =84.661, P = 0.000. (See Appendix 3).

In Scene 1, 26 participants, 39 % of the responses perceived evenly lit lighting as less interesting than targeted lighting. In Scene 2, 63 % considered evenly lit as boring. Furthermore, in Scene 3, Targeted lighting was considered interesting by 24 % of the total of participants' responses. In Scene 4, 55% perceived targeted lighting as being much more interesting than Evenly lit spaces. This is represented graphically in Figure 4.24.

Figure 4.24. Results of Chi-Square Test (Scene 1,2,3 &4) on Participants' Perception Between Interesting/Boring Lighting and Evenly Lit/Targeted Lighting (Source: author)

4.3.2.2.25. Scenes 1,2.3 and 4 (Interesting/Boring Lighting Verses Colourful/ Neutral Lighting)

There is a significant relationship between Interesting/Boring Lighting and Colourful/ Neutral. Scene 1, X2 (1, N = 66) = 29.167, P = .023, Scene 2, X2 (1, N = 66) =68.700, P = 0.000, Scene 3, X2 (1, N = 66) =44.633, P = 0.000, Scene4, X2 (1, N = 66) =56.387, P = 0.000. (See Appendix 3).

In Scene 1, 26 participants, 39 % of the responses perceived Neutral lighting as less interesting. In Scene 2, 30 % of participants considered Neutral lighting as boring. In Scene 3, neutral lighting was considered boring by 24 % of participants' responses. In Scene 4, 36 % perceived colourful lighting as more interesting than neutral lighting. This is represented graphically in Figure 4.25.

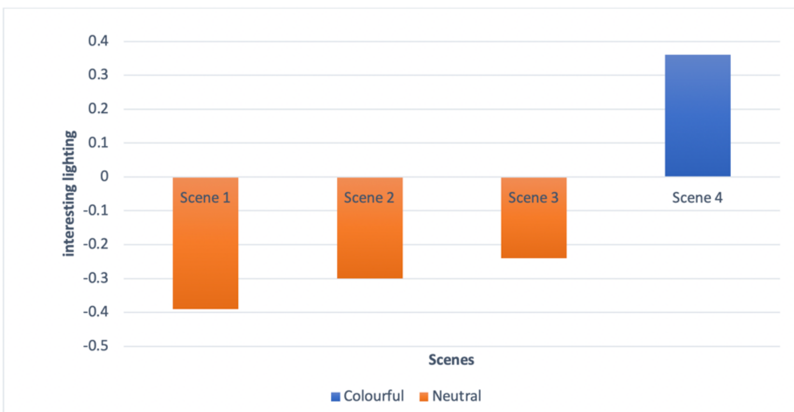


Figure 4.25. Results of Chi-Square Test (Scene 1,2,3 &4) on Participants' Perception Between Interesting/Boring Lighting and Colourful/Neutral Lighting (Source: author)

4.3.2.2.26. Scenes 1,2,3 and 4 (Spacious/Confined Lighting versus Uniform/differentiated Lighting)

There is a significant relationship between Spacious/ Confined Lighting and Uniform/differentiated, X2 (1, N = 66) = 30.919, P = .014, Scene 2, X2 (1, N = 66) = 19.745, P = 0.032, Scene 3, X2 (1, N = 66) =83.811, P = 0.000, Scene4, X2 (1, N = 66) = 70.230, P = 0.000. (See Appendix 3).

In Scenes 1,2, 3 & 4 the relationship between spacious/confined and uniform and differentiated lighting was statistically significant. In Scene 1, 33 % of participants perceived uniform lighting as more spacious than differentiated lighting. Moreover, in

Scene 2, 33 % of responses indicated that uniform lighting gave a more spacious atmosphere than differentiated lighting. In Scene 3, 52 % of responses perceived differentiated lighting as giving a confined impression. Finally, in Scene 4 differentiated lighting was perceived as confined by 33 % of the total responses. This is represented graphically in Figure 4.26.

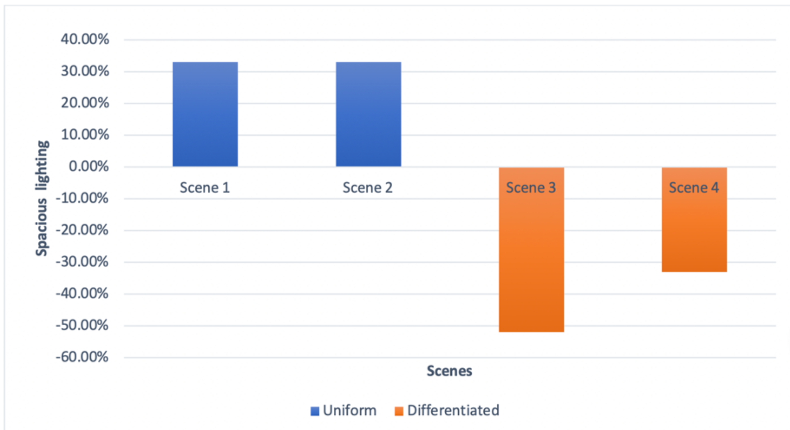


Figure 4.26. Results of Chi-Square Test (Scene 1,2,3 &4) on Participants' Perception Between Spacious/Confined Lighting versus Uniform/differentiated Lighting (Source: author)

4.3.2.2.27. Scenes 1,2,3 and 4 (Spacious/Confined Lighting versus Warm/ Cool Lighting)

There is a significant relationship between Spacious/ Confined Lighting and Uniform/differentiated, X2 (1, N = 66) = 32.882, P = .008, Scene 2, X2 (1, N = 66) = 45.783, P = 0.000, Scene 3, X2 (1, N = 66) = 95.003, P = 0.000, Scene4, X2 (1, N = 66) = 69.383, P = 0.000. (See Appendix 3).

In Scene 1, 33 % of responses denoted that warm lighting gave a spacious impression. In Scene 2, 55 % of participants indicated that warm lighting provided a spacious impression while cool lighting gave an impression of a confined atmosphere. In Scene 3, 51% indicated that warm lighting gave a more spacious impression while cool lighting gave a confined impression by 30 % of the responses. In Scene 4, 36 % of the responses of participants indicated that cool lighting gave a confined impression. This is represented graphically in Figure 4.27.

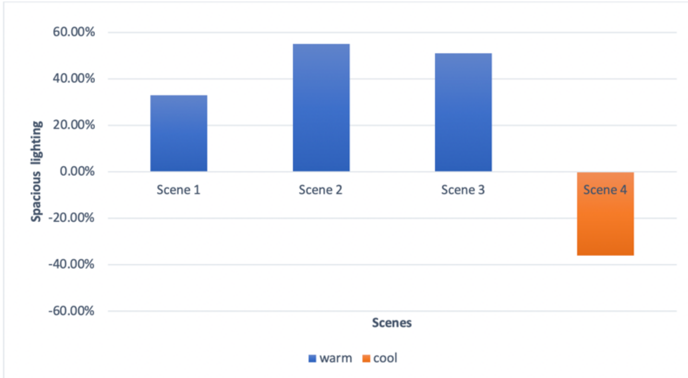


Figure 4.27. Results of Chi-Square Test (Scene 1,2,3 &4) on Participants' Perception Between Spacious/Confined Lighting versus warm/cool Lighting (Source: author).

4.3.2.2.28. Scenes 1,2,3 and 4 (Spacious/Confined Lighting versus Diffused /Contrast Lighting)

There is a significant relationship between Spacious/ Confined Lighting and Uniform/differentiated, X2 (1, N = 66) = 34.076, P = .005, Scene 2, X2 (1, N = 66) = 76.640, P = 0.000, Scene 3, X2 (1, N = 66) = 71.631, P = 0.000, Scene4, X2 (1, N = 66) = 74.444, P = 0.000. (See Appendix 3). In Scenes 1,2, 3 & 4 the relationship between spacious/confined and diffused/Contrast lighting was statistically significant. In Scene 1, 33 % of participants implied that diffused lighting provided a more spacious impression than contrast lighting. In Scene 2, 39 % of responses indicated that diffused lighting offered a more spacious impression than contrast lighting. In Scene 3, 36 % of responses implied that contrast lighting delivered a confined atmosphere. Finally, in Scene 4, 42 % of responses indicated that contrast lighting provided a confined impression of the space. This is represented graphically in Figure 4.28.

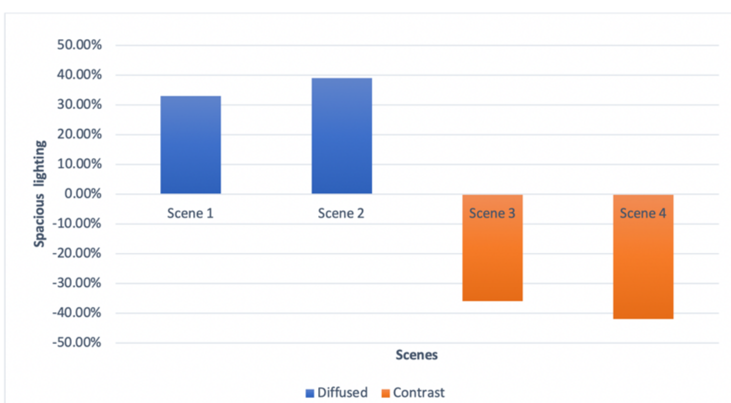


Figure 4.28. Results of Chi-Square Test (Scene 1,2,3 &4) on Participants' Perception Between Spacious/Confined Lighting versus Diffused/Contrast Lighting (Source: author)

4.3.2.2.29. Scenes 1,2,3 and 4 (Spacious/Confined Lighting versus Evenly Lit Targeted Lighting)

There is a significant relationship between Spacious/ Confined Lighting and Evenly Lit /Targeted, Scene 1, X2 (1, N = 66) = 38.084, P = .001, Scene 2, X2 (1, N = 66) = 110.673, P = 0.000, Scene 3, X2 (1, N = 66) = 55.550, P = 0.000, Scene4, X2 (1, N = 66) = 87.276, P = 0.000. (See Appendix 3).

In Scene 1, evenly lit lighting gave an impression of spaciousness as perceived by 51.5% of participants. In Scene 2, 64% of responses indicated that evenly lit lighting offered a spacious impression more than targeted lighting that delivered a confined impression. In Scene 3, 33% of responses implied that Targeted lighting provided a confined atmosphere than Evenly lit lighting. Additionally, in Scene 4, 54.5% of replies indicated that targeted lighting delivered a confined atmosphere. This is represented graphically in Figure 4.29.

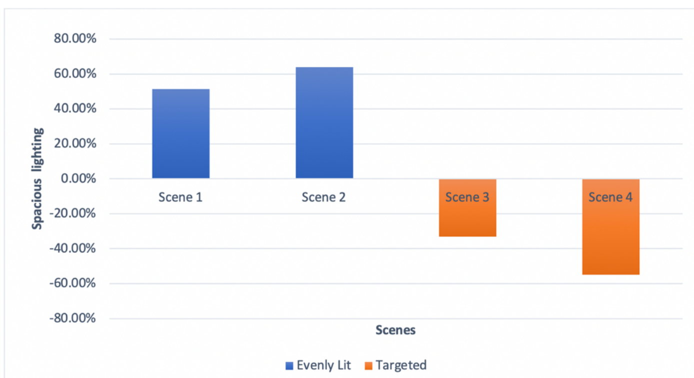


Figure 4.29. Results of Chi-Square Test (Scene 1,2,3 &4) on Participants' Perception Between Spacious/Confined Lighting versus Evenly Lit /Targeted Lighting (Source: author)

4.3.2.2.30. Scenes 1,2,3 and 4 (Spacious/Confined Lighting versus Colourful/ Neutral Lighting)

There is a significant relationship between Spacious/ Confined Lighting and Colourful/ Neutral, X2 (1, N = 66) = 58.145, P = .000, Scene 2, X2 (1, N = 66) = 81.472, P = 0.000, Scene 3, X2 (1, N = 66) = 63.160, P = 0.000, Scene4, X2 (1, N = 66) = 67.223, P = 0.000. (See Appendix 3).

It was concluded that in Scene 1, 21% of responses implied that Neutral lighting provided a spacious atmosphere. Additionally, in Scene 2, 30% of participants indicated that Neutral lighting gave a spaciousness sense of space. Moreover, in Scene 3, 30% of responses denoted that neutral lighting provided a spacious atmosphere while very neutral delivered a confined atmosphere as indicated by 33 % of responses. In Scene 4, 55% of responses indicated that colourful lighting delivered a confined atmosphere more than that of neutral lighting. This is represented graphically in Figure 4.30.

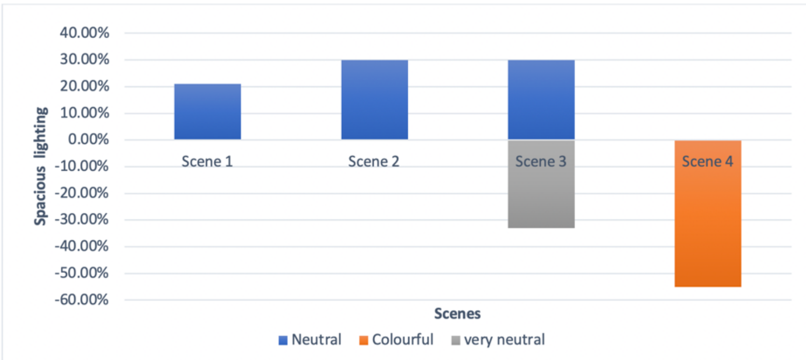


Figure 4.30. Results of Chi-Square Test (Scene 1,2,3 & 4) on Participants' Perception Between Spacious/Confined Lighting versus Colourful/ Neutral Lighting (Source: author)

4.3.2.2.31. Scenes 1,2,3 and 4 (Awake/Sleepy Lighting versus Uniform/ Differentiated Lighting)

There is a significant relationship between Awake/Sleepy Lighting and uniform/differentiated Lighting, Scene 1, X2 (1, N = 66) = 52.841, P = .000, but was not significant in Scene 2, X2 (1, N = 66) = 17.211, P = .372, but significant in Scene 3, X2 (1, N = 66) = 85.800, P = 0.000, and Scene4, X2 (1, N = 66) = 46.538, P = 0.000. (See Appendix 3).

It was spotted that in Scene1, 36% of participants' responses indicated that uniform lighting had a less awakening feeling than differentiated lighting. Moreover, in Scene 2, 30 % of participants' replies implied that uniform lighting delivered a sleepy atmosphere. In Scene 3, 30% indicated that differentiated lighting provided an awakening impression. In Scene 4, 24% of participants' responses indicated that differentiated lighting had more awakening feeling. This is represented graphically in Figure 4.31.

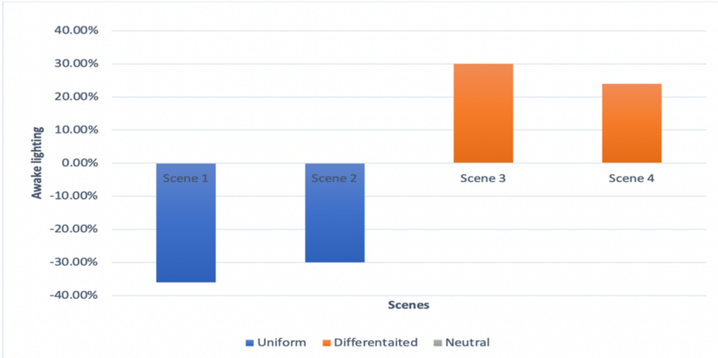


Figure 4.31. Results of Chi-Square Test (Scene 1,2,3 &4) on Participants' Perception Between Awake/Sleepy Lighting and uniform/differentiated Lighting (Source: author)

4.3.2.2.32. Scenes 1,2,3 and 4 (Awake/Sleepy Lighting versus Warm/Cool Lighting)

There is a significant relationship between Awake/Sleepy Lighting and Warm/Cool Lighting, X2 (1, N = 66) = 61.395, P = .000, Scene 2, X2 (1, N = 66) = 65.184, P = 0.000, Scene 3, X2 (1, N = 66) = 72.236, P = 0.000, Scene4, X2 (1, N = 66) = 50.397, P = 0.000. (See Appendix 3).

In Scene 1, it was indicated by 33 % of participants' responses that warm lighting provided a less awakening atmosphere than cool lighting. In Scene 2, 55 % of replies implied that warm lighting gave a sleepy atmosphere. Additionally, in Scene 3, 33 % of responses implied that warm lighting delivered a sleepy feeling than cool lighting. Furthermore, in Scene 4,36 % of participants' responses indicated that cool lighting brought an awakening atmosphere, unlike warm lighting. This is represented graphically in Figure 4.32.

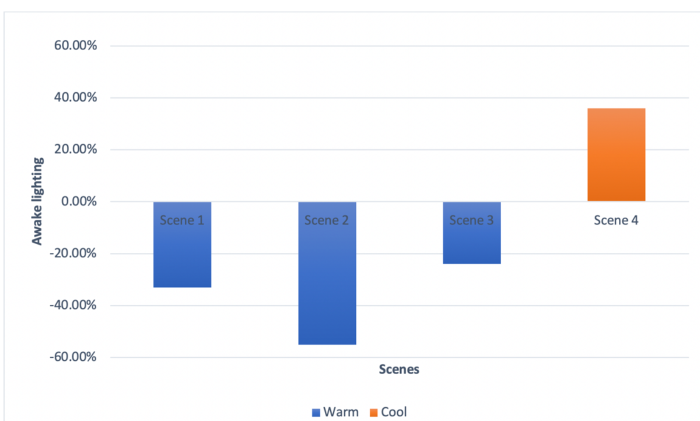


Figure 4.32. Results of Chi-Square Test (Scene 1,2,3 &4) on Participants' Perception Between Awake/Sleepy Lighting and Warm/Cool Lighting (Source: author)

4.3.2.2.33. Scenes 1,2,3 and 4 (Awake/Sleepy Lighting versus Diffused/Contrast Lighting)

There is a significant relationship between Awake/Sleepy Lighting and Diffused/Contrast Lighting, X2 (1, N = 66) = 38.952, P = 0.001. Scene 2, X2 (1, N = 66) = 81.837, P = 0.000, Scene 3, X2 (1, N = 66) = 66.137, P = 0.000, Scene4, X2 (1, N = 66) = 58.819, P = 0.000. (See Appendix 3).

In Scene 1, it was indicated by 22 participants, 33 % of the total responses that diffused lighting delivered a sleepy atmosphere, unlike contrast lighting. Moreover, in Scene 2, 40 % of participants' replies implied that diffused lighting brought a less awakening atmosphere than contrast lighting. Furthermore, in Scene 3, 42% of participants' replies indicated that contrast lighting was a lighting setting that gave a more awakening sense of space. In Scene 4, 50 % of responses indicated that contrast lighting offered a more stirring-up feeling than diffused lighting. This is represented graphically in Figure 4.33.

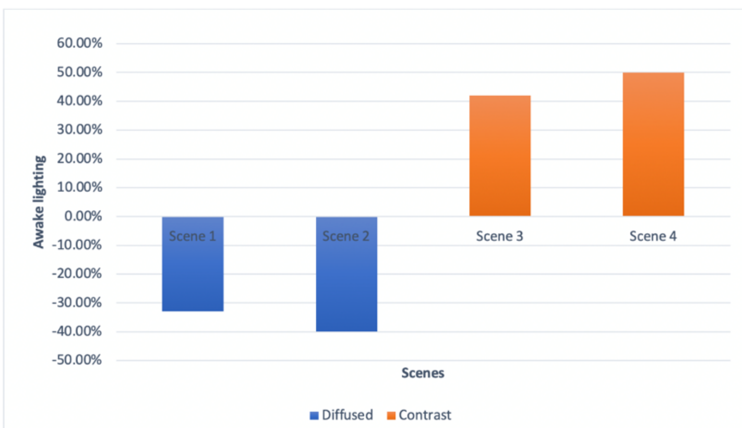


Figure 4.33. Results of Chi-Square Test (Scene 1,2,3 &4) on Participants' Perception Between Awake/Sleepy Diffused/Contrast Lighting (Source: author)

4.3.2.2.34. Scene 1,2,3 and 4 (Awake/Sleepy Lighting versus Colourful/Neutral Lighting)

There is a significant relationship between Awake/Sleepy Lighting and Colourful/Neutral Lighting, X2 (1, N = 66) = 35.604, P = 0.003. Scene 2, X2 (1, N = 66) = 65.286, P = 0.000, Scene 3, X2 (1, N = 66) = 81.400, P = 0.000, Scene4, X2 (1, N = 66) = 61.188, P = 0.000. (See Appendix 3).

The results showed that 33 participants, 45 % of the total responses implied that neutral lighting in Scene 1 had a sleepy atmosphere. Moreover, in Scene 2, 24 replies (36% of the total responses) considered Scene 2 as a neutral Scene that delivered a sleepy atmosphere. Furthermore, Scene 3 was considered a neutral lighting Scene. It was perceived as a sleepy Scene by 70% of the total replies. In Scene 4, 60 % of participants considered it as a colourful Scene that promoted a more awakening feeling than neutral lighting. This is represented graphically in Figure 4.34.

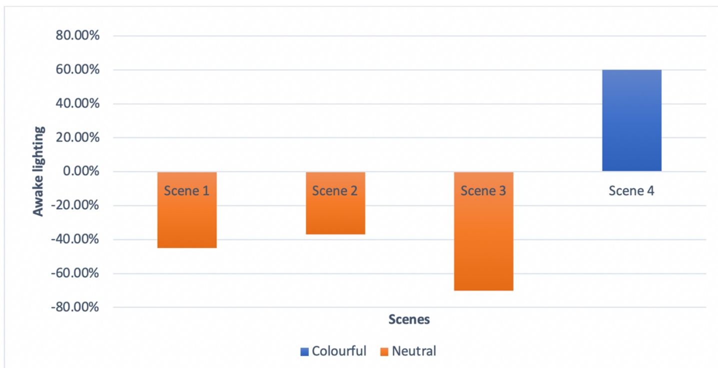


Figure 4.34. Results of Chi-Square Test (Scene 1,2,3 &4) on Participants' Perception Between Awake/Sleepy Colourful Neutral Lighting (Source: author)

4.3.2.2.35. Scenes 1,2,3 and 4 (Exciting/Calm Lighting versus Uniform /Differentiated Lighting)

There is a significant relationship between Exciting/Calm Lighting and Uniform /Differentiated Lighting), X2 (1, N = 66) = 32.628, P = 0.008. Scene 2, X2 (1, N = 66) = 29.133, P = 0.000, Scene 3, X2 (1, N = 66) = 69.300, P = 0.000, Scene4, X2 (1, N = 66) = 62.531, P = 0.000. (See Appendix 3).

The results indicated that in Scene 1, 20 participants (30 % of total responses) inferred that uniform lighting offered a more exciting atmosphere than contrast lighting that delivered a sleepy feeling as replied by 8 % of participants. In Scene 2, 12 % of replies implied that uniform lighting delivered an exciting atmosphere while 15 % indicated that differentiated lighting provided a calm atmosphere. In Scene 3, diffused lighting was perceived as more exciting by 30 %, and 27% considered it as a differentiated lighting Scene with a calm atmosphere. In Scene 4,33 % of responses indicated that differentiated lighting offered a more exciting ambiance than uniform lighting. This is represented graphically in Figure 4.35.

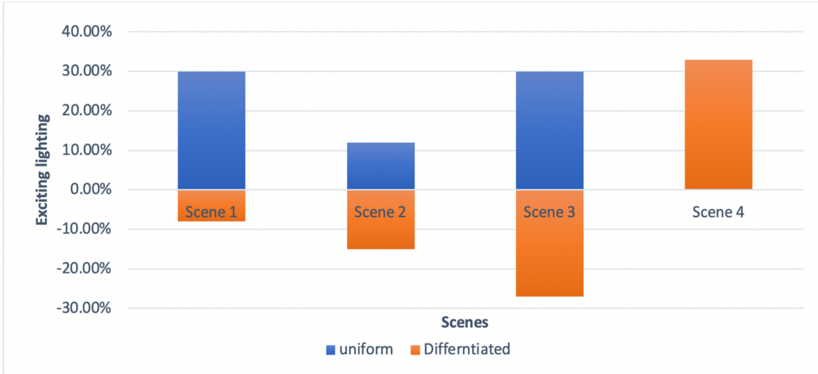


Figure 4.35. Results of Chi-Square Test (Scene 1,2,3 &4) on Participants' Perception Between Exciting/Calm Lighting and Uniform /Differentiated Lighting (Source: author)

4.3.2.3. Birmingham Museum Real Environment Analysis Results

Means and standard deviations of the sixteen semantic differential scales and the lighting colour, and distribution in the real environment of the Birmingham Museum in the UK were put in Table 4.9.

Table 4.9 Mean and Standard Deviation of the Emotional Scales in the Real Environment (Source: author)

EMOTIONAL SCALE		REAL ENVIRONMENT	
IMPRESSION (PAD) Pleasure, Arousal, Dominance		**MEAN**	**SD**
Good/Poor	(Pleasure)	2.7250	0.45220
Pleasing / Depressing	(Pleasure)	2.8500	0.53349
Satisfying / Disappointing	(Pleasure)	3.0250	0.86194
Interesting / Boring	(Pleasure)	3.4000	0.54538
Spacious/Confined	(Pleasure)	3.4750	0.67889
Awake / Sleepy	(Arousal)	3.4500	0.74936
Calm /Excited	(Arousal)	3.5750	0.74722
Interesting /Boring	(Arousal)	3.1000	0.37893
Controllable/ Controlling	(Dominance)	2.6500	0.73554
Uniform /Differentiated	(Lighting Description)	2.9000	0.59052

Bright /Dark	(Lighting Description)	2.8250	0.74722
Warm /Cool	(Lighting Description)	2.5500	0.50383
Diffused /Contrast lighting	(Lighting Description)	2.4500	0.59700
Evenly/Targeted lighting	(Lighting Description)	3.8500	0.83359
Colourful /Dull	(Lighting Description)	2.8500	0.53349
IDENTITY		**SD**	**SD**
Revisit / No Revisit		2.8250	0.71208
Recommend to others/ Don't recommend to others		3.0750	1.07148

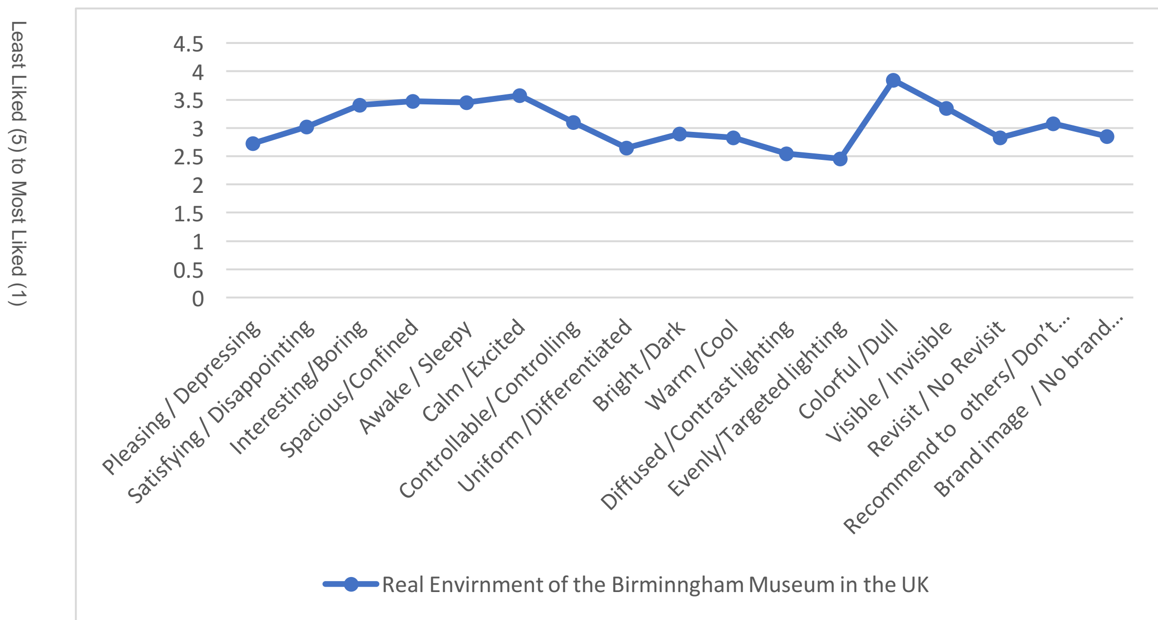


Figure 4.36. Graphical representation of the Real Environment in the Birmingham Museum in the UK. (Source: author)

Figure 4.36 shows graphically how respondents visually perceived the exhibition hall in terms of means and standard deviations. The results showed that visitors assessed the atmosphere generated by the lighting settings as neutral to almost all the emotional states. While for the lighting settings, the participants assessed the lighting settings of the exhibition hall as targeted lighting as Mean and SD have been given (3.8500 & 0.83359).

4.3.2.4. Birmingham Museum in the Virtual Environment Analysis.

For the Virtual Reality Experiment in the UK, 33 participants carried out the experiment, 10% of the participants were undergraduates and 90% were graduates. There were 27 males (80%) and 6 females (20%) among the participants and 65% of the participants' age range varies from 25-44 years old. About 12% of the participants had an architecture background and 88% came from other fields as (Business economics, Law, Chemical Engineering and Microbiology etc.) The total number of surveys for both virtual exhibition halls that took place in Egypt is 66 which was from 33 participants in Egypt and another 66 surveys were conducted from another 33 participants in the UK (33 participants for 4 simulated scenes for each exhibition in each of the two countries). Means and standard deviation were calculated as shown in Table 4.10.

Table 4.10 Means and Standard Deviations of the Emotional Scales in the VR Environment (Source: author)

EMOTIONAL SCALE	SCENE1 (DL)		SCENE 2 (AL) & (WW)		SCENE 3 (AG)		SCENE 4 Colour & (AP)	
IMPRESSION	MEAN	SD	MEAN	SD	MEAN	SD	MEAN	SD
Pleasing / Depressing	2.000	1.00000	2.0303	0.84723	2.3103	1.36548	2.4848	1.20211
Satisfying / Disappointing	2.0606	1.05887	1.8182	0.76871	1.8966	0.97632	2.6970	1.21153
Interesting/Boring	2.6061	1.22320	2.4242	1.03169	2.0690	1.16285	2.2424	1.25076
Spacious/Confined	2.3030	0.91804	1.7576	0.86712	2.6552	1.20344	2.6667	1.08012
Awake / Sleepy	2.2727	1.03901	2.0303	1.10354	2.6897	1.07250	2.0909	1.01130
Calm /Excited	2.5455	1.09233	2.4848	1.00378	2.6207	1.34732	2.2424	1.17341
Controllable/ Controlling	2.3939	0.99810	2.3030	1.04537	3.0345	1.40109	3.0606	1.32144
Uniform /Differentiated	2.1212	1.24392	2.0606	1.17099	2.8621	1.45710	3.5152	1.43878
Bright /Dark	1.9091	.94748	1.6667	0.88976	3.5862	1.29607	2.6061	1.17099
Warm /Cool	3.1212	1.21854	2.8485	1.12142	2.7586	1.24370	3.0000	1.19896
Diffused /Contrast lighting	2.6667	1.31498	2.6970	1.23705	3.2069	1.23576	2.8788	1.36376
Evenly/Targeted lighting	2.1818	0.91701	2.1515	1.03444	3.7586	1.27210	3.5152	1.52318
Colourful /Dull	3.3939	1.43482	3.3939	1.27327	2.8276	0.96618	1.4242	0.90244

4.3.2.5. Birmingham Museum in the UK (Real Environment Versus Virtual Reality)

The means did not vary significantly between the Real environment and the Virtual Reality. Means were all parallel for “Good/Poor”, “Depressing/Pleasing”, “Satisfying/Disappointing”, “Spacious /Confined”, “Sleepy /Awake”, “Calm /Excited”, “Controllable/ Controlling”, and the lighting settings as described “Uniform /Differentiated”, “Warm /Cool”, “Diffused /Contrast lighting”, “Evenly/Targeted lighting”, “Colourful /Dull” except for “Bright /Dark” which had higher means in the real environment. This similarity validates the use of virtual reality as a tool to evaluate the effect of the various lighting settings on people’s visual perception as if they are in the real environment. This is graphically presented in Figure 4.37.

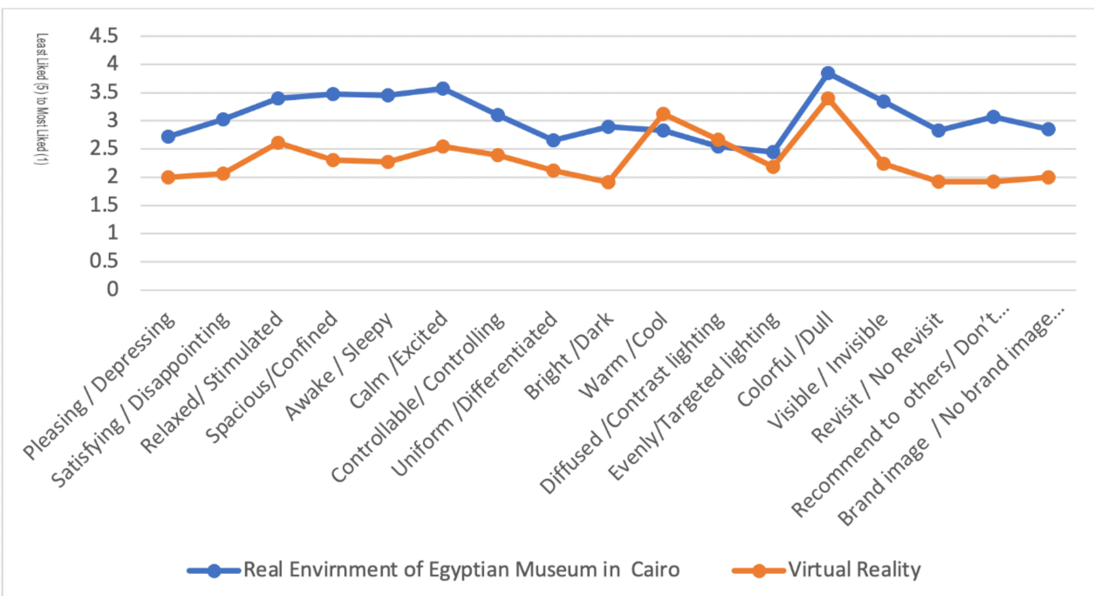


Figure 4.37. Graphical representation of the comparison between the Real Environment and the virtual Environment in the Birmingham Museum in the UK. (Source: author)

4.3.2.6. Analysis and Comparison of the four Scenes of the Birmingham Museum in the Virtual Environment

The scenes with different colour hues showed that the yellow-coloured scene was perceived to be more spacious, satisfying, and brighter than the cool-purplish coloured one. Scene 4(coloured &AP) has been perceived as more confined than Scene 2(WW& AL) which had a yellow-coloured atmosphere. This finding was similar to (Yildirim et al., 2007; Yildirim et al., 2012) had suggested before in their research.

Additionally, warm-white light in Scene 1 was more pleasing, satisfying, and brighter than Scene 4 that had a cool colour light. This was similar to the findings of (Hidayetoglu et al., 2012; Knez & Kers, 2000; Knez, 2001; Park & Farr, 2007) which indicates that warm white light is perceived as more positive than cool white light. This is graphically presented in Figure 4.38.

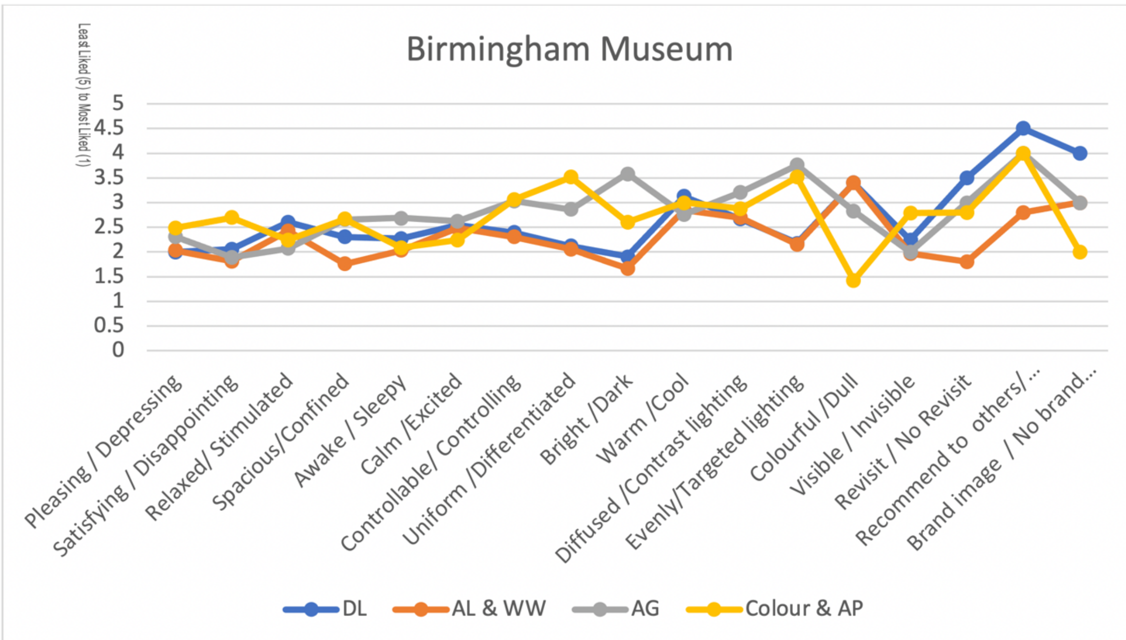
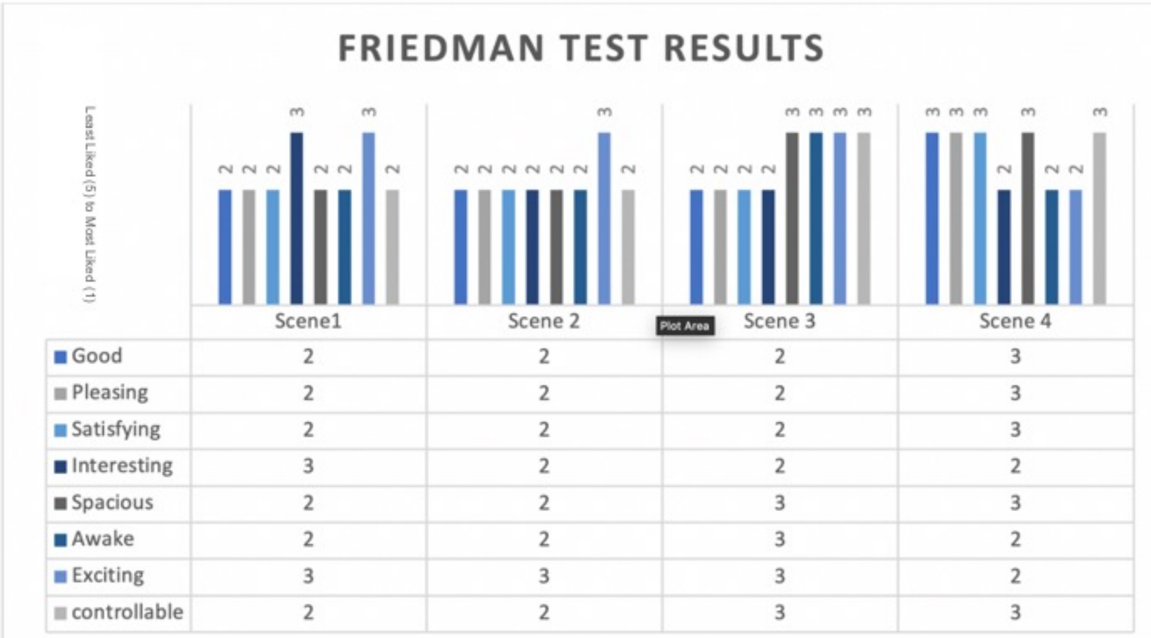


Figure 4.38. Graphical representation of the four Scenes in the Birmingham Museum in the UK in the Virtual Environment. (Source: author)

4.3.2.7. Friedman Test for the Birmingham Museum in the UK:

For proving the hypothesis which stated that the more the lighting characteristics of the exhibition spaces are diverse and thrilling, the better the exhibition space is perceived, a Friedman test was carried out with Bonferroni correction because a normal distribution was mainly not given. The Friedman test was carried out for the four scenes for each emotional item. The test indicated that there is a significant difference across the four scenes ((3, n=33) = 15.54, p < .001) for the **Good/Poor lighting**. By inspecting the median values Scenes 1, 2, and 3 were perceived as better (Md=2), while Scene 4 was perceived as worse (Md=3). The hypothesis was proved for **Pleasing/Unpleasing** emotional items as there is a significant difference ((3, n=33) = 8.005, p < .005). The median values were (Md=2) for Scenes1, 2, and

3, while the median value (Md=3) for Scene 4, indicated that this Scene is less pleasant than the other scenes. The hypothesis was accepted for **Satisfying/Dissatisfying** emotional items as there is a significant difference ((3, n=33) = 21.07, $p < .001$). The median value for Scene 4 (Md=3) indicates that it is less satisfying than the other three scenes that had a median value of 2 (Md=2). **Interesting/Boring** showed significant difference ((3, n=33) = 6.074, $p < .005$) and Scene 1 was considered less interesting with a median value of 3 (Md=3) unlike Scenes 2, 3 and 4 with a median value of 2 (Md=2). A significant difference existed for **Spacious/Confined** items ((3, n=33) = 34.415, $p < .001$), Scenes 1 and 2 had a median value of 2 (Md=2), while Scenes 3 and 4 had a median value of 3 (md=3) which indicates that Scenes 1 and 2 were perceived as more spacious than Scenes 3 and 4. For Awake/Sleepy, there was a significant difference across the scenes, ((3, n=33) = 20.063, $p < .001$), the median value for Scenes 1, 2, and 4 is 2 (Md=2) which showed that Scene 3 is considered a less awaking Scene with a median of 3 (Md=3). Significant differences occurred for **Exciting/Calm** ((3, n=33) = 12.179, $p < .005$); Scene 4 was considered more exciting with a median value of 2 (Md=2) while Scenes 1, 2, and 3 turned out to be less exciting with a median of 3 (Md=3). This analysis confirmed that comparing different lighting settings in the 4 scenes for the same exhibition hall significantly affects multiple emotional items which agree with the research hypothesis. The results were graphically presented in Figure 4.39.



	Scene1	Scene 2	Scene 3	Scene 4
Good	2	2	2	3
Pleasing	2	2	2	3
Satisfying	2	2	2	3
Interesting	3	2	2	2
Spacious	2	2	3	3
Awake	2	2	3	2
Exciting	3	3	3	2
controllable	2	2	3	3

Figure 4.39. Friedman Results for the Birmingham Museum in the UK (Source: author)

4.3.2.8. Mann-Whitney Test to compare between the same simulated Scene in both Museums

This test was conducted to address the question, Q6; Does the difference in the exhibition's room dimensions and areas while having the same lighting settings have a different impact on people's visual perception of the space in terms of lighting?

4.3.2.8.1. Scene1 Egyptian Museum in Cairo and Scene1 Birmingham Museum in the UK

According to the significance level that the test indicated as shown in Table 4.11, there is no significant difference in the emotional levels scores of Scene 1 in the Egyptian Museum in Cairo and Scene 1 in the Birmingham Museum in UK. Both Scenes had the same lighting settings and delivered the same lighting visual message to participants although they are of different sizes and have a different organization of displays. Thus, the exhibition's areas and dimensions do not affect how visitors visually perceive the exhibition's lighting settings.

Table 4.11 Mann-Whitney U Test (3) (Source: author)

Test Statistics								
Emotional Items	Good Poor.	Pleasing. Depressing	Satisfying. Dissatisfying.	Interesting boring	Spacious. confined	Awake sleepy	Exciting Calm	Controllable. Controlling
Mann-Whitney U	502.000	486.500	490.000	521.500	499.500	522.00	456.000	472.500
Wilcoxon W	1063.00	1047.500	1051.000	1082.500	1060.500	1083.0	1017.00	1033.500
Z	-.571	-.788	-.732	-.304	-.604	-.302	-1.174	-.965
Asymp. Sig. (2-tailed)	.568	.431	.464	.761	.546	.762	.240	.334

As for the lighting settings in Scene 1 in Birmingham Museum in the UK and the Egyptian Museum in Cairo, they were both perceived similarly by participants in terms of the description of the lighting settings. As shown in Table 4.12, the significance level is not less than or equal to 0.05, consequently, the result is not statistically significant which indicated that there are no differences in people's scores regarding the lighting settings for both Scenes. Both exhibitions were perceived visually the same although they were of different dimensions and areas.

Table 4.12 Results of Mann-Whitney (4) (Source: author)

Lighting Characteristics	Uniform. Differentiated	Bright Dark	Warm Cool.	Diffused Contrast	Evenly Lit. Targeted.	Colourful. Neutral
Mann-Whitney U	419.000	475.500	456.500	518.500	523.000	520.000
Wilcoxon W	980.000	1036.500	1017.500	1079.500	1084.000	1081.000
Z	-1.665	-.933	-1.163	-.343	-.288	-.323
Asymp. Sig. (2-tailed)	.096	.351	.245	.731	.773	.746

4.3.2.8.2. Scene 2 Egyptian Museum in Cairo and Scene 2 Birmingham Museum in the UK

As shown in Table 4.13, there was also no significant difference between the participants' responses regarding the emotional scale in both museums in Scene 2, as the degree of significance was more than 0.05. Both Scenes had the same lighting settings and were visually perceived similarly by participants although they are of different areas and dimensions. The same case is in Scene 1 for both museums.

Table 4.13 Mann-Whitney u Test (5) (Source: author)

Test Statistics

Emotional Items	Good Poor.	Pleasing. Depressing	Satisfying. Dissatisfying.	Interesting. boring	Spacious. confined	Awake. sleepy.	Exciting Calm	Controllable. Controlling
Mann-Whitney U	471.000	472.500	515.500	401.500	422.000	459.000	520.000	490.500
Wilcoxon W	999.000	1000.500	1043.500	929.500	983.000	1020.000	1048.000	1018.500
Z	-.798	-.778	-.176	-1.734	-1.479	-.955	-.109	-.519
Asymp. Sig. (2-tailed)	.425	.437	.860	.083	.139	.339	.913	.604

The lighting settings in both museums for Scene 2 were almost identical as there was no major difference in the responses of people to the lighting settings in both museums (The Birmingham Museum in the UK and the Egyptian Museum in Cairo) as shown in Table 4.14.

Table 4.14 Mann-Whitney U Test (6) (Source: author)

Lighting Characteristics	Uniform. Differentiated	Bright Dark	Warm Cool.	Diffused Contrast	Evenly Lit. Targeted.	Colourful. Neutral
Mann-Whitney U	406.500	367.000	415.500	496.000	508.000	410.500
Wilcoxon W	967.500	928.000	943.500	1057.000	1069.000	938.500
Z	-1.657	-2.255	-1.543	-.435	-.276	-1.601
Asymp. Sig. (2-tailed)	.098	.024	.123	.664	.783	.109

4.3.2.8.3. Scene 3 Egyptian Museum in Cairo and Scene 3 Birmingham Museum in the UK

For Scene 3, the findings were similar and there is no substantial difference between the responses of participants regarding their emotional states to the lighting settings that address the question; if there are exhibition rooms of different dimensions, areas, and organization of displays but they have the same lighting settings, will they deliver a similar experience to visitors regarding the perception of the lighting settings. The answer is yes according to Man Whitney U test as shown in Table 4.15. The same case is in Scenes 1 and 2 for both museums.

Table 4.15 Results of Mann-Whitney U Test (7) (Source: author)

Test Statistics

Emotional Items	Good Poor.	Pleasing. Depressing.	Satisfying Dissatisfying.	Interesting boring.	Spacious confined	Awake sleepy.	Exciting calm	Controllable Controlling
Mann-Whitney U	432.500	458.000	397.000	492.500	534.500	376.000	392.000	534.500
Wilcoxon W	993.500	1019.000	958.000	1053.500	1095.500	937.000	953.000	1095.500
Z	-1.486	-1.145	-1.969	-.695	-.131	-2.222	-2.009	-.131
Asymp. Sig. (2-tailed)	.137	.252	.049	.487	.895	.026	.045	.896

Lighting was also perceived as similar for both Scenes as shown in table (4.16). There is no significant difference in participants' responses regarding how they perceived the lighting inside the exhibition halls in Scene 3.

Table 4.16 Results of Mann-Whitney U Test (8) (Source: author)

Lighting Characteristics	Uniform. Differentiated	Bright Dark	Warm Cool.	Diffused Contrast	Evenly Lit. targeted.	Colourful. neutral
Mann-Whitney U	450.000	510.000	474.500	529.500	514.000	342.500
Wilcoxon W	1011.000	1071.000	1035.500	1090.500	1075.000	903.500
Z	-1.243	-.463	-.921	-.198	-.413	-2.692
Asymp. Sig. (2-tailed)	.214	.644	.357	.843	.679	.007

4.3.2.8.4. Scene 4 Egyptian Museum in Cairo and Scene 4 Birmingham Museum in the UK

Mann- Whitney U test indicated no significant difference in participants' responses with regards to their emotional scores in Scene 4 in both museums. As shown in Table 4.17 the p value is not less than or equal to 0.05, so the result is not significant. There is no statistical difference in the emotional scores of Scene 4 in the Birmingham Museum in the UK and the Egyptian Museum in Cairo. The same case is in Scenes 1, 2, and 3 for both museums.

Table 4.17 Results Mann-Whitney U Test (9) (Source: author)

Test Statistics

Emotional Items	Good Poor.	Pleasing. Depressing.	Satisfying Dissatisfying.	Interesting boring.	Spacious confined	Awake sleepy.	Exciting calm	Controllable Controlling
Mann-Whitney U	513.000	515.500	536.000	472.500	537.000	488.500	516.000	539.500
Wilcoxon W	1074.000	1076.500	1097.000	1033.500	1098.000	1049.500	1077.000	1100.500
Z	-.415	-.382	-.112	-.958	-.099	-.757	-.379	-.066
Asymp. Sig. (2-tailed)	.678	.702	.911	.338	.921	.449	.704	.948

According to the test conducted there is no significant difference in people's scores regarding how they perceive the lighting settings in both museums for Scene 4 as shown in Table 4.18, which indicated that the lighting settings succeeded in delivering the same lighting atmosphere across the Scenes for both museums.

Table 4.18 Results of Mann-Whitney U Test (10) (Source: author)

Lighting Characteristics	Uniform. Differentiated	Bright Dark	Warm Cool.	Diffused Contrast	Evenly Lit. Targeted.	Colourful. Neutral
Mann-Whitney U	506.000	345.000	501.000	540.500	333.000	442.000
Wilcoxon W	1067.000	906.000	1062.000	1101.500	894.000	1003.000
Z	-.508	-2.658	-.571	-.052	-2.778	-1.573
Asymp. Sig. (2-tailed)	.612	.008	.568	.958	.005	.116

The present study investigated the impact of lighting variations on people across different cultures (Western and Middle Eastern) by conducting the survey in Egypt and the United Kingdom. Inferential analysis methods were used to understand the relationship between the lighting settings and culture. This approach revealed no significant difference across the two cultures when applying a comparative evaluation of the four lighting scenes for two museums located in two different cultural environments. Participants from different cultural backgrounds, one from an Eastern Culture (Egypt), and the other from a Western Culture (UK) were surveyed about their visual perception of the four lighting scenes for both museums to allow for the exploration of the cultural aspect. However, Man-Whitney U inferential test showed no significant difference between the responses of the two culture samples.

4.4. Summary:

The experiment showed clear relationships between the different lighting conditions and the aesthetic impression indicators. This showed that the different lighting settings can actually change the visual appearance of displays and accordingly increases or decreases the visual appeal of the exhibition hall. In addition to, the willingness of visitors to return to the exhibition hall and repay it a visit. The results showed that the lighting aesthetics values were related to the visitor's level of satisfaction achieved from the lighting conditions. To sum up, since lighting contributes to the museum's overall image, it is important to invest in the lighting design and have a deep understanding of the lighting attributes as it plays an important role in communicating the correct message for a successful museum environment.

5. Chapter 5: Research Findings, Conclusions and Recommendations

The main aim of the research was to study the effect of light in exhibition design and branding practices. The motivation to study the impact of lighting on people's experience in museums emerged from the lack of previous literature that has explained and investigated this relationship. The conducted research aimed to contribute and fill this knowledge gap to help understand the impact of the lighting concepts on people's perception and their visual experience in the exhibition halls, and their willingness to return to the visited museum. One of this study's aims is to offer decision-makers of museums in lighting design, exhibition design, and marketing fields a clear understanding of people's lighting perceptions and resulting preferences. Moreover, the research has provided an insight into the relationship between the architectural spaces, lighting settings, and the brand image. This chapter presents a summary of the research's key findings, recommendations, and limitations for future studies.

5.1. Key Research Findings

In this study, a novel approach for collecting visitor's lighting preferences for exhibition halls was adopted by using Virtual Reality to simulate already existing exhibition halls in Egypt and the UK. Four different lighting scenes were developed to collect people's preferences towards each one of these scenes, and a (Lighting – Emotional Related) Matrix was developed. This virtual environment helped in delivering a similar environment to the actual museum and assisted in assessing visitors' impressions and their satisfaction preferences in relation to the lighting settings. Participants' preferences were collected and analysed by applying different statistical tests using SPSS, to help designers of exhibition halls in designing people-oriented spaces that satisfy their needs of the visit and encourage visitors to return. The results of the research approved the suggested hypothesis; that lighting can have an impact on the overall visual experience in exhibition halls and contributes positively to the museum's brand image. One of the main contributions of this thesis is studying lighting as a part of the overall exhibition environment and not on its own as it was studied in relation to the visitors' perception, satisfaction, and visual experience. This chapter includes the contribution to the knowledge of this research and a summary of the key findings. These findings are discussed in relation to the research objectives stated for this study to achieve the main aim of the thesis. The research key findings are as follows.

Firstly, the lighting arrangements and their effect on the different emotional states were discussed. To achieve the first research objective, a lighting matrix that includes all expected lighting combinations in museums, to satisfy different stakeholders' outcome needs of the museum's visit, was developed. The research developed a lighting matrix to facilitate the use of the different lighting combinations for a better visual experience in the exhibition halls for visitors. Furthermore, the developed matrix concluded that Pleasure levels were achieved in the scenes that had more of an evenly lit, uniform, and diffused lighting setting in terms of the lighting distribution aspect. These scenes provided high levels of happiness and satisfaction. This agrees with Cinai (2010), who added that when the lighting design is in harmony with the furniture and accessories, the environment is perceived as more pleasant. According to the research's experiment outcomes, it was inferred that the lighting distribution in the exhibition halls affected its spaciousness significantly.

Moreover, it was concluded that the uniform, diffused, and evenly lit lighting arrangements gave a sense of spaciousness unlike targeted or contrast lighting. This agrees with Custers et al. (2010) as they implied that although indirect lighting creates a sense of spaciousness, non-uniform lighting can lead to complexity and generates focal points of interest. This conclusion has achieved the research aim to develop an approach that increases the understanding of visitor's perceptions and responses to different lighting settings in exhibition spaces to help enhance future exhibition designs and have better exhibition lighting environments. This is considered a crucial piece of information that allows designers to have a lighting design that serves a specific purpose and takes the human factor into consideration. Additionally, an exhibition hall that is more concerned with spaciousness rather than having focal points of attractions should adopt the uniform, diffused type of lighting arrangement and vice versa. The research findings implied that the differentiated and targeted lighting arrangements were more interesting than the uniform and diffused lighting settings.

According to the research outcomes the differentiated, targeted, and contrast lighting settings had a more arousal effect. These lighting arrangements were more stirring up and awakening. Furthermore, targeted lighting and accent lighting provided a dominant effect as they were more controlling as in Scenes 3 and 4. However, Scenes 1 and 2 implied a controlled atmosphere due to the presence of the uniform and diffused lighting. This conclusion has met the research objective that was concerned with the assessment of the potential lighting design approaches and the enhancement of the presence of the human factor.

Secondly, the brightness or darkness of the lighting settings and their effect on visitors' emotional states are discussed. After the use of Virtual Reality, it was determined that the participants preferred significantly to have a bright environment more than a dark one to feel more satisfied, pleased, and awake. This agreed with the previous research by (Mahnke & Mahnke, 1987; Park & Farr, 2007) who inferred that bright light has an arousal effect, while dark atmosphere is more interesting. This notion could be adopted to imply a feeling of excitement when needed in the exhibition halls during the design phase. Furthermore, this met the objective of evaluating the use of virtual reality as a tool to assess the different lighting settings that have different patterns of lighting distribution, brightness, darkness, and colour in understating people's perceptions and impressions to help in developing a lighting approach that focuses on the shift from designing lighting spaces and displays to lighting people-centric places. This concept agreed with the previous research by Areni and Kim (1994), who indicated that visitors observe more displays and have a more pleasant mood under bright lighting, unlike soft lighting. Moreover, this also agreed with Markin et al. (1976), who recommended the use of soft lighting to reduce the level of stimulation and hence slow down the pace of people moving through the space to enjoy their experience. Additionally, to decide whether to use bright or dark lighting, the pace of visitors and level of stimulation needed inside the exhibition hall should be considered. According to Boyce's (1997) scientific theory, the amount of light is related to the level of arousal. The more lighting is available; the more arousal levels are present. In fact, arousal levels should be optimized to have a good lighting performance system as low levels of arousal and high levels could have a negative impact on the overall lighting performance.

Thirdly, the research developed four different lighting scenes using virtual reality. The experiment was set up in two different museums however same lighting settings were applied. This met the objective of exploring and comparing the same exhibition's atmosphere using different lighting settings and see how visitors perceive and respond to different kinds of lighting settings in the exhibition spaces. Furthermore, it was concluded that the use of warm or cool colours influenced the visual perception of the exhibition space. The warm colour tone in Scenes 1, 2, and 3 were perceived as more pleasing, satisfying and more spacious unlike the cool colours presented in Scene 4. Moreover, the warm light was observed more positively than the cool light, which agreed with what the previous research implied (Yildirim et al., 2007; Yildirim et al., 2012). In fact, the research inferred that cooler light of high colour temperature generated more arousal levels than warmer light of low colour temperature as in Scene 4. According to Park & Farr (2007), cool white light provides more arousal effects than warm white light and is brighter than a warm source at the same illuminance. This agreed with the suggestions of the research developed lighting matrix. According to the research findings, it is inferred that the neutral scenes allowed for a more pleasant emotional state unlike the colourful scenes as in Scene 4, however a higher level of arousal was present. The research findings indicated that whereas colourful lighting settings offered a more awakening atmosphere, it was still perceived as less pleasing, less satisfying, and less spacious, unlike the neutral lighting. The developed matrix is shown in Table 5.1. The ✔ sign indicates that the mentioned lighting distribution or colour provides one of the emotional states listed on the left-hand side of the matrix.

Table 5.1. Developed Lighting Matrix

Lighting Settings / Emotional State	Uniform	Differentiated	Bright	Dark	Warm	Cool	Evenly Lit	Targeted	Diffused	Contrast	Colourful	Neutral
Pleasing	✔		✔		✔		✔		✔			✔
Less Pleasing		✔		✔		✔		✔		✔	✔	
Satisfying	✔		✔		✔		✔		✔			✔
Less Satisfying		✔		✔		✔		✔		✔	✔	
Spacious	✔		✔		✔		✔		✔			✔
Less Spacious		✔		✔		✔		✔		✔	✔	
Interesting		✔		✔		✔		✔		✔	✔	
Less Interesting	✔		✔		✔		✔		✔			✔
Exciting		✔		✔		✔		✔		✔	✔	
Less Exciting	✔		✔		✔		✔		✔			✔
Awake		✔	✔			✔		✔		✔	✔	
Less Awake	✔			✔	✔		✔		✔			✔
Controllable	✔		✔		✔		✔		✔			✔
Controlling		✔		✔		✔		✔		✔	✔	

Generally, the research findings could be a guiding plan for the decision-making in defining exhibition spaces. It can help in deciding when to use targeted lighting, how to achieve a calm atmosphere or an exciting atmosphere, when spot lighting, dramatic or basic functional lighting is used, and how this can affect the visual experience of visitors and consequently the visitor's overall museum experience. Moreover, the objective of identifying the importance of the exhibition's lighting settings in enhancing the museum's brand image has been met. After carrying out the Virtual Reality experiment and the analysis of the questionnaire's responses, it was concluded that visitor's satisfaction according to the lighting settings has an impact on their loyalty and hence their willingness to revisit the museum and recommend it to others. According to (Gursoy et al., 2014) who stated that when visitors become loyal, they tend to recommend it to others and accordingly affect the museum's brand image. Consequently, increasing visitors' satisfaction will increase visitors' loyalty thus improving their willingness to return and hence enhancing the brand image. Visitors' lighting preferences that lead to visitors' satisfaction should be taken into consideration while designing exhibition halls to create spaces that really work for people and enhance their willingness to return. One of the other significant contributions of this research is that the loyalty itself has a direct relationship with two aspects that contribute to the museum's brand image; that are revisit and recommendation intentions.

This research concluded that investing and a deeper understanding of how lighting communicates the right image to the museums' visitors is considered a valuable approach for a more positive and successful museum environment. Virtual Reality could be a tool to visualize museums virtually without the need of visiting the actual exhibition halls; in some situations, as in the case of Covid-19 pandemic, people were not allowed to go and visits museums. So, tourism could be through Virtual tours instead of actual ones. Additionally, it is the designer's call to state which state of emotion the exhibition hall needs to deliver to its visitors and accordingly chooses the lighting settings suitable for this emotional state.

5.2. Novel Contribution to Knowledge

This study has explored the influence of the lighting setting factors on human visual perception and preferences in exhibition halls. As explained in the literature review and demonstrated throughout this thesis, this research has offered a new perspective by analysing the relationship between the lighting settings and people's emotional states, perception, and satisfaction in museums. Moreover, this research delivered a new perspective by using Virtual Reality as an assessment tool. Additionally, a hybrid method for collecting the data sets was used through collecting questionnaires in the real-life environment and the virtual reality environment. This allowed studying visitors' visual perception according to different lighting conditions in two different settings. The methodology used in this thesis to study the impact of the lighting settings on people's emotional states, and the use of virtual reality to assess people's visual perception in exhibition halls is novel and provides new insights and contributions to knowledge.

The main contribution of this research is the provision of novel outcomes in the field of lighting in museums and its relation to human visual perception and emotional states. This was attained through developing a lighting matrix that describes to a certain point the discrepancy of visitors' emotional states in relation to different lighting settings in exhibition halls. This matrix can provide different stakeholders with the data needed while designing the lighting settings of the exhibition halls to meet the visitor's expectations and intentions of the visit. Furthermore, this matrix predicts some emotional states and visual perceptions that are developed by specific lighting settings.

Moreover, the thesis offers a substantial empirical contribution for lighting design decision-makers; marketers, architects, and evaluators that lies in the empirical basis that the research provides. Additionally, the research presented the relationships between the lighting settings and emotional states in a visual language that can be understood by practitioners through the aid of the lighting matrix that the research developed. Furthermore, this research provides a set of recommendations for lighting design in the exhibition halls of museums based on the analysis conducted in the Egyptian Museum in Cairo and the Birmingham Museum in the UK. The approaches presented in this study could help in shaping the lighting atmosphere and the interior of exhibition halls. These recommendations could inform architects and lighting designers about visitors' lighting preferences and how visitors' satisfaction and loyalty could be achieved.

5.3. Limitations and Future Studies

This research's evaluative approach has some limitations, although many trials were made to reduce the impact of these limitations through the methodology; however, it was nearly impossible to avoid them all. One of these limitations is that the research used only 16 different emotional items combined with the lighting scenes; this does not cover all the possible emotional items that originate in the visitor's museum experience. Moreover, the research attempted to cover the most common emotional items and carried out the factor analysis test to determine which emotional items are the most important to test the research hypothesis and to understand fully the relationship between the lighting settings and the visitor's visual experience.

According to prior research on lighting perception and visual experience the sample size is considered acceptable. However, an increased sample size leads to more supportive data; hence, future research can use the same research methodology but with an increased sample size especially in the Virtual Reality experiment. Moreover, this research has taken into consideration the cultural environmental aspects by carrying the research in two different cultural environments which were Egypt and the UK; however, some demographic factors like (age, gender, and educational background) were still not highly analysed and were not the main factor in analysing the visitor's visual satisfaction in exhibition halls. Accordingly, future research may consider studying the visual visitor's experience in museums from the demographic perspective.

In comparison to previous studies that took real environmental settings as case studies, the choice of two case studies is considered suitable to carry out the research. However, future research may consider more case studies to provide more data to allow the generalizations of findings. Additionally, despite the research various attempts to consider all the possible lighting combinations that could be present in exhibition halls, more lighting combinations and scenarios might still be needed to increase the comprehension of the effect of the different lighting settings on people's visual perceptions, satisfaction, and emotional states to extend the knowledge on this aspect.

Furthermore, the research has adopted the Virtual Reality approach and not the actual physical environment, which might make the participant not fully engaged in the real museum environment. However, previous research has admitted that the Virtual Reality environment could be as efficient as the actual physical mock-up environment while still saving costs and time. Future research could still assess the possibility of applying a four-dimensional experiment in real museums and create an actual physical mock-up environment.

5.4. Implications of Research

This research studied the different lighting aspects in the museum environment. The study has adopted a quantitative approach by collecting questionnaire responses in both the Real environment by distributing surveys in the actual museums' environments and the Virtual environment using a Virtual Reality approach. This took place in two museums one was in Egypt and the other was in the UK. Moreover, the research considered a real-life case study analysis to have a better insight into people's lighting preferences in the real environment and compared it to the virtual environment to prove the validity of the findings. The responses of the collected surveys were analysed through descriptive and inferential analysis and various statistical tests were applied using SPSS programme. The survey was designed after considering the different emotional items that were discussed by prior research to assess the various levels of pleasure, arousal, and dominance of the participants in relation to the ambient environment. Furthermore, this study created an empirical knowledge base that was built on the combination of theoretical background, and actual case study analysis, in addition to the virtual reality as an assessment tool.

The inferential analysis of the responses indicated that there is a direct relationship between pleasure and the lighting settings; as well as some of the items of arousal, dominance, and branding determinants. Most of the lighting parameters had a statistically significant relationship with the willingness of people to recommend to others to visit the exhibition hall for the preferred lighting settings which supported the hypothesis that the more the lighting characteristics of the exhibition spaces are diverse and thrilling, the better the exhibition space is perceived, thus, contributing positively to the museum’s brand image. Likewise, the different lighting conditions in the exhibition halls changed the visual appearance of the displays, and consequently gave different impressions to visitors. Additionally, it was indicated that there were no major variations between the responses obtained from the two independent groups in the Virtual environment and real environments while assessing the same lighting conditions in both environments.

Moreover, the use of virtual reality as a tool to imitate the real environment and present the same environment to people has proved to be a valid assessment tool. This is considered one of the methodological contributions of the thesis. Furthermore, the research implied that although the exhibition halls were of different sizes, and have a different organization of displays, the same visual message was delivered to participants in each of the simulated scenes that had the same lighting settings in the Virtual Reality for each of the two museums. In fact, lighting design practitioners, museums owners, marketers and architects could find this research useful to determine the visual environment of the different exhibition halls in museums according to the message they need to convey to the visitors. This research suggested different emotional states that visitors might feel in an exhibition environment and how lighting affects those states; thus, if the lighting factor in addition to other atmospheric factors are well research on and understood better museums’ environments will be present that enriches the visitors’ overall experience.

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Appendix 1 (Questionnaire)

This survey is part of a PhD research project that has gained ethics approval from the School Architecture and Built Environment from London South Bank University. Your responses will remain completely anonymous. Thank you for agreeing to participate in this research. The survey will take approximately 10-15 minutes to complete.

Q1. Please indicate your gender

Male ………………………… ☐
Female ……………………… ☐

Q2. Age Group

18-24……………………….. ☐
25-44……………………….. ☐
45-60……………………….. ☐
Over 60……………………… ☐

Q3. Which country are you from?
………………………………………..

Q4. What is the main purpose of your visit? Leisure………………………
- Educational…………………
- Tourism ……………………

Q5. How many people were in your party today?
- Adults………………………
- Children……………………
- None………………………...

Q6. How often do you visit the Egyptian exhibition?

- This is my first ever visit to this museum
- This is my first visit in over 5 years
- I have visited this museum 1-2 times before in the past 5 years
- I have visited this museum 3-5 times before in the past 5 years
- I have visited this museum more than 5 times in the past 5 years

Q.7. If you have the choice what time of the day do you prefer visiting the Egyptian exhibition? please specify the reason?

- Morning when daylighting is available.
- Afternoon when Daylighting is available.
- Night when no Daylighting is available.
- I don’t really pay attention to daylighting aspect.

Q8. Do you find the lighting in the Egyptian exhibition different than the other exhibitions? if yes please specify the reason.

- No ………………….
- Yes ………………… Why?.......................

Q9. How much time did you spend approximately in the Egyptian exhibition in total?

Q.11.How do you feel when you are filling the survey?

- Currently, I am in a good mood………………………………….
- As I answer these questions I feel cheerful………………………
- For some reason I am not very comfortable right now…………
- At this moment I feel stressed or irritable……………………….

First, please consider the lighting environment in the exhibition space, not the whole museum). Note your impressions of the exhibition 'space' concentrating on the lighting atmosphere. not the specific content of individual exhibits.

Please describe the characteristics of this lighting environment by choosing one of the circles between each word pair below. The more appropriate a certain word seems, the closer the circle you should choose. If you think neither of the words in a given pair applies, please choose the circle at the mid-point.

For each question, please indicate your response by drawing a circle in the applicable space as shown:

-------: -------: -------: -------: -------:---------

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Draw a circle closest to your desired response – please do not put responses in intermediate positions between the circles. If you make a mistake, put a cross through the incorrect response and fill in another circle:

-------: -------: -------: -------: -------: -------

Q.12. How do you find the lighting in the exhibition?

- Very Good -------: -------: -------: -------: -------: ------- Poor
- Pleasing -------: -------: -------: -------: -------: ------- Depressing
- Satisfying -------: -------: -------: -------: -------: ------Disappointing
- Interesting -------: -------: -------: -------: -------: ------- Boring
- Spacious -------: -------: -------: -------: -------: ------- Confined
- Awake -------: -------: -------: -------: -------: ------- Sleepy
- Exciting -------: -------: -------: -------: -------: ------- Calm
- Controllable-------: -------: -------: -------: -------: ------- Controlling
- Uniform -------: -------: -------: -------: -------: ------- Differentiated
- Bright -------: -------: -------: -------: -------: ------- Dark
- Warm -------: -------: -------: -------: -------: ------- Cool
- Diffused -------: -------: -------: -------: -------: ------- Contrast lighting
- Evenly lit -------: -------: -------: -------: -------: ------- Targeted lighting
- Colourful -------: -------: -------: -------: -------: ------- Neutral

Q.13.How realistic was the virtual environment?

- Realistic -------: -------: -------: -------: -------: ------- unrealistic

Now consider the following statements. Indicate how much you agree with each of them by choosing the appropriate circle.

Q.14. When looking around in the exhibition, lighting gives me an idea where to start or where to go next?

Strongly Agree Agree Neither/Nor Disagree Strongly Disagree

Q.15. Does the exhibition lighting will encourage you to revisit it?

Strongly Agree Agree Neither/Nor Disagree Strongly Disagree

Q.16. Are you going to recommend this exhibition to others because of the present lighting settings?

Strongly Agree Agree Neither/Nor Disagree Strongly Disagree

Q.17. Do the lighting settings give a specific image to the exhibition and the whole experience in the museum?

Strongly Agree Agree Neither/Nor Disagree Strongly Disagree

Q.18. Lighting in the exhibition hall took me a lot of effort to stay focused on this exhibition.

Strongly Agree Agree Neither/Nor Disagree Strongly Disagree

Q.19. The exhibition lighting made you have a worthwhile experience in this exhibition.

Strongly Agree Agree Neither/Nor Disagree Strongly Disagree

Q.20. This lighting environment of the exhibition really invites me to explore it.

Strongly Agree Agree Neither/Nor Disagree Strongly Disagree

Q. 21.I don’t really pay attention to the exhibition environment as I just like to look at the exhibits

Strongly Agree Agree Neither/Nor Disagree Strongly Disagree

Q.22. Did you ever take any courses in Lighting Design or worked in Lighting Design Profession?

o Yes

o No

(Questionnaire Arabic Version)

هذا المسح هو جزء من مشروع بحث الدكتوراه التي حصلت على موافقة من قسم الهندسة المعمارية والبيئة من جامعة لندن بإنجلترا. ستظل ردودك في سريه تامه. نشكرك على موافقتك على المشاركة في هذا البحث. سيستغرق الاستطلاع ما يقرب من 10-15 دقيقة لاستكماله.

١.النوع

- ذكر ....
- انثي ....

٢.الفئة العمرية

- تحت 18..........................
- 18-24 ... .
- 25-44 ... .
- 45-60 ... .
- أكثر من 60 ....

٣. ما هي جنسيتك؟

.. ..

٤. ما هو الغرض الرئيسي من زيارتك؟

- سياحي
- تعليمي
- ترفيهي

٥. كم من الناس كانوا في رفقتكم اليوم؟ (لتحديد مجموعة التركيز سواء كانت فردية أو عائلية أو مجموعة مدرسية)

- الكبار.................................
- الأطفال...............................
- لا يوجد ....

٦. كم مرة تزور المعرض المصري؟

- هذه هي أول زيارة
- هذه هي زيارتي الأولى في أكثر من 5 سنوات
- لقد زرت هذا المتحف 1-2 مرات من قبل في السنوات ال 5 الماضية
- لقد زرت هذا المتحف 3-5 مرات من قبل في السنوات ال 5 الماضية
- لقد زرت هذا المتحف أكثر من 5 مرات في السنوات ال 5 الماضية

٧. إذا كان لديك الخيار في أي وقت من اليوم تفضل زيارة المعرض المصري؟ يرجى تحديد السبب؟

- الصباح عندما يتوفر ضوء النهار.
- بعد الظهر عندما يتوفر ضوء النهار.
- ليلا عندما لا يتوفر ضوء النهار.
- أنا لا اهتم بضوء النهار.

....

٨. كم من الوقت قضيت تقريبا في هذه القاعة في المجموع؟

....

٩. ما هو شعورك وانت تقوم الان بملء الاستطلاع؟

- حاليا، أنا في مزاج جيد ....
- وأنا أجيب على هذه الأسئلة أشعر البهجة ....
- لسبب ما أنا لا اشعر براحة الآن ....
- في هذه اللحظة أشعر بالإجهاد أو الانفعال ....

لاحظ انطباعاتك عن "القاعة كفراغ" والتركيز على جو الإضاءة وليس المحتوى المحدد للمعروضات الفردية.
يرجى وصف خصائص بيئة الإضاءة هذه عن طريق اختيار إحدى الدوائر بين كل زوج من ا لكلمات أدناه. يجب عليك اختيار الدائرة الأقرب للكلمه التي توصف احساسك.

بالنسبة إلى كل سؤال، يرجى الإشارة إلى ردك من خلال رسم دائرة في المساحة السارية كما هو موضح:

رسم دائرة الأقرب إلى الاجابة المطلوبة - من فضلك لا تضع الردود في مواقف وسيطة بين الدوائر. إذا قمت بخطأ ما، ضع علامة عبر الاستجابة غير الصحيحة وملء دائرة أخرى:

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-------: -------: -------: -------: -------: -------

١٠. كيف تجد الإضاءة في المعرض؟

- جيده جدا -------: -------: -------: -------: -------: ------- فقيره
- مفرحه -------: -------: -------: -------: -------: ------- كئيبه
- مرضيه -------: -------: -------: -------: -------: ------- مخيبة للآمال
- مثيرة -------: -------: -------: -------: -------: ------- مملة
- شعور بالاتساع -------: -------: -------: -------: -------: ------- محصورة
- شعور بالاستيقاظ -------: -------: -------: -------: -------: ------- شعور بالنعسان

- مثيرة -------: -------: -------: -------: -------: -------: ------- هادئة
- شعور بالتحكم بها -------: -------: -------: -------: -------: -------: ------- مسيطرة
- موحدة -------: -------: -------: -------: -------: -------: ------- متباينة
- مشرقه -------: -------: -------: -------: -------: -------: ------- شعور بالعتمه
- شعور بالدفيء -------: -------: -------: -------: -------: -------: ------- بارده
- منتشره -------: -------: -------: -------: -------: -------: ------- إضاءة متباينه
- مضاءة بشكل متساوي -------: -------: -------: -------: -------: -------: ------- الإضاءة مستهدفة أماكن معينه
- ملونة -------: -------: -------: -------: -------: -------: ------- محايده

ا

١١.عندما تنظر حولك في المعرض، الإضاءة تعطيك فكرة من أين ستبدأ أو إلى أين ستذهب بعد ذلك؟

أوافق بشده	اوافق	محايد	لا اوافق	لا وافق بشده
○	○	○	○	○

١٢. هل إضاءة المعرض سوف تشجعك على زيارة المتحف مره اخري؟

أوافق بشده	اوافق	محايد	لا اوافق	لا وافق بشده
○	○	○	○	○

١٣. هل ستوصي بزيارة المعرض للآخرين بسبب إعدادات الإضاءة الحالية؟

أوافق بشده	أوافق	محايد	لا اوافق	لا وافق بشده
○	○	○	○	○

١٤. هل تعطي إعدادات الإضاءة صورة محددة للمعرض وتجربة كاملة في المتحف؟

أوافق بشده	اوافق	محايد	لا اوافق	لا وافق بشده
○	○	○	○	○

١٥. الإضاءة في قاعة المعرض جعلتني ابذل الكثير من الجهد للبقاء على التركيز في هذا المعرض.؟

أوافق بشده	اوافق	محايد	لا اوافق	لا وافق بشده
○	○	○	○	○

١٦. جعلت إضاءة المعرض لديك تجربة جديرة بالاهتمام في المعرض.

أوافق بشده	اوافق	محايد	لا اوافق	لا وافق بشده
○	○	○	○	○

١٧. الإضاءة بالمعرض تدعوك حقا لاستكشاف المعرض أكثر.

أوافق بشده	اوافق	محايد	لا اوافق	لا وافق بشده
○	○	○	○	○

١٨. ان لا اعي اهتماما حقا ببيئة المعرض كما أود فقط أن انظر الي المعروضات.

أوافق بشده	اوافق	محايد	لا اوافق	لا وافق بشده
○	○	○	○	○

١٩. هل سبق لك أن اخذت أي دورات في تصميم الإضاءة أو عملت في تصميم الإضاءات؟

- نعم
- لا

Appendix 2

London South Bank University
EST 1892

School of The Built Environment and Architecture

Direct line: 0208 815 7264
E-mail: kaluaray@lsbu.ac.uk
Ref: RME1

2nd July 2018

Dear Youmna Ahmedy

Re - The Impact of Lighting Design on Perceived Architecture and Human Satisfaction in Museums

Thank you for submitting this proposal for ethical review.

I am pleased to inform you that Dr Yamuna Kaluarachchi, on behalf of the School of the Built Environment & Architecture, has given full Chair's Approval for your review.

I wish you every success with your research.

Yours sincerely,

Yamuna Kaluarachchi

Chair, Research Ethics Coordinator
School of the Built Environment & Architecture
London South Bank University

Appendix 3

Table 5.2 Results of Chi-Square Test (Scene 1,2,3, & 4) on Participants' Perception Between Good/poor Lighting verses Bright/Dark (Source: author)

	Scene 1			Scene 2		
Chi-Square Tests	Value	df	Asymptotic Significance (2-sided)	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	30.222	9	.000	64.433a	9	.000
Likelihood Ratio	34.775	9	.000	45.541	9	.000
Linear-by-Linear Association	16.690	1	.000	23.584	1	.000
N of Valid Cases	66			66		
	Scene 3			**Scene 4**		
Chi-Square Tests	Value	df	Asymptotic Significance (2-sided)	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	60.415	16	.000	54.028	16	.000
Likelihood Ratio	65.275	16	.000	56.168	16	.000
Linear-by-Linear Association	20.041	1	.000	25.352	1	.000
N of Valid Cases	66			66		

Table 5.3 : Results of Chi-Square Test (Scene 1,2,3, & 4) on Participants' Perception Between Good/poor Lighting and Warm/Cool Lighting (Source: author)

	Scene 1			Scene 2		
Chi-Square Tests	Value	df	Asymptotic Significance (2-sided)	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	23.403	12	.024	37.793	9	.000
Likelihood Ratio	25.926	12	.011	43.610	9	.000

Linear-by-Linear Association	.407	1	.523	23.235	1	.000
N of Valid Cases	66			66		
	Scene 3			Scene 4		
Chi-Square Tests	Value	df	Asymptotic Significance (2-sided)	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	122.57	16	.000	77.521	16	.000
Likelihood Ratio	97.641	16	.000	75.344	16	.000
Linear-by-Linear Association	31.528	1	.000	28.062	1	.000
N of Valid Cases	66			66		

Table 5.4 Results of Chi-Square Test (Scene 1,2,3 & 4) on Participants' Perception Between Good/poor Lighting and Targeted/Well Lit Lighting (Source: author)

	Scene 1			Scene 2		
Chi-Square Tests	Value	df	Asymptotic Significance (2-sided)	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	37.373	12	.000	63.107a	12	.000
Likelihood Ratio	38.026	12	.000	45.106	12	.000
Linear-by-Linear Association	5.293	1	.021	23.589	1	.000
N of Valid Cases	66			66		
	Scene 3			Scene 4		
Chi-Square Tests	Value	df	Asymptotic Significance (2-sided)	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	52.194	16	.000	77.236a	16	.000
Likelihood Ratio	60.158	16	.000	73.564	16	.000
Linear-by-Linear Association	24.568	1	.000	29.124	1	.000
N of Valid Cases	66			66		

Table 5.5 Results of Chi-Square Test (Scene 1,2,3 & 4) on Participants' Perception Between Good/poor Lighting and Colourful/Neutral Lighting (Source: author)

	Scene 1			Scene 2		
Chi-Square Tests	Value	df	Asymptotic Significance (2-sided)	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	21.774	12	.040	58.143	12	.000
Likelihood Ratio	23.140	12	.027	55.663	12	.000
Linear-by-Linear Association	10.998	1	.001	24.721	1	.000
N of Valid Cases	66			66		
	Scene 3			**Scene 4**		
Chi-Square Tests	Value	df	Asymptotic Significance (2-sided)	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	52.093	16	.000	56.387	16	.000
Likelihood Ratio	57.501	16	.000	56.815	16	.000
Linear-by-Linear Association	24.430	1	.000	24.639	1	.000
N of Valid Cases	66			66		

Table 5.6 Results of Chi-Square Test (Scene 1,2,3 & 4) on Participants' Perception Between Pleasing/Depressing and Uniform/ Differentiated Lighting (Source: author)

	Scene 1			Scene 2		
Chi-Square Tests	Value	df	Asymptotic Significance (2-sided)	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	16.481	8	.036	18.699a	16	.028
Likelihood Ratio	15.755	8	.046	17.742	16	.339
Linear-by-Linear Association	.035	1	.852	1.178	1	.278
N of Valid Cases	66			66		
	Scene 3			**Scene 4**		

Chi-Square Tests	Value	df	Asymptotic Significance (2-sided)	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	64.873	16	.000	65.718	16	.000
Likelihood Ratio	61.771	16	.000	64.111	16	.000
Linear-by-Linear Association	25.472	1	.000	25.561	1	.000
N of Valid Cases	66			66		

Table 5.7 Results of Chi-Square Test (Scene 1,2,3 & 4) on Participants' Perception Between Pleasing/Depressing Lighting and Bright/Dark Lighting (Source: author)

	Scene 1			Scene 2		
Chi-Square Tests	Value	df	Asymptotic Significance (2-sided)	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	13.750a	6	.033	68.263a	12	.000
Likelihood Ratio	14.599	6	.024	47.265	12	.000
Linear-by-Linear Association	8.381	1	.004	22.903	1	.000
N of Valid Cases	66			66		
	Scene 3			**Scene 4**		
Chi-Square Tests	Value	df	Asymptotic Significance (2-sided)	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	48.277	16	.000	61.921a	16	.000
Likelihood Ratio	50.827	16	.000	56.445	16	.000
Linear-by-Linear Association	12.902	1	.000	24.262	1	.000
N of Valid Cases	66			66		

Table 5.8 Results of Chi-Square Test (Scene 1,2,3 & 4) on Participants' Perception Between Pleasing/Depressing Lighting and Warm/Cool Lighting (Source: author)

	Scene 1			Scene 2		
Chi-Square Tests	Value	df	Asymptotic Significance (2-sided)	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	18.774	8	.016	40.400a	12	.000
Likelihood Ratio	22.386	8	.004	43.224	12	.000
Linear-by-Linear Association	8.629	1	.003	21.562	1	.000
N of Valid Cases	66			66		
	Scene 3			**Scene 4**		
Chi-Square Tests	Value	df	Asymptotic Significance (2-sided)	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	83.490	16	.000	61.267	16	.000
Likelihood Ratio	72.871	16	.000	64.946	16	.000
Linear-by-Linear Association	27.618	1	.000	27.624	1	.000
N of Valid Cases	66			66		

Table 5.9 Results of Chi-Square Test (Scene 1,2,3 & 4) on Participants' Perception Between Pleasing/Depressing Lighting and Diffused/Contrast Lighting (Source: author)

	Scene 1			Scene 2		
Chi-Square Tests	Value	df	Asymptotic Significance (2-sided)	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	19.994	8	.010	74.700	16	.000
Likelihood Ratio	22.206	8	.005	58.325	16	.000
Linear-by-Linear Association	.067	1	.796	24.450	1	.000
N of Valid Cases	66			66		

	Scene 3			Scene 4		
Chi-Square Tests	Value	df	Asymptotic Significance (2-sided)	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	67.595	16	.000	74.250	16	.000
Likelihood Ratio	66.740	16	.000	74.887	16	.000
Linear-by-Linear Association	25.524	1	.000	28.974	1	.000
N of Valid Cases	66			66		

Table 5.10 Results of Chi-Square Test (Scene 1,2,3 & 4) on Participants' Perception Between Pleasing/Depressing Lighting and Evenly Lit/Targeted Lighting (Source: author)

	Scene 1			Scene 2		
Chi-Square Tests	Value	df	Asymptotic Significance (2-sided)	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	24.649	8	.002	77.787	16	.000
Likelihood Ratio	30.068	8	.000	48.790	16	.000
Linear-by-Linear Association	4.325	1	.038	24.961	1	.000
N of Valid Cases	66			66		
	Scene 3			**Scene 4**		
Chi-Square Tests	Value	df	Asymptotic Significance (2-sided)	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	59.930	16	.000	69.208	16	.000
Likelihood Ratio	66.807	16	.000	65.800	16	.000
Linear-by-Linear Association	22.932	1	.000	27.930	1	.000
N of Valid Cases	66			66		

Table 5.11 Results of Chi-Square Test (Scene 1,2,3 &4) on Participants' Perception Between Pleasing/Depressing Lighting and Colourful/Neutral Lighting (Source: author)

	Scene 1			Scene 2		
Chi-Square Tests	Value	df	Asymptotic Significance (2-sided)	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	26.845a	8	.001	71.707a	16	.000
Likelihood Ratio	30.690	8	.000	61.736	16	.000
Linear-by-Linear Association	14.030	1	.000	26.210	1	.000
N of Valid Cases	66			66		
	Scene 3			**Scene 4**		
Chi-Square Tests	Value	df	Asymptotic Significance (2-sided)	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	52.470	16	.000	69.184	16	.000
Likelihood Ratio	59.608	16	.000	54.548	16	.000
Linear-by-Linear Association	20.848	1	.000	22.795	1	.000
N of Valid Cases	66			66		

Table 5.12 Results of Chi-Square Test (Scene 1,2,3 &4) on Participants' Perception Between Satisfying/ Dissatisfying Lighting and Uniform/Differentiated Lighting (Source: author)

	Scene 1			Scene 2		
Chi-Square Tests	Value	df	Asymptotic Significance (2-sided)	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	62.049	16	.000	20.150a	16	.021
Likelihood Ratio	67.409	16	.000	19.200	16	.258
Linear-by-Linear Association	7.163	1	.007	.773	1	.379
N of Valid Cases	66			66		

	Scene 3			Scene 4		
Chi-Square Tests	Value	df	Asymptotic Significance (2-sided)	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	77.970	16	.000	73.432a	16	.000
Likelihood Ratio	66.276	16	.000	68.668	16	.000
Linear-by-Linear Association	27.367	1	.000	25.156	1	.000
N of Valid Cases	66			66		

Table 5.13 Results of Chi-Square Test (Scene1 ,2,3 & 4) on Participants' Perception Between Satisfying/ Dissatisfying Lighting and Bright/Dark Lighting (Source: author)

	Scene 1			Scene 2		
Chi-Square Tests	Value	df	Asymptotic Significance (2-sided)	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	18.073	12	.013	64.433a	12	.000
Likelihood Ratio	19.683	12	.073	45.541	12	.000
Linear-by-Linear Association	5.486	1	.019	22.729	1	.000
N of Valid Cases	66			33		
	Scene 3			**Scene 4**		
Chi-Square Tests	Value	df	Asymptotic Significance (2-sided)	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	48.331	16	.000	54.221	16	.000
Likelihood Ratio	52.384	16	.000	56.445	16	.000
Linear-by-Linear Association	19.405	1	.000	24.159	1	.000
N of Valid Cases	66			66		

Table 5.14 Results of Chi-Square Test (Scene 1,2,3 and 4) on Participants' Perception Between Satisfying/ Dissatisfying Lighting and Warm/Cool Lighting (Source: author)

	Scene 1			Scene 2		
Chi-Square Tests	Value	df	Asymptotic Significance (2-sided)	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	46.009	16	.000	39.915a	12	.000
Likelihood Ratio	45.116	16	.000	44.853	12	.000
Linear-by-Linear Association	6.972	1	.008	22.320	1	.000
N of Valid Cases	66			66		
	Scene 3			**Scene 4**		
Chi-Square Tests	Value	df	Asymptotic Significance (2-sided)	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	79.381	16	.000	70.427	16	.000
Likelihood Ratio	73.856	16	.000	69.905	16	.000
Linear-by-Linear Association	28.565	1	.000	27.957	1	.000
N of Valid Cases	66			66		

Table 5.15 Results of Chi-Square Test (Scene 1,2,3 & 4) on Participants' Perception Between Satisfying/ Dissatisfying Lighting and Diffused/Contrast Lighting (Source: author)

	Scene 1			Scene 2		
Chi-Square Tests	Value	df	Asymptotic Significance (2-sided)	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	34.190	16	.005	81.429	16	.000
Likelihood Ratio	32.558	16	.008	64.349	16	.000
Linear-by-Linear Association	.374	1	.541	25.504	1	.000
N of Valid Cases	66			66		
	Scene 3			**Scene 4**		
Chi-Square Tests	Value	df	Asymptotic Significance (2-sided)	Value	df	Asymptotic Significance (2-sided)

Pearson Chi-Square	57.087	16	.000	82.421	16	.000
Likelihood Ratio	62.216	16	.000	78.568	16	.000
Linear-by-Linear Association	27.580	1	.000	29.127	1	.000
N of Valid Cases	66			66		

Table 5.16 Results of Chi-Square Test (Scene 1,2,3 & 4) on Participants' Perception Between Interesting/Boring Lighting and Uniform/Differentiated Lighting (Source: author)

	Scene 1			Scene 2		
Chi-Square Tests	Value	df	Asymptotic Significance (2-sided)	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	40.863	16	.001	15.237	12	.029
Likelihood Ratio	47.622	16	.000	13.172	12	.357
Linear-by-Linear Association	.410	1	.522	1.517	1	.218
N of Valid Cases	66			66		
	Scene 3			**Scene 4**		
Chi-Square Tests	Value	df	Asymptotic Significance (2-sided)	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	85.800	16	.000	61.292	16	.000
Likelihood Ratio	73.116	16	.000	62.958	16	.000
Linear-by-Linear Association	28.491	1	.000	23.943	1	.000
N of Valid Cases	66			66		

Table 5.17 Results of Chi-Square Test (Scene 1,2,3 and 4) on Participants' Perception Between Interesting/Boring Lighting and Bright/Dark Lighting (Source: author)

	Scene 1			Scene 2		
Chi-Square Tests	Value	df	Asymptotic Significance (2-sided)	Value	df	Asymptotic Significance (2-sided)

Pearson Chi-Square	24.390	12	.018	61.521	9	.000
Likelihood Ratio	24.009	12	.020	55.006	9	.000
Linear-by-Linear Association	6.801	1	.009	24.579	1	.000
N of Valid Cases	66			66		
	Scene 3			**Scene 4**		
Chi-Square Tests	Value	df	Asymptotic Significance (2-sided)	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	38.746	16	.001	54.565	16	.000
Likelihood Ratio	44.821	16	.000	57.179	16	.000
Linear-by-Linear Association	16.233	1	.000	25.555	1	.000
N of Valid Cases	66			66		

Table 5.18 Results of Chi-Square Test (Scene 1,2,3&4) on Participants' Perception Between Interesting/Boring Lighting and Warm/Cool Lighting (Source: author)

	Scene 1			**Scene 2**		
Chi-Square Tests	Value	df	Asymptotic Significance (2-sided)	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	41.494	16	.000	38.486	9	.000
Likelihood Ratio	46.892	16	.000	43.797	9	.000
Linear-by-Linear Association	8.062	1	.005	21.935	1	.000
N of Valid Cases	66			66		
	Scene 3			**Scene 4**		
Chi-Square Tests	Value	df	Asymptotic Significance (2-sided)	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	75.756	16	.000	81.233	16	.000

Likelihood Ratio	70.527	16	.000	77.437	16	.000
Linear-by-Linear Association	28.759	1	.000	28.384	1	.000
N of Valid Cases	66			66		

Table 5.19 Results of Chi-Square Test (Scene 1,2,3 &4) on Participants' Perception Between Interesting/Boring Lighting and Diffused/Contrast Lighting (Source: author)

	Scene 1			**Scene 2**		
Chi-Square Tests	Value	df	Asymptotic Significance (2-sided)	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	49.851	16	.000	90.375	12	.000
Likelihood Ratio	57.177	16	.000	73.337	12	.000
Linear-by-Linear Association	122	1	.726	27.119	1	.000
N of Valid Cases	66			66		
	Scene 3			**Scene 4**		
Chi-Square Tests	Value	df	Asymptotic Significance (2-sided)	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	82.830	16	.000	82.343	16	.000
Likelihood Ratio	75.576	16	.000	77.924	16	.000
Linear-by-Linear Association	27.999	1	.000	29.098	1	.000
N of Valid Cases	66			66		

Table 5.20 Results of Chi-Square Test (Scene 1,2,3 &4) on Participants' Perception Between Interesting/Boring Lighting and Evenly Lit/Targeted Lighting (Source: author)

	Scene 1			**Scene 2**		
Chi-Square Tests	Value	df	Asymptotic Significance (2-sided)	Value	df	Asymptotic Significance (2-sided)

Pearson Chi-Square	17.767	16	.038	61.564	12	.000
Likelihood Ratio	23.280	16	.106	53.276	12	.000
Linear-by-Linear Association	.240	1	.624	25.984	1	.000
N of Valid Cases	66			66		
Scene 3				**Scene 4**		
Chi-Square Tests	Value	df	Asymptotic Significance (2-sided)	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	59.636	16	.000	84.661	16	.000
Likelihood Ratio	63.494	16	.000	78.026	16	.000
Linear-by-Linear Association	22.505	1	.000	29.818	1	.000
N of Valid Cases	66			66		

Table 5.21 Results of Chi-Square Test (Scene 1,2,3 &4) on Participants' Perception Between Interesting/Boring Lighting and Colourful/Neutral Lighting (Source: author)

	Scene 1			**Scene 2**		
Chi-Square Tests	Value	df	Asymptotic Significance (2-sided)	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	29.167	16	.023	68.70	12	.000
Likelihood Ratio	31.657	16	.011	59.68	12	.000
Linear-by-Linear Association	1.576	1	.209	25.54	1	.000
N of Valid Cases	66			66		
	Scene 3			**Scene 4**		
Chi-Square Tests	Value	df	Asymptotic Significance (2-sided)	Value	df	Asymptotic Significance (2-sided)

Pearson Chi-Square	44.633	16	.000	56.38	16	.000
Likelihood Ratio	52.465	16	.000	56.81	16	.000
Linear-by-Linear Association	22.445	1	.000	24.59	1	.000
N of Valid Cases	66			66		

Table 5.22 Results of Chi-Square Test (Scene 1,2,3 &4) on Participants' Perception Between Spacious/Confined Lighting versus Uniform/differentiated Lighting (Source: author)

	Scene 1			Scene 2		
Chi-Square Tests	Value	df	Asymptotic Significance (2-sided)	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	30.919	16	.014	19.745a	16	.032
Likelihood Ratio	31.226	16	.013	17.468	16	.356
Linear-by-Linear Association	.326	1	.568	.972	1	.324
N of Valid Cases	66			66		
	Scene 3			**Scene 4**		
Chi-Square Tests	Value	df	Asymptotic Significance (2-sided)	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	83.811	16	.000	70.230	16	.000
Likelihood Ratio	75.979	16	.000	67.808	16	.000
Linear-by-Linear Association	29.492	1	.000	25.199	1	.000
N of Valid Cases	66			66		

Table 5.23 Results of Chi-Square Test (Scene 1,2,3 &4) on Participants' Perception Between Spacious/Confined Lighting versus warm/cool Lighting (Source: author)

	Scene 1			Scene 2		
Chi-Square Tests	Value	df	Asymptotic Significance (2-sided)	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	32.882	16	.008	45.783	12	.000
Likelihood Ratio	33.600	16	.006	46.850	12	.000
Linear-by-Linear Association	11.051	1	.001	23.310	1	.000
N of Valid Cases	66			66		
	Scene 3			**Scene 4**		
Chi-Square Tests	Value	df	Asymptotic Significance (2-sided)	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	95.003	16	.000	69.383	16	.000
Likelihood Ratio	80.754	16	.000	70.114	16	.000
Linear-by-Linear Association	29.887	1	.000	27.681	1	.000
N of Valid Cases	66			66		

Table 5.24 Results of Chi-Square Test (Scene 1,2,3 &4) on Participants' Perception Between Spacious/Confined Lighting versus Diffused/Contrast Lighting (Source: author)

	Scene 1			Scene 2		
Chi-Square Tests	Value	df	Asymptotic Significance (2-sided)	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	34.076	16	.005	76.640	16	.000
Likelihood Ratio	37.052	16	.002	67.419	16	.000
Linear-by-Linear Association	.597	1	.440	26.595	1	.000
N of Valid Cases	66			66		
	Scene 3			**Scene 4**		

Chi-Square Tests	Value	df	Asymptotic Significance (2-sided)	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	71.631	16	.000	74.444	16	.000
Likelihood Ratio	70.653	16	.000	71.669	16	.000
Linear-by-Linear Association	27.786	1	.000	28.511	1	.000
N of Valid Cases	66			66		

Table 5.25 Results of Chi-Square Test (Scene 1,2,3 &4) on Participants' Perception Between Spacious/Confined Lighting versus Evenly Lit /Targeted Lighting (Source: author)

Scene 1				Scene 2		
Chi-Square Tests	Value	df	Asymptotic Significance (2-sided)	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	38.084	16	.001	110.673	16	.000
Likelihood Ratio	40.889	16	.001	66.293	16	.000
Linear-by-Linear Association	7.626	1	.006	28.538	1	.000
N of Valid Cases	66			66		
Scene 3				**Scene 4**		
Chi-Square Tests	Value	df	Asymptotic Significance (2-sided)	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	55.550	16	.000	87.276	16	.000
Likelihood Ratio	60.296	16	.000	75.488	16	.000
Linear-by-Linear Association	24.070	1	.000	28.980	1	.000
N of Valid Cases	66			66		

Table 5.26 Results of Chi-Square Test (Scene 1,2,3 & 4) on Participants' Perception Between Spacious/Confined Lighting versus Colourful/ Neutral Lighting (Source: author)

	Scene 1			Scene 2		
Chi-Square Tests	Value	df	Asymptotic Significance (2-sided)	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	58.145	16	.000	81.472	16	.000
Likelihood Ratio	56.375	16	.000	65.683	16	.000
Linear-by-Linear Association	11.153	1	.001	27.367	1	.000
N of Valid Cases	66			66		
	Scene 3			**Scene 4**		
Chi-Square Tests	Value	df	Asymptotic Significance (2-sided)	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	63.160	16	.000	67.223	16	.000
Likelihood Ratio	62.599	16	.000	59.897	16	.000
Linear-by-Linear Association	25.498	1	.000	24.672	1	.000
N of Valid Cases	66			66		

Table 5.27 Results of Chi-Square Test (Scene 1,2,3 &4) on Participants' Perception Between Awake/Sleepy Lighting and uniform/differentiated Lighting (Source: author)

	Scene 1			Scene 2		
Chi-Square Tests	Value	df	Asymptotic Significance (2-sided)	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	52.841	12	.000	17.211	16	.372
Likelihood Ratio	36.967	12	.000	16.306	16	.432
Linear-by-Linear Association	21.198	1	.000	.402	1	.526
N of Valid Cases	66			66		
	Scene 3			**Scene 4**		

Chi-Square Tests	Value	df	Asymptotic Significance (2-sided)	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	85.800	16	.000	46.538	16	.000
Likelihood Ratio	81.398	16	.000	49.578	16	.000
Linear-by-Linear Association	27.503	1	.000	19.089	1	.000
N of Valid Cases	66			66		

Table 5.28 Results of Chi-Square Test (Scene 1,2,3 &4) on Participants' Perception Between Awake/Sleepy Lighting and Warm/Cool Lighting (Source: author)

Scene 1				**Scene 2**		
Chi-Square Tests	Value	df	Asymptotic Significance (2-sided)	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	61.395	16	.000	65.184	12	.000
Likelihood Ratio	47.401	16	.000	58.504	12	.000
Linear-by-Linear Association	10.639	1	.001	25.705	1	.000
N of Valid Cases	66			66		
Scene 3				**Scene 4**		
Chi-Square Tests	Value	df	Asymptotic Significance (2-sided)	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	72.236	16	.000	50.397	16	.000
Likelihood Ratio	70.250	16	.000	55.878	16	.000
Linear-by-Linear Association	26.591	1	.000	23.947	1	.000
N of Valid Cases	66			66		

Table 5.29 Results of Chi-Square Test (Scene 1,2,3 &4) on Participants' Perception Between Awake/Sleepy Diffused/Contrast Lighting (Source: author)

	Scene 1			Scene 2		
Chi-Square Tests	Value	df	Asymptotic Significance (2-sided)	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	38.952	16	.001	81.837	16	.000
Likelihood Ratio	39.029	16	.001	65.068	16	.000
Linear-by-Linear Association	.966	1	.326	26.034	1	.000
N of Valid Cases	66			66		
	Scene 3			**Scene 4**		
Chi-Square Tests	Value	df	Asymptotic Significance (2-sided)	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	66.137	16	.000	58.819	16	.000
Likelihood Ratio	64.177	16	.000	58.650	16	.000
Linear-by-Linear Association	27.092	1	.000	25.230	1	.000
N of Valid Cases	66			66		

Table 5.30 Results of Chi-Square Test (Scene 1,2,3 &4) on Participants' Perception Between Awake/Sleepy Colourful Neutral Lighting (Source: author)

	Scene 1			Scene 2		
Chi-Square Tests	Value	df	Asymptotic Significance (2-sided)	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	35.604	16	.003	65.286	16	.000
Likelihood Ratio	37.711	16	.002	58.181	16	.000
Linear-by-Linear Association	7.809	1	.005	26.275	1	.000
N of Valid Cases	66			66		

	Scene 3			Scene 4		
Chi-Square Tests	Value	df	Asymptotic Significance (2-sided)	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	81.400	16	.000	61.188	16	.000
Likelihood Ratio	73.680	16	.000	65.442	16	.000
Linear-by-Linear Association	28.871	1	.000	26.291	1	.000
N of Valid Cases	66			66		

Table 5.31 Results of Chi-Square Test (Scene 12,3 &4) on Participants' Perception Between Exciting/Calm Lighting and Uniform /Differentiated Lighting (Source: author)

	Scene 1			Scene 2		
Chi-Square Tests	Value	df	Asymptotic Significance (2-sided)	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	32.628	16	.008	29.133	16	.023
Likelihood Ratio	37.018	16	.002	29.444	16	.021
Linear-by-Linear Association	.017	1	.897	.342	1	.559
N of Valid Cases	66			66		
	Scene 3			**Scene 4**		
Chi-Square Tests	Value	df	Asymptotic Significance (2-sided)	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	69.300	16	.000	62.531	16	.000
Likelihood Ratio	69.490	16	.000	65.641	16	.000
Linear-by-Linear Association	26.130	1	.000	23.518	1	.000
N of Valid Cases	66			66		