THE EFFECT OF LIGHTING DESIGN AND APPLICATION ON LIMAR TEXTILE IN TERENGGANU STATE MUSEUM

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THE EFFECT OF LIGHTING DESIGN AND APPLICATION ON LIMAR TEXTILE IN TERENGGANU STATE MUSEUM

by

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Alaa Al-Hamed

Penang, Malaysia

TABLES OF CONTENTS

LIST OF TABLES

Page

LIST OF FIGURES

Page

LIST OF ABBRIVIATIONS

CFL	Compact Fluorescent Lamp
CFT C	Compact Fluorescent Tube
CRI	Color Rendering Index: Measure the quality of light with the eye's ability to view the true light hue to be able to see colour properly
CT	Color Temperature: Measure the light quality appearance ranging from cool to warm
FC / ft-c	Measurement of light intensity
IR	Infrared Radiation
LEDs	Light-Emitting Diode
Lux/lx	A unit of illumination equal to the direct illumination on a surface
MH	Metal Halide Lamps
^{o}C	Degree Celsius is a unit of temperature
OLED	Organic Emitted Diode
OTHL	Quartz Tungsten-Halogen Lamps
RH	Relative Humidity
UV	Ultraviolet Radiation
nm	The type of radiation calculation applied

LIST OF APPENDICES

KESAN REKA BENTUK DAN APLIKASI PENCAHAYAAN KE ATAS TEKSTIL LIMAR DI MUZIUM NEGERI TERENGGANU

ABSTRAK

Aplikasi pencahayaan muzium tekstil menggabungkan seni, sains dan kejuruteraan, di mana pencahayaan menyepadukan nilai estetik dan keperluan pemeliharaan pameran. Pencahayaan boleh menimbulkan sensasi dan emosi. Ia mengawal persepsi pameran tertentu, seperti tekstil. Kualiti pencahayaan di galeri tidak ditentukan semata-mata oleh sumber pencahayaan, tetapi juga oleh watak dan konfigurasi ruang. Cara pencahayaan mengenai objek dan seni bina menghasilkan penembusan cahaya dan cahaya yang dipantulkan, serta bagaimana pencahayaan tersebut diterima oleh minda dan mata penonton. Penyelidikan ini tertumpu kepada aplikasi pencahayaan galeri pameran tekstil limar. Penyelidikan ini menekankan aplikasi pencahayaan di Muzium Negeri Terengganu untuk membantu mengekalkan pemuliharaan tekstil limar yang lebih baik dengan menyiasat kesan buruk reka bentuk pencahayaan. Pemilihan tekstil limar, dengan alasan, adalah nilai budaya penting yang ada pada limar dalam mewakili sejarah dan budaya Malaysia. Oleh itu, tekstil yang halus dan bernilai ini perlu dipulihara untuk mengekalkannya untuk generasi akan datang. Kajian ini mengkaji komponen aplikasi pencahayaan pameran tekstil limar di Muzium Negeri Terengganu. Ia juga menyiasat keperluan pencahayaan untuk pameran tekstil limar di Muzium Negeri Terengganu. Selain itu, ia mewujudkan persepsi untuk melindungi tekstil daripada kerosakan cahaya oleh sinaran cahaya dan persekitaran muzium. Kajian ini cuba mengenal pasti sama ada piawaian pemuliharaan terkawal dipatuhi dalam memelihara tekstil limar. Hasil penyelidikan semasa akan membantu mengenal pasti dan menghapuskan sumber cahaya buatan yang boleh memberi kesan

negatif pada tekstil limar, yang membawa kepada pudar warna dan melemahkan fabriknya. Selain itu, kajian ini perlu dijalankan memandangkan bilangan institusi muzium secara amnya semakin meningkat di Malaysia dan akan terus meningkat pada masa hadapan. Inovasi dalam tekstil adalah salah satu motor utama fesyen. Oleh itu pakaian, tekstil dan fesyen disatukan dalam hubungan segi tiga - tidak dapat dipisahkan, tetapi nyata dan bernilai diteliti Muzium tekstil dipilih kerana koleksi tekstil negara mesti dipelihara. Koleksi berharga kain limar yang dipamerkan di Muzium Negeri Terengganu dan berasal dari tahun 1920, memerlukan kepakaran teknikal pereka lampu. Kajian ini juga cuba mengenal pasti sama ada piawaian pemuliharaan terkawal dipatuhi dalam memelihara tekstil tersebut. Ini berikutan timbulnya pelbagai kenyataan dan tuduhan berhubung pameran muzium di negara ini. Selain daripada mendapatkan gambaran sebenar secara teknikal keadaan sebenar yang berlaku dalam pameran tekstil muzium, kajian ini juga memberikan pandangan tentang kepentingan aspek tersebut untuk kegunaan masa hadapan. Penyelidikan menggunakan kaedah kualitatif. Temu bual kualitatif adalah cara yang berkesan untuk mencipta makna tentang topik tertentu. Temu bual mendalam telah dijalankan oleh kurator muzium, konservator, dan pereka pencahayaan. Kemudian, data visual dikumpul melalui pemerhatian lekapan lampu, kerosakan tekstil limar, dan kemerosotan. Data dikumpul menggunakan alat pengukur untuk mendapatkan butiran yang tepat. Akhir sekali, data dianalisis menggunakan analisis kandungan. Melalui analisis data, penyelidikan menunjukkan sejumlah besar kerosakan pada tekstil limar dan menemui punca kerosakan. Oleh itu, kajian ini mencadangkan cadangan untuk mencari penyelesaian bagi mengurangkan masalah ini.

THE EFFECT OF LIGHTING DESIGN AND APPLICATION ON LIMAR TEXTILE IN TERENGGANU STATE MUSEUM

ABSTRACT

The lighting application of a textile museum combines art, science, and engineering, whereby the lighting integrates the aesthetic value and the exhibition preservation requirements. Lighting can evoke sensations and emotions. It controls the perception of specific exhibitions, such as textiles. The quality of the lighting in the galleries is not determined solely by the source of the lighting, but also by the characters and the space configuration. The means by which the lighting hits the object and the architecture results in light penetration and reflected light, as well as how such lighting is accepted by the minds and eyes of the viewers. This research focuses on the lighting application of the limar textile exhibition gallery. This research emphasizes the lighting application in the Terengganu State Museum to help maintain better conservation of limar textiles by investigating the adverse effects of the lighting design. The selection of limar textile, by reason, is the essential cultural value that limar has in representing the history and culture of Malaysia. Therefore, this delicate and worthy textile needs to be conserved to preserve it for the upcoming generation. This study examines the lighting application components of the limar textile exhibition at Terengganu State Museum. It also investigates the lighting needs for the limar textile exhibition in the Terengganu State Museum. As well as, it establishes the perception of safeguarding the textiles from light damage by light radiation and the museum environment. The study attempts to identify whether the regulated conservation standards are complied with in preserving the limar textiles. The results of the current research will help to identify and eliminate the sources of

artificial light that can have negative effects on limar textile, which leads to fading its colour and weakening its fabric. Moreover, this study needs to be conducted considering that the number of museum institutions is generally increasing in Malaysia and will keep rising in the future. Innovation in textiles is one of the main motors of fashion. Thus dress, textiles and fashion are united in a triangular relation - inextricable, but real and worth researching. Textile museums were selected because the nation's textile collection must need to be conserved. The valuable collection of kain limar which was displayed in the Terengganu State Museum and originated in 1920, requires the technical expertise of lighting designers. The study also attempts to identify whether the regulated conservation standards are complied with in preserving such textiles. This follows the rise of various statements and accusations regarding the museums' exhibits in this country. Aside from obtaining the actual pictures technically of the real situation happening in the museums' textile exhibition, the study also provides outlooks on the importance of those aspects for future use. The research employs a qualitative method. Qualitative interviews are an effective way in which to create meaning about a particular topic. The in-depth interviews were conducted by museum curators, conservators, and lighting designers. Then, visual data is collected through observation of lighting fixtures, limar textile damage, and deterioration. The data is gathered using measuring instruments to get accurate details. Finally, the data is analyzed using content analysis. Through the data analysis, the research shows a significant amount of deterioration on limar textile and discovers the causes of the damage. Therefore, this study suggests recommendations to find a solution to reduce this problem.

CHAPTER 1

INTRODUCTION

1.1 Introduction

Light is a crucial aspect of architecture, it creates emotion, and it can be therapeutic (Kelly, 2016). It can create subtle effects that change how people think, feel and decide, which means that light can enhance the sentiment and evoke the sensation (Kelly, 2016). Besides emotion, when it comes to displaying light is a fundamental factor in improving the visualization of any element includes the textiles museum (Kartashov et al., 2019). In interior design, light plays a central role, and design lighting also has cultural effects (Pathak et al., 2015). Malaysia is saturated and filled with this value due to the variety of the races' influence (Md Nawawi et al., 2016). One of the valuable elements that represent Malaysia's culture is limar textile (Md Nawawi et al., 2016). Limar is a single weft textile from Terengganu and Kelantan (N. H. Ismail & Nawawi, 2011). It is the preserve of nobility as it employs costly materials made out of organic material (N. H. Ismail & Nawawi, 2011).

As stated above, light is necessary for viewing and appreciating textiles. At the same time, however, it harms textiles, fades colours, and weakens fibres (Renée Dancause, 2018). This research focuses on the application of exhibition lighting design's impact on limar textile. In order to get a systematic and informative review of the lighting design in the textile exhibition in Malaysia, this research incorporates the Terengganu State Museum in Malaysia. The selection for this specific museum is made based on a few factors that fulfil the need for the study. The first factor is the amount of limar textile collections of the Terengganu State Museum (Suzanne Stankard, 2010). The second factor is that the Terengganu State Museum has become

a local and foreign tourist attraction (Abi et al., 2012). The third factor is that the museum chosen was associated with the arrival of the advanced and latest technology. This latest technology has been identified using LED, dimmer, and sensor on the limar textile exhibition space. Furthermore, is the connection between limar textile and Terengganu state is that it is mainly originated from Terengganu and Kelantan (Md Nawawi et al., 2016). As well as that, the remaining old weavers are in Terengganu (Md Nawawi et al., 2016).

In figure 1.1, all light is categorized by it is different wavelengths of the Electromagnetic Spectrum. Visible light for humans occurs between 400 nanometers and 780 nanometers; light above that is infrared, while blew that, roughly 100 nanometers to 400 nanometers, is ultraviolet light (Planck, 2020).

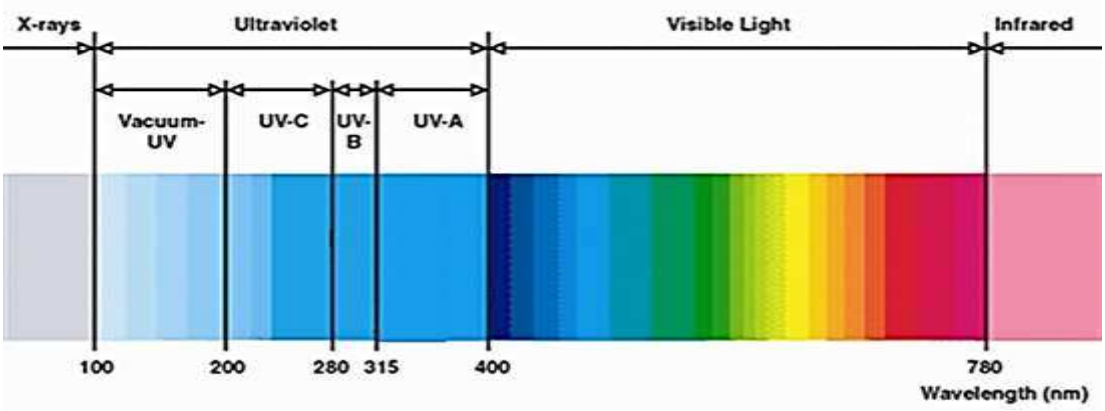

Figure 1.1 The Electromagnetic Spectrum

Source: (J. da Silva et al., 2019)

Equaling to human beings' skin, all organic materials which come from original sources such as animals or plants can be absolutely damaged by light (Farke, Binetti & Hahn, 2016). Exactly like how human skin reacts to the sunlight, whether it is short period damage such as sunburn or even long-term damage like wrinkling or

loss of skin tone (Leun & Gruijl, 1993). It also applies to limar textile since it is made out of organic material such as organic silk, organic cotton, and the dye originated from plants (Md Nawawi et al., 2016). The damage that occurs from UV and IR is explained as the following chart shows.

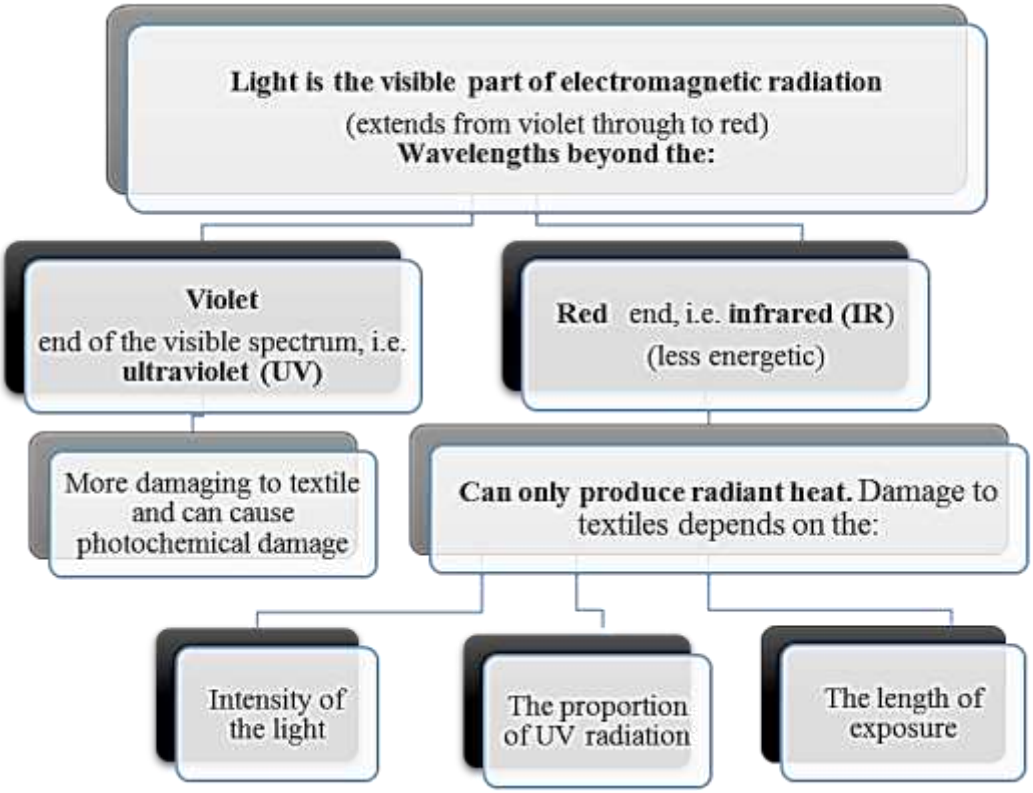

Figure 1.2 Concluded from the study of textiles and the environment

Source: (CCI, 2013)

1.2 Background of the Research

Each country is represented by its culture, which defines its identity (Masolo, 2002). One indication of a healthy society is its tendency to conserve and innovate its culture, such as to maintain its tradition and history while at the same time creating new expression for the present time. Heritage and history are frequently essential

sources of meaning that give a place character and resonance (Derman, 2003). The history of Malaysia is incredible; it is saturated with a combination of valuable cultures; those cultures can be reflected through traditional handicrafts (Md Nawawi et al., 2016). Malaysia boasts a remarkable collection of traditional crafts, Choices range from priceless authentic antiques to exquisite modern hand-made crafts besides the marvellous hand-woven crafts of Malaysia (Fadeli, 2019). Varieties of Malaysia's traditional textiles include songket, batik, pua kumbu, and limar textile (Md Nawawi et al., 2016).

A central element ensuring the success of a country's identity is well conservation of its cultural value (Masolo, 2002). One of the magnificent elements that represent the culture of Malaysia is limar textile (N. H. Ismail & Nawawi, 2011). The importance and true value of limar textile will be discussed in the following subchapter under 1.2.1 the value of limar textile.

The largest museum in Malaysia is Terengganu State Museum (Abi et al., 2012). It preserves a tremendous amount of limar textile collections; as stated above, the associations of limar textile with cultural attributes represent the Malay identity (Suzanne Stankard, 2010). Therefore, to get the best conservation to this delicate element, this study must highlight the factors that obstruct the conservation mission. Light is one of the most significant influences that harm limar textile. The unsuitable lighting can damage the textile, such as fading in colour, different dry expansion, and contraction (Renée Dancause, 2018). This matter will be investigated in detail in this research. For this reason, the study aims to focus on the effect of lighting design on limar textile in Terengganu State Museum.

1.2.1 The Value of Limar Textile

According to a description provided by Dr. Norwani (2016), understanding the historical background of the Malay textile will lead to an appreciation of the design in ikat limar fabrics and of the tedious work involved in making them. Understanding the importance of Limar textile requires analyzing each aspect of its cultural value (the tangible and the intangible), as shown in figure 1.3 (more in-depth and detailed information will be stated in chapter 2).

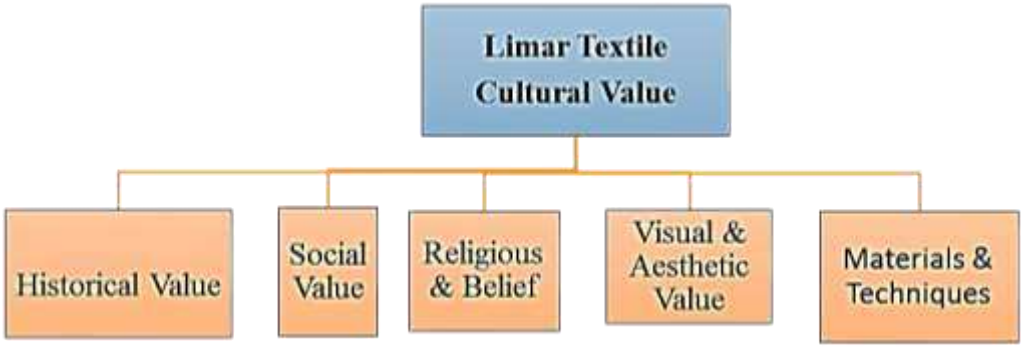

Figure 1.3 The Aspects of Limar Textile Value

Source: (Norwani Md. Nawawi, 2016)

Ikat limar is documented in traditional Malay literature and poems and is considered the most delicate and precious textile. Therefore, it was made specifically for the royal court and the past nobility (Md Nawawi et al., 2016).

This worthy textile figure 1.4 goes back to the 16th century; it is worn on special occasions such as weddings, traditional dance ceremonies, and circumcision for boys, *Khatm Al-Qur'an*, and even sometimes on the coffin in Muslim funerals (Md Nawawi et al., 2016) (detailed information in chapter 2). Limar textile reflects the

costumes, traditions, climate, local material, and the cultural legacy of ages that passed through Malaysia.

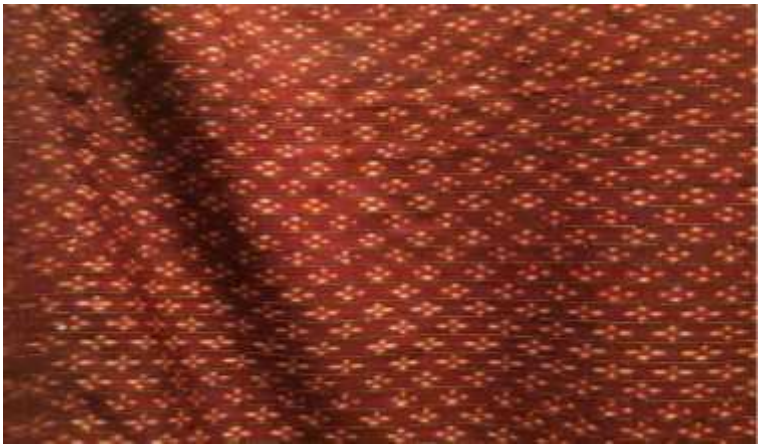

Figure 1.4 Limar Textile

Source: (“Author” Islamic Art Museum, 2019)

Figure 1.5 Kain Limar Telepuk Decorated with Gilded Gold Leafs on the Surface of the Ikat Sarong

Source: (Textile Museum, Kuala Lumpur)

Limar textile is made out of organic materials such as organic silk from China, organic cotton from India, gold or silver thread from an Arab country, and the dye originated from plants (Md Nawawi et al., 2016).

1.3 Theoretical Framework

Textiles in all forms are an essential part of human civilization (Bergfjord et al., 2012). Malaysia has a history that is filled with significant values, and textiles are one of the artefacts that provide an important reference to understand the historical prosperity and the culture in Malaysia (Md Nawawi et al., 2016). Unfortunately, all textiles, including limar textiles in museums are exposed to many risks such as uncontrolled relative humidity (RH) and temperature, light and air pollution, and non-standard storage and display methods (Karadag, 2014). This research investigated the light factor that affects the conservation of limar textile at Terengganu State Museum. The way in which the level of damage and the amount of deterioration through investigating the light fixture, the amount of lux, the angle installation, the UV/ IR radiation and the exposure time. The theoretical framework specifies which key variables influence the level of the deterioration to examine the state of limar textile collections at Terengganu State Museum.

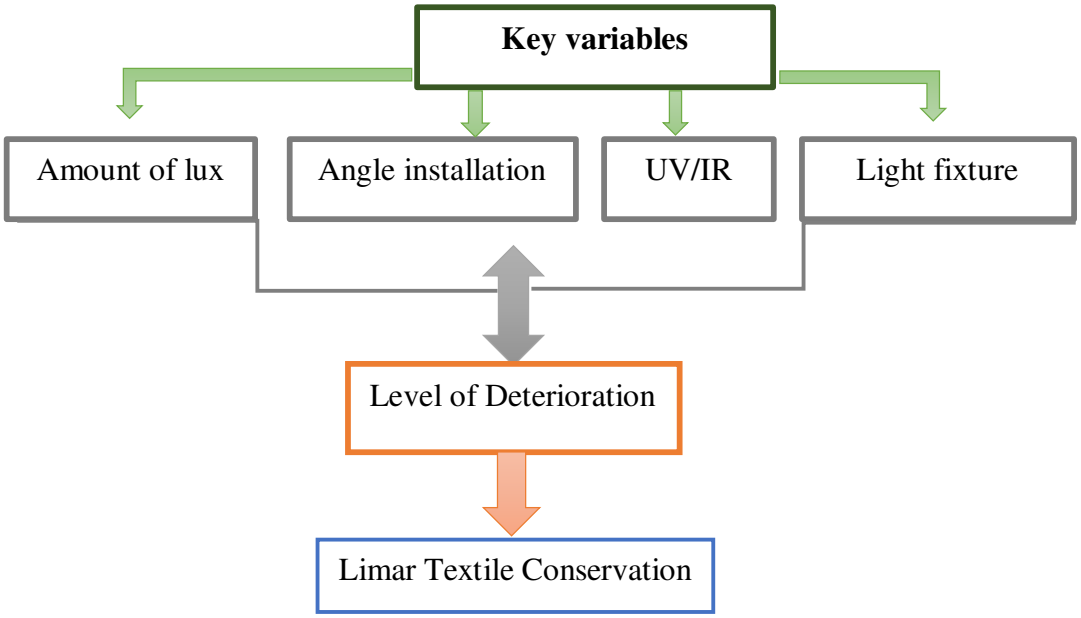

Figure 1.6 Theoretical Framework

1.4 Conceptual Framework

Every state in Malaysia has a unique history, Terengganu is rich in history, and it stands out as having one of the most unique and beautiful natural attractions. It is also rich in arts and culture. The state is considered to have many of Malaysia's leading artisans and craftsmen in songket, batik, limar, wood carving, boat building, and traditional woodworking. In essence, Terengganu has contributed and shaped many elements of Malay culture (Yusof & Ibrahim, 2018). Terengganu's location by the South China Sea is indeed strategic. This location ensured that it was on trade routes since ancient times, and nowadays, it becomes a great attraction for tourists. Terengganu Malay women have been considered for the skill of their pleating and the wide range of their patterns (Legino, 2012). In traditional Malay culture, a woman was not well-prepared for life until she gained a talent in the art of mat-weaving; this skill was. Therefore, an essential element in the development of character and personality.

Figure 1.7 Terengganu State Museum.

Source: (Rahim et al., 2016)

Figure 1.8 Textile Display Exhibition

Source**:** (Rodgers, 2012)

The levels of temperature and humidity must be measured. Many museums have set their relative humidity at 45% and gallery temperatures between 65 and 68 degrees Fahrenheit (H. Alten, 2014). On the other hand, people also have a significant effect on the environment. They raise the temperature and increase the humidity in common show corridors. Outdoor conditions are also considered one of the major factors which affect the museum in the environment. The main character of these factors that the research will be focusing on is the lighting design. The nature of the lighting in the galleries is dictated not just by the source of the illumination but also by the characters, the design of the room, and also the layout (Darragh et al., 1993).

The level of probability of the textile damage due to the lighting depends on three factors; the illumination level on the textile, the amount of time exposed to the lighting, and the lighting spectrum composition. The lighting mentioned includes

ultraviolet radiation and infrared (Boer, J.B. de & Fischer, 1978). The damage inflicted on the textile that is light sensitive can be slowed down by limiting the illumination to the constant value stipulated by the conservation experts, lessening the time of exposure and reducing the distance of the short light wave, in particular, the ultraviolet (Boer, J.B. de & Fischer, 1978). By considering the composition of the light spectrum, it is known that the damage to the textile increases with the reduction of the distance of the light wave, which is the kind that is visible, to the blue-coloured spectrum and eventually to the ultraviolet type (Cuttle, 1995). Thus, for the conservation purpose, the source used for the textile lighting must be the one that relatively has low ultraviolet ray emission/production (Boer et al., 1978).

Hence, by comprehending the damaging factors created by types of lamps, it is presumed for the designers and conservators to choose and position the various lighting sources for the textile lighting in the local museum in order following the damaging factor constantly gained (Boer et al., 1978).

The effect of lighting on the colour of textile products is an integral component of the textile museum and visual merchandising. Through this research, the technical aspect such as the lighting system and the general maintenance will be identified. The amount of light, the distribution of light, colour, direction, and the movement of the light contribute to the ability to see and the safety level of the collection itself.

According to Bas Swaen and Tegan George (2022) a conceptual framework illustrates the expected relationship between variables it defines the relevant objectives of the research process and maps out how they come together to draw coherent conclusions. Figure 1.9 demonstrate the relationship between the (time of exposure

factor, UV and IR radiation, the lamp selection, the angle installation, and the amount of lux) with the level of the deteroration occurring on limar textile.

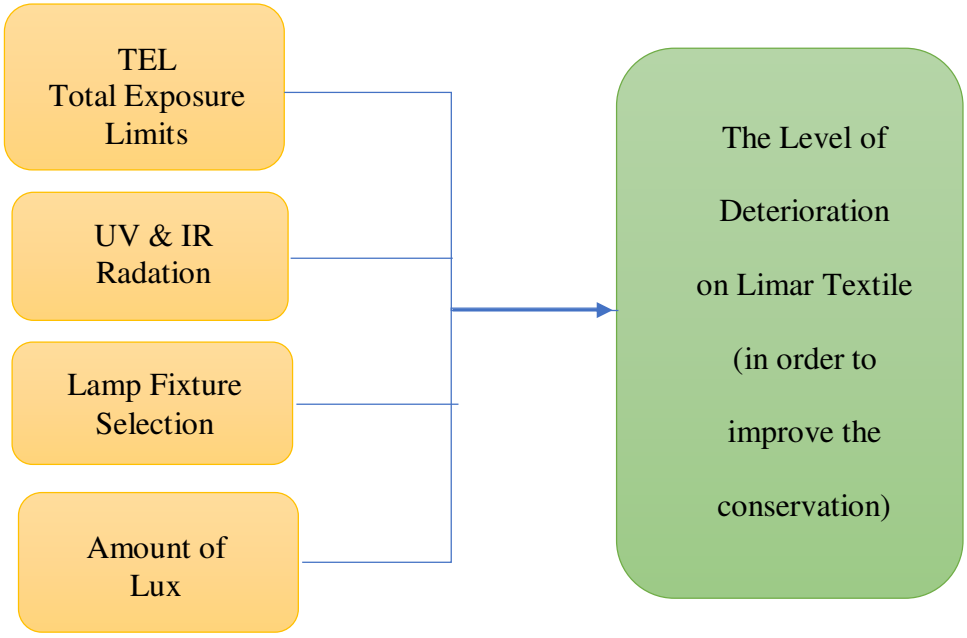

Figure 1.9 Conceptual Framework Diagram

This research is conceptualized to fill the research gap, which is related to the mismatch between the lighting design in Terengganu State Museum and the conservation of limar textile. Therefore, in order to respond to this gap, there is a need to examine this issue by investigating the damage on limar textile caused by the light in Terengganu State Museum through the objectives mentioned above.

1.5 Problem Statement

The problem is that museums have to display their textile in a place where their visitors can see them, and also to preserve these textiles for a long time without getting

destroyed by environmental aspects such as light. The museum has a role to balance both preservation of the textile and making their display as appealing as possible for their visitors. Limar textile is one of the most valuable elements in Malaysia's culture, which also represents the history of Malaysia (Zakaria, Latif, & Bahauddin, 2018). Therefore, it has been conserved in the museums, specifically in Terengganu State Museum. In order to protect and preserve textile and prolong its lifetime, it needs to be kept in a dark place (Ritzenthaler, 2016). Keeping textiles in closed cabinets or drawers helps protect them entirely from light and UV; however, this undermines the task of museums to exhibit and display their artefacts (Mary W. Ballard et al., 2015). Textile museum environment factors have some negative impacts that affect the mission of preserving the textiles. One of these significant factors is the lighting design; the museum's lighting is the main factor contributing to the interior design of the museum and the interior space creating a pleasant visual atmosphere (Aderonmu & Ediae, 2019). All substances of plant or animal sources (organic materials) could be extra fragile and delicate to the light, causing damage (Conn, 2012). Limar textile considers an organic fabric since it is made out of natural fabric "silk" and natural dye (Md Nawawi et al., 2016).

Since the UV radiation in daylight, sunlight, and some electric light sources is a major cause of yellowing and weakening of fibres, along with light, UV also causes fading or change in colour of many textile dyes, including natural and synthetic dyes (CCI, 2013). Therefore, this research addresses the effect of lighting design on Limar textile in Terengganu State Museum, which is located in Kuala Terengganu.

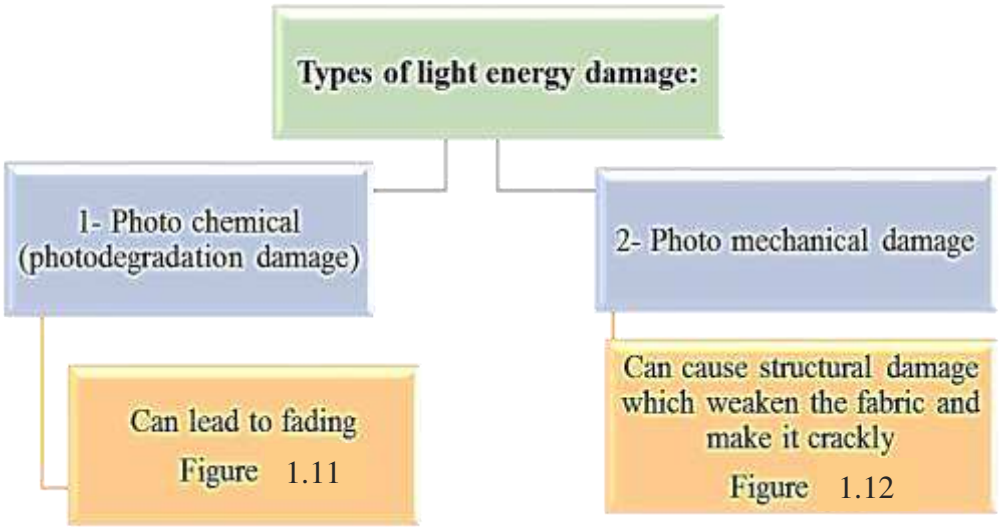

Figure 1.10 Types of Light Energy

Source: (Youssef, Sheibani, & Albert, 2011)

It is about the chemical structure of the object, Photo-degradation is the technical term for colour fading (Highsmith, 2014). There are light-absorbing colour bodies called chromophores that are present in dyes and the colour which is seen based upon these chemical bonds and the amount of light that is absorbed in a particular wavelength Ultraviolet rays can break down the chemical bonds and thus fade the colour in an object it is sort of a bleaching effect (Highsmith, 2014). Usually, the light energy is either reflected or absorbed; the absorbed light energy is the one that causes damage (Sami, 2018). Therefore, the damage can be minimized by reducing the absorbed light by eliminating the non-visible radiation, which is "IR" Infrared Radiation and "UV" Ultra Violet light (Farke et al., 2016).

Figure 1.11 Textile colour fading

Source: (Farke et al., 2016)

Figure 1.5 Structural damage and weaken textile

Source: (Terengganu State Museum)

Damage can happen due to the lighting beamed upon the textile, the timeline of the beamed lighting as well as the type of components of the lighting spectrum (Darragh et al., 1993). This research focuses on all the sides of the latest technology in the lighting design adding the time factor to the radiation control, and the concept of the TEL (Total Exposure Limits) involves both time and illuminance to have a final of lux-hours per year. The way to measure the damage to the materials is to multiply the light level by the time of exposure, measured in lux hours (lx h) for example 10 hours

a day at 50 lux for 100 days equals 50,000 lx h (Conn, 2012). This lighting design study will compare the limar textile needs and whether the museum lighting design is neglecting the requirements of the textile conservation and exhibition in every aspect.

Table 1.1 Recommended light levels for museum collections while on exhibition

	Visible light	**Ultraviolet (UV) light**
Sensitive collections Including textiles, watercolours, photographs, and other papers	Maximum: 50 lux (15 footcandles)	Ideal: 0-10 microwatts per lumen Maximum: 75 microwatts per lumen
Less sensitive collections Including oil paintings, wood, and leather	Maximum: 150 lux (15 footcandles)	Ideal: 0-10 microwatts per lumen Maximum: 75 microwatts per lumen
Least sensitive collections Including most metal, ceramics, stones, and glass	Maximum: 300 lux (30 footcandles)	Ideal: 0-10 microwatts per lumen Maximum: 75 microwatts per lumen

Source: (Michalski, 2018)

As stated above some specialists have also added the time factor to radiation control and the concept of 'TEL' (Total Exposure Limits) involves both time and illuminance to have a final of lux-hours per year by mean that TEL= (illuminance (hours per day)(days per year). In relation to Infrared radiation, the parameter to be controlled is the actual temperature on the surfaces of illuminated objects. According to Palacio (2007), ideally, incident light should not increase the temperature of the object compared to the ambient temperature present in the exhibition space. As to Ultraviolet radiation, it is important to say that conservators have decided to use the

units of _W/lm microwatt per lumen which in the face refers to the amount of UV per visible light present in a light source. For practical applications, UV has nothing to add to visibility conditions, but it is a definite factor of deterioration (Palacio, 2007). The main problem is how this affects the life expectancy of the textiles in the museum exhibition at Terengganu State Museum.

1.6 Research Questions

Like any study, the research objectives and research questions needed to be prioritized. After referring to and reading up on the works of previous researchers on managing the textile collections within the museum environment, researchers attempted to raise several issues and scenarios in the study to find that lighting design is one of the major affecting factors, the table below proves this finding. Table 1.3 demonstrates the number of years of a noticeable fade of an object shown 3000 hours per year at 50 lux (in the table 'UV rich' refers to a spectrum similar to daylight through the glass, and 'No UV' means no radiant power below 400 nm). Furthermore details in Table 1.4

Table 1.2 Years for a noticeable fade for objects

Material responsiveness classification	**ISO Rating**	**Years of noticeable fade**	
		UV rich	**No UV**
Highly responsive	1 2 3	1.5 4 10	2 7 20
Moderately responsive	4 5 6	23 53 130	67 200 670
Slightly responsive	7 8	330 800	2000 7300

Source: (L. Cuttle et al., 2007)

Table 1.3 Four category classifications of materials according to responsiveness to visible light.

Material Responsiveness classification	**Material description**
Non-responsive	The object is composed entirely of permanent materials, in that they have no response to light. Examples: most metals, stone, most glass, genuine ceramic, enamel, most minerals
Slightly responsive	The object includes durable materials that are **slightly light-responsive**. Examples: oil and tempera painting, fresco, undyed leather and wood, horn, bone, ivory, lacquer, and some plastics.
Moderately responsive	The object includes fugitive materials that are **moderately light-responsive.** Examples: costumes, watercolours, pastels, tapestries, prints and drawings, manuscripts, miniatures, paintings in distemper media, wallpaper, gouache, dyed leather, and most natural history objects, including botanical specimens, fur, and feathers.
Highly responsive	The object includes highly light-responsive materials. Examples: silk, colourants are known to be highly fugitive, newspaper.

Source: (L. Cuttle et al., 2007)

This study addresses the research problem by answering the following questions:

1. Is the lighting application in the Terengganu State Museum's limar textile exhibition gallery in accordance with the regulated standard?

2. Does the lighting application in the limar textile exhibition gallery at Terengganu State Museum adhere to the regulated standard?

3. What lighting and other environmental parameters are required for the limar textile collection at Terengganu State Museum?

Therefore, this study will work on answering these research questions through the following research objectives.

1.7 Research Objectives

The following objectives are of vital concern:

1. To examine the lighting application component requirements of Terengganu State Museum's limar textile exhibition gallery.

2. To develop at Terengganu State Museum the perspective of preserving limar textile against light application damage caused by light radiation and the environment.

3. To propose constructive methods to address the damage of the light application and improve limar textile conservation, taking into account the museum environment in Terengganu State Museum.

1.8 Research Flowchart

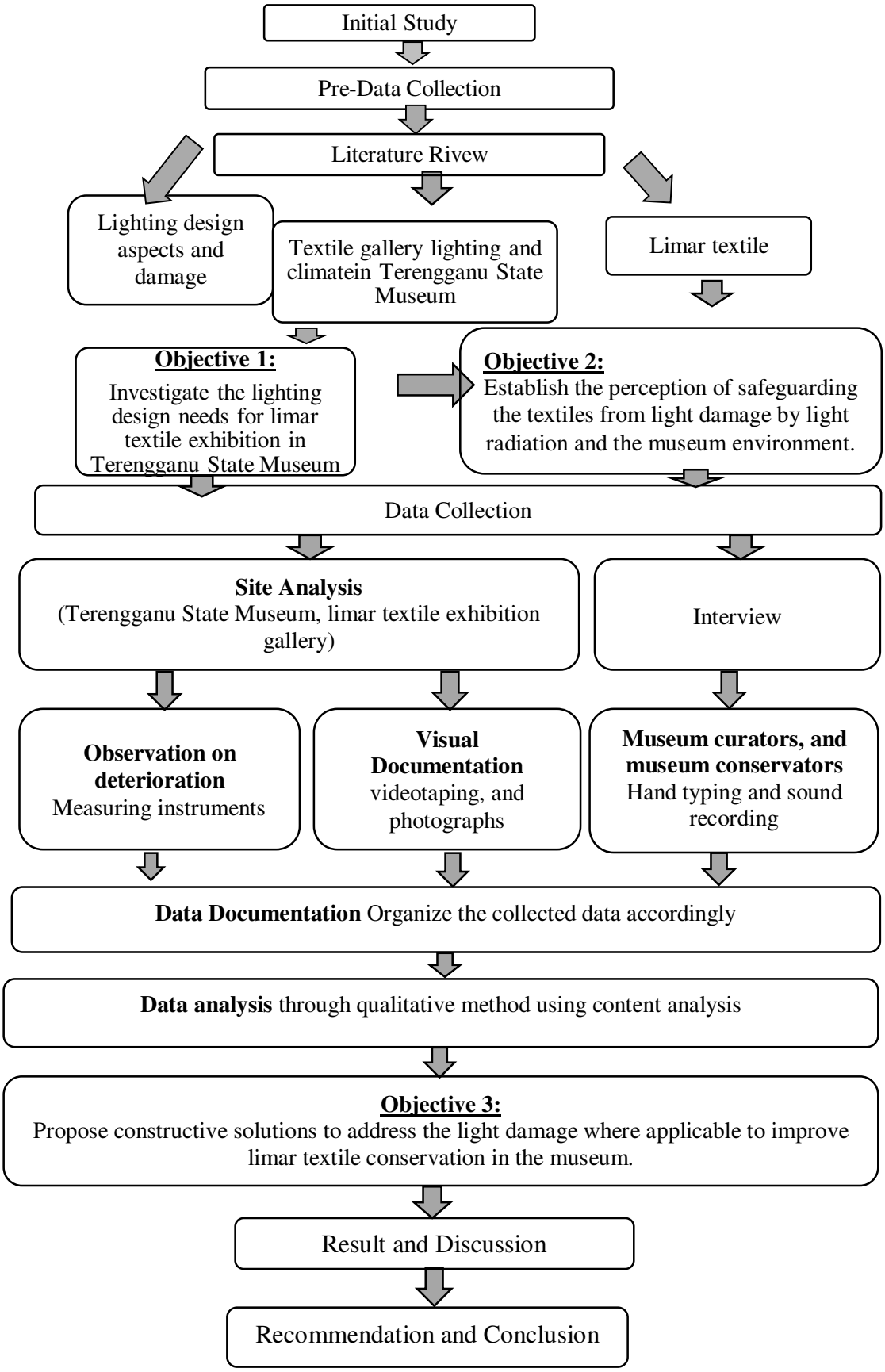

Figure 1.6 Research Framework Flow

1.9 Significance of Research

The study attempts to identify whether the regulated conservation standards are complied with in preserving the limar textiles. The results of the current research will help to identify and eliminate the sources of artificial light that can have negative effects on limar textile, which leads to fading its colour and weakening its fabric. Fig 1.14 shows the importance and contribution of the research in terms of education, academic work, and community.

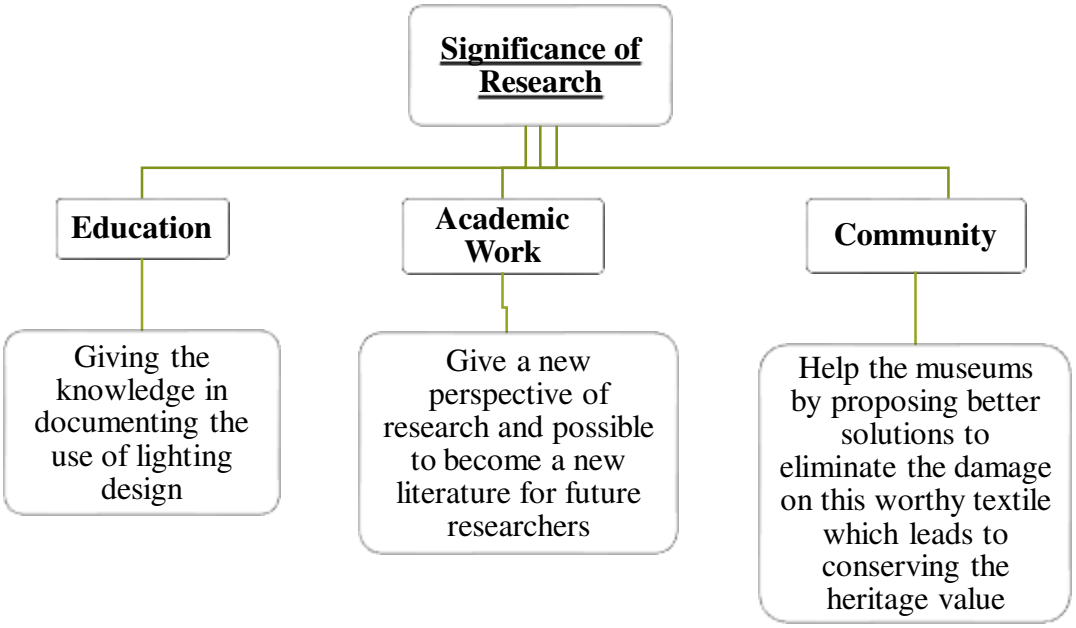

Figure 1.7 Significance of the research

This study needs to be conducted considering that the number of museum institutions is generally increasing in Malaysia and will keep rising in the future. Innovation in textiles is one of the main motors of fashion. Thus dress, textiles and fashion are united in a triangular relation - inextricable, but real and worth researching (Belger Krody, 2014). Textile museums were selected because the nation's textile collection must need to be conserved. The valuable collection of kain limar which was

displayed in the Terengganu State Museum and originated in 1920, requires the technical expertise of lighting designers.

The study also attempts to identify whether the regulated conservation standards are complied with in preserving such textiles. This follows the rise of various statements and accusations regarding the museums' exhibits in this country. Aside from obtaining the actual pictures technically of the real situation happening in the museums' textile exhibition, the study also provides outlooks on the importance of those aspects for future use.

1.10 Limitation of Research

The study acknowledges three main limitations when conducting the research so that the study can be read with these shortcomings in mind. The first limitation faced was the lack and absence of lighting designers in Malaysia and the hardship to communicate with the overseas lighting designers as the researcher did not get any feedback response from them.

The second limitation of this research was the language barrier. The researcher cannot read Bahasa Melayu. As most of the literature on ikat limar is written in the Malay language and not translated, the researcher could only rely on limar textile literature written in English, which is mainly by the great Norwani Md. Nawawi.

Finally, the third limitation of the research was the lack of a UV light meter and infrared thermometer. Although the researcher's reference on the UV measurements was based on the museum's data, yet the researcher thinks it would be beneficial to get specific detailed measurements using those measuring devices.

1.11 Thesis Outline

Six chapters are included in this study. The chapters of this study are organized as follows:

Chapter one introduces the background of the study. It presents and discusses the problem of the study, the research gap, the research objectives, and the questions. Also, it discusses the significance of this study as well as the limitations of the research.

Chapter two includes comprehensive literature pertinent to the variables of the study. The study framework is also discussed in-depth research about the limar textile and museum lighting design, as well as the proposed damage relationships between them.

Chapter three discusses the research analysis design. Measurements and data analysis techniques for the qualitative data are presented with the research validity.

The fourth chapter presents detailed explanations of the analysis and results. Qualitative data analysis and results are presented in this chapter.

Chapter five introduces the discussions of the research findings. It discusses the application of the research objectives and research questions in this study. The direct relations were presented.

Finally, chapter six provides the summary of the whole research, the validity of the research based on the relation with the objectives and putting forward recommendations for future research. Chapter six ends with a conclusion.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

A museum is a significant institution that conserves a collection of worthy objects, including textiles. Unfortunately, the museum environment considers a factor that can lead to the defeat of the mission of conservation. Light is a major factor, and it is the main focus of this research. Figure 2.1 displays the nowadays challenge facing museums and galleries towards the lighting design which is to reach a balance between the use of the energy level throughout the installation life and the quality of the lit environment (Sylvania et al., 2007). The inevitable challenge for museum lighting is to combine excellent rendering of both detail and colour with minimal damage exposure of the displayed objects (L. Cuttle et al., 2007).

Figure 2.1 The Lighting Challenge in Museums

Source: (Sylvania et al., 2007)

This research will be focusing on the light application of one of the greatest museums in Malaysia, which is the Terengganu State Museum, and the target point is limar textile. Light can have a variety of adverse effects on textiles. In some cases (Figure 2.2) it may contribute to fading or discolouration, which is photochemical damage, as stated in chapter 1. On the other hand, is the intense damage, which occurs to the fibres as a result of the long period of exposure to ultraviolet and infrared lighting which are the non-visible light. Without a doubt, textiles should be stored in total darkness and displayed in as little light as possible (Rubeziene et al., 2012). However, this is impractical as it defeats the museum's mission, which is displaying and exhibiting.

Figure 2.2 Color Fading due to Light Deterioration (the original colour is protected from the light under the belt)

Source: (Behring, 2007)