



**SUDAN UNIVERSITY OF SCIENCE AND
TECHNOLOGY
COLLEGE OF POSTGRADUATE STUDIES**



ROLE OF URBAN NIGHTSCAPE IN GOOD PERCEPTION OF THE CITY

(Case Study: Khartoum City)

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(دراسة حالة: مدينة الخرطوم)**

**A THESIS SUBMITTED AS A PARTIAL REQUIREMENT FOR THE DEGREE
OF M.Sc**

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March 2017

الآية

بسم الله الرحمن الرحيم

قال تعالى :

”وآية لهم الليل نسلخ منه النهار فإذا هم مظلمون“

صدق الله العظيم

الآية (37) سورة يس

Dedication

I dedicate this work to my parents for supporting me and their dedicated partnership for success in my life.

Acknowledgement

Thanks to ALLAH (SWT) for all the countless gifts and guidance and the support and for inspiring me to believe in my self.

Thanks to my family for their love and support.
And thanks to Dr. Awad Saad Hassan for his kind supervision. It was a great honor to work under his supervision.

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Abstract :

The way people perceive the city's elements at night is totally depends on lighting design and man-made facilities. Due to the development of cities' economic and citizen's life style, the nightscape of the city became as important as the appearance of the city at daytime and sometimes it is more important because it can make more impact on people's minds about the city.

Though the potential of Khartoum city to become an iconic lighted city on the Nile river, the city at night looks deserted and dark, also it has a huge amount of lighting pollution and sky glow.

This thesis aimed to achieve the proper understanding of urban nightscape and the strategies that can enhance the perception of the city to apply it in Khartoum city.

To achieve these objectives, the thesis asked many questions which have been answered from the theoretical studies and nightscape analysis.

This thesis uses descriptive analysis for specific sites that have been chosen in Khartoum city to figure out the nightscape statement of the city and to be a starting point toward developing the city.

The study found that there is a huge amount of lighting pollution specially sky glow that caused by poor lighting facilities that have been used for streets and buildings, also there is a financial issue makes the overall nightscape of the city dark more than bright.

Khartoum city is an excrescence city, therefore, the architects and urban designer must be aware about the lighting design in the very beginning stages of the projects design and take the lights into account while designing and improving the projects. Also the government and owners must be aware about the nightscape statement and its role in the growth of the city economy.

المستخلص :

إن الطريقة التي يتلقى بها الناس عناصر المدينة ليلاً تعتمد كلياً على تصميم الإضاءة و الوسائل من صنع الإنسان. مع التطور الاقتصادي للمدن وتطور أسلوب حياة السكان أصبح مشهد المدينة الليلي بنفس أهمية مظهرها خلال النهار وفي بعض الأحيان أكثر أهمية بسبب أثرها الكبير على تصور الناس للمدينة ليلاً.

بالرغم من الإمكانيات التي تتميز بها مدينة الخرطوم و التي تجعلها مدينة النيل المضاءة إلا أنها تبدو مهجورة و مظلمة. وكذلك إحتوائها على كمية هائلة من التلوث الضوئي وتوهج السماء.

تهدف هذه الأطروحة لتحقيق الفهم الصحيح لمشهد المدينة الليلي الحضري و الإستراتيجيات التي يمكن إتباعها لتحسين إدراك المشهد الليلي الحضري للمدينة و تطبيق ذلك في مدينة الخرطوم.

لتحقيق هذه الأهداف طرح البحث عدد من الأسئلة و التي تم الإجابة عليها من خلال الإطار النظري للدراسات و البحوث وتحليل المشهد الليلي.

إستخدمت هذه الأطروحة أسلوب التحليل الوصفي لمواقع معينة تم إختيارها في مدينة الخرطوم لإكتشاف الحالة العامة للمشهد الحضري الليلي وتحديد المشاكل ونقاط الضعف في هذه المواقع ولكي تصبح نقطة البداية نحو تطوير المدينة.

وجدت الدراسة ان هناك كمية كبيرة من التلوث الضوئي خاصة توهج السماء الناتج من استخدام عناصر انارة رديئة في الشوارع والمباني مما جعل المشهد الليلي للمدينة مظلم و مهجور.

مدينة الخرطوم مدينة نامية, لذلك يجب على المماريين و المصممين الحضريين أن يضعوا تصميم الإنارة في عين الاعتبار من المراحل الأولى لتصميم المشروع. كذلك على الحكومات والملاك أن يكون لديهم الوعي الكافي بدور المشهد الحضري الليلي في ازدهار اقتصاد المدينة.

Chapter (1)

Introduction

CHAPTER 1

Introduction

1.1 Introduction

The city and its elements such as streets, urban spaces and buildings are sound familiar and legible during the daytime, where the sun reflects the design of the city. But the period of daytime is just a part of the day, then how the appearance of the city looks like during the night time?

Unlike daytime, the appearance of the city at night is totally depend on man-made facilities, which need a proper understanding of the nightscape and urban illuminations.

Recently, within the development of city economic and citizens' life style, most people are busy at work during the daytime, night time become their main leisure periods. Therefore, the nightscape of the city is as important as how it looks like during the daytime. And sometimes nightscape can make more impact on people's mind about the city.

Its important to understand what is nightscape to create cities that simulate people to walk around streets and urban spaces with feel of safe and enjoyment.

Urban lighting is not the end in itself, it is means by which we can deliver improved community and economic outcomes. The challenge is to extend a truly human-centric urban design and planning approach to include the after dark hours and the people and positive experience that thrive within them (M Scaffidi, Lisa. 2014).

Good public lighting can transform cities at night. It can provide a sense of amenity and with careful planning boots the aesthetic qualities of a city and permit the icons of the city landscape to stand out by night as well as the day. Good well-planned lighting can make a city more legible and thus make it easier for people to use it after dark. People out after dark

have a number of needs include safe movement, visual orientation and visual comfort; lighting provided to meet these needs will in general also provide a sense of amenity and help with legibility (Raynham, P J. 2011). Lighting is a key factor affecting environmental experiences. Its connected with perceived restorativeness, preference, pleasantness and fears. These factors were chosen because it is believed that they significantly affect people's willingness to use urban spaces after dark (Nikunen, Heli. 2013). The perceived quality of the lighting environment correlates with perceptions about the potential for restoration, thus providing a new framework for lighting research. The results indicate that perceived restorativeness is positively connected with the perception of a pleasant color quality, whereas the connection may be negative when the light is focused on urban scene contents. (Nikunen, Heli. 2013).

Kevin Lynch (1961) brought our subjective feelings into his study of urban spaces in his book *Image of the city*. Lynch's theory occurred just during the time when American big cities constructing their nightscape. The combination between nightscape and creating the image of the city helped American urban nightscape's rapid development. With the theory of creating the image of the city, urban spaces is no longer a cold spatial concept, but a social place which can meet people's physical and psychological needs (Hongxiang, Yan. 2014). It is equally important to look for the favourable effects of nightscape as a means of grasping the whole picture of environmental experiences during the hours of darkness. Outdoor lighting creates a scene for various actions, including romantic walks, jogging, a space for kids to play and relaxation. There is a need to widen the scope from the negative connotations of fearful passers-by performing visual tasks to seeing the full diversity of human needs and experiences during the hours of darkness (Nikunen, Heli. 2013).

1.2 Objectives of the research:

The thesis is searching about the effect of nightscape and urban illumination on people's feelings of safe and pleasure about their neighborhoods, streets and urban spaces, and how it can influence on social, safety, economic, aesthetic aspects of the city. Therefore, the specific objectives of this thesis are:

- To figure out how could nightscape and urban illumination contribute in creating the image of the city.
- To make some contribution on studies of the structural plan of Khartoum city.
- To find out how could nightscape make impact on people's mind about the city.
- To become a different starting point toward developing the city.

1.3 The Statement of the research Problem :

This thesis tried to figure out the nightscape statement of the chosen sites in Khartoum city. It found out that the lighting design of urban lights and illuminations are unsuitable which made the overall nightscape dark more than bright. Also the lighting design of each component in the chosen sites is extremely unplanned and didn't take human scale into consideration. This thesis can bring more opportunities for further researches to study more sites in Sudan cities. The studies on this topic can bring different solutions to improve different aspects of the city.

1.4 Research questions:

To achieve the research objectives, many questions must be answered:

- 1)- How could nightscape improve the perception of the city?
- 2)- How could nightscape effects on human's behavior?
- 3)- What are the problems that result from poor design of nightscape and urban illuminations?
- 4)- What is the relationship between urban lighting and reducing crimes and increase feeling of safe?

5)- What is the problems and short comings in the nightscape of the chosen sites in Khartoum city?

1.5 Research Methodology:

This thesis uses descriptive analysis to figure out the problems and short comings of the nightscape in the chosen sites in Khartoum city. And according to the theoretical studies there is certain criteria and indicators will be taken into account to evaluate the nightscape statement of each site.

1.6 Scope and limitation:

The research is concern on nightscape of specific sites in Khartoum city according to its importance of the city's economy, aesthetic and entertainment. Due to the lack of researches and studies about the nightscape of Khartoum city, there is a limit of the information about urban illumination of the city.

1.7 Organization of the research:

This thesis consist of five chapters. **Chapter 1** gives a brief introduction about the research and the objectives, questions and limitations.

chapter 2 presents the nightscape and urban illumination and detailing its importance for the city.

Chapter 3 presents the strategies that could enhance the perception of the city at night from various researches and papers for the components of the city such as: streets, buildings, parks and so on.

Chapter 4 study the chosen sites of Khartoum city from the scope of the previous theoretical researches and trying to figure out the problems and short comings.

Chapter 5 contains the conclusion of the thesis and recommendations and the limitations and further research.

Chapter (2)
Nightscape and
Urban Illumination

CHAPTER 2

Nightscape and Urban Illumination

2.1 Introduction

Light is a fundamental to all social life, yet public realm lighting can often focus on prescriptive design standards, rather than designing with social relevance for the way that humans interact in a modern 24 hour city (Lam, Florece and others. 2015).

Many researches seek to get a proper definition of nightscape from their own perspective. Yan (2014) has pointed out definition of nightscape is addressed from the scope of urban design:

- * it is a concept which can be treated as a branch of landscape, it contains both natural landscape (the natural environment that are not influenced or slightly changed by human) and culture landscape (the landscape caused mainly by human activities) with natural lighting, which usually comes from the moon and other luminous planets during night, and man-made illuminating.

- * It usually appears as composite scenes with natural environment, urban elements, human activities, lighting facilities and so forth. It exists as a different representation of urban facilities as its carrier.

- * Nightscape aims to create a night view for a certain area or a city with artistic effects. It usually uses different lighting methods to change the appearance of urban spaces and human's psychological feeling about them.

- * A nightscape can be designed to work for a long periods like years, but also can be temporary built for special purposes and can be divided into different types . Master planning urban lighting is a comprehensive concept that considers the urban nightscape in all its aspects. It starts with safety and security and moves on to the forming of the objective impressions of all the various visual components of both residents and visitors that help to ensure an attractive, commercially successful and energy efficient night-time economy.

Currently, most urban lighting is undertaken by separate bodies such as highways departments looking after the roads and signage, tourist boards looking after the decorative lighting of major features and the private developer looking to illuminate his office building or advertising hoarding (CIE news, 2008).

People start to pay more attention to their nightlife. This trend brings out an increasing need of consumptions. The night economy of cities are usually stimulated by people's night activities, it also drives the development of the relevant industries and keeps the public facilities in use during night. And nightscape can provide a more comfortable environment for people's night activities which will get more people willing to enjoy their nightlife in urban public spaces (Hongxiang, Yan. 2014).

2.2 The Importance of a Well Designed Night-Time Lighting:

As we have mentioned previously that the appearance of the city at night have more impact on people's minds. Also, the city that have a proper lighting design become more memorable, safe and efficient night-time trade. The city of planned use of lighting have a social, aesthetic, economic, safety and psychological benefits. The 24 hour city is a phenomenon that increasingly shapes the way we experience urban life. A growing percentage of social and economic life now takes place in the hours after dark. Current developments toward 24h cities tend to blur our perception of day and night. As we started to understand the importance and distinctiveness of the different shades of night-from dusk till dawn-we shift away from seeing light as a purely functional element. This understanding paves the way for night-time illumination that is more relevant and meaningful to the specific context: bus shelter lighting that improves health and wellbeing of commuter; interactive lighting installations that encourage human interaction; or street lighting that is programmed to enable different levels and types of illumination throughout the night (Lam, Florece and others. 2015). A planned use of lighting will result in the following benefits to the city:

- * The city can be made more legible and easier for people to use after dark, thus encouraging more people to use the city at night and also to walk or use public transport at night thus reducing car reliance.

- * Good lighting can assist to make a reduction in the night-time crime rate of an area.
- * Energy efficient lighting can achieve savings in the amount of energy used and a reduction in greenhouse gas emissions.
- * Improve retail trade and the night time economy by encouraging citizens and visitors to remain in the city in the evening.
- * Good lighting significantly reduces the night-time vehicle/pedestrian accident rate, the cost savings easily paying for the improved lighting.

Work by the International Commission on Illumination studied road accident data in a number of countries and came to the conclusion that road lighting reduces accidents at night by 30%.

- * Supports the increases of tourism and length of stay through activation.
- * Highlights unique qualities of the city.
- * Provides a stimulus for a more cosmopolitan, vibrant and interesting city (M Scaffidi, Lisa. 2014).

The advent of smart LEDs and their intelligent integration in city systems can enable lighting that is responsive to specific hidden impacts of light on human behaviour can help us design inclusive and more liveable urban environment (Lam, Florece and others. 2015).

The primary purpose of urban lighting is the provision of sufficient illumination to perceive the environment in order to facilitate orientation, safety and security. This aspect is termed “utility” lighting and covers such items as roads, squares, bus stations and car parks. However its further purpose is to enhance the urban nightscape by emphasizing its aesthetic values, such as architecture, parks and the natural setting or landscape and this can be termed loosely “architectural” lighting (CIE news, 2008).

2.2.1 Economic Aspect :

Night-time economy is a new topic which draws more and more attentions from global academics. On this topic, British scholars have made lot contributions to it. Nightscape lighting with proper colors and diversified functions can become an attraction to human during the night. Cooperate with urban public facilities and business industry, the nightscape can make excellent aesthetic effects and stimulate people's night-time consumptions (Hongxiang, Yan. 2014). A clear approach to lighting is crucial to the performance of the city's evening economy, specifically its population-driven industries. These industries mainly include consumer services businesses in the area of retail, entertainment, hospitality and tourism (M Scaffidi, Lisa. 2014). The nature of population-driven industries makes them oriented towards servicing a given population, and they require effective place activation and management in order to capture an adequate proportion of visitor expenditure. Their commercial success is largely dependent on a high level of pedestrian flow and the unplanned purchases that they can generate; the Retail Traders' Association estimates that approximately half of all transaction for these type of businesses is unplanned (Raynham, P.J. 2011).

Improving place management of the city through high-quality lighting that directs pedestrian flow to major commercial nodes and past shop windows will support the performance of local businesses within population, driven industries. By encouraging an increased length of visit and by attracting more visitors to the city, the lighting strategy will contribute to businesses with an opportunity to capture a greater proportion of expenditure from a larger expenditure pool (M Scaffidi, Lisa. 2014).

It is reasonable to expect that the city will achieve increasing in expenditure capture by achieving the following expected benefits:

- * Increased length of stay per visit to the city.
- * Increased visitation to the city.
- * Increased expenditure capture for population-driven businesses.
- * Greater on-street activation at night-time.

- * Improved value proposition for the whole city as a destination by adding to its point of difference from suburban centers.
- * Reduced costs related to anti-social behaviour (e.g. avoided property damage, reduced security measures, reduced clean-up costs) for local businesses and the city.
- * Improve well-being and enhanced quality of life for city residents by improved safety, reduced crime and vandalism, and increased offerings for enjoyment.
- * Increased capacity to host well-attended events in the night-time.
- * Uplift in local property values in the long term due to the factors above (M Scaffidi, Lisa. 2014).

A considerable amount of modern life takes place after dark. Many industries operate across 24/7 time spans, necessitating adequate urban accessibility and mobility for those working at night 18% of China's, 19% of the UK's, and 27% of the United States' working population are performing some kind of night work during the hours from 10 pm to 6 am (Lam, Florence and others. 2015).

Many cities and businesses already understand the economic implications of a flourishing night-time economy. In 2009, the UK's night-time economy was estimated to generate 27% of total urban turnover, while Sydney was able to create \$2.7bn of economic benefits with only \$127m spending on night-time management (Association of Town Center Management, 2012).

When designing for night-time, we need to consider the necessity for streets and places to enable a complex set of economic and social uses, and see lighting as the enabler of thriving urban economies (Lam, Florence and others. 2015).

For example, in Chinese cities, people can easily find self-help banks, supermarkets, shopping malls, restaurants and city parks open in the night, some are even open for 24 hours. Most Chinese cities have already noticed that a good nightscape can accelerate the development of night-time economy. This will expand citizens' night life, keep the urban facilities in use, stimulate citizens' night consumptions and provide more job opportunities (Hongxiang, Yan. 2014).

2.2.2 Social Aspects :

People's activities in public spaces, according to Jan Gehl (2008), can be divided into three types: necessary, optional and social behaviors. He pointed out that the necessary behaviors (including going to school, going to work, shopping, waiting for buses and so on) usually take place regardless of the quality of physical environment and the participants can barely make their own choice. The optional activities, however, depend to a significant degree on what the place has to offer and how it makes people behave and feel about it. The better place, the more optional activity occurs and the longer necessary activity lasts. In Jan Gehl's description (2008), social activity is "the fruit of the quality and length of the other types of activities, because it occurs spontaneously when people meet in a particular place". Social activities include children's play, greetings and conversations, communal activities of various kinds, and simply seeing and hearing other people. Communal spaces in cities and residential areas become meaningful and attractive when all activities of all types occur in combination and feed off each other. In another word, the quality of public spaces is relevant to people's activities. Also, the quality of the nightscape in a public space can affect how frequently activities take place and how long the activities last. During the night, people usually enjoy their leisure time with different optional activities or social activities in urban public spaces, like walking, sight viewing, chatting and resting. Therefore, the nightscape needs to contain good conditions for the residents around tourists to have optional and social activities (Hongxiang, Yan. 2014). Light is a fundamental aspect of our lives, the backdrop for all social interaction. Everything we do happens in some degree of light and darkness. Light determines not only if there is social interaction, but also what kinds of social practices are possible after dusk, how safe we feel and how well we can navigate through nocturnal environments. Lighting design is a major social intervention, impacting people and their ways of life. It depends on social

knowledge designers act on information and assumptions about the people and spaces they design for. Designers have to develop detailed understandings about the spaces they intervene in – not only in terms of the built environment, but also what these spaces mean to the people who use them. These social understandings, however, are usually not made explicit and systematic, even though they are largely driving design processes and designers often need tools that will allow them to systematically capture the needs, understandings and practices of the social groups or communities they design for (social research in lighting design,2015).

2.2.3 Safety and Security Aspects:

There is a wide range of factors that contribute to a feeling of safety including individual behaviour, media, law enforcement, personal experience and environmental design. Lighting is a critical element of environmental design and contributes not only to our sense of safety but also to crime prevention and management(M Scaffidi, Lisa. 2014).

Boyce's study looked at a series of car parks in Albany and compared the feeling of safety during the day and at night. In all cases he found that people felt safer during the day. Moreover, he was able to relate the change in the feeling of safety between day and night to illuminance at night, the higher the illuminance the less the change in feeling of safety. (Figure 2.1) shows the findings of Boyce's study where asked to rate the feeling of safety that they had whilst walking in particular car parks during the day and at night, the difference in the day and night scores were then plotted against the night time illuminance (Raynham, P J.2011).

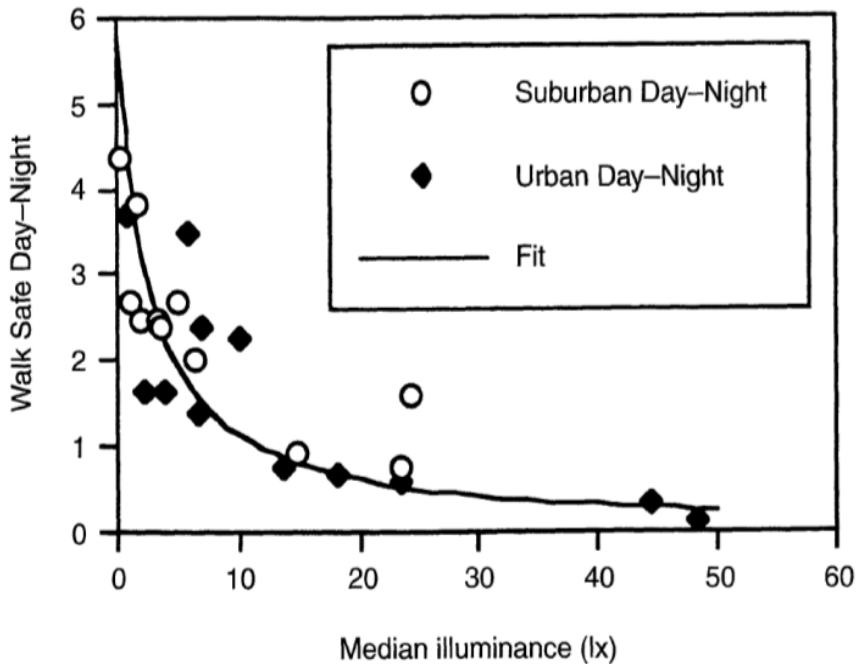


Figure 2.1 Difference in mean ratings of perceived safety day and night (day-night) plotted against mean illuminance
Source: Public Lighting in Cities

A review by the UK Home Office of 13 UK and US studies on the interrelation between improved street lighting and crime levels documented an overall decrease in recorded crime of on average of 20% across experimental areas. This reduction was observed across day-and night-time, supporting increased social control and community pride through improved lighting as a reason, instead of increased surveillance through higher illumination (Lam, Florence and others. 2015).

Lighting can contribute to crime prevention for the following reasons:

- * Minimize the opportunity and reduce the risk of crime.
- * Reduce the fear and risk of crime for people using private and public space.
- * Lower the incidence of crime in the local government area rather than simply displace it.
- * Improve the quality of life of residents, especially vulnerable groups, by reducing their fear of crime.

* Create a more sustainable environment by improve usage of public spaces and reducing maintenance and crime associated costs.

* People feel safer in well-illuminated areas because they can see what and who is around them.

* It increases the risk of offenders being seen, reported and potentially apprehended.

* People are encouraged to use well-illuminated areas, which increases activity and thereby deters crime and unwanted behaviors.(M Scaffidi, Lisa. 2014).

When considering Jane Jacobs' urban theory on the importance of 'eyes on the street'. Public spaces of cities are not kept by the police. It is kept by the an intricate, unconscious network of voluntary controls and standards shared and enforced by the people themselves (1961).

Design for safety in any regeneration project needs to be centered on the residents who live there. Involvement of local communities has been proven to reduce levels of vandalism and crime. It is imperative

for the community and lighting designer to have personal involvement in the design process – and the people in the area need to have a personal attachment to the design. The key features of the design process can be summarized as follows:

- Design for the community and not for design's sake.
- Research the area, in relation to its crime statistics and local perceptions.
- Discuss the design with the community, find out what they need and want for their area.
- Monitor the design after completion to ensure effectiveness.
- Do not only rely on design alone to provide a safer environment. If needed, suggest security measures which can aid the design (Bell, Natalie. 2009).

2.3 Lighting Design for the Perception of Nightscape :

The perception of space is directly connected to the way light integrates with it. What we see, what we experience and how we interpret the elements is affected by how light interacts with us and with the environment (Fontenella, Ciro. 2008).

In his theory, Liljefors,(1999) presents a list of seven basic terms for description of the light in the space by the visual experience:

- Level of lightness.
- Spatial distribution of brightness.
- shadows.
- Reflections
- glare.
- Color of light.
- colors.

Using these terms, it is effective to describe and understand the effects of lighting in a space and to make a reliable classification. Shadows, for example, play an important role to our observation. they can be soft or strong; they can present sharp or diffused borders. Good shadows are pleasant to see, but bad shadows can destroy the ambience.

There are a number of factors in a constructed environment that influence the psychological and emotional state of the users. Light intensity and color are two important factors with impact on the users performance in the space. While people are known to adapt to different environments, it is believed that there is a loss of productivity and general well being if they are not in certain conditions. It was noted by Illumination Engineering Society of North America (IES) that lighting can play an important role in reinforcing special perception, activity and mood setting (Abbas, Nadeen. 2006). Lighting designers think about how behavior is affected by lighting. Here are a few interesting examples in terms of how lighting shapes behavior:

- Visibility of vertical and horizontal junctions aids orientation.
- People follow the brightest path.
- Brightness can focus attention.
- Facing wall luminance is a preference.
- Lighting can affect body position.

A lot of possibilities to regulate the urban atmosphere through light and color offers artificial lighting, or night city lighting which enables a sensitive and aimed support, as well as manipulation of the formal manifestations of both the particular parts and the whole spatial structure. Artificial illumination of the urban silhouette strengthens the aesthetic effect of the overall image and highlights the unique symbols typical for the city. A special effect at the day into night transitions brings about the twilight with reflections of first lights on the city panorama and its water surfaces, and also the color of evening waterworks, or exploitation of various lighting shows and effects. The interplay of artificial lights and from dark (black and white) night background enliven colors affects the whole dynamics of the city nightlife (Kardos, Peter. 2013).

Lynch (1961) explained how people get a mental image from feeling the physical environment. It works like a reflection in our mind about how we know the world. Based on this, he pointed out that legibility (or Image ability) should be one of targets for the construction of the image of the city. In his theory, urban spaces can be understood as a “mental map” for people, consisted by paths, edges, districts, nodes and landmarks.

Chapter (3)

Strategies to Enhance the Perception of the City Nightscape

CHAPTER 3

Strategies to Enhance the Perception of the City Nightscape

3.1 Introduction :

After knowing the huge effect of light and illumination on how people perceive urban spaces, it can point out that: to get a proper perception of the city at night, the city must achieve integrated urban night-time design of its components such as streets, buildings, squares and so on. This chapter lists the appropriate lighting design for each component of the city according to the theoretical studies and researches.

3.2 Street Lighting :

The basic goal of roadway lighting is to provide patterns and level of horizontal pavement luminance and of horizontal and vertical illuminance of objects. A driver's eye discerns an object on or near the roadway due to contrast between the brightness of the object and the brightness of the background or pavement, or by means of surface detail, glint, or shadows. Lighting design is concerned with the selection and location of lighting equipment so as to provide improved visibility and increased safety while making the most efficient use of energy within minimum expenditure (Urban Design Standard Manual, 2005).

Road lighting is quite different from the others. It must obey a lot of strict regulations to provide a safe traffic environment. The artistic effects of it are limited by many rules about the luminance, light colors, forms of luminaires and so on. But it still has a chance to do some design work on the road lamps' forms and shapes. As the lightened object, the road is usually a linear space, which give an opportunity for the nightscape lighting to create a kind of dynamic nightscape. Since the traffic flows always move along the linear space fast, an appropriate repetition of road lamps, which designed into an

enjoyable driving environment (Hongxiang, Yan. 2014).
Lighting columns and fittings make a major impact on the appearance of the scheme and should be planned as part of the overall design concept. It is especially important that in historic towns and conservation areas particular attention should be paid to the aesthetic quality of the street lighting installation (Manual for Streets,2012).



Figure 3.1 street lighting
Source: self-sufficient street light/Architecture Magazine



Figure 3.2 street lighting
Source: street lighting - Anesco

Street lighting has an important role to play in :

- Reducing risks of night-time accidents.
- Assisting in the protection of property.
- Discouraging crime and vandalism.
- Making residents feel secure.
- Enhancing the appearance of the area after dark.
- Identify the function of different roads. For example, two lamp columns at the entrance to a road can be used to create a gateway effect.
- Enhance safety and security for drivers, pedestrians and cyclists.
- Enable road users to see potential obstacles and each other after dark and to reduce the fear of crime (Manual for Streets, 2012).

Lighting design according to the illumination method relies on the amount of light flux reaching the pavement and the uniformity of the light on the pavement surface. The steps in the design process are as follows:

- Determination of the foot-candle value by assessing the facility to be lighted.
- Selecting the type of light source.
- Selecting light source size and mounting height.
- Selecting luminaire type.
- Determining luminaire spacing and location.
- Checking for design adequacy (Urban Design Standard Manual, 2005).

3.2.1 Street Lighting Considerations :

- Size of trees and shrubs when mature and their location in the layout must be considered in relation to street lighting.
- Lighting must be planned as an integral part of the initial layout of access and shared surface roads, shared driveways, footpaths and in conjunction with the location and anticipated growth of trees.

- The standard of lighting provided should ensure that shadows are avoided in places where pedestrians would otherwise be vulnerable.
- Lighting columns, wall-mounted brackets and other fittings need to be resistant to vandalism and be placed in positions that minimize risks of damage by vehicles.
- Lighting columns should be located within the limits of the adoptable highway, at back edge of the footway, verge or service strip. However, it is acceptable to attach lighting units to buildings to help reduce street clutter, provided electrical connections are external to the building. This will necessitate an agreement between the freeholder of the property and the Highway/Lighting Authority.
- Lighting columns should be aligned with other street furniture and located to ensure that a clear pedestrian path, preferably at a minimum 2m width, is maintained.
- Where lighting is taken out of service, it should be removed (Manual for Streets, 2012).

- The dimension of light poles on footpaths should relate to a human scale and the height of lanterns kept as low as possible. Streetlights should be located where they provide good light to building frontages so that visual interest is concentrated on the street edge. Ensure a holistic approach is taken to major and minor spaces and that lighting turns the corner into side streets and resolves the junction between one lighting layout and another at intersections. Passers-by are invited

to enter spaces if lighting is continuous and of high quality, whereas poorly lit spaces can undermine the effectiveness of public street lighting (M Scaffidi, Lisa. 2014).

In designing lighting within streets, consideration should be given to the type of lighting that is appropriate in the context. It is often the case that lighting in streets is essentially suitable for highway illumination but is not entirely in keeping with the street environment. Key issues in the provision of lighting are:

- Luminance.
- Scale.
- Color.

*** Luminance:**

An acceptable level of street lighting is c5lux, although DfT (Inclusive Mobility, 2005) recommend that at locations where people gather, for example bus stops, 10lux is appropriate. In providing inclusive streetscape, continuity of lighting levels is important, with sudden changes in lighting level being particularly problematic for partially sighted people. The shading effect of street trees should also be considered in determining their species, location and management (Manual for Streets, 2012).

*** Scale:**

As noted above, much street lighting is actually provided for highway purposes. A consequence of this is that it is often located at a height inappropriate to the cross section of the street and of scale with pedestrian users. Consideration should be given in street design to the purpose of lighting, the scale of lighting relative to human users of the street and the signals sent to drivers by lighting design. Highway lighting and footway lighting are both required, some highway authorities have provide lamp columns featuring a secondary, and lower level, footway light (Manual for Streets, 2012).



Figure 3.3 Piggyback lighting to illuminate footway as well as carriageway

Source: Manual of Streets

*** Color of lighting:**

The color of lighting is an additional consideration. Where pedestrians are concerned, white lighting is preferable, rather than orange. White lighting allows better discernment of street features, including the facial expressions of other street users, which can be an important factor in allaying personal security concerns (Manual for Streets, 2012).

3.1.2 Lighting Hierarchy:

The pattern of major streets can be made more visible and apparent to users of the street network at night if the lighting of major streets is different from that of minor streets. The difference between major and minor streets can be made clearer by varying the apparent brightness, spread and color temperature of light, as well as the height, spacing and scale of street fixtures (M Scaffidi, Lisa. 2014).

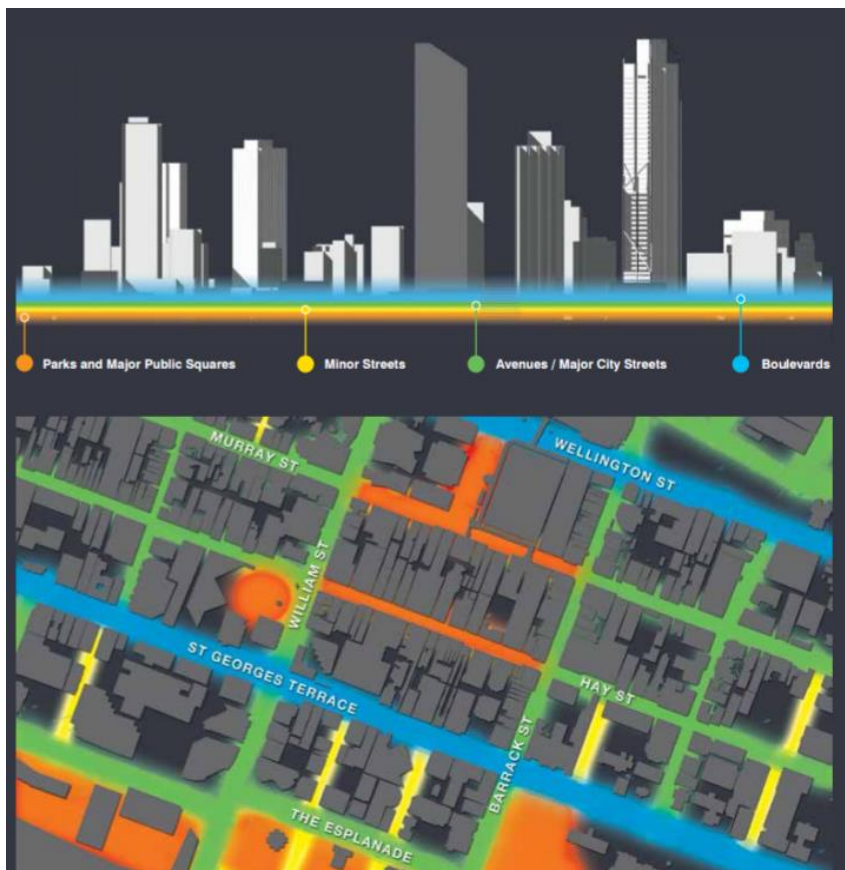


Figure 3.4 lighting hierarchy

Source: the city of Perth lighting strategy book

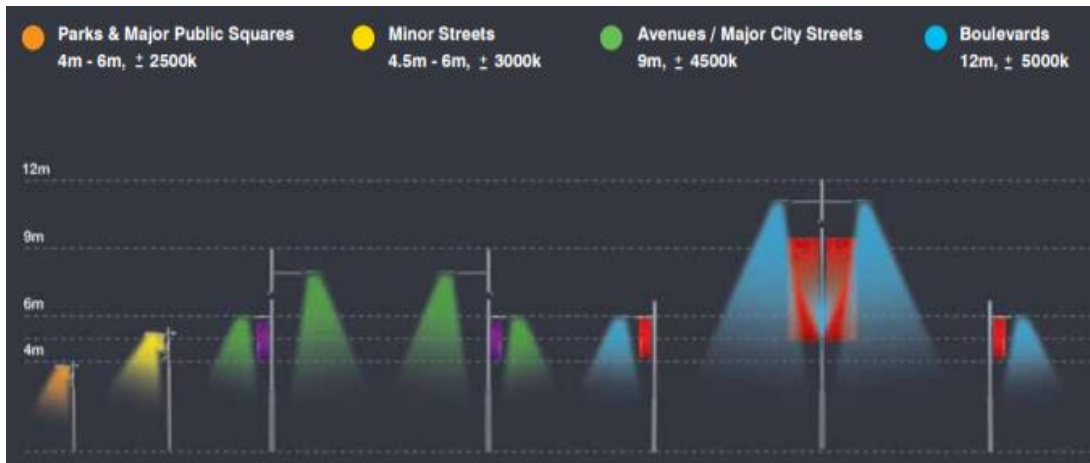


Figure 3.5 lighting hierarchy
Source: the city of Perth lighting strategy book

Area Classification

- **Commercial** : that portion of a municipality in a business development where ordinarily there are large numbers of pedestrians and heavy demand for parking space during periods of peak traffic or a sustained high pedestrian volume and a continuously heavy demand for off-street parking space during business hours. This definition applies to densely developed business areas outside of, as well as those that are within , the central part of a municipality.
- **Intermediate** : That portion of a municipality which is outside of a downtown area but generally within the zone of influence of a business or industrial development, often characterized by a moderately heavy night-time pedestrian traffic and a somewhat lower parking turnover than is found in a commercial area. This definition includes densely developed apartment areas, hospitals, public libraries, and neighborhood recreational centers.
- **Residential** : A residential development, or a mixture of residential and commercial establishments, characterized by few pedestrians and a low parking demand or turnover at night. This definition includes areas with single family homes, townhouses, and/or small apartments. Regional parks, cemeteries, and vacant lands are also included (Urban Design Standard Manual, 2005).

<u>Road Classification</u>	<u>(1) Area Classification</u>	<u>(2) Average Illuminance</u>		<u>Uniformity Ratio (Aver./Min.)</u>
		<u>Foot-candles</u>	<u>Lux</u>	
Arterial (Minor & Major)	Commercial	1.1	12	3 to 1
	Intermediate	0.8	9	
	Residential	0.6	6	
Collector (Minor & Major)	Commercial	0.7	8	4 to 1
	Intermediate	0.6	6	
	Residential	0.4	4	
Local	Commercial	0.6	6	6 to 1
	Intermediate	0.5	5	
	Residential	0.3	3	
Alleys	Commercial	0.4	4	6 to 1
	Intermediate	0.3	3	
	Residential	0.2	2	
Sidewalks (Roadside)	Commercial	0.2	3	3 to 1
	Intermediate	0.6	6	4 to 1
	Residential	0.2	2	6 to 1
Pedestrian Ways (3) & Bicycle Lane		1.4	15	3 to 1

Table 3.1 recommended illuminance values and uniformity ratios

Source: urban design standard manual

3.1.3 Obstructions to avoid in street lighting :

- * Trees
- * bushes/hedges
- * Overhead lines (electrical)
- * Overhead lines (other)
- * Vehicular accesses/gateways
- * Bedroom windows (street lighting design guide, 2010).

* **Trees:**

- The scheme shall be designed so that columns are sited mid way between trees even if the design criteria is exceeded.
- Where there an alternative location, away from the tree, then utilize this location and reconfigure the design accordingly.

- It may be possible to locate a column underneath the tree canopy but it must be at least 1m clear above the lantern and the designer must be sure that this space will not be encroached upon at a later date.
- When locating columns amongst trees lanterns must be clearly visible when standing at the mid point between columns.

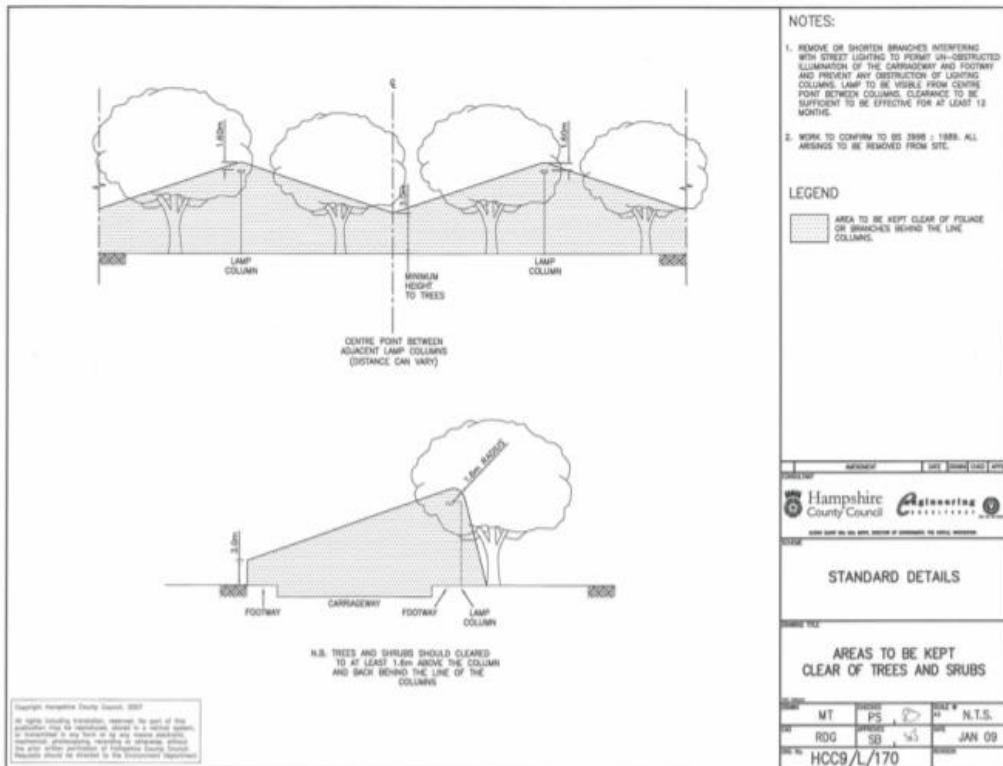


Figure 3.6 tree trimming detail
Source: street lighting design manual

*** Bushes/Hedges :**

Whilst bushes most likely won't block the lantern they will prevent future maintenance by blocking the access door. Trimming needs to be carried out on a regular basis so it is best to move the column away from existing locations where possible.

*** Footpaths (narrow & wide) :**

Where columns are being located on footpaths the choice of column position will depend on the width of the footpath and any verge available. In most cases there will be three possible alternatives as shown below:

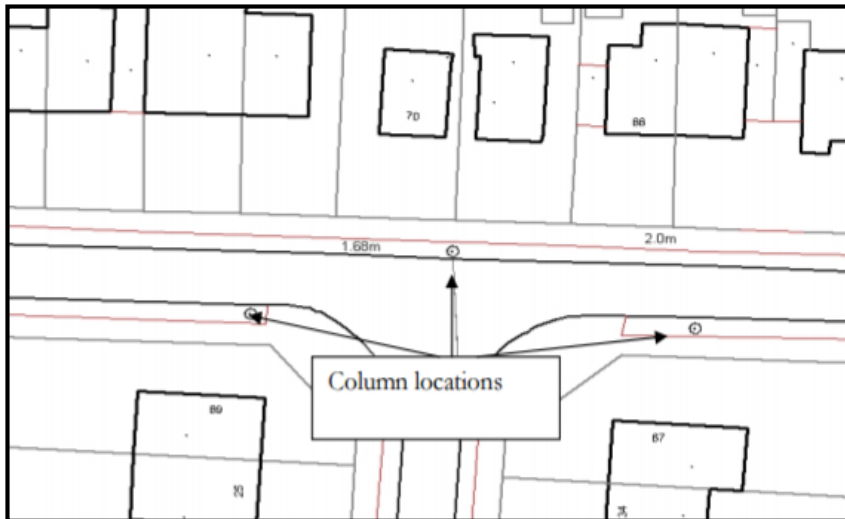


Figure 3.7 column mounted in verge with minimum setback
Source: street lighting design manual

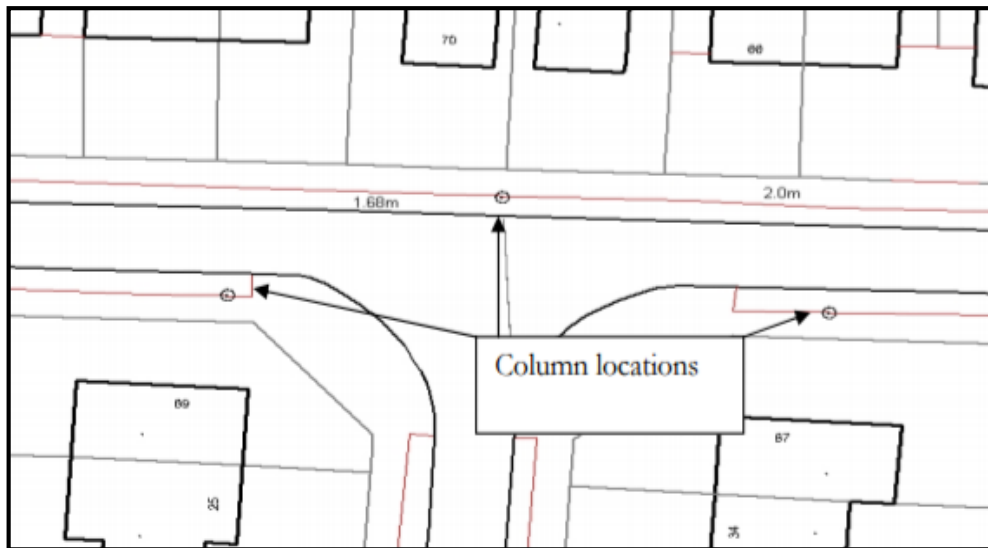


Figure 3.8 column mounted at rare of verge
Source: street lighting design manual

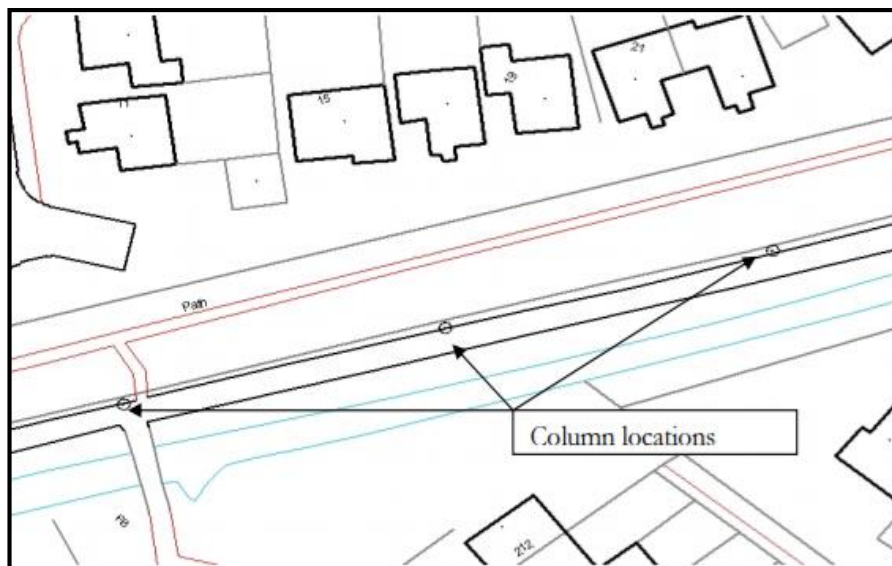


Figure 3.9 column mounted at rare of footpath
Source: street lighting design manual

3.1.4 LED lighting to enhance the perception of street :

The LED (Light Emitting Diode) road lighting system is similar to conventional road lighting HPSV (High Pressure Sodium Vapor) to the extent that the basic parts are the same – both systems have the pole, cabling, and the luminaire which houses the light source. However, while conventional lighting technologies include a single source (the bulb), the luminaire of an LED road light until houses several parts, starting with multiple LED chips arranged in an array, combined with optics, heat management, and a driver – all enclosed in a high pressure die-cast aluminum and glass cover (LED road lighting design manual, 2014).

LED road lighting solutions offers significant benefits and options which are not possible with conventional lighting. Some benefits hold true for all LED lighting applications, while others are specific to LED lighting :

*** Technological benefits :**

- High lumen efficacy.
- Directionality and reduced light pollution.

- Long lifespan.
- Superior quality of light.
- Extended controllability.
- durability.
- aesthetics.

*** Economic benefits :**

- Lower lifetime cost.
- Income generation.

*** Social benefits :**

Road safety: LED road lighting provides better quality light, which increases visibility for both drivers and pedestrians. In off-grid locations, solar LED road lighting, can significantly improve road safety conditions, especially in poorly lit areas and highly populated cities in developing countries. While conventional technologies can meet the key lighting factors (luminance, uniformity, glare, surround ratio, color rendering index), LEDs meet these at more desirable levels, making it more pleasing to the eye, as evident in (figure 3.10) (LED road lighting design manual, 2014).



Figure 3.10 comparison between HPSV (left) and LED (right)
Source: LED road lighting design manual

3.3 Buildings Facades Lighting :

Architecture/building lighting including the lighting of building façade, it is used to redraw a night time picture of the architectures which work as carriers of human activities and behaviors during the day. Architecture lighting can be seen in different types of urban public spaces. The lighting object can be a skyscraper in central business district, or some shops on a pedestrian street, or a tower in a civic park, or some special monumental buildings. This kind of nightscape lighting's focus point in its designing may differ from one case to another. Since the architectures can have different types, functions, structures and so on, the lighting can be design to enhance the buildings' style, spatial structures, materials, historical character, or just some parts which have high aesthetic value (Hongxiang, Yan. 2014).

The co-operation of key building owners is essential in delivering a unified display that includes the whole of the central city. Taller buildings should make a stronger statement than shorter buildings and the lighting signature should be fully integrated with the building's form. A small number of special buildings should be highlighted with most of the city's fabric appearing as a backdrop (M Scaffidi, Lisa. 2014).



Figure 3.11 building lighting
Source: exterior building lighting

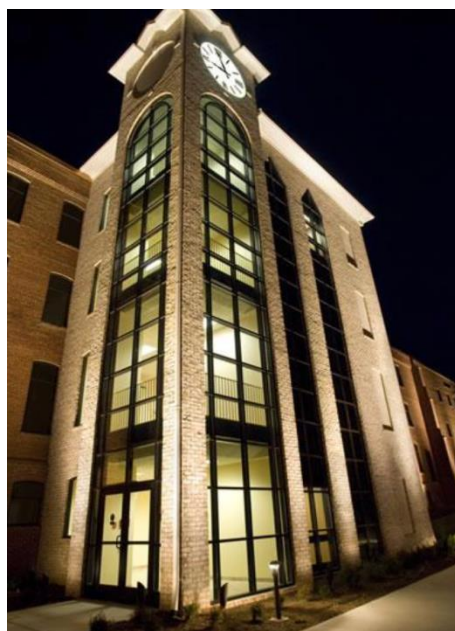


Figure 3.12 building lighting
Source: exterior building lighting

3.3.1 Buildings Facades' lighting methods :

According to the building's situation, the lighting methods used in architecture lighting can be various:

- For some monumental architecture, or the main landscape architecture in a park or a square, or some important municipal buildings, the **floodlights** will be designed outside the building in a distance to make the architecture much brighter than the surroundings to claim its importance (Hongxiang, Yan. 2014).



Figure 3.13 floodlights
Source: outdoor building lighting

- **Contour lighting** is the most common way in architecture lighting. It uses neon lights or some other luminaires to outline the building's contour (Hongxiang, Yan. 2014).



Figure 3.14 contour lighting

Source: http://commons.m.wikimedia.org/wikifile:HK_Night_central_standard_chartered_bank_building_lighting_a.jpg

- Another lighting method is lighting the building with its **interior lights**. This method is usually used for the lighting of modern architectures, especially the ones with glass curtain walls or some reflective materials. The widely use of glass and other reflective materials among modern architectures make it difficult to use floodlighting or contour lighting. The floodlighting reflected by glass or similar materials will cause light pollution to the surroundings, and the contour lighting will make bad influence on the interior activities through the building's glass wall. Using the interior lights can both avoid light pollution and reduce the cost of energy. Besides, interior lighting is quite popular in the lighting design of shops, restaurants, galleries and big shopping malls. By the gentle lights coming out from the interior, these buildings can attract more customers by showing their interior environment and wares (Hongxiang, Yan. 2014).



Figure 3.15 interior lighting
Source: exterior building lighting

3.3.2 Buildings Facades' lighting considerations :

The lighting of buildings should be based on the use of light sources that create a clear contrast with those used for the street lighting. When lighting public and private buildings and structures such as bridges, the use of primary and saturated color should be avoided except during festival occasions. Saturated colors overwhelm the natural color of the materials in buildings and the permanent presence of color soon tires the eye with any surprise factor wearing thin after a while. Priority should be given to the following features and locations:

- Street corners.
- Entrances of buildings.
- Shop fronts.
- Colonnades (M Scaffidi, Lisa. 2014).

Some of the more modern structure tend to be more ethereal in structure, have linear elements of steel and filled in with glass. The lighting for such structures tend to depend on the form and it is common for the floodlighting to highlight certain elements of the structure, often with a multi-layered minimalist approach. The use of highly saturated colors is a common choice for the lighting of contemporary structure, it is not necessarily the main component of the lighting, but is often used for design details. It can be concluded that in areas where historic and contemporary buildings co-exist a difference in luminance is desirable (Raynham, P J. 2011).

Sometimes, the architecture nightscape lighting can be design during the architecture design process. In this way, some parts or elements of the building, like walls, columns, eaves, windows, corners or rooftop, can be constructed with lights on or inside them, making the nightscape lighting incorporate with the building much better. In some situation the architecture may have particular design in some parts of it, like a statue or a garden on the rooftop. The nightscape lighting can also be designed to enhance the aesthetic effects of the very part of the building by setting a special lighting (Hongxiang, Yan. 2014).

Derek Phillips in his book *the Lit Environment* (2002) states *the nature of a building and its materials should be taken into account, in order for a permanent system of floodlighting to express a credible appearance*. Phillips also makes the point that for temporary installations the use of almost any saturated color may be appropriate to make a building stand out for a particular reason (Raynham, P J. 2011).

3.3.3 Historic buildings Facades lighting :

Lighting of heritage places provides an opportunity to celebrate the city's cultural heritage in an engaging and accessible way. It also provides new and exciting ways to experience heritage places. Lighting of heritage places can be used to highlight heritage significance associated with architectural features and landmark qualities. It can also be used to enhance the social and historical significance of a place (M Scaffidi, Lisa. 2014).

Our historic buildings and monuments are often amazing feats of architecture and engineering. Many have been enhanced and brought to life at night-time with striking and subtle external lighting schemes. Some, however, have produce far more negative results by highlighting flaws and views of the structure never meant to be seen. Just because a building or structure happens to be listed does not mean this is a good enough reason to proceed with external lighting (external lighting for historic buildings, 2015).

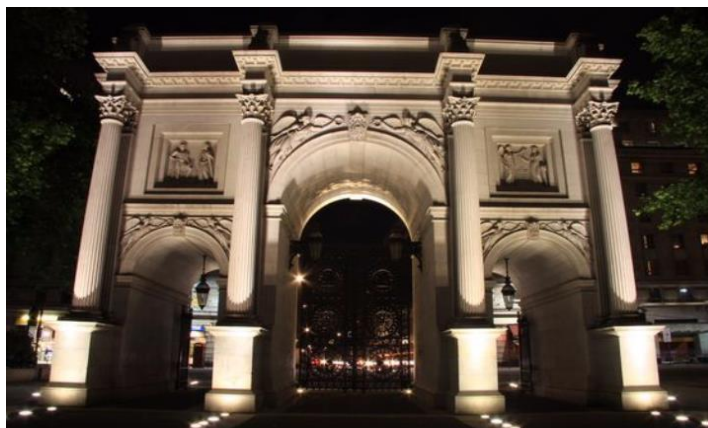


Figure 3.16 historic building lighting
Source: external lighting for historic buildings

It is rarely necessary to light all the elevation of a building, some parts often being unsuitable or inaccessible for viewing. It is usually better to concentrate on the prime nearby and distant night-time viewpoints. As part of the design process distance, angle and position of the viewer should always be taken into account (external lighting for historic buildings, 2015).



Figure 3.17 lighting certain parts of the building
Source: external lighting for historic buildings

It is often better to illuminate selected architectural and sculptural features such as pediments, columns, porticos or niches, rather than illuminating the whole building. External lighting to reinforce a building's patterns can increase the appreciation of architectural details. Cross lighting, uplighting and backlighting should all be considered, although uplighting must be limited and well controlled to avoid light pollution. Design can be refined by the use of tight beam control; shutters or baffles can also help reduce night-time light spill. However, the latter solution is rarely acceptable in appearance during the day unless the fittings can be concealed (external lighting for historic buildings, 2015).



Figure 3.18 lighting selected feature
Source: external lighting for historic buildings



Figure 3.19 lighting selected feature
Source: external lighting for historic buildings

Such lighting schemes can achieve:

- Enhances aesthetic appearance of heritage places at night.
- A greater sense of identity and culture.
- Encourage more frequent evening visits by residents and tourists and enhance night time orientation.
- Increased awareness and perception of city's cultural heritage (M Scaffidi, Lisa. 2014).

3.4 Squares and parks Lighting :

Square lighting is one of the most common lighting in urban public space. It can be used in different type of squares in the city. Generally, there is always an overall lighting planning which may contain a particular theme of the square and an overall lighting layout. The density of lights will be lightened up with a proper distance between each two luminaires. The square lighting does not mean to make the whole square bright like the day time or provide the same luminance for everywhere. The lighting design usually highlights the entrances, the traffic paths and the public gathering spaces, while the grass or bushes will be less bright (Hongxiang, Yan. 2014).

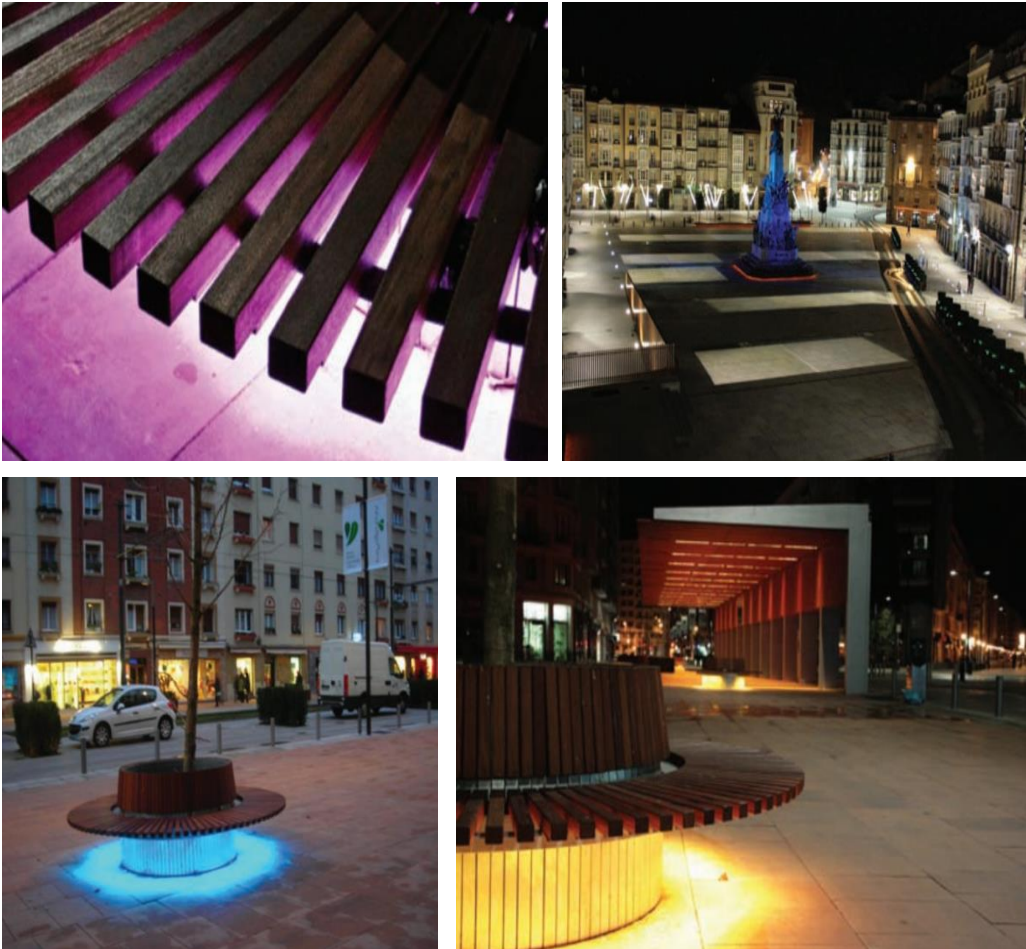


Figure 3.20 squares lighting
<https://www.slideshare.net>

The square lighting usually uses basic functional lighting to provide a convenient walking environment for places with slopes, steps, stairs and other kind of elevation changes. In square lighting, sometimes the lights can be designed as lamps with a lower height or even buried in the ground or grass. In this way, ground can be easily lightened for walking with gentle lights. For some saying spaces or some landscape spots, the lighting can be designed to create some contrast between the main object and the background, by using lights in different colors and luminance. For some corner spaces or edge spaces, the lighting design can even create a silhouette by setting the lights behind the objects. The forms and appearance of luminaires in square lighting are also quite important. The lighting facilities can also be designed in an artistic way to present the square's theme and characters (Hongxiang, Yan. 2014).



Figure 3.21 creating attractive activities by using lights in squares
Source: cities alive rethinking the shades of night

Park lighting like square lighting, park lighting is also quite familiar to public. It can be designed to fit in with different types of parks. A park's nightscape design also needs an overall lighting planning which may contain a particular theme of the park and an overall lighting layout . In most situations, park lighting contains three main parts:

- **Hard landscape lighting:** this means the lighted objects usually include hard landscape like hills, rocks, paths. Its usually brighter than the others, it usually highlights the entrances. The traffic paths and the public gathering spaces. Park lighting also has basic functional lighting to ensure the ground can be seen clearly by pedestrians, especially the places with slopes, steps, stairs, children playgrounds and other kind of elevation changes.(Hongxiang, Yan. 2014).

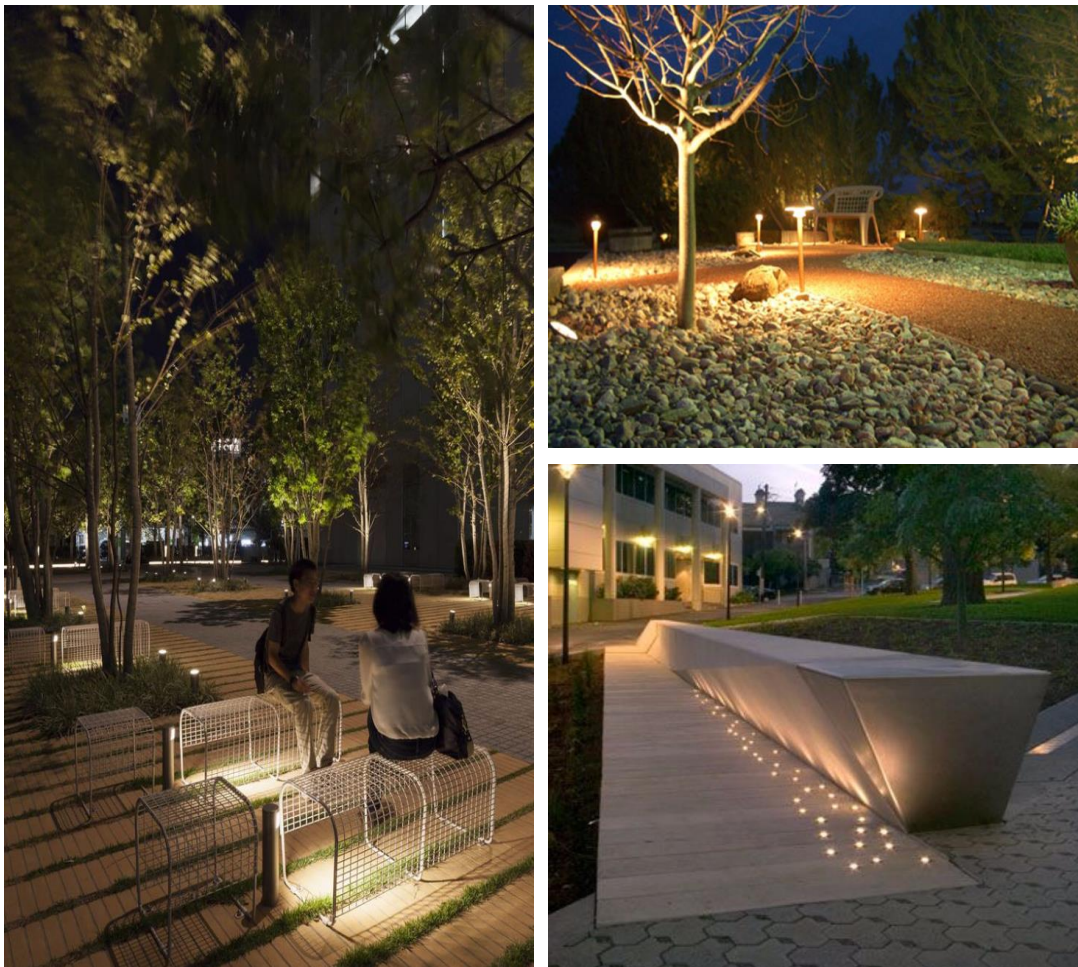


Figure 3.22 hard landscape lighting

<https://www.slideshare.net>

- **Vegetation lighting:** like grass, bushes, trees.



Figure 3.23 vegetation lighting
<https://www.slideshare.net>

- **Waterscape lighting:** like rivers, waterfalls, lakes, fountains and so on.



Figure 3.24 waterscape lighting
<https://www.slideshare.net>

The vegetation lighting and waterscape lighting are the two factors that make park lighting quite unique. Sometimes, a special lighting method will be used in park lighting: by setting a light source on the branch of all tree, it will shine like the moon in the sky and the shadows of the tree and other elements under the light will become a dramatic scene in a small area. When designing vegetation lighting, the most important factor is not to harm the vegetation by lights or facilities installations. In waterscape lighting design, the reflection of the water should always be taken into consideration so that the reflection can enhance the artistic effects without causing light pollution (Hongxiang, Yan. 2014).

3.5 Bridges Lighting :

Bridge lighting must be sensitive to motorists, pedestrians, boaters and other users. It should be selected and located to enhance and highlight the structure, yet minimize glare and unnecessary distraction. The lighting must respond appropriately to the context, both in terms of surrounding light pollution in the night sky concerns should be weighed together with those of aesthetics. Luminaire selection and placement as well as the color of the lighting can detract from or strengthen any of the visual design elements (Bridge Aesthetic Sourcebook, 2009).

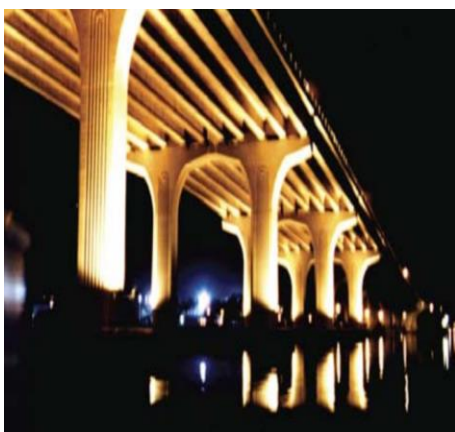


Figure 3.25 bridges lighting
Source: bridge aesthetic sourcebook



Figure 3.26 bridges lighting
Source: sf.funcheao.com / "the Bay Light
"Bay Bridge Light Show

3.6 Cultural and Festival lighting :

Lighting for events has in recent years advanced considerably with imaginative lighting using 3D mapping technology now possible on buildings and other features. Lighting Urban Communities International (LUCI) recently published a report on the success of light festivals after contacting 26 cities hosting over 30 light events and looking at 10 case studies from around the world. The report takes a detailed look at the qualitative and quantitative evaluation tools that were used to demonstrate the positive impact of the festival and concludes that while evaluation methods may vary, the general consensus was that these festivals had an overall positive effect. To meet the demand for lighting at events the city needs to ensure that the lighting design for the city is flexible enough to take additional lighting when required for events (M Scaffidi, Lisa. 2014).



Figure 3.27 using building façade as screen in national day celebration
Source: i;loveuae42.blogspot.com



Figure 3.28 festivals lighting
Source: the city of Perth lighting strategy

3.7 Lightings of Advertisements and Signs :

This kind of lighting can be seen in all kinds of urban spaces. It is usually used to send message to the public with some lightened boards, facilities or some other kind of structures. In most situation, the lighting objects are public information, business advertisements, public service advertisements, words, photos, symbols and patterns. The lighting focuses on making the message attractive and can be seen clearly by people from a long distance to read . To gain that purpose, the lighting could be quite bright with outstanding colors or even flashing. This makes the lighting design should always pay attention to the luminance and its glare in case of causing light pollution. Another character of this kind of lighting is that most situations, the contents can also be seen during the daytime without lighting. The facilities need to be designed beautiful in the place during both day and night. Usually the lighting facilities' owner takes charge of the maintenance and the advertiser should pay to get the access to the facilities (Hongxiang, Yan. 2014).

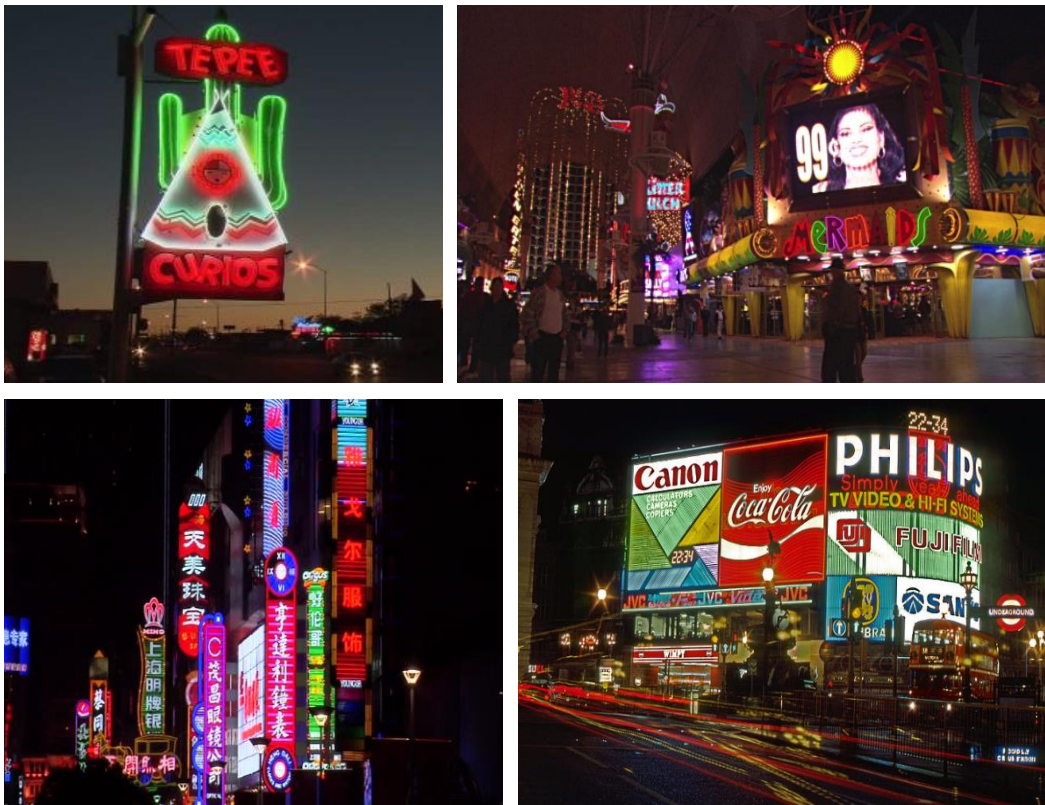


Figure 3.29 lighting of advertisement and signs

Source: www.alamy.com

3.8 Light Pollution :

Urban lighting is not an unmitigated good and can cause problems as well as solve them. Most of the problems with lighting involves the issue of lighting pollution (Raynham, P J. 2011).

Light pollution occurs when unwanted light falls outside the area intended for illumination. Unnecessary, excessive or badly designed and installed systems that allow light to go upwards or trespass outside the target area are wasteful and are of no benefit to anyone (Lighting against crime, 2011).

Simple spillage from a badly designed external lighting scheme can cause a major nuisance to others, for example by trespassing into a window and keeping occupants awake. This in addition to the wasted electricity and its contribution to emissions of greenhouse gases (external lighting for historic buildings, 2015).

3.8.1 Types of Light Pollution :

The result of our carelessness is that glare, light trespass, and sky glow have taken over the urban nightscape. These travelling bedfellows are more precisely described as follows:

- **Glare:** is illumination that reduces, rather than enhances, visibility. Its usual source is bright lamps and translucent surrounds whose output is carelessly directed into our line of sight, rather than onto the object to be illuminated (Walkere, Chris. 2013).

glare is uncomfortable brightness of a light source when viewed against a dark background. Glare from poorly designed floodlighting of buildings, exterior sports facilities and poor road lighting can create a form of visual chaos that is difficult to overcome with well-designed lighting (M Scaffidi, Lisa. 2014).



Figure 3.30 light problem: glare
Source: www.urban-astronomer.com

- **Light trespass:** is unwanted illumination coming from an adjacent property. It interferes with the quiet enjoyment of our property and may keep us awake at night (Walker, Chris. 2013).

Light pollution and light trespass are general terms used to describe circumstances where light has been allowed to get into areas where it is not wanted and where the lighting design did not intend it to go. It is sometimes referred to as light trespass, though light nuisance is the legally correct term to use (Lighting against crime, 2011).

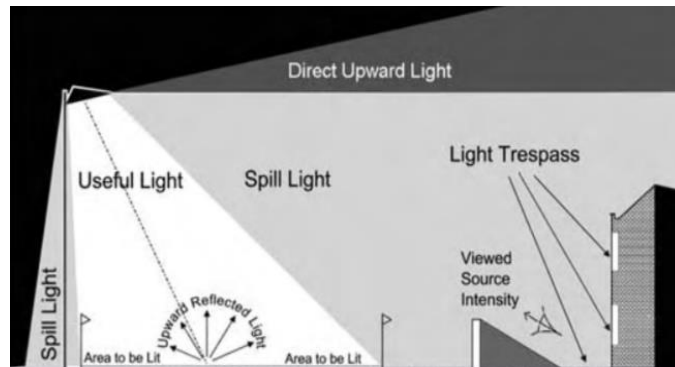


Figure 3.31 light problem: light trespass

Source: lighting against crime

- **Sky glow:** is illumination that carelessly allowed to spill into the open sky, highlighting birds and the undersides of airplanes and making our vision of the universe beyond. Indeed, most city dwellers in the world today have never glimpsed the Milky Way, our home galaxy. An orange glow now hovers over our major cities, obscuring the vast majority of the 6000 stars that were once visible to the naked eye on any clear night (Walker, Chris. 2013).

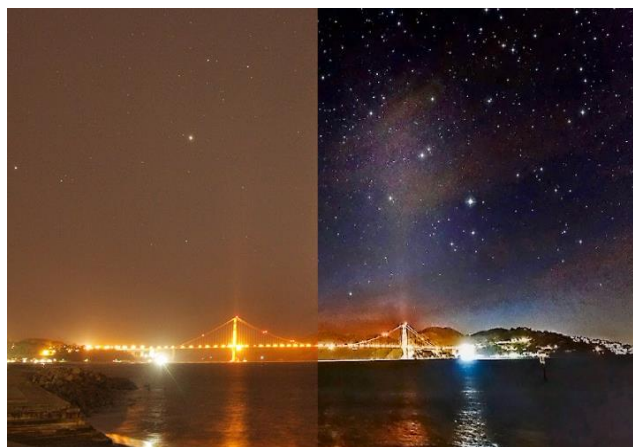


Figure 3.32 light problem: sky glow
source: nentallysound.wordpress.com

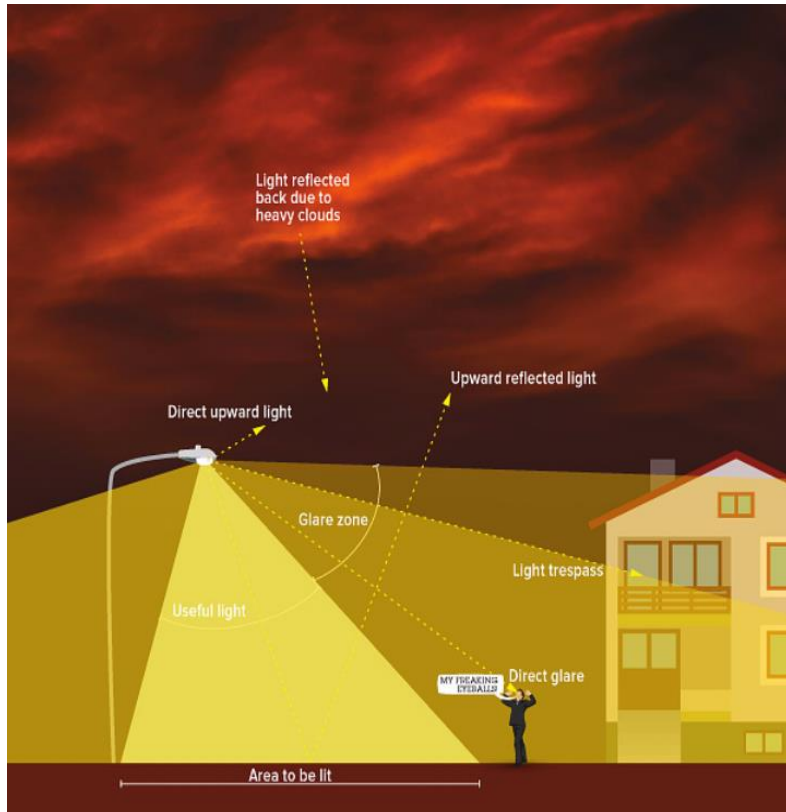


Figure 3.33 light problems
Source: darksky.org

3.8.2 Simple guidelines to help in reduce light pollution :

The first, and simplest, step is to use only shielded fixtures. They do not allow light to escape upward into the atmosphere, but direct it downward to illuminate the target. With a steep enough shielding angle, the glare from such sources can be greatly reduced, cutting the needed light and energy consumption by half. The U.S. alone wastes \$2 billion a year needlessly lighting up the night sky (Animals such as birds, butterflies, and turtles that are confused by inappropriate light suffer along with us from this waste). Outdoors, we tolerate a level of glare and energy waste that would never be permitted indoors (Walker, Chris. 2013).

Second, we must pay as much attention to the appearance of properties at night as we do during the daytime. To do so, hire a lighting consultant (rare as good ones are) because the effectiveness of the architectural presentation at night can be so dramatic, and the focus is different-literally the difference between night and day. Also, the specification and purchasing of lighting have some hidden pitfalls that require professional guidance.

Third, with public infrastructure, we must insist on quality rather than simply low initial cost. If you are specifying pedestrian or area lighting from a local utility, insist on shielded fixtures and the minimum available wattages. Remember, utilities are in the business of selling electricity, and nighttime, off-peak consumption is very profitable. Don't be put off by talk of what is "standard". Ask for, or show them, new, improved products, which are now being offered competitively by many manufacturers. In Connecticut, so many developers and localities demanded quality fixtures that the utility companies there simply stopped offering the old, cheap "standards" that had purchased in large lots and foisted on the public for so long.

Finally, for the first time, such standards bodies are formally addressing the quality of lighting, rather than just the quantity. Soon, we will have recommended minimum and maximum illumination levels for specific outdoor tasks in four described environmental zones, ranging from urban to rural preservation (Walker, Chris. 2013).



Figure 3.34
Source: the city of Perth
lighting strategy



Figure 3.35
Source: the city of Perth
lighting strategy

3.9 Indicators for the Evaluation:

This section lists out the indicators that will be used in the chosen sites of Khartoum city to evaluate its components according to the previous theoretical studies:

* **Buildings Evaluation :**

The buildings will be evaluate according to its lighting method to figure out if it suitable to the building function and the façade's materials (100% of 100%).

* **Streets Evaluation :**

The streets will be evaluate by three indicators, which are:

- **Scale:** the street lighting design must take into account human scale and provide the suitable scale of light columns for both cars and pedestrians. (40% of 100%).

- **Color of lighting:** as it has mentioned previously white lighting is preferable rather than orange, also LED lighting is the suitable choice for street lighting. (40% of 100%).

- **Advertisements and signs lighting:** must be attractive and can be seen clearly by people from along distance to road. (20% of 100%).

* **Bridges Evaluation:**

will be evaluate by the same streets' indicators above.

* **Parks Evaluation :**

The parks will be evaluate by four indicators which are: hard landscape lighting, vegetation lighting, waterscape lighting (25% for each indicator of 100%).

The total of above components' percents of the evaluation will considered as (suitable nightscape lighting) if it got more than 70% and will considered as (unsuitable nightscape lighting) if it got less than 70%.

Chapter (4)
Case Study Analysis
(Khartoum city)

CHAPTER 4

Case Study Analysis

(Khartoum city)

4.1 Introduction :

After having a quite good background about the nightscape and urban illumination and the strategies that can play role in improving the perception of the city nightscape. This chapter is trying to apply the previous theoretical studies on the chosen sites in Khartoum city to figure out the overall nightscape statement and determine the problems and short comings. It has been chosen according to considering Khartoum city as the capital of Sudan and the center of the economic, social and recreational activities. The chosen sites are divided into two groups: **the Nilotic façade of the city**, it has been chosen because of its aesthetic value to the city on Nile river, and **the commercial & recreational area**, it has been chosen because it contains diverse activities on it.

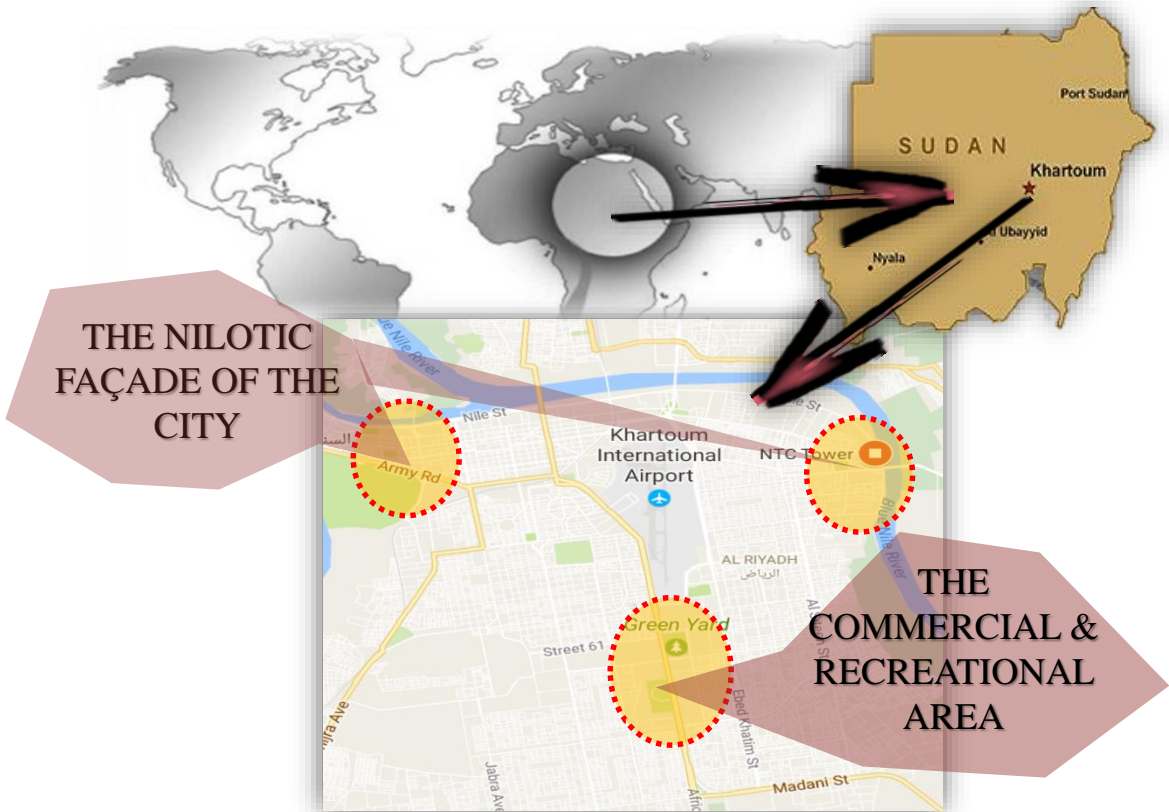


Figure 4.1 the chosen sites in Khartoum city

Source: www.googlemap.com

4.2 Group (1): The Nilotic Façade of the City:

Nile river gives Khartoum city the potential to have an aesthetic nightscape façade, and from urban design view, the river makes any city more livable and motional. Therefore, the first chosen site to study its nightscape statement was the Nilotic façade of the city. We have chose a specific elements on the Nilotic façade that have a major effect on it, which are:

*The buildings:

-Corinthia Hotel: has been selected according to its aesthetic and architectural value to the city, it is considered as an iconic building in Khartoum city.

-Friendship Hall: has been selected according to its cultural value and most important events and conferences are held in it.

- NTC Tower: has been selected because it is the tallest building in Sudan.

- **The street:** Nile street : has been selected according to its location next to Nile river.

- **The bridge:** Al-Manshia bridge: has been selected because it has a unique feature comparing with other bridges in the city .

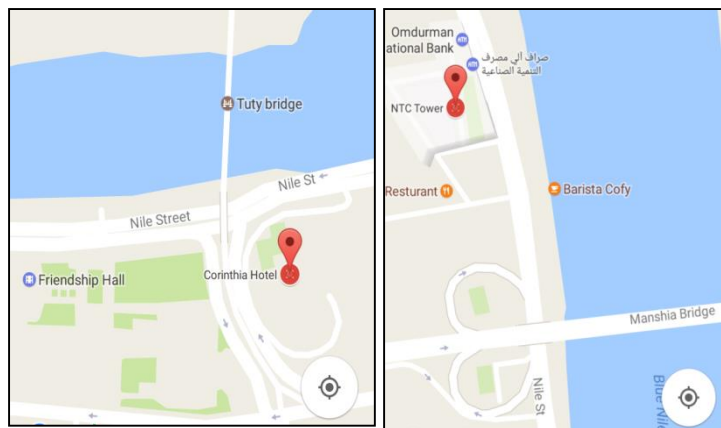


Figure 4.2 group (1) location
Source: www.googlemap.com

4.2.1 Corinthia Hotel Khartoum :

The Corinthia Hotel Khartoum is a five-star hotel in central Khartoum, on the meeting point of the Blue Nile and White Nile and in the center of Khartoum's commercial, business, and administrative districts. It is located next to the Friendship hall of Khartoum and the tuti bridge (Figure 4.2) .



Figure 4.3 Corinthia Hotel Khartoum
 Source: <http://www.pinterest.com>

The Corinthia Hotel is an iconic building in Khartoum, being considered as an important symbol of Sudan. It has an incredible panoramic view for Khartoum. It has a modern oval shape and a horizontal slices of curtain walls. It consist of 19 stories, which considered one of the tallest building in Sudan. The lighting method used at the entrance and ground floor and the top part of the building is floodlights, the middle part of the building used a combination between interior lighting and floodlights (Figure 4.3). The lighting system is considered a successful example comparing with most of other building Khartoum. The lighting design of the building makes it the most favorable place in the city for the people to capture there spatial moments and events.

Building	Indicator	Percent of (100%)	(suitable nightscape lighting)
Corinthia Hotel	Lighting method	80%	

Table 4.1 Corinthia Hotel evaluation

4.2.2 Friendship Hall :

Friendship hall was built in 1979. It is located in the site on the Nile street, from the east Corinthia hotel and in the west of the Sudan National Museum and Park April 6 and hotel Coral Khartoum and the Bridge of the White Nile, while in the north is located Tuti Island (Figure 4.2).



Figure 4.4 Friendship Hall
Source: <https://www.pinterest.com>

Friendship hall is a complex of buildings in Khartoum consist of halls for conferences, meetings, exhibitions and galleries and theater and cinema closed and other facilities attached. The lighting design is extremely simple (Figure 4.4). The ground floor is more brighter than the other floors, it uses a colorful floodlights, the other floors uses contour lighting to highlight each floor.

Building	Indicator	Percent of (100%)	(unsuitable nightscape lighting)
Friendship Hall	Lighting method	40%	

Table 4.2 Friendship Hall evaluation

4.2.3 NTC Tower :

National Telecommunications Corporation Tower is a skyscraper located east of Khartoum and next to Al-Manshia Bridge and on view of the Blue Nile (Figure 4.2).



Figure 4.5 NTC Tower

Source: skyscrapercity.com/shpwthread.php?=-487493&page=3

NTC Tower is the tallest building in Sudan consist of 29 story. The ground floor consist of reception hall and Al- Nile Bank and conferences hall and other facilities, the other stories consist of offices. The building is depending on the interior lighting of the offices and the out doors lighting columns during the year, while the colorful floodlights used only at special events and celebrations of the country (Figure 4.5).

Building	Indicator	Percent of (100%)	(unsuitable nightscape lighting)
NTC Tower	Lighting method	60%	

Table 4.3 NTC Tower evaluation

4.2.4 Nile Street :

Nile street is one of the main streets of the capital of Sudan. Street stretches from the White Nile Bridge and bounded on the north Blue Nile and Southern Avenue of the Republic who is mediated the business district of Khartoum (Figure 4.6).

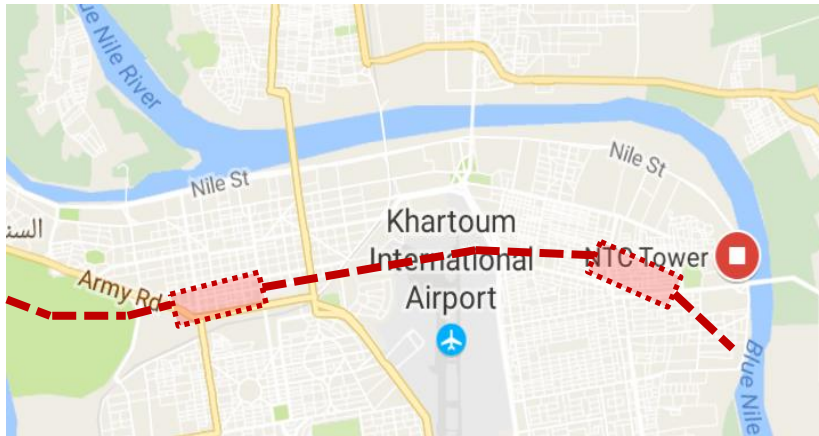


Figure 4.6 Nile street location
Source: www.googlemap.com



Figure 4.7 Nile street lighting
Source: sudacon.net/2013_08_01_archive.html?m=1

Nile street is the most beautiful and one of its salient features, where it overlooks the most important of governance, politics, economy and culture centers in Sudan as we mentioned previously. The lighting system used in the street is High Pressure Sodium Vapor (HPSV) which we have mentioned its bad color render for the street.



Figure 4.8 Nile street's advertisement signs lighting
Source: taken by the author

The advertisement sign located on one site of the street. It is uses neon lights and most of the signs are redeemed (Figure 4.8).



Figure 4.9 Nile street's kiosks lighting
Source: taken by the author

The kiosks around the streets are use neon lights on the top and some kiosks use floodlighting as well (Figure 4.9).

Street	Indicator	Percent of (100%)
Nile street	Scale	20% of 40%
	Color lighting	15% of 40%
	Advertisement's lights	7% of 20%

Total:40% (unsuitable nightscape lighting)

Table 4.4 Nile street evaluation

4.2.5 Al-Manshia Bridge :

Al-Manshia bridge is located east of Khartoum city and link between Khartoum and east of the Nile (Figure 4.2).

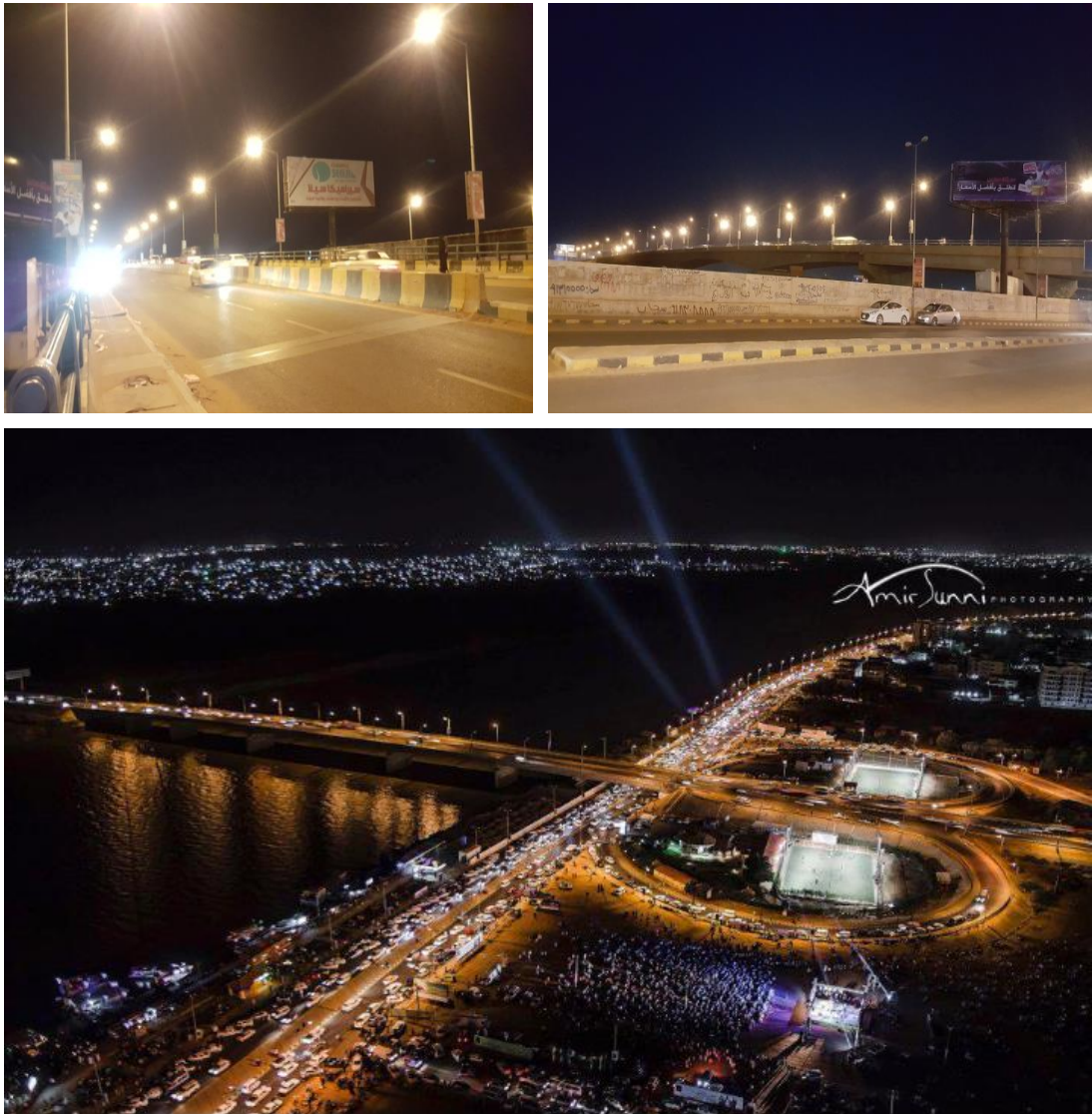


Figure 4.10 Al-Manshia Bridge

Source: <https://alchetron.com/Khartoum-6083-W>

Al-Manshia bridge is one of the most important bridges in Khartoum, it can be treated as one of the unique feature in the city. The lighting system used on it is HPSV as well as Nile street , it is also contain advertisement signs but all of its lights has been redeemed (Figure 4.10). It has the same percents of the Nile street evaluation (see table 4.4).

4.2.6 Overall Nightscape Status of Group (1) :



Figure 4.11 the Nilotic façade of the city

Source: www.graam.com

The spatial location of group (1) next to Nile river is need a proper lighting design for each feature in this area to be legible from overall view and suitable for human scales and their view. According to the previous nightscape cases of the chosen components there is a big number of shortcoming in urban illumination. The lighting system that used in the Nile street and Al-Manshia bridge are (HPSV), as we have mentioned, it has a very poor color rendering and it cause glare and lighting pollution. And as it obvious in (Figure 4.11) there is a sky glow problem caused by inappropriate lighting.

Group (1) is located in area that have a big amount of pedestrians spatially at night. Lighting design in this area didn't take human scale into consideration, there is very bright seating areas and the others are dark. Also, as we've mentioned, a few number of advertisement signs are lighted and others are redeemed which made the overall view of the street irregular and randomized.

Beside the lighting design problem, there is a financial issue makes the Nilotic façade dark more than bright. For instance, an interview we have done it with one of the engineers in the NTC tower, he has told us that they switch off the floodlights of the building because of the high monthly cost of the electricity.

The overall evaluation for the Nilotic façade according to previous components evaluations is (unsuitable nightscape lighting).

4.3 Group (2): the Commercial & Recreational Area:

Shopping, eating, walking, seating are the most activities occurring at the night after long day of working. The chosen site has all kinds of facilities for these activities which require a proper nightscape design to simulate people to stay for longest time, these facilities are:

***The buildings:**

- Afra Mall: has been selected because it is the first shopping mall center in Sudan.
- Restaurants and shops: has been selected according to its location within the chosen group as a commercial and recreational area.
- **The street:** Africa street: has been selected because it consist of five cars lanes which need to study its lighting statement, also it is the only street which contain tunnel in Khartoum .
- **The park:** Green Yard park: has been selected because of its unique location next to one of the most important streets in Khartoum witch made the accessibility more easier for the users.

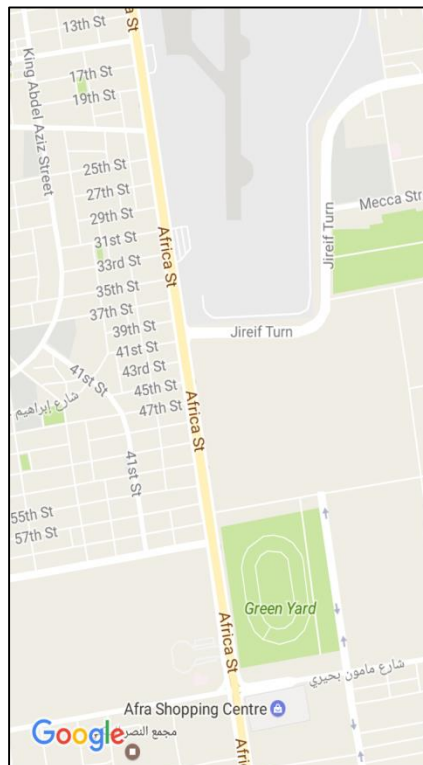


Figure 4.12 group (2) location
Source: www.googlemap.com

4.3.1 Afra Mall :

Afra mall is the first shopping center in Sudan located in Khartoum in Africa street in Arkawit district (Figure 4.12).



Figure 4.13 Afra Mall

Source: taken by the author

Afra Mall building is consist of only one floor above the ground floor and one floor under the ground.

The material used in finishing is aluminum cladding and the front elevation of the ground floor is glazed. The lighting method used is interior lightings from the glazed area in the ground floor and neon lights used in the shops signboards and the mall's logo.

The other parts of the building are solid and have no lights on it. The western side of the building contain two big advertising boards which lighted by only four floodlights (Figure 4.13).

Building	Indicator	Percent of (100%)	(unsuitable nightscape lighting)
Afra Mall	Lighting method	35%	

Table 4.5 Afra Mall evaluation

4.3.2 Restaurants and Shops :

Along Africa street and next to Alamarat districts there is a numbers of restaurants and shops located there as a creational and commercial area (Figure 4.12).



Figure 4.14 the restaurants

Source: <http://www.pinterest.com>

Along Africa street there is a row of restaurants, it is considered as one of the most popular in Khartoum. Most of the restaurants are consist of residential buildings and the ground floor and first floor are used for the restaurant. The residential stories above the restaurant are left without lighting to highlight the restaurant and make it more legible for the people from far distance. The lighting system used in the restaurants is floodlights in the ground floor and neon lights to highlight the restaurant's signboard, some other restaurants used interior lighting as well (Figure 4.14).

Building	Indicator	Percent of (100%)	(unsuitable nightscape lighting)
Restaurants	Lighting method	50%	

Table 4.6 the restaurants evaluation



Figure 4.15 the shops

Source: taken by the author

Between the restaurants there is a numbers of shops also located along Africa street. Like the restaurants, the shops and stores are use only one or two stories from the above residential stories that left without lighting. The lighting system used is spotlights, the signboards using neon lights and others use contouring lights and floodlights. The façade mainly uses curtain wall and interior lighting so the commodities can be seen clearly by pedestrians (Figure 4.15). It has the same percent of the restaurant evaluation (see Table 4.6).

4.3.3 Africa Street :

Africa street is located between El Mek Nimir Avenue and the Central Market (Figure 4.16).

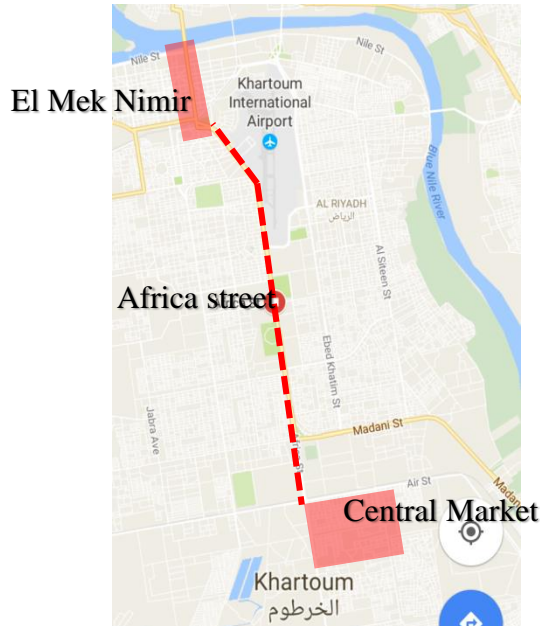


Figure 4.16 Africa street location
source: www.googlemap.com

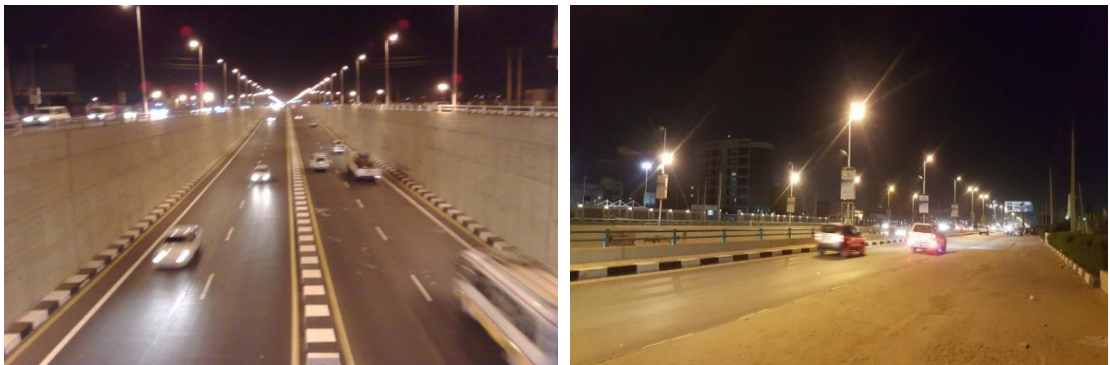


Figure 4.17 Africa street lighting
Source: Khartoum hashtag on Twitter

Africa street is considered as one of the most important streets in Khartoum, it passes through prominent commercial, governance and recreational facilities. It is consist of four cars lanes. The lighting system used is (HPSV) lights, the street contain two rows of light columns (Figure 4.17).

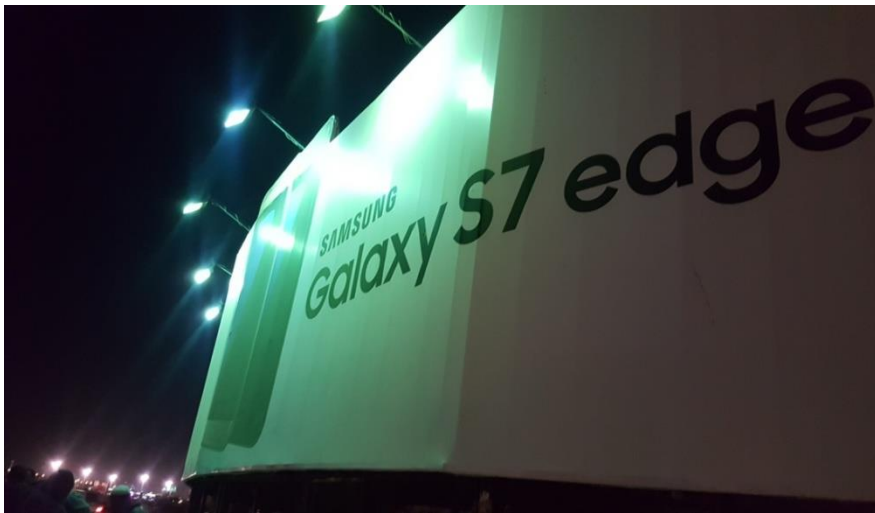


Figure 4.18 Africa street's advertisement signs lighting

Source: taken by the author

The street contains a number of advertisement signs of various types and sizes. The signboard that fixed with lighting columns are lit by neon lights, while the wall signboard lit by floodlighting (Figure 4.18).

Street	Indicator	Percent of (100%)	
Africa street	Scale	20% of 40%	Total:40% (unsuitable nightscape lighting)
	Color lighting	15% of 40%	
	Advertisement's lights	7% of 20%	

Table 4.7 Africa street evaluation

4.3.4 Green Yard Park :

Green yard is next to Arkawit district and located south of Khartoum National Airport and north of Afra Mall (Figure 4.12).



Figure 4.19 Green Yard Park lighting
Source: www.sudaneseonline.com

Green yard park is one of the biggest and important parks in Khartoum, most of the events are held in it. It has a flat morphology with no vegetation elements but the ground grass. The main gate lighted by floodlight and the lighting system used in the park is high mast column lighting which are out of human scale. Also, there is a row of kiosks lighted by floodlight and its signboard lighted by neon light. It is looks more brighter that other parts of the park. There is also a fountain in the middle of the park which lighted by high power floodlight made the fountain clear to the pedestrians from far distance (Figure 4.19).

Park	Indicator	Percent of (100%)
Green Yard Park	Hard landscape lighting	10% of 25%
	Vegetation lighting	15% of 25%
	Waterscape lighting	5% of 25%
	Pathway lighting	2% of 25%

Total:32% (unsuitable nightscape lighting)

Table 4.8 Green Yard Park evaluation

4.3.5 Overall Nightscape Status of Group (2) :

The chosen site is involves several commercial and recreational facilities, these two types of facilities are precisely need a very accurate and proper lighting design to achieve its purpose.

First type of these facilities is Afra mall and the commercial stores. As we have noticed that the lighting design that used for the mall made it not legible and unattractive like it should be. Most parts of the building are dark, the western side of the mall is dull and the advertisement sign on it are difficult to be seen from human and overall views because of the lack of floodlights that used on it.

The commercial shops and restaurants along the street are quite better, the lighting design made it legible and notable from far distance regardless some signboards that have numbers of broken neon lights.

The overall view of Africa street nightscape does not fit its image as one of the most important streets in Khartoum. The lighting system made the night view very poor, also the pedestrian walk path did not take into account the lighting, which contribute in increase the feeling of fear while walking through it. This mistakes made the overall view of Africa street nightscape very disappointed.

Finally, green yard park also did not take into account the human scale in lighting design, there is no any paths lights which made it looks dark. There is certain spots in the park are bright and others are dark which made the overall view of the park irregular and randomized.

The overall nightscape status of group (2) is close to group (1) and have the same lighting pollution like glare and sky glow.

The overall evaluation for the commercial and recreational area according to previous components evaluations is (unsuitable nightscape lighting).

Chapter (5)

Conclusion and Recommendations

CHAPTER 5

Conclusion and Recommendation

5.1 Introduction :

Nightscape status in Khartoum city in the literature review part is missed, because of the lack of the theoretical studies about the lighting design in the urban design view, the study was abbreviated.

The study needs an atmospherical photos to analyze the overall view of Khartoum city, but because of the lack photos of this kinds of pictures at night on websites and most of the existing photos have been edited by Photoshop which doesn't give the actual situation in the reality. Due to the limitations of the professional photometric equipments, the photos that have been taken were quite poorer than the reality.

5.2 Conclusion :

This research at the very beginning aimed to achieve four objectives by answering for numbers of questions. During the thesis's chapters these questions have been answered, though the shortage and lack of theoretical studies and research about nightscape in Khartoum city.

Nightscape and urban illumination are fundamental elements to the appearance of the city and how people perceive its components at night-time.

Many aspects are effected by the lighting design of the city such as: economic, social, safety and aesthetic. Cities with proper lighting design are simulate people to stay for long time at night which led to improve the night-time trade, it couldn't happened without the feeling of safe and entertainment environment that people can interact with it.

Proper lighting design of the components of the city such as: streets, buildings and urban open spaces all together are constructing the perception and the nightscape of the city.

About the nightscape of Khartoum city, we have chose a specific sites to analyze it according to its importance to the city. The study found that there is a huge amount of lighting pollution specially sky glow that caused by poor lighting facilities that have been used for streets and buildings lighting, also there is a financial issue makes the overall nightscape of the city dark more than bright.

However, this thesis have mentioned the strategies that can be applied in the components of the city and it is not impossible to be done in the chosen sites of Khartoum city.

5.3 Suggestions and Recommendations :

- The overall nightscape status of the chosen sites has the same lighting problems such as glare and sky glow which caused by (HPSV) lights on the streets and bridges, the lighting designer must be aware about this problem and exchange the lighting system to LED lighting.
- Khartoum city is an excrescence city, therefore, the architects and urban designer must be aware about the lighting design in the very beginning stages of the projects design and take the lights into account while designing and improving the projects.
- The existing buildings also can be redesign its lighting status to enhance its nightscape perception. For instance, Afra Mall building has a solid façade which made it look dull and dark, in this case we can use contouring lighting to highlight the building and make it legible and attractive.

- The government and owners must be aware about the nightscape statement and its role in the economic of the city.
- Lighting designers must take human scale into consideration when lighting streets, buildings and urban open spaces, the lighting design must be for people and pedestrian not only for cars.
- Broken lights columns and redeemed neon lights in signboards must repair to avoid the irregular nightscape of the streets and buildings.
- Use the proper lighting method that suitable for the function and purpose of the urban component.

5.4 Limitation and Further Research :

This thesis could be more successful precisely the nightscape analysis part if the interviews can involve lighting designers of each chosen components.

Finally, this thesis strives at stimulating further discussions and researches on the nightscape of Khartoum city and hopefully this thesis could be a starting point toward improve the nightscape of our cities and to study more sites in Khartoum. Hopefully this thesis made the nightscape topic more clear and easy to apply its strategies.

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Appendix





Category	Typical Example	Applications
		<p>Non AS/NZS1158</p> <p>Private roadways, existing rural roadways</p>
V		<p>AS/NZS1158 part 1</p> <p>Used for high traffic volume roadways where the requirement of <u>motorists</u> is dominant.</p> <p>Includes provision for motorways, arterial and sub arterial and main roads, speed zoning, on/off ramps, interacting carriageways, underbridges and areas accompanied by high pedestrian volumes.</p> <p>As a secondary consideration, the lighting assists pedestrians walking along the verges of the road.</p>
P		<p>AS/NZS1158 part 3</p> <p>Used for low volume traffic roadways and other outdoor public spaces where the requirement of <u>pedestrians</u> is dominant.</p> <p>It is applicable to pedestrian pathways, cycleway, external car parks, outdoor shopping precincts, malls, town squares, transport interchanges, subways, footbridges, ramps and stairways where lighting for pedestrians is the main consideration. As a secondary consideration, the lighting assists drivers of vehicles to identify kerbs, intersections and other key features across the whole of the roadway.</p>
PX		<p>AS/NZS1158 part 4</p> <p>Used for Zebra crossings unless otherwise specified by the Public Body.</p> <p>Floodlighting is to provide illumination in the vertical plane so that the person is contrasted against the background. Within Category PX, there are three subcategories.</p>
Underpass		<p>Used for both traffic and pedestrian underpasses, tunnels where the lighting is fixed directly to walls.</p>

Table (1) AS/NZS1158 Public Lighting Categories
Source: Public Lighting Design Manual







Sub Section	Typical Example	Application
P3 - 4		Local collection roads used for accessing abutting properties and common areas, pedestrian path and cycle ways.
P5		Local roads used for accessing abutting properties and common areas
P6 - 8		Outdoor shopping precincts, malls, open arcades, town squares, civic centres , transport terminals and interchanges
P9		Stairs and ramps
P11		Public car park spaces, aisles, circulation roadways. There are three sub categories for this category.
P12		Designated parking spaces specifically intended for people with disabilities

Table (2) subcategories of category P lighting utilized by Queensland DNSPs

Source: Public Lighting Design Manual






Light	Typical Example	Application
Standard		This is the most common street light column. It may support single, or multiple outreaches and luminaires. Generally steel columns and outreaches (Ergon Energy use some concrete in certain circumstances).
Decorative		There is a variety of decorative lighting arrangements available for use in underground estates and roadways. These are more stylish column and luminaire combinations and are used to improve the prestige of an area. They are generally used for category P lighting arrangements. However, they have some category V lighting applications. They can present problems with glare.
Post Top		Post top lighting is used to provide general lighting for an area e.g. car parks, cycle or walk ways. They are used for category P lighting only. They can present problems with glare.
High Mast		The high mast column is taller than the standard street lighting column and can have a number of luminaires attached to a headframe. They are used for Category V and P applications. They are utilised for centre roundabouts, car parks and complex intersections where central light dispersal can be achieved.
Bulkhead		Used in vehicular and pedestrian underpasses and tunnels where it is not possible to install conventional lighting arrangements but is convenient to attach the luminaires directly to the walls.

Table (3) Lighting Styles
Source: Public Lighting Design Manual



Type	Typical Example	Application
Semi Cut Off (SCO)		The most commonly used for road lighting Designed to reduce the glare impact on drivers
Aeroscreen (cut off)		Aeroscreen luminaires are used: <ul style="list-style-type: none"> • in areas where spill light is to be reduced to a minimum because of legislative requirements e.g. restrictions with spill light in the vicinity of airports, • to reduce intrusive lighting (residential properties abutting major roads), • to reduce glare where the background is normally dark e.g. bridges, flyovers, overpasses, railway crossings • to comply with certain Public Body requirements. They are spaced closer together than SCO lighting due to reduced lateral light dispersion.

Table (4) Typical luminaires types
Source: Public Lighting Design Manual






Positioning Limit Factor	Typical Example	Possible Solution
Physical and non-physical site features including driveways, vegetation, overhead and underground utility infrastructure, pram ramps, barricades		Locate lights clear of obstructions. Clearances will depend on statutory clearances, adequate physical separation or as required by the Public Body.
Conflict points including roadway narrowing		Highlight by adjacent streetlight installations
Street light maintenance program e.g. safe EWP access to lights		<ul style="list-style-type: none"> • Use of hinged high mast poles • Installation of barricades • Provision of maintenance bays • Road access to high mast lights
Environmental e.g. Spill light and glare		<ul style="list-style-type: none"> • Use of Aeroscreen luminaires • Luminaire orientation with respect to the roadway
Locations that lead to false indications to motorists		Locate luminaires to avoid misleading visual guidance to the passage ahead.
Locations that can create hazards to motorists e.g. poles located on roundabouts, about intersections or on the outside of curves where they can be easily impacted by errant vehicles		<ul style="list-style-type: none"> • Locate luminaires clear of possible conflict areas • Install guard rail or steel/concrete barriers • Consider joint use of poles with other utilities • Specified setbacks from the kerb or running lane • Use of building walls, verandas etc • Locate poles on the inside of curves
SBM poles striking overhead mains after vehicle has impacted them		<p>A pole shall not be located closer than:</p> <ul style="list-style-type: none"> • 1.2 times the mounting height on the approach side of cross roads mains • 0.6 times the mounting height on the departure side of cross roads mains • 0.6 times the mounting height where the mains run parallel to the carriageway
Slip-base-mounted poles must not be used in areas of high pedestrian volume e.g. schools, shopping centres, bus stops		Utilise BPM structures in these locations.
Public Body requirements		As an example, some Public Bodies require minimum setbacks from vehicle carriageways, cycle way and footpath trees.

Table (5) Typical position limiting factors for luminaires
Source: Public Lighting Design Manual

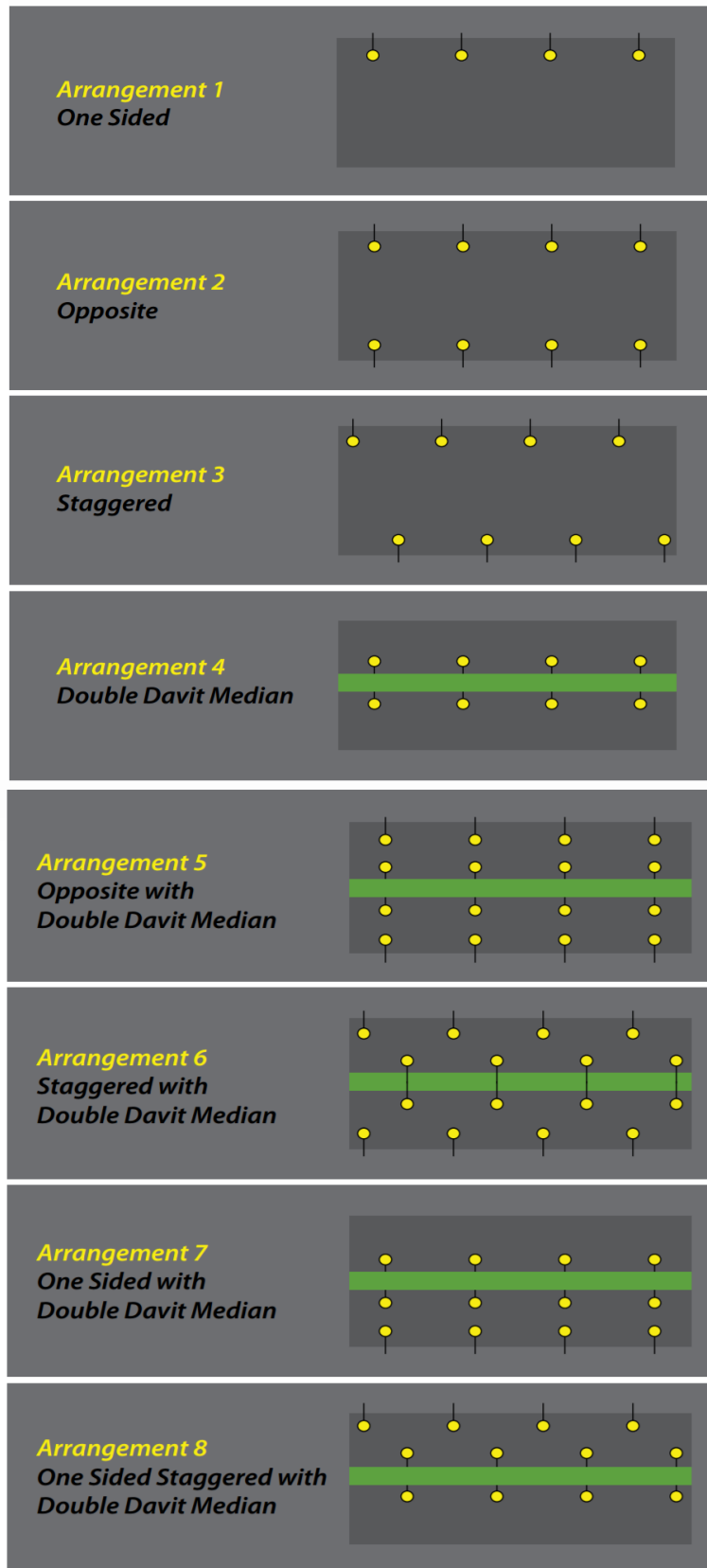


Figure (1) Typical Lighting Arrangements
 Source: www.fortisalberta.com/street lighting catalogue