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PEDESTRIAN LIGHTING

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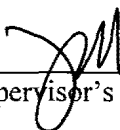
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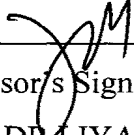
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IMPROVING PEDESTRIAN FACILITIES IN KUANTAN
CENTRAL BUSINESS DISTRICT (CBD) AREA: PEDESTRIAN LIGHTING

NOR AMIRA AINI BT ISMAU

Thesis submitted in fulfillment of the requirements
for the award of the degree of
Infrastructure Management

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ABSTRAK

Kajian ini dijalankan untuk menambahbaik kemudahan pejalan kaki di kawasan “central business district” (CBD) Kuantan khususnya lampu pejalan kaki. Pencahayaan pejalan kaki ditakrifkan sebagai pencahayaan yang menerangi pejalan kaki dan juga laluan pejalan kaki. Objektif penyelidikan ini adalah untuk mengenalpasti keperluan pejalan kaki di kawasan CBD Kuantan, untuk menyiasat halangan pada kemudahan pejalan kaki khususnya pencahayaan pejalan kaki di kawasan CBD Kuantan dan mencadangkan parameter infrastruktur pejalan kaki dalam meningkatkan pencahayaan pejalan kaki di kawasan CBD Kuantan. Kaedah penyelidikan yang berlainan dijalankan termasuklah kajian literatur, soal selidik, temu duga dan pemerhatian kawasan kajian sebelum meneruskan analisis data dan diikuti kesimpulan serta cadangan. Di akhir kajian ini, ia akan berjaya mengenal pasti keperluan pejalan kaki dan keperluan kemudahan serta halangan pelaksanaan lampu pejalan kaki di kawasan CBD Kuantan. Peningkatan “connectivity”, keselamatan dan keselesaan diperoleh melalui penambahbaikan dan pelaksanaan pencahayaan pejalan kaki dengan lokasi dan reka bentuk yang paling sesuai di kawasan CBD Kuantan.

ABSTRACT

This research is conducted to improve the pedestrian infrastructure in Kuantan central-business district (CBD) area specifically on pedestrian lighting. Pedestrian lighting is defined as any lighting which illuminates the pedestrians and pedestrian walkways. The objectives of this research are to identify the pedestrian needs and requirements in Kuantan CBD area, to investigate the barriers on pedestrian facilities specifically the pedestrian lighting in Kuantan CBD area and to propose pedestrian parameters in improving the pedestrian lighting for pedestrians in Kuantan CBD area. Different methods of research are conducted which include literature review, survey method by means of questionnaire, interview and site observation before proceeding to data analysis and followed by conclusion and recommendation. At the end of this research, the study will able to identify the pedestrian needs and requirements as well as barriers on the implementation of pedestrian lighting in Kuantan CBD area. The improvement on the pedestrians' connectivity, safety, comfort and security especially at night are obtained through the improvement and implementation of pedestrian lighting with the most suitable placement and design in Kuantan CBD area.

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CHAPTER 1

INTRODUCTION

1.1 Background

Pedestrian is a term refers to a person who chooses to travel on foot instead of travelling via other mode of transportations such as cars, buses, trains or rapid transit. Those who are travelling by skateboards, scooters and wheelchairs users are also considered as pedestrians. Melbourne, Toronto, Vienna and Vancouver are among the livable cities that promotes the concept of walkability which encourages the people of these cities to prefer walking for their daily routine activities (Sukor et al., 2017). Currently, walking culture in a city is being promoted in order to improve the minimization of carbon emission and at the same time foster “green” mode of transport as well as improve the traffic flow by reducing traffic congestion and develop sustainable environment. Besides that, walking also encourages healthy lifestyle among the communities which leads to both physical and mental benefits.

Meanwhile, in Malaysia, the development of pedestrian infrastructures has not achieved the satisfactory level yet (Sukor et al., 2017). Therefore, designing and planning a better environment for the pedestrian has become a concern in current development. Developing a pedestrian environment involves more than simply providing the sidewalks for their convenience. A truly practical pedestrian system should be implemented and this can be associated with the accessible design where the accessibility of the facilities provided should be universal at which it is accessible for both pedestrians and those with disabilities (Zegeer et al., 2001). The pedestrian infrastructures’ quality is the key element for the livability a community especially for the pedestrian. Walkways, curb ramps, crosswalks, lighting, pedestrian overpasses or underpasses and street furnitures are part of the example of pedestrian facilities that can be improved in providing a better pedestrian environment (Zegeer et al., 2001).

In this research, the implementation and improvement of pedestrian lighting will be highlighted in the improvement of the pedestrian infrastructures. According to Donnell et al., (2011), the term of pedestrian lighting can be defined in certain ways. Some people might interpret pedestrian lighting as all the lighting that involved in illuminating the pedestrians or pedestrian facilities. Meanwhile, there are also some people who interpret this pedestrian lighting term as the specifically-designed lighting for the pedestrian and pedestrian facilities' illumination. For all purposes of this work, it is defined as any form of luminaires that assist in the illumination of the pedestrians or pedestrian facilities (Donnell et al., 2011). Example of pedestrian lighting are the street lights, highway lighting, residential light posts, and commercial areas' lighting. Specifically, pedestrian lighting should be designed of minimum intensity luminaires with a shorter pedestrian-scale lighting poles which will indeed help in the provision of more practical illuminations.

This research covers the improvement of pedestrian lighting in Kuantan Central Business District (CBD) area. In the modern society, CBD can be defined as a district with convenient traffic and infrastructures which fully integrated the institutions for economy, business, culture and service as well as supporting facilities like hotels, shopping malls, business office buildings and commercial buildings (Sun, 2011). Kuantan CBD area is where most businesses and commerces are located. The businesses and commerces include building of offices, shops and banks. The research will be focusing on area that incorporate the nodes of locations of Urban Transformation Centre (UTC), Pasar Besar Kuantan, Gio Mall, Kompleks Belia & Sukan, Berjaya Megamall, Kuantan City Mall and East Coast Mall.

1.2 Problem Statement

One of the significant reasons for the installation of the lighting which illuminates the walkway is to improve the reassurance of the pedestrians. Reassurance is defined as the pedestrian's confidence which is obtained from the lighting provided, that encouraged him/her to walk along the road or walkway especially when walking alone in the dark (Fotios et al., 2015). Reassurance eventually contribute to a higher perceived safety and at the same time minimize the fear of crime. In Kuantan CBD area, most of the illumination of the pedestrians are supported by the nearby existing streetlights. Specialized pedestrian lighting had been placed in few locations around this area but there

are also some locations that are supposedly to be provided with better lighting and yet are not well-illuminated until now. This will eventually lead to a lower reassurance of the pedestrian in using that particular poor-lit areas. Therefore, effective measures should be taken in improving the well-being of the pedestrian who travel along this area and one of the key component that can be address is the proper implementation of pedestrian lighting which should be typically focusing more on the suitability of the placement and design of the pedestrian lighting itself with regard to the pedestrians' convenience, security and safety aspects.

1.3 Research Objectives

The objectives of this research are:

- To identify the pedestrian needs and requirements in Kuantan CBD area.
- To investigate the barriers on pedestrian facilities specifically the pedestrian lighting in Kuantan CBD area.
- To propose pedestrian infrastructure parameters in improving pedestrian lighting for pedestrians in Kuantan CBD area.

1.4 Research Questions

Research questions that might arise include:

- What are the pedestrian needs requirements in Kuantan CBD area?
- What are the barriers on pedestrian facilities specifically the pedestrian lighting in Kuantan CBD area?
- What are the parameters to improve pedestrian lighting for pedestrians in Kuantan CBD area?

1.5 Research Significance

This research is targeting the pedestrian facilities improvement of the existing and emerging Kuantan CBD area with appropriate concentrations of pedestrian lighting implementation that is expected to affect the pedestrian travel volumes positively and significantly by increasing the reassurance of the pedestrians to walk especially at night. This research is also significant in encouraging “green” mode of transport which will eventually reduce vehicle-dependent and promote healthy lifestyle. At the same time, the outcome of this research is looking forward to support further research and application. For instance, it can be advocated to the responsible authority which is Kuantan Municipal Council in order to establish this pedestrian infrastructure improvement in the future.

1.6 Research Limitations

This research is expected to have its limitations which are basically due to the scope of work and time frame. Firstly, the research is mainly focus on the pedestrian only. It does not incorporate other road users such as cyclist, motorcyclists, motorists and public transportations’ users. In this research, it is actually desirable to also focus on the other potential components that contributes in improving the pedestrian infrastructure such as the crosswalk, shading, traffic barriers and walkway as we will be able to come out with a wider range of output. However, it only focuses on one component of pedestrian infrastructures improvement which is the pedestrian lighting. Lastly, this research is limited to the Kuantan CBD area only. It only covers the area that encompasses the seven nodes of locations which are UTC, Pasar Besar Kuantan, Gio Mall, Kompleks Belia & Sukan, Berjaya Megamall, Kuantan City Mall and East Coast Mall.

1.7 Research Location

Generally, this research is focusing on implementing the pedestrian lighting at Kuantan CBD area. Kuantan CBD area encompasses of specified nodes of locations of UTC, East Coast Mall, Kuantan City Mall, Berjaya Megamall, Maybank, Pasar Besar Kuantan and Hentian Bandar Kuantan. In overall, the area of the whole Kuantan district is 2960.42 km². The area for Kuantan city is 3.81 km² and the area of the research location of Kuantan CBD area is 0.27 km².

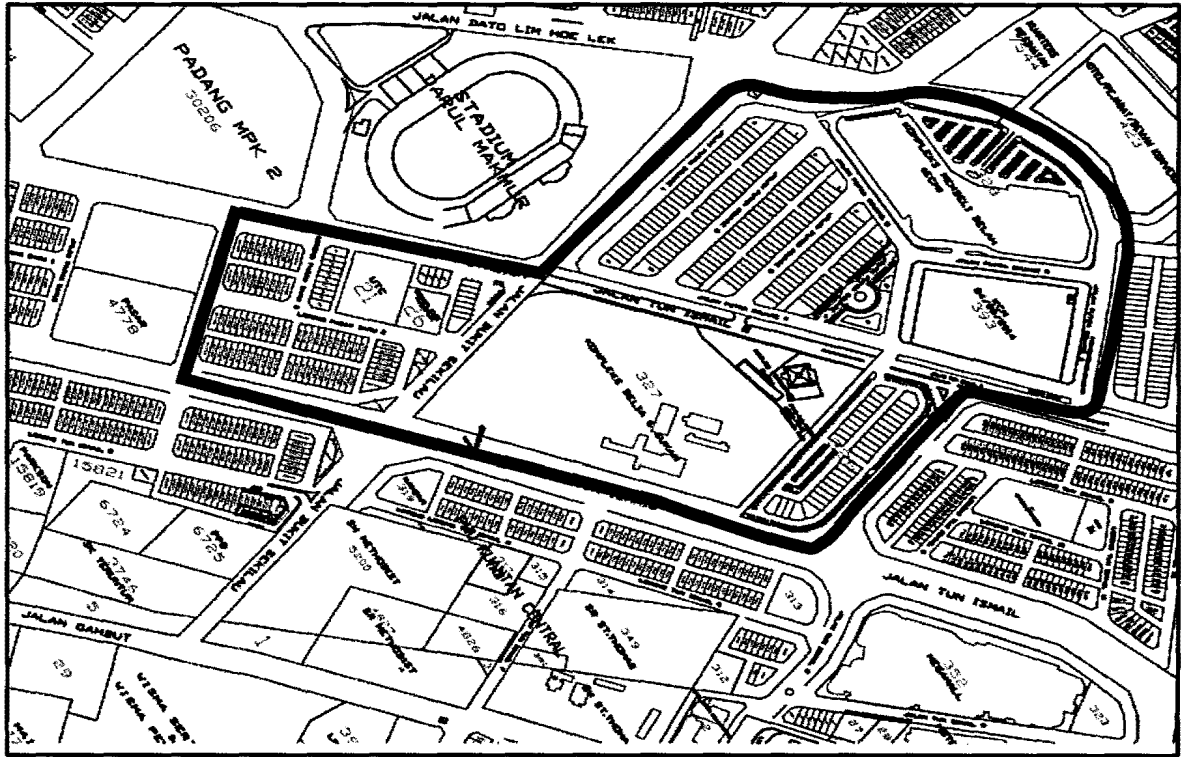


Figure 1.1 Plan view of Kuantan CBD area.

Source: Majlis Perbandaran Kuantan (2018). Map of Kuantan city.

For a detailed view, Figure 1.1 above shows the plan view of the Kuantan CBD area. The blue line indicates the research route which connected the specified nodes of locations. The route of research starts from UTC – Pasar Besar Kuantan – Gio Mall – Kompleks Belia & Sukan – Berjaya Megamall – Kuantan City Mall – East Coast Mall – UTC. These nodes represent the places of attraction in Kuantan CBD area. It is expected that along the road and walkway that connect these seven nodes to have a higher pedestrian volume especially during the weekend. Therefore, the pedestrian facilities should indeed be improved along this route in order to ensure the safety, security and comfort of the pedestrian that pass through it.

1.8 Expected Outcomes

At the end of the research, the expected outcomes are:

- Improvement and implementation of the pedestrian lighting in Kuantan CBD area with the most suitable placement and design.
- Improvement on the pedestrians' connectivity, safety, comfort and security especially at night.
- The solution on the implementation of the pedestrian lighting is expected to support the key element of user-friendly, less maintenance, low cost and high durability.

1.9 Conclusion

In this chapter, the overall overview and scope of this research is being briefly outlined in order to provide understanding and background information about the research. The background typically explained the overall definition of the research topic, which is improvement on pedestrian facilities in Kuantan CBD area specifically on pedestrian lighting. All the elements of problem statement, research objectives, research questions, research questions, research significance, research limitations and research location provide essential context and focus that assist the completion of this research.

CHAPTER 2

LITERATURE REVIEW

2.1 Importance of Pedestrian Lighting

Pedestrian-scale lighting or simply referred as pedestrian lighting act as the illumination supplement for the existing roadway lighting. Sufficient illumination obtained from the roadway lighting improves the roadway users' safety meanwhile the pedestrian lighting enhances the safety of the pedestrian (Herring, 2016). Both pedestrian lighting and roadway lighting should be provided complementarily to each other to effectively emphasize the illumination for both walkways and travel lines. The pedestrian lighting itself can be placed in between the existing street light if both illumination for roadways and walkways are needed. To a certain extent, when there is limited space for the installation of the pedestrian lighting pole, pedestrian-height luminaires heads may be mounted to the street lighting pole (U.S. Department of Energy Efficiency & Renewable Energy, 2013).

Specifically, pedestrian lighting assists in improving the accessibility of the pedestrians via illuminating walkways, curbs, crosswalks, signs, any barriers and potential hazards that may exist along their journey. Most of pedestrian prefer in having lower height and illumination of lighting fixtures compared to the tall, bright lighting fixtures (Sacramento Transportation & Air Quality Collaborative, 2005). To be more practical, the pedestrian lighting should be placed in the area that have high pedestrian volume. Besides that, provision of pedestrian lighting helps in minimizing the crime such as robbery, physical and sexual harassment, snatch theft and kidnapping which involved the pedestrian (Painter, 1996). Usually, people tend to avoid using the areas that are poorly lit especially at night. Therefore, by implementing and also improving the pedestrian lighting in that poorly lit areas, it will provide better night time security and safety for the pedestrian.

2.2 Design of Pedestrian Lighting

The outdoor lighting is recommended to be designed cautiously by taking into consideration the important factors such as the placement, quality and quantity of the luminaires, height of the luminaires, the lighting types and wattages as well as the practice of light pollution reduction (Yücel, 2013). In lighting, there is a priority order which is highest priority level and lowest priority level (Yücel, 2013). For the highest level of priority, main walkways and activity-active areas should be well-lit to maximize the pedestrian activity in that area even after dark while for the lowest priority level, some areas may be considered to be not illuminated due to the unsafe or impractical use of that areas during at night.

According to Yücel (2013), during the designing and planning on the placement of the light poles, it is recommended to identify the visual road elements such as street furniture, sidewalks, trees and nearby buildings as well as the underground utility services which might obstruct the installation of the light poles. All the elements identified should be well-coordinated when placing the light poles. Other than that, the light poles should not be installed near to tree canopy that may block their illuminations. If the present of the tree canopy is not avoidable, specific type and level of height of the light poles should be considered to avoid any luminaires blockage and helps in achieving the desired illumination level (Yücel, 2013).

Different luminaires' sources have significant effect on the visual and safety of the walkway at night, especially. High-pressure sodium luminaires should be avoided as their yellowish-orange glow distort colours, decrease the visual clarity and the quality of the night time environment tend to be diminished (Donnell et al., 2011). One of the best practices is by using the metal halide luminaires as they provide white and soft glow which precisely visualize colours, better visual clarity and lower wattage is needed for the same visibility level (Djuretic & Kostic, 2018). To obtain the desired luminaires quality, the source of light must be placed within the specified height ranges for a specified brightness.

For the height of luminaires, pedestrian pathways need intensities ranging from less than one-half footcandle for walkways to five footcandle for intersections, steps and building entrances. Usually, the height for mall and walkway light poles are 3 to 4.5

meters (Yücel, 2013). Mounting luminaires height have increased compared to previous decades with current luminaires technology that allows for higher and brighter road lights. However, it does not contribute to the convenience of the pedestrians as it might only efficient in illuminating the motorists only. Therefore, it is encouraged to reduce the luminaires' height and adjusted it to pedestrian-scale lighting level. For more practical solution, a specified pedestrian-scale lighting can be directly installed. The brightness of the luminaires is dependable on the height of the luminaires (Yoomak et al., 2018). It should complement with the luminaires' height in order to avoid any excessive glare created for the pedestrians.

In addition to the height of the light source, appropriate spacing of light fixtures is critical to achieving consistent illumination of streets and sidewalks and to prevent the pedestrian from encountering intervals of darkness (Yücel, 2013). Consistent light coverage is important, particularly along the sidewalk, because the perception of light is relative to its surroundings. Therefore, a poorly lit area will seem so much darker in contrast to a brightly lit area nearby. The minimum required space between lights might meet lighting standards but may or may not achieve the desired effect.

2.3 Types of Pedestrian Lighting

2.3.1 Light Emitting Diodes (LED) Lighting

Light Emitting Diode (LED) performs an essential role for energy saving and protection of environment in lighting fixtures industry. LED pedestrian lighting is one of the effective option that could be installed. This is because currently energy-saving lighting is being highly promoted and it can be achieved by switching the usage of traditional light sources to more productive ones like LED lighting itself (Juntunen et al., 2015). LED lighting is as much as 80% more green than the traditional lighting sources which include fluorescence and incandescent lamps. The LED lighting which typically known as Solid-State Lighting (SSL) consist of semiconductor or polymeric materials that converts electricity into illuminates (Primiceri & Visconti, 2017). LEDs have been around for about 50 years, however until the early 2000s it was only used in digital devices as indicator lamps (Vitta et al., 2012). Figure 2.1 below indicates one of the example of the LED lighting application in Houston Uptown district sidewalks.



Figure 2.1 LED lightings installed along the Houston Uptown district sidewalks.

Source: Landscape Communications Inc. (2019). Uptown Houston: "Pockmarked Booby Trap" to Vibrant, Safe, Public Realm.

Technological growth in the previous 20 years have enabled LEDs to be utilized first in signal devices such as the traffic light and exit signs and followed by the used in a few limited lighting applications like the flashlights and currently being applied in many universal lighting applications from houses up to exterior lighting. According to (Yoomak & Ngaopitakkul, 2018), LED lighting is used in various applications of illuminations as it brings many significant benefits which include long life, energy savings, better quality of light emission, intrinsically safe, smaller and flexible illumination fixtures as well as high resistant.

In terms of long life, the LEDs can supply 50000 hours or more life that eventually minimize the cost of maintenance (Primiceri & Visconti, 2017). To compare, incandescent light bulb only last roughly for about 1000 hours. White LED lighting application leads to three or even more luminous efficacy which contrast from the incandescent lamps. Coloured LEDs are substantially superior for coloured illumination applications due to the fact of optical filters are not essential. The LEDs have low infrared radiation and ultraviolet and its light can be tuned to any colour occurrence (Yoomak & Ngaopitakkul, 2018). Intrinsically safe means that the LEDs system is fed at minimum voltage and usually are cool to the touch. Next, the LEDs small size enable them to be installed for illumination tight spaces. The LEDs are also having a high resistant as they have no filament to break and vibrations-resist.

2.3.2 Solar-Powered LED Lighting System

The reduction of the electrical consumption of lighting systems via the LED lighting adoption enable enormous comfort from the pressure to attain extra energy portions in almost all evolved economies. In under-developed countries, the major impact of LED lighting might be to provide lighting in the locations or areas wherein the illumination level has formerly been insufficient. For off-grid communities or areas, the combination of LED lighting and the photovoltaic technology offers the most favourable solution for lighting facilities feeding in spite of developing the grid for the electricity transmission (Primiceri & Visconti, 2017). This combination is known as the solar-powered LED lighting as shown in Figure 2.2 below. Photovoltaic propounds a reasonable solution for the light points power as well as allowing to acquire electricity in many developing countries and places.



Figure 2.2 Solar-powered LED lighting along the walkway.

Source: Madan (2015). India's first battery-less, carbon neutral solar lighting in Kolkata parks.

According to the 2016 report prepared by Bloomberg New Energy Finance and Lighting Global for the Global Off-Grid Lighting Association, the market of the off-grid illumination has obtained an astounding development over the past five years with 20 million branded products being sold by more than 100 companies. These solar-powered LED lamps has provided light for about 100 million people or not more than 8% of the potential market. Africa's main markets are Ethiopia, Tanzania and Kenya meanwhile in Asia, India is the leader (Bloomberg New Energy Finance and Lighting Global, 2016). The key to a well-founded and sturdy solar-powered LED lighting system is to ensure that each of the components quality is being guaranteed as well as ensuring proper configuration and integration (Development Finance International Inc, 2014).

The five main components for a complete solar-powered LED lighting system are the solar photovoltaic (PV) panel, battery, charge controller, luminaire and mechanical components (Development Finance International Inc, 2014). Solar PV panel functioned in harvesting energy for the sunlight before converting it to electricity that will be utilized by the lighting system itself. Battery is the supply component of the system. It usually rechargeable and provided to transmit energy to the lighting system for up to three to five continuous rainy or non-sunny days. Charge controller harvests the current to charge the battery during the daytime and discharges the battery at night to power the LED module as efficiently as possible. Luminaire is functioning as the component for providing sufficient light to the road or pedestrian walkways. As for the mechanical components which include poles and internal cables, it acts as the “backbone” of the system by connecting all the other components together.

In terms of key benefits of the solar-powered LED lighting, it has additional benefits compared to the LED lighting system. One of the benefits that can be emphasized is higher energy savings. It offers 100% energy savings over the traditional road illuminations and at the same time assist in higher energy bill savings. In addition to the money savings, solar-powered LED lighting provide considerable health and environmental welfares due to the non-use of kerosene (Primiceri & Visconti, 2017). Use of kerosene leads to production of heavy particulates. In off-grid area, it allows the energy access that assist in lengthen the work day, supporting growing economic activities, community communication and interaction as well as the educational-related activities.

2.3.3 Light Bollard

Light bollard is also one of the effective type of pedestrian lighting as it potentially assists in improving the visibility of the pedestrian as well as enhance the pedestrian safety. By referring to Bullough and Skinner (2015), during full light output operation, the light bollard consumed the electrical power of less than 7 W while during the operation at the reduced output level, it used no more than 2 W. When comparison is being made between the light bollard and the outdoor overhead luminaires, these outdoor overhead luminaires such as the cobra head street lights consumed higher wattages primarily because the higher mounting heights they used to produce long pole spacings requires the power to increase approximately with the square of the mounting height which also can be explained as the inverse square law (Bullough & Skinner, 2015).

Light bollards are installed when light is necessary at a lower level due to hindrances, tree canopies or close to buildings at which pole-mounted light is not applicable and also when there is restriction in the movement or access of the vehicles or in other condition is to outline walkways in the environment that has less curb (Seattle Department of Transportation, 2012). The normal distance of a light bollard is 3m from the street centre and they must be installed next to the walking path to avoid from blocking the pedestrian walking convenience (Yücel, 2013). Aside from that, the light bollards are recommended to be placed 45 cm from the curb's back edge (Yücel, 2013). As in Figure 2.3, it shows the application of the light bollards to illuminates the pedestrian walkways.

By placing these light bollards close to the pedestrians which they intended to illuminate and retaining the lighting within the pedestrian walkway area, the energy consumed can be significantly minimized corresponds to convention overhead lighting appeal. There are two forms of the light bollards illumination (Yücel, 2013). The first one is the area lighting which functioning in lighting up the ground plane around it. Secondly, the marker lighting which produces a glow that shows the location of the bollard. Connection to the electrical grid is not necessary when utilizing the marker bollard as it is solar powered. In terms of the light bollards spacing and placement, it depends on few conditions which include the application of the illuminated area, availability of other light sources and the light bollards optic.



Figure 2.3 Light bollards illuminating the pedestrian walkway.

Source: Reliance Foundry Co. Ltd. (2017). Dispelling the “Fragile” Solar Light Myth.

2.3.4 High Mast Lighting (Spotlight)

High mast lighting is defined as mounted lighting with a height of 100 feet and above while for the lighting with mounting height of 50 feet and below is known as the conventional lighting system (Chacon, 2018). High levels of lighting, low maintenance and slightest hindrance of the ground level are part of the advantages offered by the high mast lighting. It was first introduced in the mid 60's and has become the desirable choice in lighting wide ranging areas such as the sports areas like football fields, car parks and airport (Carlsson et al., 1983). It is also applicable to be used as a pedestrian lighting which usually installed to illuminate large-scale areas. At the same time, it will also lead to reduction of the number of pedestrian lighting to be installed in certain areas as the high mast lighting itself already illuminates wide range of area.

By referring to Chacon (2018), the comparison on positive and negative consequences in the utilization of the conventional lighting system and high mast lighting system has been carried out. It focuses on the installation costs and maintenance costs. When comparing on the installation cost between these two lighting systems, it depends on the specific application. High mast lighting needed for substitution is usually more reasonable to install than conventional one as the number of attachment and poles required is smaller. When it is not involving interchanges, conventional lighting typically needs a lower initial cost.

In terms of maintenance cost, it has great difference between these two systems. For the maintenance of conventional lighting, it needs the use of a bucket truck and essentially needed substantial traffic control like cones, signs and lane closures. When the poles of the conventional lighting are installed on concrete traffic barriers, the lane of the inside position typically need to be closed at which leads to traffic obstructions and safety hazards. On the other hand, in conducting the maintenance for the high mast lighting, only one or two persons occupied with the pickup truck is already enough. It also eliminates the likelihood of exposing the personnel to the risks involved of working near the rapid traffic.

In the design of the lifting and lowering mechanism of the high mast lighting, two primary key factors need to be taken into consideration which are reliability and safety (Journal et al., 2017). Upon the completed installation of the high mast lighting, the lifting and lowering operation should be conducted for only once or twice in a year for the cleaning and maintenance process. Therefore, it is very important in ensuring that all the system components are long-last and reliable. With this perception, all of the components of the high mast system are being produced to the maximum safety factors. Throughout their life, high mast lighting is designed to have either little or no maintenance. Figure 2.4 indicates the example of the high mast pole used.



Figure 2.4 High mast light poles used for illuminating over large area.
Source: Valmont Industries, Inc. (2018). Lighting: High Mast Lighting.

2.3.5 Wall-Mounted Lighting



Figure 2.5 Wall-mounted lighting application on the exterior wall of the building.
Source: Stouch Lighting (n.d.). Wall Pack and Building Lights Definition.

Wall-mounted lighting can be delineated as exterior luminaires that usually mounted on the external building walls and it is typically used to equip lighting to areas which used by vehicles and pedestrians as well as act as the key element for safety purposes (Stouch Lighting, n.d.) as illustrated in Figure 2.5. It is normal to see various types of this kind of lighting mounted on the walls of building with specific spacing between each of them to light up the ground level around the outside of the building. It is recommended to secure the luminaires at the pedestrian level as it potentially attract attention to the building and promote the area to be used at night (Auerbach & Glasow, n.d.). It also recommended to use last-long and white light sources such as fluorescent, metal halide and light emitting diode (LED).

This wall-mounted lighting is also typically beneficial in and around structures like bridge walkway and also used in concurrence with building façade as a cost-efficient corresponding to pole-mounted lighting (Seattle Department of Transportation, 2012). Pole-mounted pedestrian lighting is used when both road and pedestrian lighting are highly needed in that area. This wall-mounted lighting is being installed when additional pedestrian lighting is needed and it is not suitable for any installation of lighting pole in that particular area (Notes, 2002). It should offer a high colour performance level to area involved. The determination on the spacing of the lighting might be based on certain factors like the pedestrian and crime issues in the allocated area of the lighting, light pollution prevention and reducing uplight in the area.

2.4 Issues Associated with Pedestrian Lighting

2.4.1 Absence of Illumination Along Pedestrian Bridge in Kuala Lumpur

According to the article written by Anuar (2016), an issue had arisen regarding a poorly-lit pedestrian bridge in Kuala Lumpur that raises worries among the pedestrians who used it especially during at night. This pedestrian bridge which is spanning across the Maju Expressway Sdn Bhd's highway provides walkways and motorcycle lane through two separate lanes. It connects both Jalan Emas and Cheras Light Rail Transit Station (LRT). However, by referring to Figure 2.6 below, with the absence of functioning luminaires and poor-maintained condition of the pedestrian bridge, the gloomy and dark environment raises the concerns of the pedestrians over security because of limited visibility and fears of criminals who might take advantage on them.



Figure 2.6 The pedestrian bridge in Kuala Lumpur which is not well-maintained and poorly-lit

Source: Anuar (2016). *Jejantas 'Hantu' Undang Bahaya*.

The poorly-illuminated pedestrian bridge also invites other illegal activities. Surprisingly, some of the pedestrian bridge facilities were equipped with lights but there was absence of electrical supply. In addition to the non-functioning light, the location of the pedestrian bridge itself is far from commercial and residential areas. This indeed leads to inconvenience to the pedestrians. Based on this issue, proper maintenance of this pedestrian bridge should be done as soon as possible to avoid any crime to happen that involved the pedestrians, provide convenience and comfort to the pedestrians as well as improve the pedestrians' reassurance in using it especially at night.

2.4.2 Insufficient Street Lighting in Student Neighbourhoods Surrounding University of Michigan

In the student neighbourhoods surrounding the University of Michigan, poor illumination raises concerns as majority of the students and residents of Ann Arbor make a connection between continual campus crime alerts, safety of pedestrians and poor street lighting (Kay, 2018). Potential interrelation between the city's crime and poorly-lit areas had been highlighted in the online crime statistics that shows the major and attempted crimes reported during March 2018 at Ann Arbor addresses as shown in Table 2.2 below. The crimes are classified into burglaries, sexual assaults, vehicle thefts, robberies and homicides.

Table 2.1 The major and attempted crimes reported in March 2018

Crime	Total
Burglaries	23
Sexual Assaults	13
Vehicle Thefts	3
Robberies	1
Homicides	0

Source: Ann Arbor Observer (2018). Crime Map for March 2018.

The crime that occurred in the student neighbourhoods is identified not only due to the poorly-lit areas but also due to the lack of education on safety among the students. In response to this issue, responsible authorities in the city has been continuously making attempts in improving the safety of the student neighbourhoods by prioritizing on the expenditures and installation of street lights to improve the illuminations. From this issue, it is proved that poor-illuminated area increases the potential of crime to happen. Therefore, lighting should indeed be considered as one of the crucial key element in ensuring the safety and security of the pedestrian and also the people who are living nearby.

2.4.3 Poor Placement of Street Light Along Pedestrian Walkway in Bogor, Indonesia

The installation of street light along the pedestrian walkway on Jembatan Bale Binarum, Jalan Pajajaran in Bogor has been protested by the pedestrians (Henaldi, 2015) as shown in Figure 2.7 below. This is due to their installations which are on the existing pedestrian walkway that make it difficult for the pedestrians to walk along it. In addition, the concrete that acts as the buffer of the street light pole is done inadvertently. Initially, this pedestrian walkway can occupy two pedestrians at the same time. However, after the street light installation, only one pedestrian can walk through it at one time. As the pedestrians had started to complain on the poor placement of the street light, further actions will be taken by the authorities in solving the issue. Based on this issue, despite of the aesthetic features that is practiced nowadays on the pedestrian infrastructures especially the pedestrian lighting, the safety and comfort of the pedestrian should come first and cannot be neglected. The placement of the pedestrian lighting should also be considered wisely and strategically.

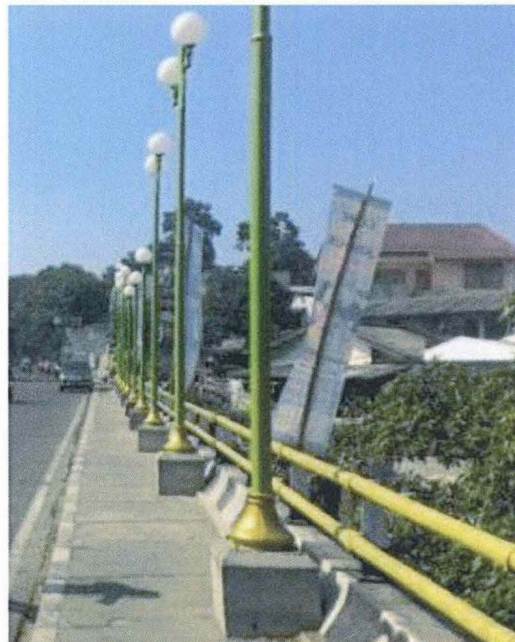


Figure 2.7 Installation of the street light on the pedestrian walkway in Bogor, Indonesia.

Source: Henaldi (2015). *Lampu Penerangan, Ganggu Pejalan Kaki*.

2.5 Best Practices Associated with Pedestrian Lighting

2.5.1 Market Street Bridge Walkway Illumination

The Market Street Bridge is a historic suspension bridge connecting Steubenville, Ohio and Follansbee, West Virginia over the Ohio river (Paramount Industries, 2017). It was built in 1905 and spanning a length of 1,794 feet. Upon hearing the reports that the bridge might be closed, both city councils of Steubenville, Ohio and Follansbee, West Virginia requested for the bridge to be renovated. The repairs and embellishment of the bridge were done in two phases, Phase 1 and Phase 2 started from January 2010. The pedestrian lighting along the walkway was installed during Phase 2. The Market Street Bridge used Paramount's durable stainless steel J9 Series luminaires in illuminating the pedestrian walkway (Paramount Industries, 2017). The J9 Series walkway luminaires is a high resistant, surface mounted linear lighting. It is produced of 18GA, 304 grade stainless steel for unsurpassed protection from corrosion. Figure 2.8 and Figure 2.9 below illustrates the walkway illumination along the Market Street Bridge.

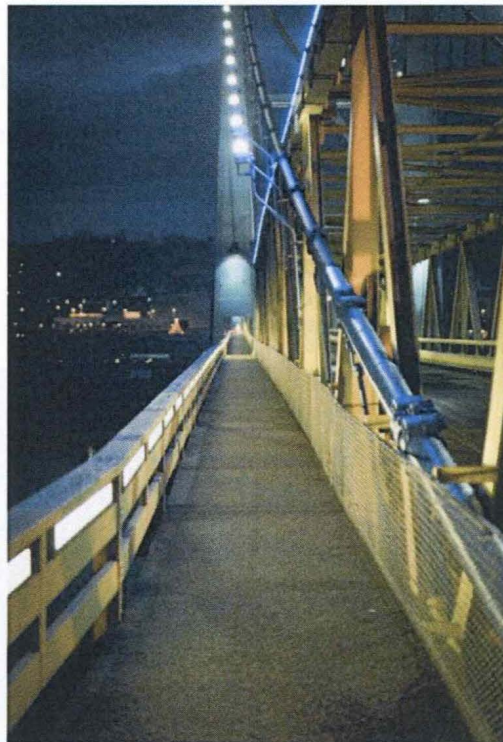


Figure 2.8 The illuminated pedestrian walkway along the Market Street Bridge.

Source: Paramount Industries (2017). Successful Bridge Walkway Illumination.



Figure 2.9 A close up on the J9 Series luminaires installed along the pedestrian walkway of Market Street Bridge.

Source: Paramount Industries (2017). Successful Bridge Walkway Illumination.

2.5.2 River Thames Pedestrian-Cycle Bridge Lighting

This bridge was constructed to provide sustainable travel for the pedestrians and cyclists across the river. In terms of walking ambience enhancement advantage, the pedestrians that used this bridge will feel the convenience as the walking ambience is in a high quality at which it includes the provision of lighting that will illuminate the walkway along the bridge during at night especially, recorded and monitored surveillance cameras, information aids like information boards and local area maps as well as appropriate and systematic walkway (Case, 2016). For the lighting aspect, in order to provide the fully integrated lighting for this pedestrian-cycle bridge, LED handrails has been installed together with colour-change lighting display and floodlights (Brister, 2015) as shown in Figure 2.10 below.

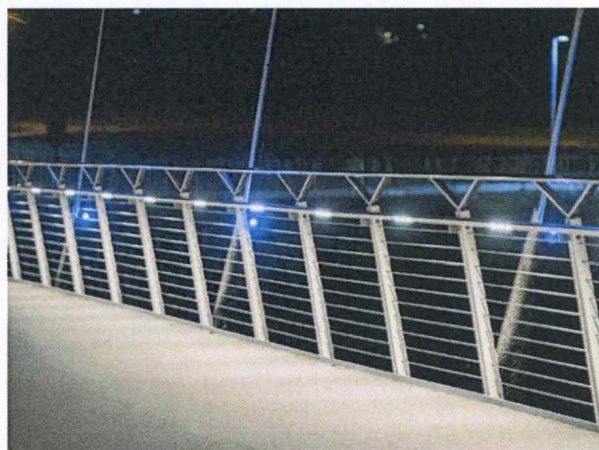


Figure 2.10 LED handrails installed along the River Thames bridge to illuminate the pedestrians and cyclists who are using the bridge.

Source: Brister (2015). Schröder Designs Lighting for New bridge over the Thames River.

A bespoke system is created to fix the 400-meter LED handrail onto the bridge curvature and at the same time allow it to bend with the bridge suspension. The floodlights light up the bridge and also the middle of the “tuning fork” at the 40-meter mast top as shown in Figure 2.11. Meanwhile, the colour-changing lighting display of different types are installed around the rest of the bridge like cable of the suspension, the underneath part of the bridge and also beneath “floating” benches placed on the bridge as illustrated in Figure 2.12.



Figure 2.11 The “tuning fork” is illuminated by the floodlight.

Source: Brister (2015). Schröder Designs Lighting for New bridge over the Thames River.

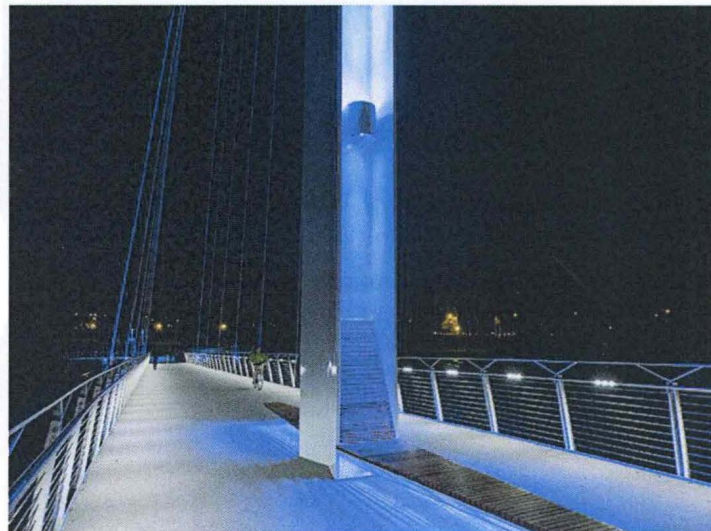


Figure 2.12 Flexible LED strips installed beneath the “floating” benches.

Source: Brister (2015). Schröder Designs Lighting for New bridge over the Thames River.

2.5.3 Solar and Pedestrian-Powered Street Light in Las Vegas

In Sin City of Las Vegas, throughout the Boulder Plaza, multifunctional street lights are being introduced which primarily powered by the solar and kinetic energy obtained from the pedestrian's footpaths (Primiceri & Visconti, 2017). This off-grid street light is designed to provide efficient illuminations to the pedestrians as well as promotes the exploitation of renewable energy in current economies due to the minimum cost installation, energy and maintenance. By the utilization of piezoelectric tiles which were placed underneath the pedestrian walkway, it helps in harvesting power supply for the street lamp resulting from the pedestrians' footsteps. Each time a pedestrian step on one of these tiles, it produces power up to about 7 W which will be used later (Goodner, 2016).

In addition, it also occupied with additional features such as intelligent motion sensor, temperature and air quality sensor, surveillance cameras that recorded and monitored the traffic and incorporated Wi-Fi that delivers actual data while also operated as hotspot for mobile devices (Goodner, 2016). Charging spots are also provided for the convenience of the pedestrian. All of these additional features eventually act as a forward revolution in lighting facilities. Figure 2.13 below shows the solar and pedestrian-powered street light along the Boulder Plaza in Sin City, Las Vegas.

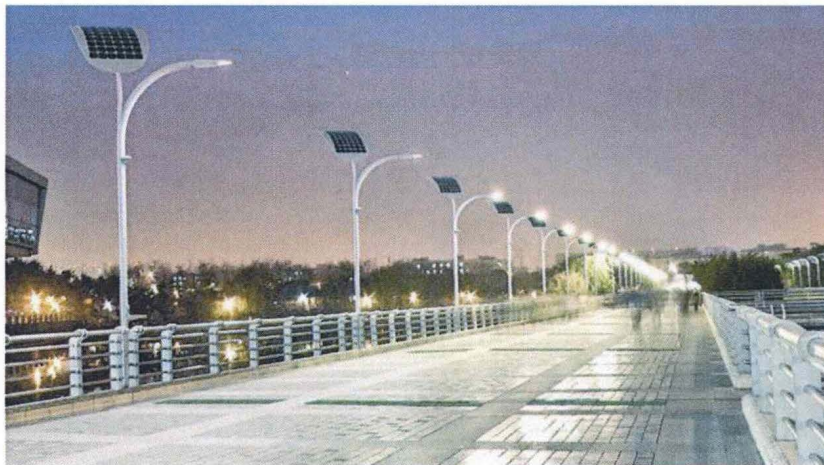


Figure 2.13 The solar and pedestrian-powered street light implemented along the Boulder Plaza in Sin City, Las Vegas.

Source: Goodner (2016). Sin City Going Green: Las Vegas to Use Solar and Pedestrian Power for Street Lights.

2.6 Conclusion

To conclude, this chapter allows a better understanding on the research topic which include the definition of the pedestrian lighting itself, its importance and its design criteria. Based on the literature review conducted, different types of pedestrian lighting have been identified and for each of the type of the pedestrian lighting, it has its own advantages and disadvantages as well as key features that differentiate them with each other. In terms of the issues and best practices associated with the pedestrian lighting in Malaysia and other countries, it could be a platform where ideas on the improvement on pedestrian lighting in Kuantan CBD area can be boosted by considering the strength and also the weaknesses identified.

CHAPTER 3

METHODOLOGY

3.1 Introduction

Research methodology is a systematic approach in searching the solution for a specified problem that is also regard as research problem (Williams, 2011). In solving the research problem, different descriptive research methods can be applied. As this research is on improving the pedestrian facilities in Kuantan CBD area which has been specified on the implementation of the pedestrian lighting, it is conducted via different research methods of literature review, observational method which mainly on naturalistic observation as well as survey methods which conducted through interviews and questionnaires. Upon obtaining the final results of these research methods, data analysis is carried out and followed by the overall conclusion and recommendation for the research.

Generally, research methodology can be quantitative, qualitative or even both. Quantitative research concerned with quantity or amount of measurement and essentially the result is in terms of numbers meanwhile the qualitative research is based on qualitative phenomenon which involved the quality aspect (Rajasekar et al., 2006). For this research, it is typically a qualitative research because it is aiming on the collection of data through observations and surveys and the data obtained will be analysed to assist in the understanding and interpretation of the needs of the pedestrians in Kuantan CBD area specifically on the pedestrian lighting as well as to assist on the decision making on the solutions to be implemented for a better improvement of the pedestrian infrastructure.

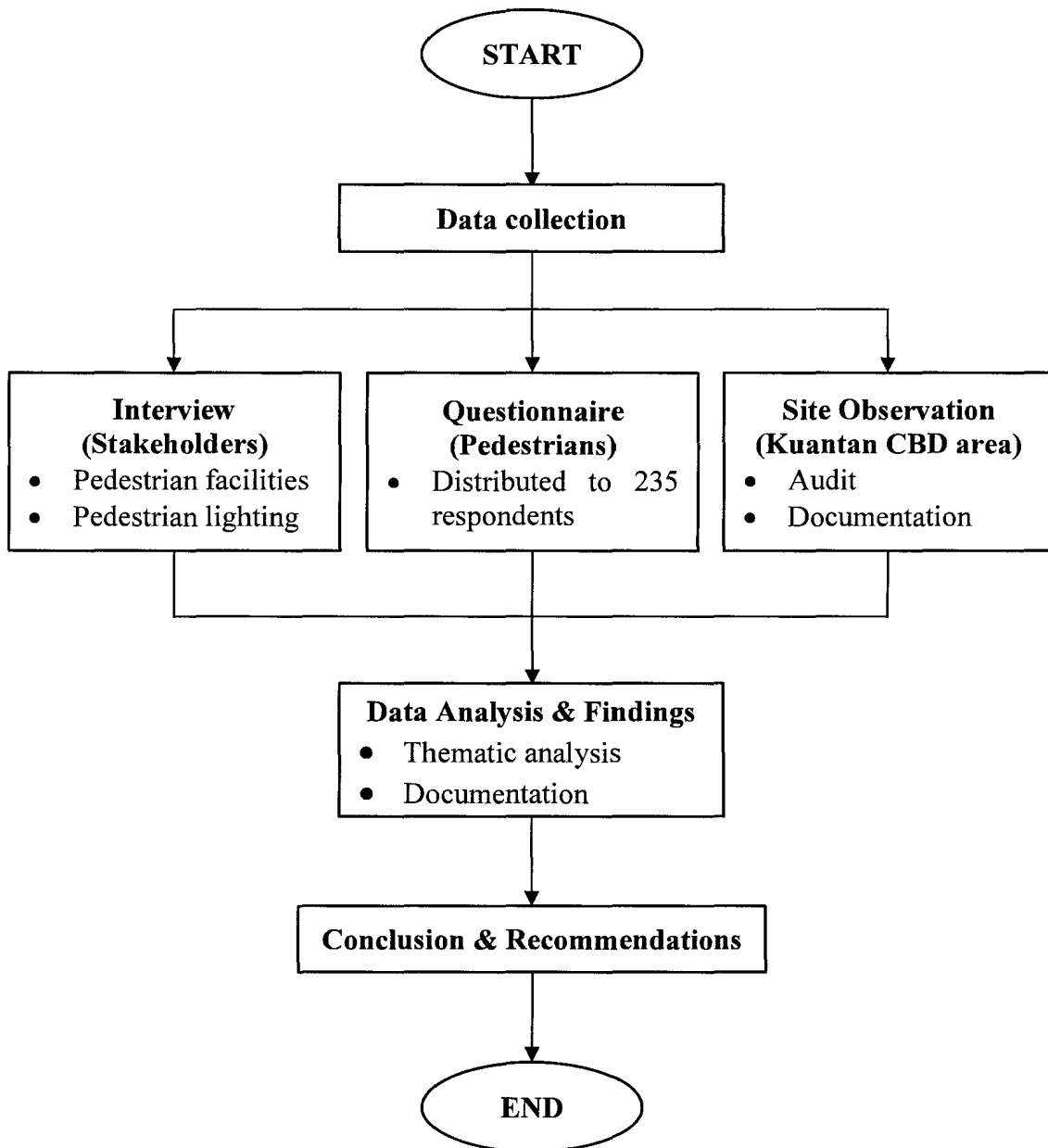


Figure 3.1 Flowchart of research methodology for the research.

3.2 Literature Review

Literature review is defined as the report of information evaluation on the literature which relates with the area of study that had been selected or assigned (Literature Review Tutorial, 2018). In this review, the literature should be described, summarized, evaluated and clarified well and at the same time it should also allow the research to have a theoretical base at which this will assist in the determination of the nature of the research (Literature Review Tutorial, 2018). All the components which involved in the review need to be read to gain proper and deeper understanding, evaluated and analysed. In the writing of a literature review, it helps in conveying to the individuals the knowledge and also ideas related to the literature as well as helps in identifying its strengths and weaknesses.

From the literature review, all of the information related to the research which are specifically on the pedestrian lighting had been summarized. It is divided into several subtopics which include the importance of pedestrian lighting, the design criteria of pedestrian lighting, the types of applicable pedestrian lighting, the issues regarding the pedestrian lighting and the best practices associated with pedestrian lighting. The literature review helps in getting the overall overview about the implementation of the pedestrian lighting as well as provides a better understanding on the research topic.

3.3 Data Collection

For this research, the data is collected via three different methods which are interview, questionnaire and site observation. This research is started by collecting the data through the interview, followed by the distribution of the questionnaire and lastly is the site observation. For both questionnaire and site observation, they were conducted in Kuantan CBD area meanwhile for the interview, it is conducted in the preferred places decided by the interviewees themselves. This data collection is conducted during the semester break. Before the site observation was carried out, the research area is firstly divided into seven stretches to ensure a systematic overall coverage of the area.

3.3.1 Interview

Based on Sun (2011), an interview is described as a widely-used method for collecting information at which it involved two personnel which are the interviewer and interviewee. The interviewer is the person who handles the conversation process by asking questions while the interviewee is the person who responds to the questions. Interviews can be carried out via face-to-face approach or over the telephone. Currently, internet has also emerged as a tool for interview. Interview is an appropriate research method when it is necessary to gather information on people's experiences, thoughts and opinions. Face-to-face interviews are practical when the target individuals can interact through this form of interviews better rather than via telephone or writing (Hilgert et al., 2016). This kind of target individuals include disabled individuals, elderly and children.

As for the interview method used for this research, face-to-face interview with the personnel of Kuantan Municipal Council and other related stakeholders such as engineer, and architect was conducted. In general, the questions focused on pedestrian facilities and pedestrian lighting. Specifically, on the pedestrian lighting part, the level of importance on its implementation, the approaches or initiatives that have been taken and/or going to be taken in improving it as well as the crucial issue associated with its implementation were being asked to the interviewees. From the interview conducted, real and better understanding on the pedestrian facilities and pedestrian lighting overview are managed to be obtained from the interviewees as these matters are their expertise.

3.3.2 Questionnaires

Questionnaire is a form of survey methods for conducting research. It is a research tool that consist of a series of questions which aims on the information collection from the respondents and it act like written interview (McLeod, 2018). It can be conducted via face to face approach, through electronic devices like telephone and computer, through email and through online platform survey. Questionnaires are cost-saving, time-efficient and effective approach of gaining large information data from large sample of respondents. It is also effective in measuring the behaviour, preferences, opinions and intentions of the respondents expeditiously compared to the other methods. There are two types of questions for questionnaires at which the first type is closed questions and the second one is opened questions.

For this research, questionnaires were distributed by hand to the pedestrians who travel in Kuantan CBD area in order to obtain their responds and opinions on the research topic. This questionnaire was conducted in two phases, Phase 1 and Phase 2. For Phase 1, approximately 200 respondents were involved meanwhile for Phase 2, another 50 respondents were involved. The questionnaires specifically consist of three sections. In Section A, it focuses on the respondents' personal information consist of their gender and age range. For Section B, it focuses on general questions such as their purpose of trip, frequency of walking in the area, their reassurance while walking and their opinion on current pedestrian facilities. In the last section which is Section C, specific questions regarding the pedestrian lighting were asked.

3.3.3 Site Observation

Observation is described as the approach of collecting data via observing. Naturalistic observation is one of the type of observational research methods that is commonly used at which the spontaneous, natural behaviour of the individuals or organisms is closely observed in their natural environments without any intervention from the researcher (Salkind, 2010). In this naturalistic observation, the researcher will observe and record their phenomena of interest such as the spontaneous behaviour of the individuals or organisms. This research method is usually applied at the beginning of a research project, both for the descriptive value obtained and as a foundation in relating different experiences, events or behaviours.

For this research, after the survey methods of questionnaires and interviews were completed, site observation is necessary to observe the actual environment along the walkway in Kuantan CBD area specifically on the pedestrian lighting. The information gathered through this site observation is very important as it is unbiased and being directly observed. This will provide the real natural environment as compared to the information that have been documented before. For this site observation, audit and documentation were carried out to gather the information on the existing lighting facilities included their total amount provided, sufficiency of lighting provided by them, their spacings and also any problems identified associated with them. The research area is divided into seven different stretches which are Stretch 1, Stretch 2, Stretch 3, Stretch 4, Stretch 5, Stretch 6 and Stretch 7. This is illustrated in Figure 3.2.

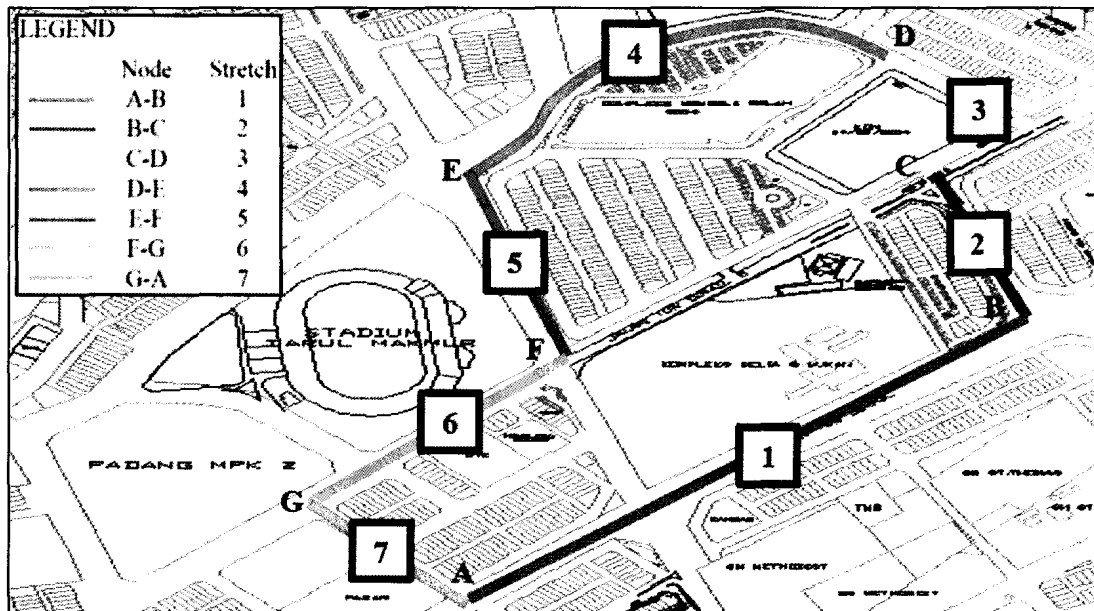


Figure 3.2 The division of stretches for the research area.
 Source: Majlis Perbandaran Kuantan (2018). Map of Kuantan city.

3.4 Data Analysis and Findings

The data collected through the interviews, questionnaire and site observation were analysed by means of thematic analysis and documentation. Thematic analysis is described as a qualitative analysis approach that will assist in the summarization of the key elements in a large data set (Nowell et al., 2017). Therefore, this type of analysis is suitable and practical to be for this research to help in the production of clear and well-organized research findings in accordance to the different methods of data collection used. Once the data of each of the methods has been analysed, the overall findings shall be obtained. Documentation also plays a crucial role in guiding efficient and effective data analysis. From the findings obtained, the proposed parameters for the improvement of pedestrian lighting in Kuantan CBD area are being suggested.

3.5 Conclusion and Recommendations

Lastly, the conclusion and recommendations are written up to summarize all the key findings and outcomes in relation to the objectives of this research. All the outcomes obtained should achieved all the objectives stated in order to ensure that this research contributes in solving the problem associated with the pedestrian lighting in Kuantan CBD area. It should also emphasize on the recommendations for further research and future project associated with the pedestrian lighting.

3.6 Conclusion

In conclusion, this chapter explained about the overall flow of methodology from the beginning until the end of this research. Starting from the literature review, continued with the data collection, followed by the data analysis and findings and finally, the conclusion and recommendations. In addition, the research flowchart act as a crucial part as it assists the progress and allows establishment of systematic and effective steps throughout the research. Each of the methods plays important role for this research in order to achieve the research objectives successfully.

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Introduction

For this results and discussion chapter, all the data and information obtained from the interview, questionnaire survey and site observation are illustrated and presented in the form of tables, graphs and figures to assist and simplify the process of interpretation, discussion and conclusion. The results obtained for each of the data collection method, are then further discussed separately according to the three different methods.

4.2 Interview

4.2.1 Results

Table 4.1 Interview analysis with Participant 1 (P1).

Issues & Limitations	Existing Improvement & Initiative
<ul style="list-style-type: none">• There are a few locations at which the pedestrian facilities cannot be practiced/implemented.• There has been initiative on encouraging people to walk but it is interrelated with the weather. That is one of the reason why people in Malaysia do not practice it.• The lighting should be sufficient but there are also some of them that are not well-maintained	<ul style="list-style-type: none">• In 2012, most of the people walk by the road sides. Thus, improvement has been done in terms of the pedestrian facilities such as the walkway. For Safe City Program 2013/2014, they increase the walkway in Kuantan.• A new technology initiative has been implemented which is solar lighting. This is due to the high electrical cost. This solar lighting is being implemented at Jalan Kemunting, near to Padang Majlis Perbandaran Kuantan (MPK) 4. One solar lighting post is equivalent to RM4,000. There are already 5 of them installed.• In the future, they will be implementing the solar lighting near to the area of UTC and Stadium.• They are also taking into consideration on the illumination of dangerous area for pedestrian.

Suggestions	Example of Application
<ul style="list-style-type: none"> • Improvement of pedestrian facilities should cover until the area of Rapid Terminal. • Visit other countries to see their pedestrian lifestyle (example: Japan). • When conducting any research, it is preferable to do a census first to know the pedestrian volume. If it high, then the research should be conducted. • After choice/decision on the application of the pedestrian facilities has been made, we need to pick the one with the high reliability, low cost and low maintenance. • Identify dark areas so that the lighting at that areas can be improved. 	<ul style="list-style-type: none"> • Application of pedestrian walkway: <ul style="list-style-type: none"> - Kuala Lumpur - Jalan Sogo (air-cond walkway)

Table 4.2 Interview analysis with Participant 2 (P2).

Issues & Limitations	Suggestions
<ul style="list-style-type: none"> • There is no proper planning for pedestrian • Budget issue- high cost as there is a need to do the maintenance on the existing facilities • Poor enforcement on pedestrian facilities standard/law • There is no linkage for crossing • Insufficient lighting in the area 	<ul style="list-style-type: none"> • Define the most crucial area for the implementation of pedestrian facilities by identifying/studying the pedestrian volume. After identifying the area with a high pedestrian volume, plan on the linkage with the point of interest in CBD area. • Also identify the desired path for pedestrian in order to enable the best design and planning for the pedestrian facilities implementation. • Consideration of universal design should be taken. • Utilizing the technology of light sensor • Lighting is important as it act as the focal point that attract the pedestrian to walk along the walkway • Lighting should be placed near to crossing area in order to ensure the safety of the pedestrian who is crossing the road • Do not focus too much on its aesthetic feature

Table 4.3 Interview analysis with Participant 3 (P3).

Issues & Limitations	Suggestions
<ul style="list-style-type: none"> • No issue 	<ul style="list-style-type: none"> • Improvement and addition of pedestrian walkway/bridge and crossing infrastructure that are still lacking in Kuantan CBD area.

Table 4.4 Interview analysis with Participant 4 (P4).

Issues & Limitations	Existing Improvement & Initiative
<ul style="list-style-type: none"> • There is an existing pedestrian walkway, but it is not continuous and does not connect with each other. • In the specific Kuantan CBD area, the pedestrian facilities are not well-planned as it is a new area. • From the aspect of lighting, there is no proper pedestrian lighting. The illumination of the pedestrian walkway is basically from the street lighting. 	<ul style="list-style-type: none"> • In certain area in Kuantan like Teluk Chempedak, downlight has been implemented but it was facing with the issue of vandalism.
Suggestions	Example of Application
<ul style="list-style-type: none"> • In front of Kompleks Belia is one of the suitable place for the implementation of pedestrian lighting • Differentiate pedestrian lighting and street lighting • Study which pattern/type of lighting to be used • Make lighting as a platform to encourage people to walk in relative with the provision the walkway • Lighting also act as a guide for the pedestrian especially at night. Think of a way in making the lighting as the focal point to attract the pedestrian and the application of lighting in Shanghai could be an idea booster. • Lighting is important for the safety of the pedestrian, giving directions for pedestrian and guiding them. 	<ul style="list-style-type: none"> • Example of area that implemented the pedestrian walkway is at Jalan Mahkota • At Jalan Tun Ismail and Jalan Wong Ah Jang, there are safety precaution facilities such as handrails, bollard and shrub • Example of country that practice pedestrian lighting implementation: Shanghai- Application of lighting like downlight.

Table 4.5 Interview analysis with Participant 5 (P5).

Issues & Limitations	Suggestions
<ul style="list-style-type: none"> • Kuantan does not have a lot of pedestrian facilities. • Pedestrian facilities are lacking in Kuantan. • In front of shopping malls like East Coast Mall and Kuantan City Mall, the lighting is sufficient but near to the area like Kompleks Belia and Sukan, the lighting provided is quite insufficient. • People nowadays only think about the high cost of electricity but does not think about the safety of the pedestrian. 	<ul style="list-style-type: none"> • In every development, MPK should include the order/regulation on the implementation of pedestrian facilities. • For new building construction, implementation on pedestrian facilities should be enforced. • Meanwhile, for existing building, the pedestrian facilities should be upgraded.
Example of Application	
<ul style="list-style-type: none"> • Example of area that exist with the pedestrian facilities is Kompleks Belia and Sukan. • Dewan Bandaraya Kuala Lumpur (DBKL) and Majlis Bandaraya Petaling Jaya (MBPJ) enforce the provision of pedestrian facilities for every development that will be carried out. 	

Table 4.6 Interview analysis with Participant 6 (P6).

Existing Improvement & Initiative	Suggestions
<ul style="list-style-type: none"> • Under Safe City Program, the improvement on pedestrian facilities will be focusing on the area in front of Kompleks Belia and Sukan only. • They already have proposed a project which mainly focusing on the improvement of connectivity for pedestrians • The elements of Safe City include segregation between the pedestrian walkway and the roadway, lighting, locked-motorcycle parking and signage for crime warning area. • Improvement on the existing pedestrian facilities are being carried out a lot nowadays in Kuantan • For lighting, they are focusing at the dark areas 	<ul style="list-style-type: none"> • In order to encourage people to walk, the area should have rest area for the pedestrian like providing benches, shading, drop curb, zebra crossing, tactile for the persons with disabilities (PWDs), information board for the pedestrian.

Table 4.7 Interview analysis with Participant 7 (P7).

Issues & Limitations	Suggestions
<ul style="list-style-type: none"> • Proper planning already exists but it is still lacking in terms of the implementation. • The pedestrian walkway is not being planned properly as the authorities are more focus on the roadway • In Kuantan CBD area, the implementation of the pedestrian walkway is not properly planned from the early beginning. For instance, from certain nodes to another node, it is still lacking in terms of the implementation of the pedestrian facilities. • There is improper planning on the pedestrian facilities in Kuantan CBD area and its implementation is not being a priority and there is absence of specific master plan for it. 	<ul style="list-style-type: none"> • Lighting should be ensured that it will enhance the image of the city • It must have high durability • The spacing between each of the pedestrian lighting depends on their intensity. For the one with high value of intensity, the spacing is quite further from each other and vice versa. Normally, the ideal spacing is 20 to 40 feet between each of the pedestrian lighting. • Applicable one is decorative lighting with lower pole height or also called as pedestrian-scale lighting • Usage of lighting such as high mast lighting (spotlight) is also applicable to illuminate both street and pedestrian walkway
Example of Application	
<ul style="list-style-type: none"> • In Jalan Mahkota and Jalan Bukit Ubi, there is existing pedestrian walkway. 	

4.2.2 Discussion

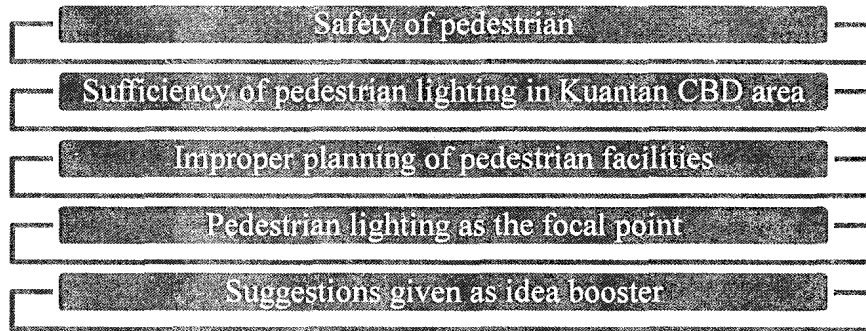


Figure 4.1 Major theme categories of interview.

Based on the Figure 4.1, these are the major themes that the research highlights that are very important in supporting the finding as well as assisting a better understanding and giving ideas on the improvement of the pedestrian infrastructure specifically for the pedestrian lighting. Firstly, the provision and improvement of pedestrian lighting in ensuring the safety of the pedestrian. P1 and P6 underlined the need of the identification of dark areas so that the implementation and improvement of lighting can be conducted in the area and this will eventually maximize the safety of the pedestrian. P1 said that there is already an initiative of illuminating dangerous area in Kuantan CBD area for the pedestrians in order to increase their safety. By providing and improving the pedestrian lighting, it does increase the reassurance of the pedestrian and this will assist in solving the problem stated in this research.

Aside from that, the sufficiency of the pedestrian lighting in Kuantan CBD area. Most of the participants have the same opinion on this point at which they emphasized that the pedestrian lighting in this area are insufficient. P4 said that the lighting of the pedestrian walkway is basically from the street lighting and pointed out the suggestion on the differentiation of pedestrian lighting and street lighting. If this suggestion is taken into action, the research is believed to maximize the implementation of pedestrian lighting along the pedestrian walkway and eventually improve the sufficiency of the pedestrian lighting in Kuantan CBD area. P5 underlined that the lighting in certain area is sufficient but in other certain area, it is not sufficient. This can be overcome by identifying the areas with the insufficient lighting and followed by the implementation of the pedestrian lighting in that particular areas.

Next, improper planning for pedestrian facilities is also being accentuated by most of the participants. This improper planning is mostly subjected to the pedestrian facilities of walkways, crossing and lighting. P1 emphasized that the resulting in improper planning is caused by the limitation of spaces and cost. In addition, P4 pointed out that the improper planning of the pedestrian facilities in Kuantan CBD area might be due to the fact that it is a new developed area compared to the other areas in Kuantan city. Therefore, the research believes that it is very practical and suitable for the improvement of pedestrian infrastructure in this area in order to recover on this improper planning issue. P7 highlighted that the improper planning of the pedestrian facilities is because the authorities are more focus on the roadway planning compared to the planning of the pedestrian facilities.

Besides that, pedestrian lighting act as the focal point is also one of the main and relevant point that had been accentuated by the respondents. P2 and P4 emphasized that the pedestrian lighting act as the focal point in attracting and encouraging the pedestrian to walk along the pedestrian walkway in relative with the provision of the walkway. By having the pedestrian lighting as the focal point, R4 said that it will act as a guide for the pedestrian, giving them directions and ensure their safety especially while walking at night. P4 also recommended on the observation on the application of lighting in Shanghai as it is one of the successful application which prove that the pedestrian lighting as the focal point is indeed able to attract the pedestrian to walk as they implemented different kind of interesting lighting such as downlight, neon light and LED lighting for crosswalk.

Lastly, all the suggestions will indeed act as an idea booster for the improvement of the pedestrian facilities specifically the pedestrian lighting. P1 emphasized that among the desired elements of initiatives to be taken are high reliability, low cost and low maintenance. P1 and P2 underlined that before any implementation of the pedestrian facilities including the pedestrian lighting, we firstly need to identify the pedestrian volume. Once we have identified the area of high pedestrian volume, we can proceed with the plan on linking all the point of interest in Kuantan CBD area. Only then we can start on the implementation of the pedestrian facilities. They also suggested on few applications of pedestrian facilities and pedestrian lighting in Malaysia and other foreign countries. Observation on these applications is indeed helping the research in getting ideas on the implementation of the pedestrian lighting in Kuantan CBD area.

4.3 Questionnaire

4.3.1 Results

Phase I

Section A

Table 4.8 Gender of respondents in Kuantan CBD area.

Gender	Total
Male	47
Female	138
Overall Total	185

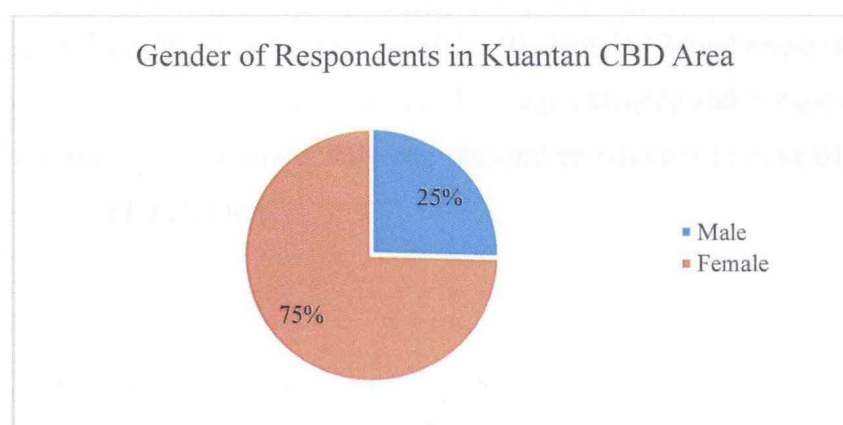


Figure 4.2 Gender of respondents in Kuantan CBD area.

Table 4.8 and Figure 4.2 above show that for the questionnaire survey, there is a total of 47 male respondents which is 25% from the overall 185 respondents. Meanwhile, another 75% are female respondents which equivalent to a total of 138.

Table 4.9 Age of respondents in Kuantan CBD area.

Age	Total
<10	0
10 - 20	87
21 - 30	76
31 - 40	12
41 - 50	6
51 - 60	2
>61	1

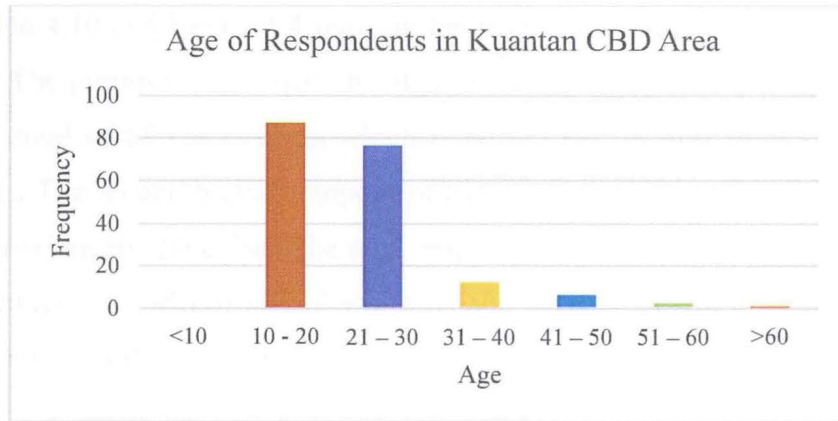


Figure 4.3 Age of respondents in Kuantan CBD area.

Based on Table 4.9 and Figure 4.3 above, from the overall 185 respondents, the highest age of respondent is 10-20 with a total of 87 respondents. The total respondents for the age of 21-30 is 76 while for the age of 31-40, there is 12 total respondents. Six out of the overall 185 respondents are from the 41-50 age category and for the age of 51-60 there are two respondents. There is only one respondent who aged above 61 and none of the respondents aged under ten.

Section B

Table 4.10 Respondents' purpose of trip in Kuantan CBD area.

Purpose of trip	Total
Work	51
School	41
Business	12
Shopping / Leisure	65
Others	16

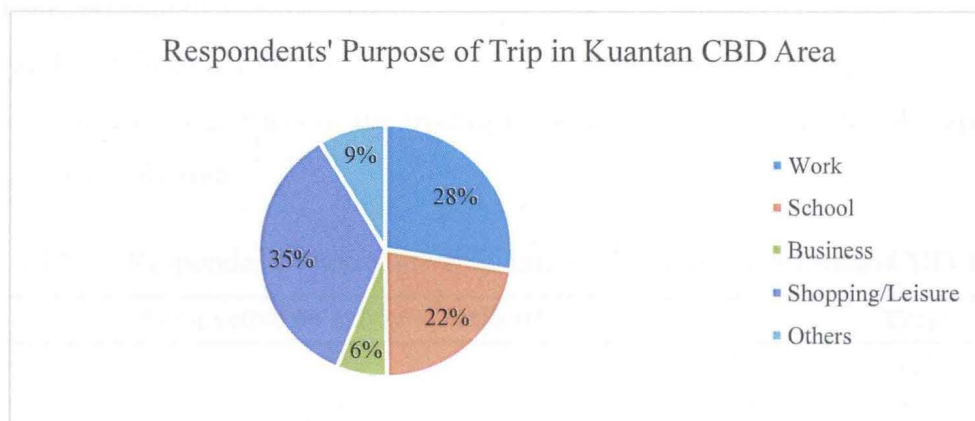


Figure 4.4 Respondents' purpose of trip in Kuantan CBD area.

Table 4.10 and Figure 4.4 indicate the respondents' purpose of trip in Kuantan CBD area. The purpose of trip with the highest total respondents is shopping or leisure. There is a total of 65 respondents which is equivalent to 35% from the overall 185 respondents. The second highest purpose of trip is work, with a total of 51 respondents that is approximately 28% from the total respondents. 22% of the overall respondents chose the purpose of trip of school while for the purpose of trip of business, 6%. For others, there is a total of 16 respondents.

Table 4.11 Respondents' frequency of walking in Kuantan CBD area.

Frequency	Total
Always	89
Often	100
Sometimes	96
Rarely	24

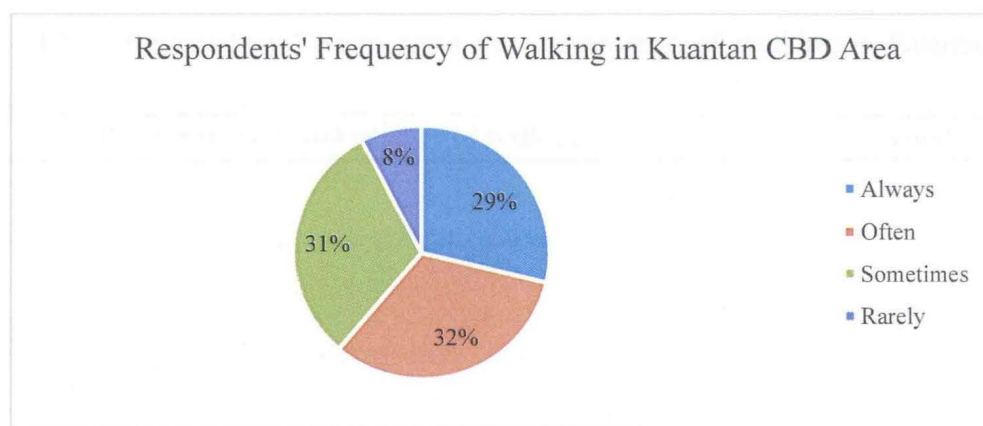


Figure 4.5 Respondents' frequency of walking in Kuantan CBD area.

According to Table 4.11 and Figure 4.5 above, a total of 89 respondents which is 28% from the overall 185 respondents always walk in Kuantan CBD area. 32% of them often walk in this area, followed by another 31% of the overall respondents who walk in this area sometimes and 8% of the overall respondents which equal to 24 respondents rarely walk in this area.

Table 4.12 Respondents' perspective on safety of walking in Kuantan CBD area.

Perspective on safety of walking	Total
Yes	118
No	67

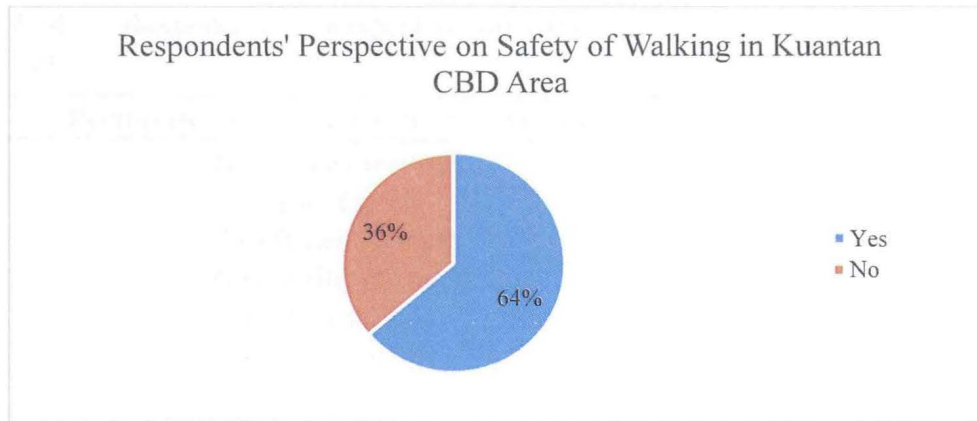


Figure 4.6 Respondents' perspective on safety of walking in Kuantan CBD area.

Table 4.12 and Figure 4.6 illustrate the respondents' perspective on safety of walking in Kuantan CBD area. 64% of the respondents feel safe while walking in Kuantan CBD area while another 36% does not feel safe while walking in this area.

Table 4.13 Respondents' perspective on convenience of walking in Kuantan CBD area.

Perspective on convenience of walking	Total
Yes	118
No	67

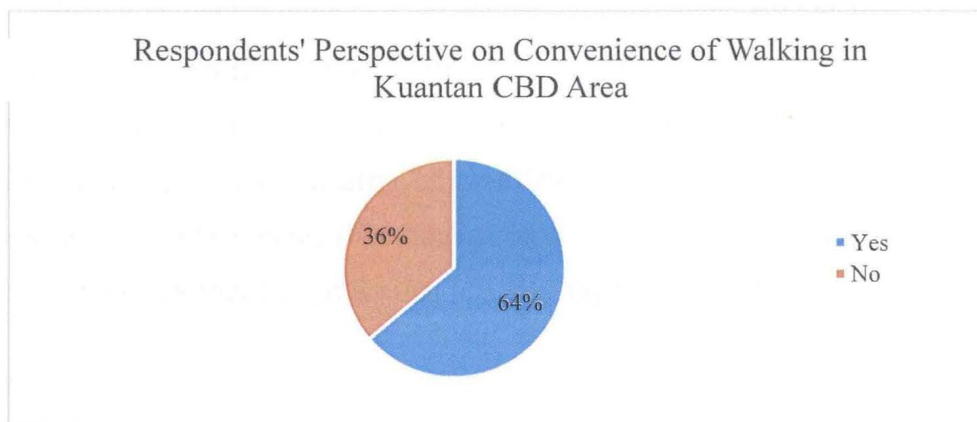


Figure 4.7 Respondents' perspective on convenience of walking in Kuantan CBD area.

Table 4.13 and Figure 4.7 represent respondents' perspective on convenience of walking in Kuantan CBD area. 64% from the overall 185 respondents feel convenience while walking in Kuantan CBD area while another 36% does not feel convenience while walking in this area.

Table 4.14 Respondents' perspective on existing pedestrian facilities in Kuantan CBD area.

Perspective on existing pedestrian facilities	Total
Not enough sidewalk	36
Lack of safety	63
Insufficient lighting	33
No crossing provided	50
Lack of shading	75
Bus stop facility	50

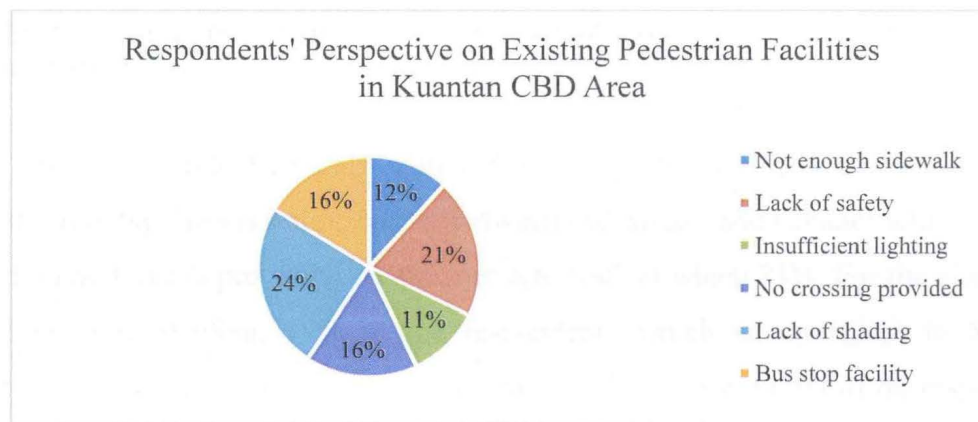


Figure 4.8 Respondents' perspective on existing pedestrian facilities in Kuantan CBD area.

Table 4.14 and Figure 4.8 show the respondents' perspective on existing pedestrian facilities in Kuantan CBD area. 12% from the overall 185 respondents feel that the sidewalk is not enough and 21% infer that the pedestrian facilities in Kuantan CBD area are lack of safety. In terms of insufficient lighting, 11% agree with it while for no crossing provided element, 16% support on it. 24% of them agreed that there is lack of shading while another 16% infer that bus stop facility is still lacking.

Section C

Table 4.15 Respondents' perspective on the improvement of pedestrian facilities in Kuantan CBD area.

Improvement on pedestrian facilities	Total
Providing more shading	66
Set barrier between pedestrians and vehicles	84
Provide continuously path walk	81
Provide more crossing	68
Provide sufficient lighting	44
Locate bus stop in strategic location	43

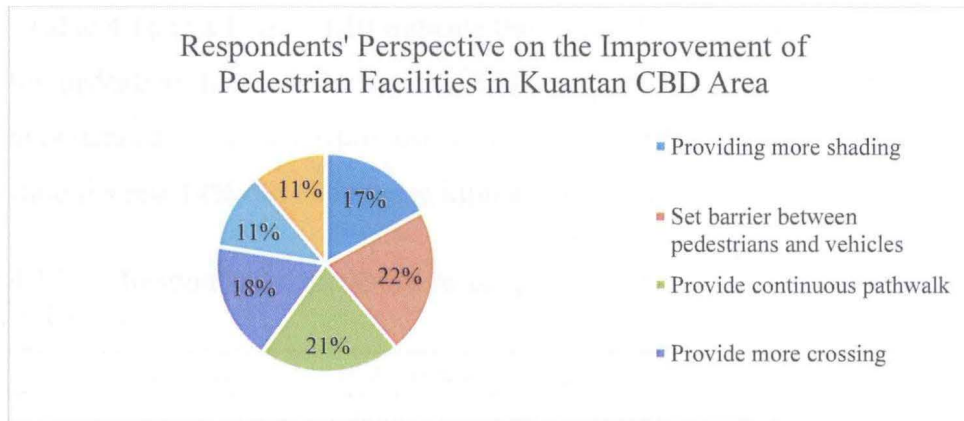


Figure 4.9 Respondents' perspective on the improvement of pedestrian facilities in Kuantan CBD area.

Based on Table 4.15 and Figure 4.8, the most chosen improvement element for the pedestrian facilities is setting barrier between pedestrians and vehicles with 22%. The second highest one is providing continuous path walk at which 21%. For the element of providing more shading, 17% of the respondents which is equivalent to 66 total respondents. Providing more crossing become the choice for a total of 64 respondents that covers 18% from the overall total respondents. For the elements of providing sufficient lighting and locating bus stop in strategic location, there are 11% of the total respondents each.

Table 4.16 Respondents' experience on injury while using the pedestrian facilities in Kuantan CBD area.

Experience on injury	Total
Yes	67
No	118

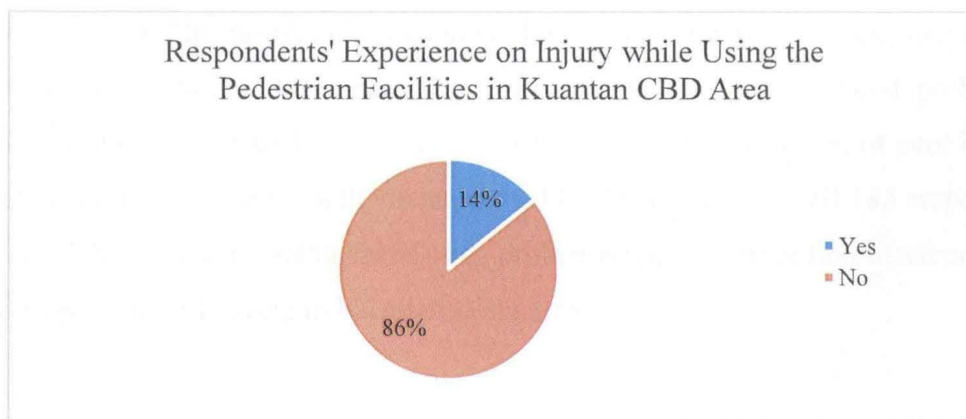


Figure 4.10 Respondents' experience on injury while using the pedestrian facilities in Kuantan CBD area.

Table 4.16 and Figure 4.10 indicate the respondents' experience on injury while using the pedestrian facilities in Kuantan CBD area. 86% of the total 185 respondents never experienced any injury while using the pedestrian facilities in Kuantan CBD area meanwhile the rest 14% did experience injuries in this area.

Table 4.17 Respondents' perspective on problem related to pedestrian lighting in Kuantan CBD area.

Problem related to pedestrian lighting	Total
Poor lighting	34
Insufficient of lighting	49
Not properly functioned	34
Feeling unsafe to use the walkway at night	88
Others	19

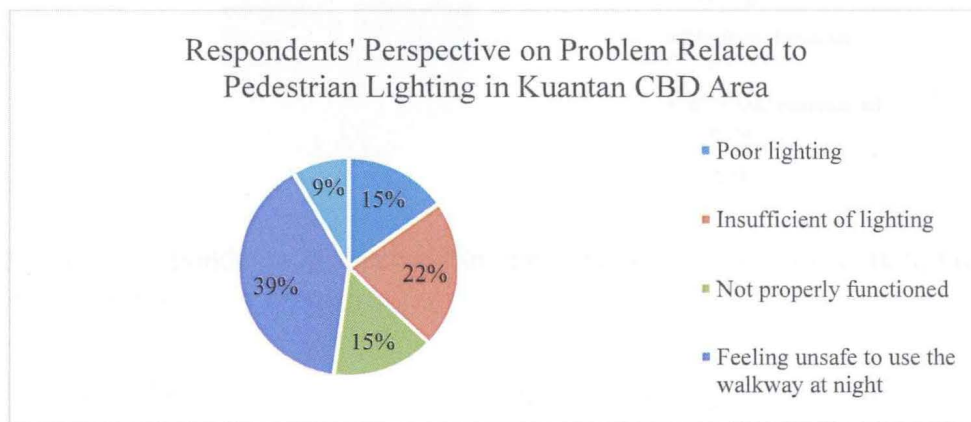


Figure 4.11 Respondents' perspective on problem related to pedestrian lighting in Kuantan CBD area.

According to Table 4.17 and Figure 4.11, the most critical problem related to pedestrian lighting that is faced by the respondents is they are feeling unsafe to use the walkway at night. This problem is encountered by 39% of the overall respondents which equivalent to a total of 88 respondents. The second most encountered problem is insufficient lighting. A total of 49 respondents faced it. For the problem of poor lighting and not properly functioned, both are supported by 15% of the overall 185 respondents each. 9% of the total respondents faced other problems apart from the four listed problems related to pedestrian lighting in Kuantan CBD area.

Table 4.18 Respondents' perspective on the improvement of pedestrian lighting in Kuantan CBD area.

Improvement of pedestrian lighting	Total
Better lighting	67
Provides more pedestrian lighting	59
Strategic location	48
Well maintenance of lighting	42
Others	10

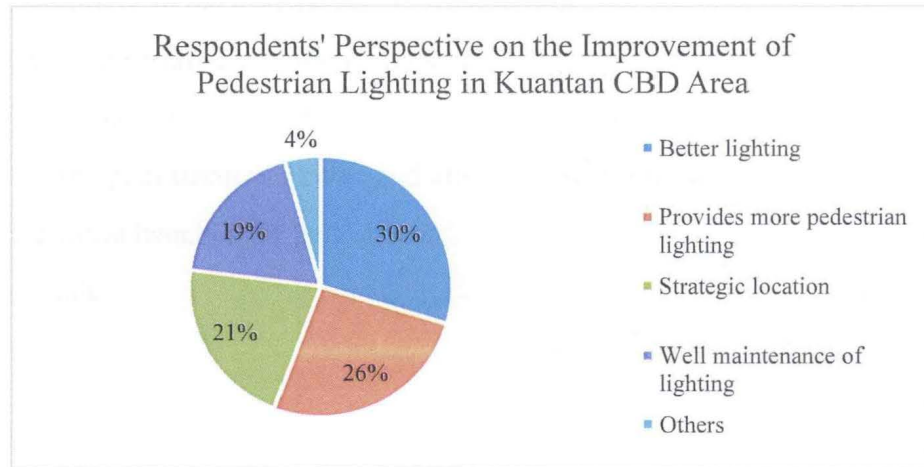


Figure 4.12 Respondents' perspective on the improvement of pedestrian lighting in Kuantan CBD area.

Table 4.18 and Figure 4.12 reveal the respondents' perspective on the improvement of pedestrian lighting in Kuantan CBD area. 67 out of 185 respondents agree with the improvement of better lighting for the pedestrian lighting in Kuantan CBD area. Improvement of providing more pedestrian lighting is chosen by 26% of the total respondents which is equal to 59 respondents. Another 21% of the respondents support on the improvement initiative of locating the pedestrian lighting at strategic location. A total of 42 respondents agree with the improvement of well maintenance of lighting while the rest of the overall respondents pick the option of other improvements beside the four improvements that have been highlighted.

Below is the list of other improvements that have been recommended by the respondents:

- Carry out patrols from time to time
- Place pedestrian traffic light at pedestrian crossings
- Build a pedestrian bridge across a big road
- Enhance appropriate facilities by category of person such as PWDs
- Build bus stops
- Increase safety in dark areas
- Improve pedestrian segregation and safety
- Improve motorists attitude towards pedestrians (lack of respect)
- Enlarge the pedestrian walkway and allocate street lighting
- Provide more benches for pedestrians
- More shade

Phase II

Section A

Table 4.19 Gender of respondents in Kuantan CBD area.

Gender	Total
Male	16
Female	34
Overall Total	50

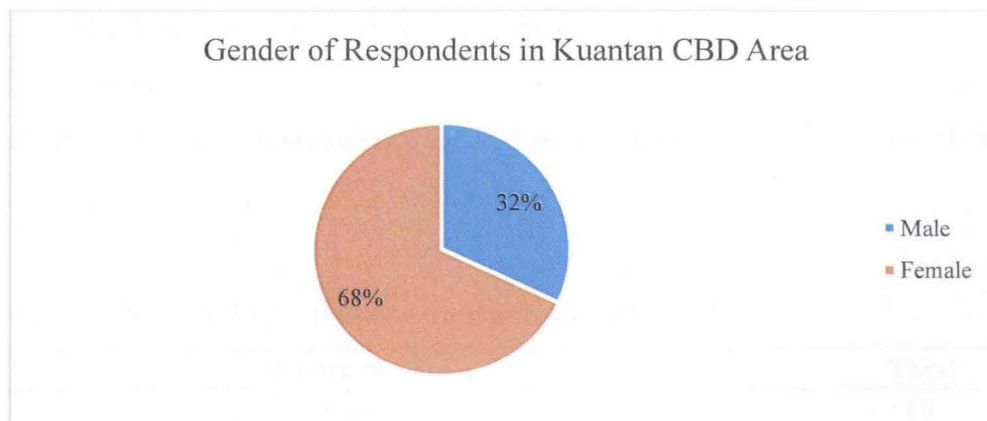


Figure 4.13 Gender of respondents in Kuantan CBD area.

Table 4.19 and Figure 4.13 shows that there is a total of 50 respondents for this questionnaire survey, 68% of the total respondents are female meanwhile the rest are male.

Table 4.20 Age of respondents in Kuantan CBD area.

Age	Total
<10	0
10 - 20	33
21 – 30	10
31 – 40	3
41 – 50	4
51 – 60	0
>61	0

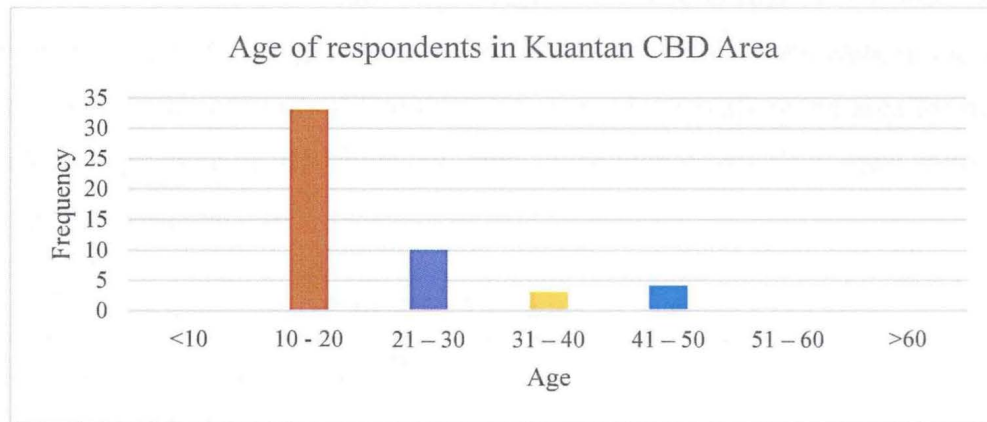


Figure 4.14 Age of respondents in Kuantan CBD area.

Based on Table 4.20 and Figure 4.14 above, there is no respondent of the age of below 10, 51-60 and above 60. The highest age of respondent is between 10 to 20 with a total of 33 respondents. The second highest age of respondents is 21-30 at which the total respondents is 10. Three respondents aged 31-40 and four respondents aged 41-50.

Section B

Table 4.21 Respondents' purpose of trip in Kuantan CBD area.

Purpose of trip	Total
Work	10
School	11
Business	1
Shopping / Leisure	25
Others	3

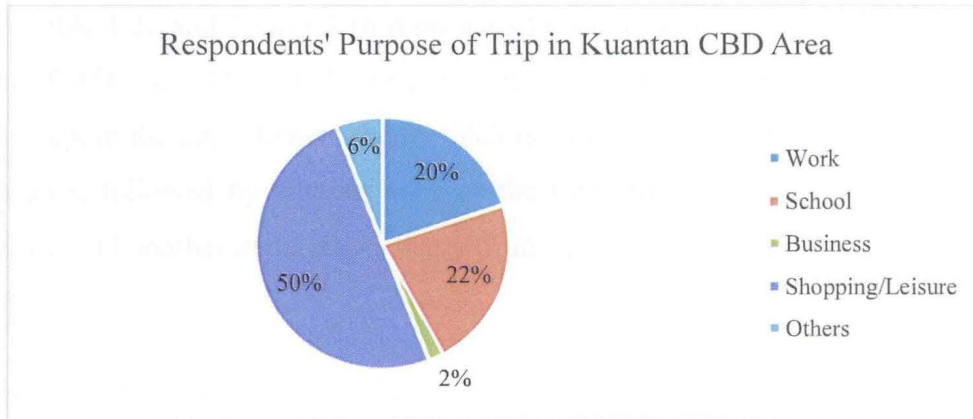


Figure 4.15 Respondents' purpose of trip in Kuantan CBD area.

Table 4.21 and Figure 4.15 illustrate the respondents' purpose of trip in Kuantan CBD area. The purpose of trip with the highest total respondents is shopping or leisure which is equivalent to half of the respondents. The second highest purpose of trip is school, with a total of 11 respondents. 20% of the total respondents walk in the area for work meanwhile there is only 2% of the total respondents walk in the area for business. For the others purpose of trip, there are only 3 respondents which is equal to 6% of the overall total of respondents.

Table 4.22 Respondents' frequency of walking in Kuantan CBD area.

Frequency	Total
Always	7
Often	15
Sometimes	20
Rarely	8

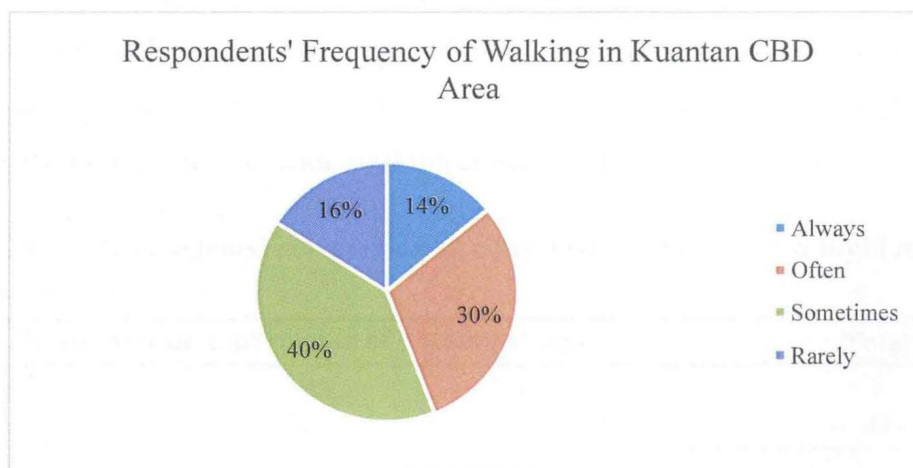


Figure 4.16 Respondents' frequency of walking in Kuantan CBD area.

Table 4.22 and Figure 4.16 represents the respondents' frequency of walking in Kuantan CBD area. 14% of the total respondents which equal to seven respondents always walk in the area. 30% of them which is equivalent to 15 respondents often walk in this area, followed by another 40% of the total 50 respondents walk in this area sometimes and another eight respondents from the total respondents rarely walk in this area.

Table 4.23 Respondents' perspective on safety of walking at night in Kuantan CBD area.

Perspective on safety of walking at night	Total
Yes	7
No	43

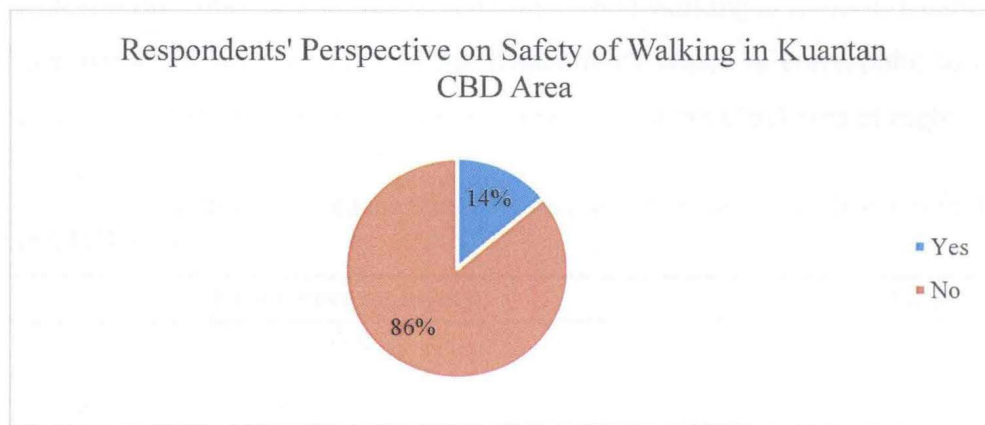


Figure 4.17 Respondents' perspective on safety of walking at night in Kuantan CBD area.

Table 4.23 and Figure 4.17 indicates the respondents' perspective on safety of walking at night in Kuantan CBD area. Only 14% of the total respondents feel safe while walking at night in Kuantan CBD area meanwhile majority of 86% of the total 50 respondents do not feel safe while walking at night in Kuantan CBD area.

Table 4.24 Respondents' perspective on convenience of walking at night in Kuantan CBD area.

Perspective on convenience of walking at night	Total
Yes	6
No	44

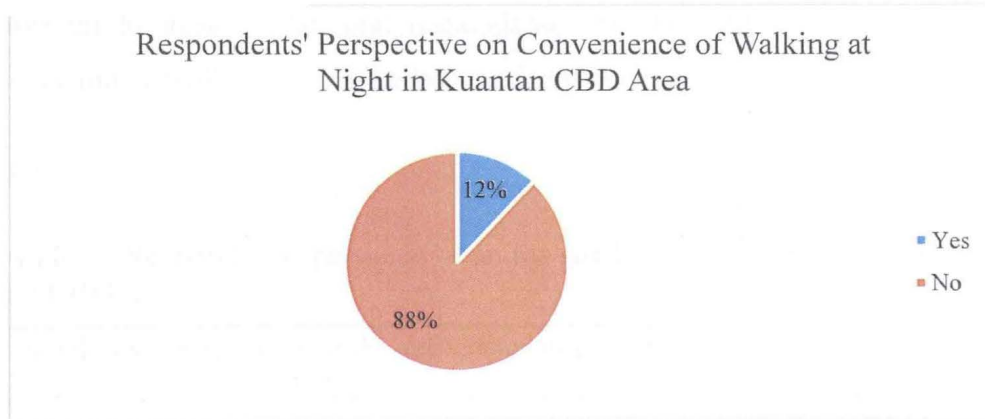


Figure 4.18 Respondents' perspective on convenience of walking at night in Kuantan CBD area.

According to Table 4.24 and Figure 4.18, most of the respondents which is 88% of the total respondents does not feel convenient while walking at night in Kuantan CBD area. Meanwhile for another 12% of the respondents which is correspond to only six respondents, they feel convenient while walking in Kuantan CBD area at night.

Table 4.25 Respondents' experience on injury while using the pedestrian facilities in Kuantan CBD area.

Experience on injury	Total
Yes	6
No	44

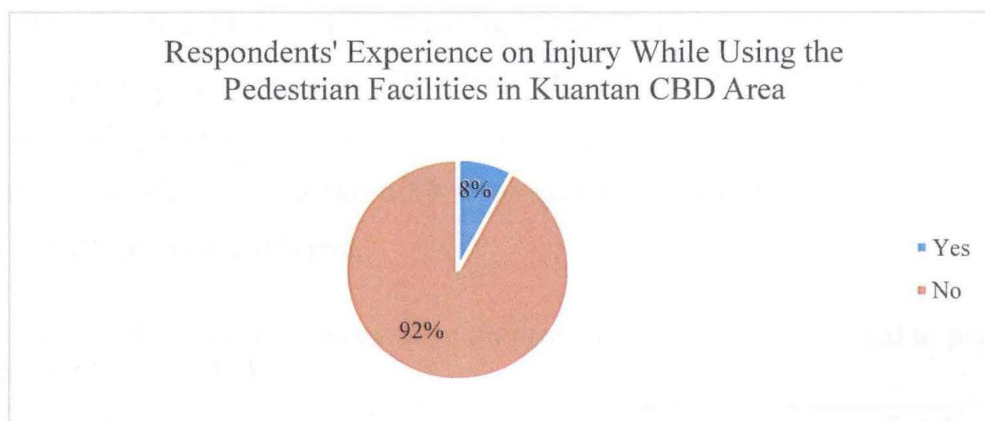


Figure 4.19 Respondents' experience on injury while using the pedestrian facilities in Kuantan CBD area.

Table 4.25 and Figure 4.19 illustrate the respondents' experience on injury while using the pedestrian facilities in Kuantan CBD area. 44 out of 50 respondents do not have any experience on injury while using the pedestrian facilities in Kuantan CBD area. This

is equivalent to 92% of the total respondents. Another 8% of the respondents did experience injury while using the pedestrian facilities in Kuantan CBD area.

Section C

Table 4.26 Respondents’ perspective on the sufficiency of the pedestrian lighting in Kuantan CBD area.

Respondents’ perspective on the sufficiency of pedestrian lighting	Total
Yes	14
No	36

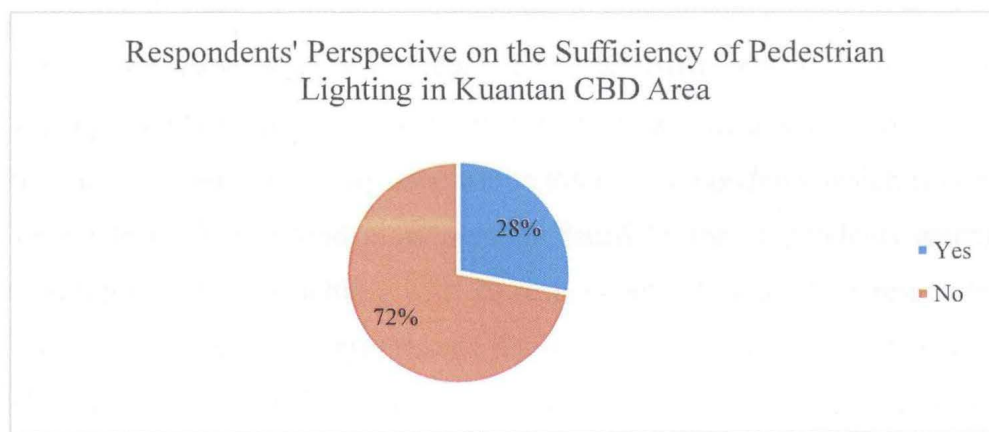


Figure 4.20 Respondents’ perspective on the sufficiency of pedestrian lighting in Kuantan CBD area.

Table 4.26 and Figure 4.20 shows the respondents’ perspective on the sufficiency of pedestrian lighting in Kuantan CBD area. 72% of the total respondents said that the pedestrian lighting in Kuantan CBD area are insufficient while the another 28% of the respondents which is equivalent to 14 respondents said that the pedestrian lighting in Kuantan CBD area are sufficient.

Table 4.27 Respondents’ perspective on problem faced at night related to pedestrian lighting in Kuantan CBD area.

Problem related to pedestrian lighting	Total
Poor lighting	20
Insufficient of lighting	18
Not properly functioned	7
Feeling unsafe to use the walkway at night	23
Others	0

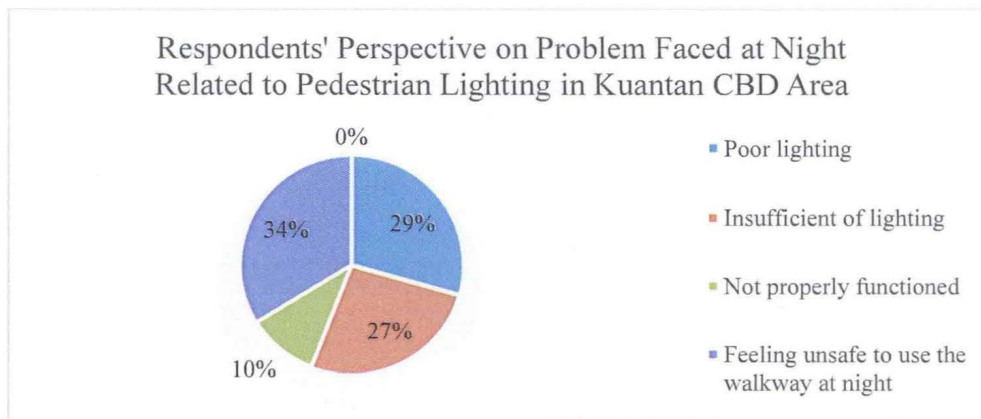


Figure 4.21 Respondents' perspective on problem faced at night related to pedestrian lighting in Kuantan CBD area.

Based on Table 4.27 and Figure 4.21, the most critical problem related to pedestrian lighting faced by the respondents is they are feeling unsafe to use the walkway at night. This problem is faced by 34% of the total 50 respondents which is correspond to 23 respondents. The second most problem faced by the respondents associated to pedestrian lighting is poor lighting with 20 respondents. A total of 18 respondents that equal to 27% of the total respondents faced the problem of insufficient lighting meanwhile the rest of the respondents which covers 10% of the total respondents encountered the problem related to pedestrian lighting of not properly functioned.

Table 4.28 Respondents' perspective on the improvement of pedestrian lighting in Kuantan CBD area.

Improvement of pedestrian lighting	Total
Better lighting	23
Provides more pedestrian lighting	30
Strategic location	6
Well maintenance of lighting	13
Others	0

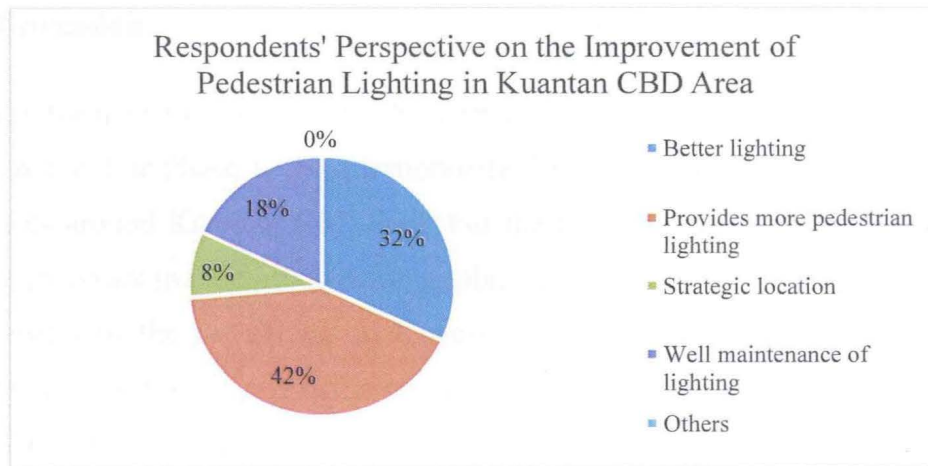


Figure 4.22 Respondents' perspective on the improvement of pedestrian lighting in Kuantan CBD area.

Table 4.28 and Figure 4.22 indicate the respondents' perspective on the improvement of pedestrian lighting in Kuantan CBD area. For the improvement of providing more pedestrian lighting, most of the respondents which is 42% of the total 50 respondents prefer it. The second most chosen improvement is better lighting with 32% of the respondents that equivalent to a total of 23 respondents. 8% of them chose on the improvement of strategic location of pedestrian lighting while 18% of them chose on the improvement of well maintenance of lighting.

Below is the list of suggestions proposed by the respondents in the questionnaire:

- Provide pedestrian traffic light
- Provide pedestrian bridge across the road
- Increase the number of pedestrian traffic light and pedestrian bridge for the pedestrians' safety
- Prioritize the assignation of security guard for the pedestrian and especially at dark areas
- Increase the number of pedestrian lighting

4.3.2 Discussion

For the questionnaire survey, there are two phases of distribution which are Phase 1 and Phase 2. For Phase 1, the questionnaire forms were distributed to a total of 185 respondents around Kuantan CBD area. For the first section, which is Section A, the questions given are in the form of demographic questions that are intended to identify the characteristics of the pedestrians in Kuantan CBD area in terms of gender and age. Demographic questions can assist in observing the way of thinking of a group of people with different gender and different age individually. Based on the results obtained, the number of female respondents is more than the number of male respondents by 91 respondents. In terms of the age of all the respondents, their ages lie between 10 and 61 above.

For Section B, it consists of five questions that include the questions on the respondents' purpose of trip, frequency of walking, perspective on safety of walking, perspective on convenience of walking and perspective on the existing pedestrian facilities. For the respondents' purpose of trip, most of the respondents walk in the area for shopping or leisure. This might be due to the existence of the commercial buildings such as shopping malls and supermarkets located at and nearby to Kuantan CBD area. Since Kuantan CBD area comprises of a lot of business and commercial buildings as well as educational institutions, there are also respondents who walk in the area for work, school, business and other purposes.

From the respondents' answers on the question of their frequency of walking in the area, it is indicated that most of the respondents often walk in the area and only 24 of them rarely walk in the area. This shows that there is a presence of high pedestrian volume in the area, thus eventually support the effort of improving the pedestrian infrastructure in the area to ensure the safety, comfort and security of the pedestrians. Based on the questions asked on the respondents' perspective on safety and convenience of walking in Kuantan CBD area, most of them feel safe and convenient while walking in the area meanwhile other respondents does not feel safe and convenient while walking in the area. This indicates that walking in the area are already safe and convenient, but it does not reach the maximum level of satisfaction in terms of safety and convenience as there are also respondents who do not feel safe and convenient while walking in the area.

For the last question of Section B, question asks on the respondents' perspective on the existing pedestrian facilities in Kuantan CBD area. The result attained represents that the respondents feel that lack of shading is the most critical one, followed by the second most critical which is lack of safety and lack of bus stop facility as both have the same total of respondents, followed by lack of sidewalk and lastly, insufficient lighting. From this, it can be emphasized that the level of needs for improvement measures based on the opinion of the respondents are being indicated. Specifically, for the pedestrian lighting, the number of respondents who chose it as in need of improvement is the lowest compared to the other pedestrian facilities. However, it should also be considered on for its improvements as it also plays its own crucial roles and eventually will contribute to the whole practical improvement of the overall pedestrian infrastructure in Kuantan CBD area.

For the last section, which is Section C, the first question is asking on the respondents' perspective on the improvement of pedestrian facilities in Kuantan CBD area. This question is correlated with the last question in Section B. Based on the result obtained, the most chosen improvement is setting barriers between pedestrians and vehicles, followed by the improvement on providing continuous path walk, providing more crossing, providing more shading, providing sufficient lighting and locating the bus stop in strategic location. Based on pie chart shown in Figure 4.8, it is shown that the improvement measures for each of the pedestrian facilities are quite balance to each other. Therefore, the improvements on all of the six pedestrian facilities should be prioritized equivalently.

For the next three questions, they are designed to primarily focus on the pedestrian facilities of pedestrian lighting. For the question on the respondents' experience on injury while using the pedestrian facilities in Kuantan CBD area, 86% of the respondents never experience injury associated with pedestrian lighting in the area while the rest of them did experience injury. This represents that the existing pedestrian lighting does not bring major harm to the pedestrian however, precautions measure or any maintenance should be practiced and implemented for any pedestrian lighting in Kuantan CBD area that might be damaged or vandalized. This is to ensure that there will be no future injury which is associated to the pedestrian lighting as well as to maintain maximum level of safety of the pedestrian.

For the questions on both respondents' perspective on problem related to pedestrian lighting and respondents' perspective on the improvement of pedestrian lighting in Kuantan CBD area, all the options will be taken in to consideration to assist in the improvement of the pedestrian infrastructure specifically for pedestrian lighting. For the respondents' perspective on problem related to pedestrian lighting, the most critical one from the respondents' overview is they are feeling unsafe to use the walkway at night. The second most critical is insufficient lighting, followed by poor lighting and the pedestrian lighting is not well-maintained. By asking for the respondents' opinion on these problems, it will help the research to classify the major and minor problem associated with pedestrian lighting. Since they are the users of the pedestrian facilities, the result obtained is reliable.

The options provided in the question on respondents' perspective on the improvement of pedestrian lighting in Kuantan CBD area are designed in correlation with the options of the problem related to pedestrian lighting provided in the previous question. The most preferred improvement initiative is better lighting, followed by the initiative on providing more pedestrian lighting, strategic location of pedestrian lighting placement, well maintenance of lighting and other initiatives. Regardless of the high and low value of percentage for each of this improvement initiatives, all of the improvements are practical for the implementation as all of them are being chosen by the respondents.

Phase 2 of the questionnaire distribution is conducted to provide a stronger support for the research on improvement of the pedestrian lighting in Kuantan CBD area. It involved another 50 respondents in this area. The results obtained from the questions of respondents' perspective on safety and convenience of walking at night in Kuantan CBD area is highlighted. Majority of the respondents do not feel safe and convenient while walking at night in this area. This eventually contributes to concrete support for my research on improving the pedestrian lighting in Kuantan CBD area. It is further supported by the result from the question of respondents' perspective on the sufficiency of the pedestrian lighting. 72% of the total respondents agreed that the pedestrian lighting is insufficient in this area meanwhile another 28% of the respondents think that the pedestrian lighting is sufficient in this area.

For both Phase 1 and Phase 2, there is a list of suggestions proposed by the respondents regarding to the pedestrian facilities. The suggestions can be classified into different elements which include crossing, safety and convenience, lighting, universal design, bus stop, segregation, walkway and shading. The classification is tabulated as Table 4.29. Based on Table 4.29, for lighting, there are two respondents that suggested on the placement of street lighting in poor illuminated areas and increase the pedestrian lighting provided in Kuantan CBD area. These suggestions are relevant to be taken into consideration in the effort of improving the pedestrian lighting in Kuantan CBD area.

Table 4.29 Classification of respondents' suggestions.

Elements	Suggestions
Crossing	<ul style="list-style-type: none"> • Provide pedestrian traffic light at road crossing • Provide pedestrian bridge across busy and multi-laned road
Safety & Convenience	<ul style="list-style-type: none"> • Increase safety in dark areas • Provide more benches for the pedestrians • Assign security guard for the pedestrians
Lighting	<ul style="list-style-type: none"> • Allocate street lighting in certain area • Increase the number of pedestrian lighting
Universal design	<ul style="list-style-type: none"> • Provide facilities that is practical for PWDs
Bus Stop	<ul style="list-style-type: none"> • Provide bus stop
Segregation	<ul style="list-style-type: none"> • Improve pedestrian segregation
Walkway	<ul style="list-style-type: none"> • Widen the pedestrian walkway
Shading	<ul style="list-style-type: none"> • Provide more shades

4.4 Site Observation

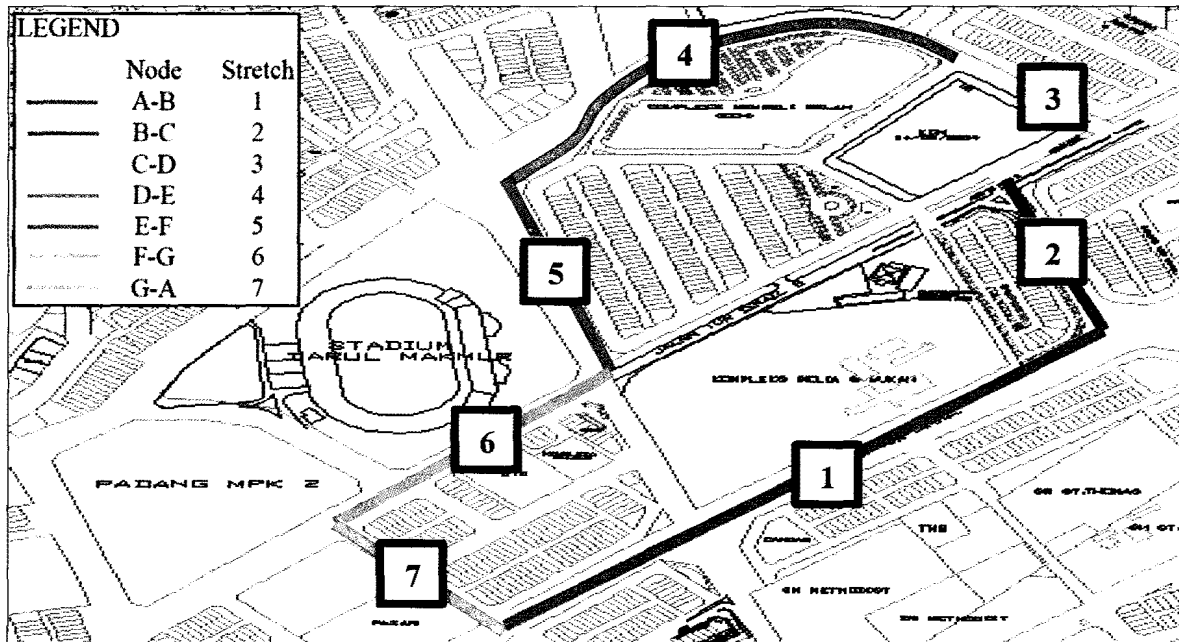


Figure 4.23 The plan view of Kuantan CBD area that is divided into seven stretches for site observation.

Source: Majlis Perbandaran Kuantan (2018). Map of Kuantan city.

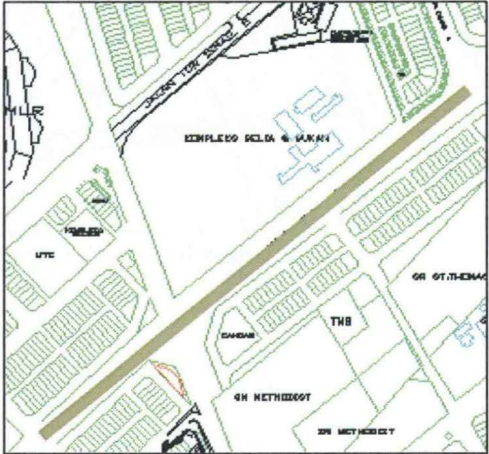

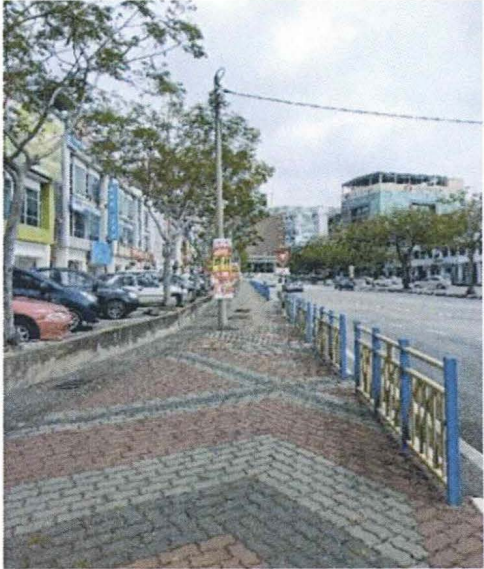
Table 4.30 Classification of stretches according to the connection of nodes.

Nodes	Stretches
A-B	Stretch 1
B-C	Stretch 2
C-D	Stretch 3
D-E	Stretch 4
E-F	Stretch 5
F-G	Stretch 6
G-A	Stretch 7

Based on Table 4.30 above, for the site observation, the Kuantan CBD area covered in the research is classified into seven different zones which are Stretch 1, Stretch 2, Stretch 3, Stretch 4, Stretch 5, Stretch 6 and Stretch 7. This is to simplify the observation and interpretation of the information gathered for each zone. The result of the site observation is tabulated for each stretch to make it simpler and easy in observing the problem, if any and also to observe the implementation of pedestrian lighting for each stretch.

4.4.1 Results

Table 4.31 Site observation according to stretches.

Stretch (Node)	Observation
<p data-bbox="469 383 571 450">Stretch 1 (A-B)</p>  <p data-bbox="244 943 616 972">Figure 4.24 Stretch 1 area.</p>	<ul data-bbox="826 383 1382 618" style="list-style-type: none"> • Based on Figure 4.25, the area in Stretch 1 is fully illuminated by the street lighting. • The walkway in front of Kompleks Belia and Sukan as shown in Figure 4.26 is poorly illuminated based on the site observation conducted at night.  <p data-bbox="826 1256 1370 1290">Figure 4.25 Site area 1 in Stretch 2 (B-C)</p>  <p data-bbox="826 1921 1382 1955">Figure 4.26 Site area 2 in Stretch 2 (B-C).</p>

Stretch 2
(B-C)



Figure 4.27 Stretch 2 area.

- For the area near to Berjaya Megamall, street light is provided to assist in the illumination of the area as shown in Figure 4.28.
- Based on Figure 4.29, there is absence of both pedestrian-scaled lighting and street lighting on the walkway. The walkway is illuminated by the street lighting across the road.
- Based on the site observation conducted at night, the area is already sufficiently illuminated by the street lighting and also nearby commercial buildings.



Figure 4.28 Site area 1 in Stretch 2 (B-C).



Figure 4.29 Site area 2 in Stretch 2 (B-C).

Stretch 3
(C-D)



Figure 4.30 Stretch 3 area.

- In the area near to Kuantan City Mall, street lighting is provided to illuminate the walkway as shown in Figure 4.37.
- In Figure 4.32, the pedestrian lighting is not well-maintained as its pole is quite slanted. This might bring harm to the pedestrians who walk along the area.
- From the site observation conducted at night, the area also sufficiently illuminated by the street lighting, pedestrian lighting and also the nearby commercial buildings such as Kuantan City Mall.



Figure 4.31 Site area 1 in Stretch 3 (C-D).



Figure 4.32 Site area 2 in Stretch 3 (C-D).

Stretch 4
(D-E)

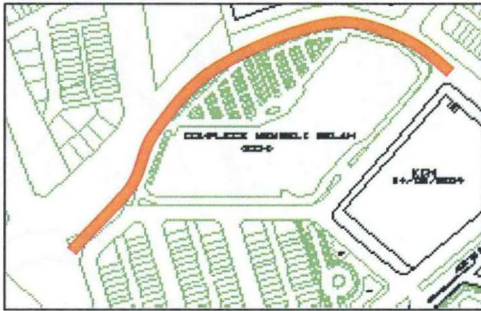


Figure 4.33 Stretch 4 area.

- In front of East Coast Mall, the illumination is provided by the street lighting around the parking area as shown in Figure 4.34.
- At the side area of the mall, pedestrian lighting is provided as shown in Figure 4.35 and Figure 4.36.
- Based on the site observation at night, the pedestrian lighting provided is not functioning.



Figure 4.34 Site area 1 in Stretch 4 (D-E).



Figure 4.35 Site area 2 in Stretch 4 (D-E).



Figure 4.36 Site area 3 in Stretch 4 (D-E).

Stretch 5
(E-F)

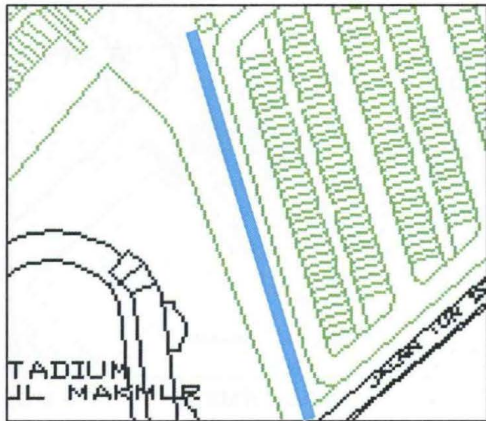


Figure 4.37 Stretch 5 area.

- In front of the commercial buildings along Stretch 5 as shown in Figure 4.37, street lighting helps in the illumination of the area but there is absence of pedestrian lighting.
- From the site observation conducted at night, the pedestrian walkway is poorly illuminated.



Figure 4.38 Site area 1 in Stretch 5 (E-F).

Stretch 6
(F-G)



Figure 4.39 Stretch 6 area.

- There is absence of pedestrian lighting along Stretch 6.
- However, the lighting from the commercial buildings and also the street lighting has sufficiently illuminated the area. It is supported also by the lighting from the spotlight at the futsal court nearby.



Figure 4.40 Site area 1 in Stretch 6 (F-G).

Stretch 7
(G-A)

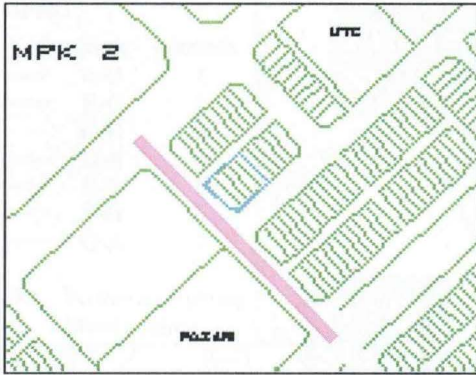


Figure 4.41 Stretch 7 area.

- The illumination along this stretch is supported by the street lighting as shown in Figure 4.41.
- However, in certain area, lighting is insufficient according to the site observation carried out at night.

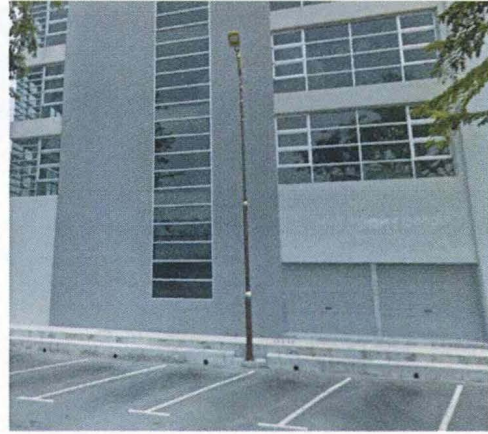


Figure 4.42 Site area 1 in Stretch 7 (G-A).

4.4.2 Discussion

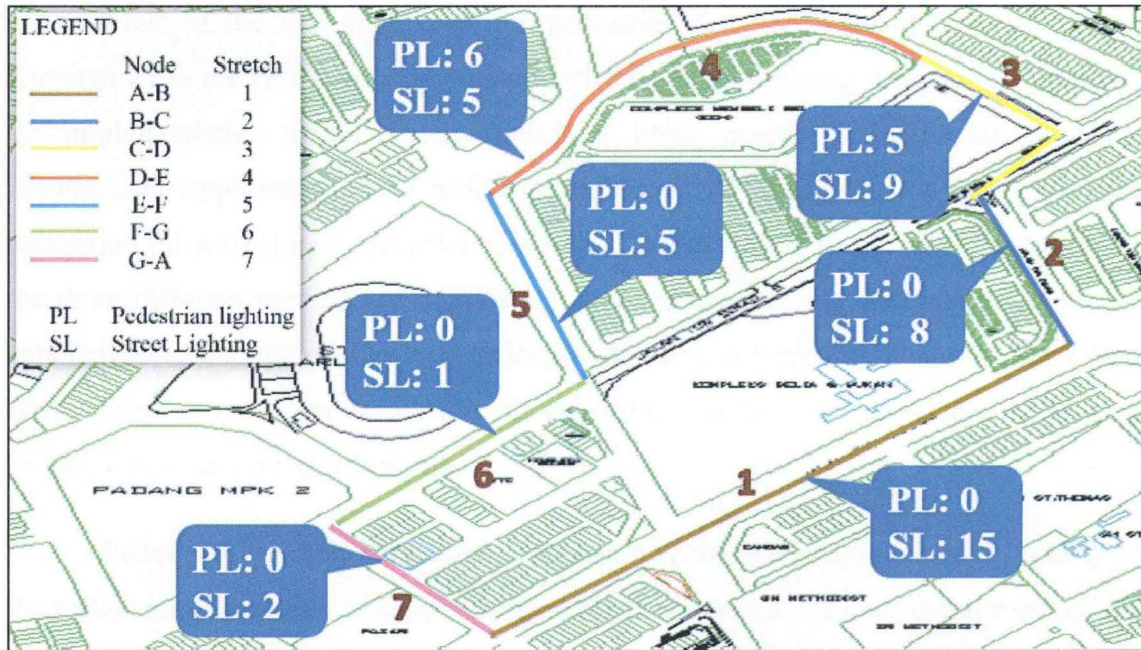


Figure 4.43 Existing pedestrian lighting and street lighting in Kuantan CBD area.

Based on Figure 4.42, it is observed that most of the areas are being illuminated by the nearby street lighting. Only in Stretch 3 and Stretch 4 at which the pedestrian lighting is provided. However, in Zone 3, there is a maintenance issue regarding the slanted pedestrian lighting pole at the walkway near to the Kuantan City Mall area. Further maintenance action should be taken to ensure the safety of the pedestrian that will be using the walkway. To be specific, Stretch 2 and 6 do not need any provision or improvements on the lighting as these areas are fully illuminated by the street lighting and also the lighting from the nearby commercial buildings.

Meanwhile, for Stretch 1, 5 and 7, provision and improvements of pedestrian lighting are needed as the areas along these stretches are poorly illuminated. For Stretch 1 and Stretch 5, both are the most crucial areas for the provision and implementations of the pedestrian lighting as they have higher pedestrian volume. This is supported by the fact that these two stretches serve as the connection pathway for the pedestrian from Hentian Bas Bandar Kuantan who would like to go to the commercial buildings such as Berjaya Megamall, East Coast Mall or Kuantan City Mall.

4.5 Conclusion

Most of the illumination of the pedestrian facilities such as the walkway in Kuantan CBD area are primarily supported by the street lighting. Only in certain area, the implementation of pedestrian lighting is being practised. Specifically, for this research, the application of the pedestrian lighting will be accentuated to improve the pedestrian infrastructure in Kuantan CBD area. Based on the results and discussion on the three different methods of interview, questionnaire and site observation, it can be concluded that the issue of lack of pedestrian lighting is highly pointed out. Therefore, further improvement and provision of the pedestrian lighting are indeed a relevant initiative in overcoming this issue.

Pedestrian lighting indeed helps in ensuring the safety, comfort and security of the pedestrians especially at night. From the results obtained, it shows that the safety and convenience of the pedestrians are still in the lower level of satisfaction at which they do not feel safe and convenient to walk in the area especially at night. Besides that, it is proved that the pedestrian volume in this area is quite high based on the questionnaire and the site observation results. This is due to the existence of numerous business and commercial buildings in Kuantan CBD area. Hence, these could also be the supporting factors for the initiative on the implementation of the pedestrian lighting in Kuantan CBD area.

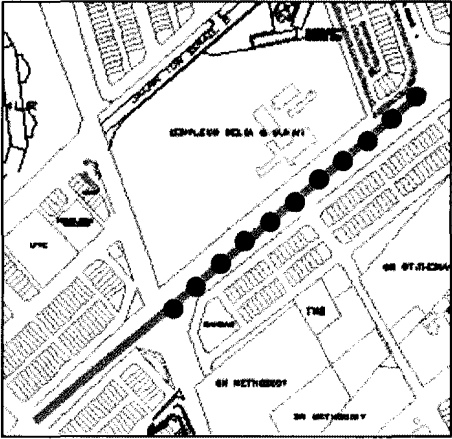
By having the pedestrian lighting as the focal point in this area, it will act as the supportive element for the other pedestrian facilities such as walkway, crossing, bus stop and shading by attracting the pedestrians to use them. Other than that, the improvement on the whole pedestrian facilities is believed to be the most preferable and practical solution as each of pedestrian facility is correlated to each other. All the suggestions recommended and proposed by the interviewee and the pedestrians themselves help the research to develop parameters on the improvement of the pedestrian lighting in Kuantan CBD area. Lastly, in relative with the improvement of the pedestrian lighting, proper planning should be focused on to ensure that all the improvements will be implemented successfully and provide maximum benefits for the pedestrians.

LEGEND		
	Node	Stretch
—	A-B	1
—	B-C	2
—	C-D	3
—	D-E	4
—	E-F	5
—	F-G	6
—	G-A	7
●	Proposed pedestrian lighting	

Figure 4.44 Legend for the illustration in Table 4.31.

By referring to the legend in Figure 4.43 above, Table 4.31 below shows the summarization of the existing barriers and suggestions on improvement on the pedestrian lighting in Kuantan CBD area in accordance to each stretch.

Table 4.32 Summary of existing barriers and suggestions on improvement.

Existing Barriers and Suggestions on Improvement	
<u>Stretch 1</u>	
	
Figure 4.45 Improvements in Stretch 1.	
<u>Barriers</u>	
<ol style="list-style-type: none"> 1. Poorly illuminated pedestrian walkway in front of Kompleks Belia and Sukan. 2. Poorly maintained lighting. 	
<u>Proposed Improvement</u>	
<ol style="list-style-type: none"> 1. Provision of pedestrian lighting. <ul style="list-style-type: none"> • Decorative Single Arm LED Pedestrian Lighting <ul style="list-style-type: none"> - 11 poles with height of 3 ft. - Along 330 m with spacing of 30 m. - Cost: RM300 per pole. 	

2. Provision of maintenance on the existing lighting facilities.

Stretch 3

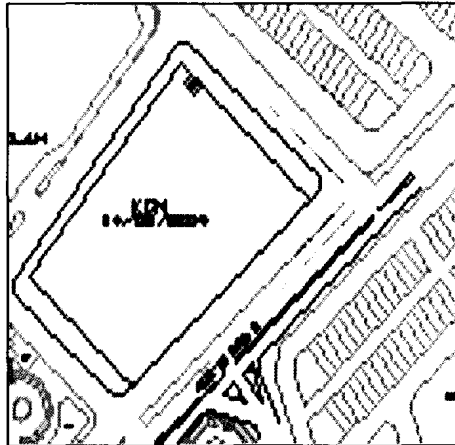


Figure 4.46 Improvement in Stretch 3.

Barriers

1. Poorly maintained lighting

Proposed Improvement

1. Provision of maintenance on the existing lighting facilities.

Stretch 4

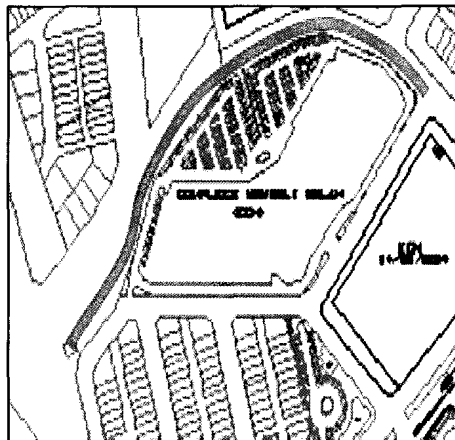


Figure 4.47 Improvement in Stretch 4.

Barriers

1. Pedestrian lighting provided is not functioning.

Proposed Improvement

1. Provision of maintenance on the existing lighting facilities.

Stretch 5

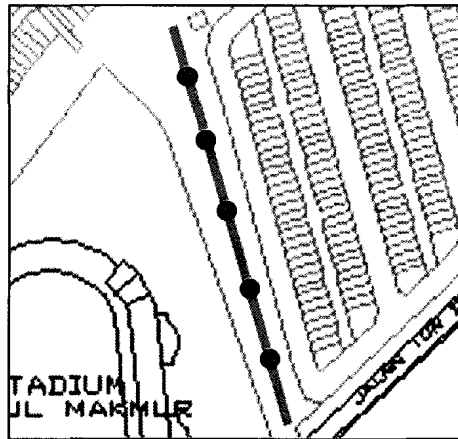


Figure 4.48 Improvements in Stretch 5.

Barriers

1. The area is poorly illuminated.

Proposed Improvement

1. Provision of pedestrian lighting.
 - Pole-Mounted Lighting
 - Cost: RM100 each
 - Total unit: 5

Stretch 7

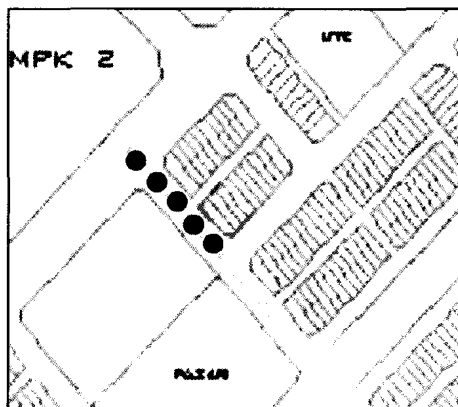


Figure 4.49 Improvement in Stretch 7.

Barriers

1. The area is poorly illuminated.

Proposed Improvement

- Provision of pedestrian lighting.
- Ground Lighting
 - Cost: RM70 per set

According to Table 4.31, Stretch 1, 5 and 7 will be provided with the pedestrian lighting. For Stretch 1, decorative single arm LED pedestrian lighting is selected as it is energy-saving, long life and better quality of light emission. In addition, the selection also allows it to blend with the existing landscape. Next, for Stretch 5, pole-mounted LED lighting is proposed to be implemented as in that area, it is not suitable for any installation lighting pole. It is cost-effective as no pole is needed. It just need to be mounted to the existing lighting pole. Lastly, for Stretch 7, ground lighting is suggested to illuminate the pedestrian. This is due to the limited space there. This ground lighting that will be implemented around the existing trees will act as a landscape in the area specially at night as well as assisting in the better illumination of the pedestrian. Figure 4.49 shows the overall overview of the suggested provision of pedestrian lighting in the research area.

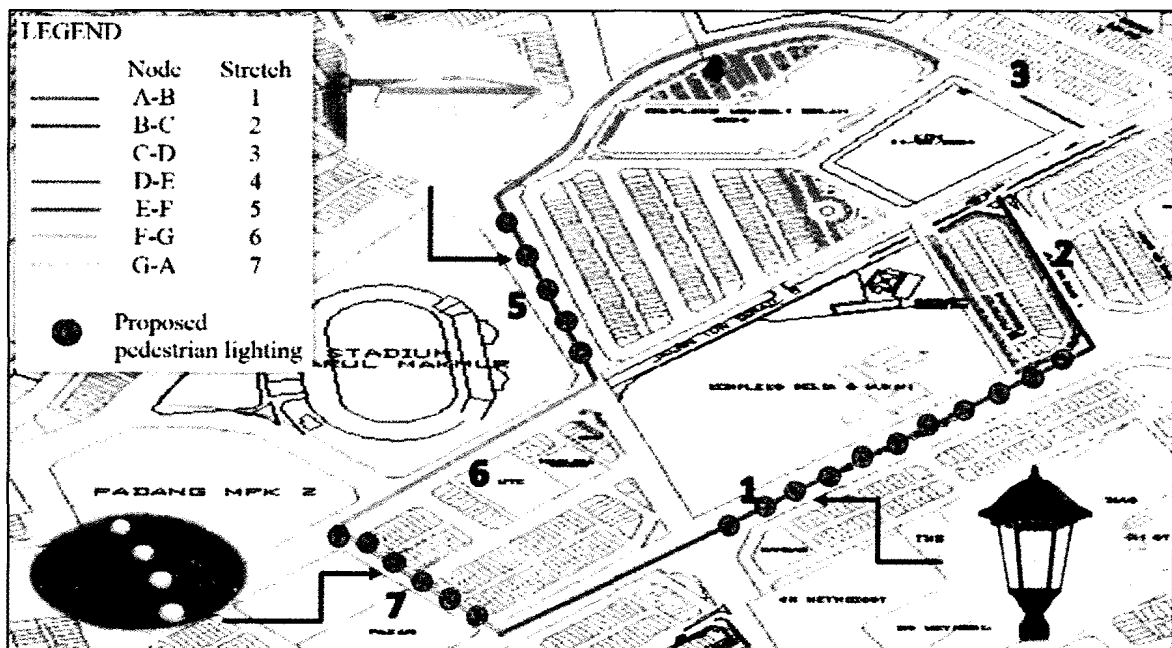


Figure 4.50 Overall overview on the proposed implementation of pedestrian lighting in Kuantan CBD area.

CHAPTER 5

CONCLUSION

5.1 Introduction

In this chapter, based on the overall research process, recommendations are pointed out to assist in the improvement of pedestrian facilities specifically pedestrian lighting.

5.2 Conclusion

In conclusion, this research accomplished its objectives. The information and data gathered throughout the data collection processes assisted in identifying the pedestrian needs and requirements in Kuantan CBD area. The pedestrian needs can be classified in two aspects which are the overall pedestrian facilities and pedestrian lighting. Meanwhile for the requirements, among the main points that need to be stressed out are the planning and the key elements of a practical implementation of pedestrian facilities.

Next, from this research, the barriers on the pedestrian facilities specifically the pedestrian lighting in Kuantan CBD area are also being identified. The barriers subjected to this research are limitation of cost and spaces, lack of awareness among the developers and local authorities on the implementation of pedestrian lighting as well as poor level of pedestrian's safety in Kuantan CBD area especially at night which resulting from the insufficient number of pedestrian lighting in the area. These barriers will indeed help in the process of figuring out the best way of the implementation of the pedestrian lighting in this area.

Lastly, based on the results obtained, there are a few pedestrian infrastructure parameters identified that we can accentuate in improving the pedestrian lighting in Kuantan CBD area. These parameters should be included in the master planning of the

improvement of the pedestrian lighting which include the provision and improvement's initiative on the pedestrian lighting. This leads the research to effective and efficient implementation of pedestrian lighting in Kuantan CBD area. Thus, objective 3 of proposing the pedestrian infrastructure parameters in improving the pedestrian lighting in Kuantan CBD area is also achieved.

5.3 Recommendations

- Review all the questions prepared for the interview session. This is to ensure that the results obtained from the interview can fully help the research in achieving the research objectives.
- Conduct thematic analysis on the results for interview. This is to help the researcher to identify the main data or information that are crucial to be interpreted and discussed.
- For the questionnaire survey, pilot study should be conducted beforehand with the individuals of the target population to avoid any overlooking errors and to verify the efficiency of the questionnaire questions.
- Keep the questionnaire questions short and simple. Ask direct questions to enable the respondents to answer it easily and in a short time.
- Review the questionnaire form once the respondents have finished completing it to ensure that they answer all the questions in the form. This is to avoid the condition of missing or incomplete responses that will lead to difficulty in interpreting the results obtained.
- Classify the research area into several zones for the site observation. This will simplify the results interpretation and allow the researcher to point out major problems associated with each stretch.

5.4 Recommendations for Future Project

- Local authorities and developers should include the provision of pedestrian facilities in the master planning of any development. For the existing development, improvement on the pedestrian facilities should be implemented.

- Apart from the improvement on the pedestrian lighting in central-business district areas, this improvement of pedestrian lighting should also be implemented in the rural areas. This is because in rural areas, there are limited number of lighting and their level of safety is more crucial.
- Before selecting the area for the improvement of the pedestrian infrastructure, conduct pedestrian volume study beforehand, in order to provide maximum utilization of the pedestrian infrastructure.

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**APPENDIX A
QUESTIONNAIRE FORM**

**FINAL YEAR PROJECT RESEARCH: IMPROVING PEDESTRIAN
INFRASTRUCTURE IN KUANTAN CBD AREA CITY.**

We are conducting a survey of the improving pedestrian infrastructure in Kuantan CBD area city for our Final Year Project. Hopefully you can fill this form with honest answer based on your experiences as pedestrian. All information on the form will be treated in **strict confidence** and will not be divulged to any third party without written consent. Thank you for your time and cooperation.

SECTION A

1. Gender

Male	
Female	

2. Age

<10	
10 - 20	
21 - 30	
31 - 40	
41 - 50	
51 - 60	
>60	

4. As a pedestrian, do you feel **convenient** to walk around in this area?

Yes	
No	

5. Why this area need to be improved? (You may choose more than one)

Not enough sidewalk	
Lack of safety	
Insufficient lighting	
No crossing provided	
Lack of shading	
Bus stop facility	

SECTION B

1. Purpose of trip

Work	
School	
Business	
Shopping / Leisure	

Others:

2. How often do you walk in this area?

Always	
Often	
Sometimes	
Rarely	

3. As a pedestrian, do you feel **safe** to walk around in this area?

Yes	
No	

SECTION C

1. How to encourage people to walk often?

Providing more shading	
Set barrier between pedestrians and vehicles	
Provide continuously path walk	
Provide more crossing	
Provide sufficient lighting	
Locate bus stop in strategic location	

2. You may tick more than one.

	Shading	Segregation	Walkway	Crossing	Lighting	Bus Stop
Have you experienced any injuries while using these facilities in this area?	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No
What other problem you faced while using these facilities?	<input type="checkbox"/> Non-continuous shading <input type="checkbox"/> Insufficient of shading <input type="checkbox"/> Not provide weather protection <input type="checkbox"/> Direct exposure to sunlight <input type="checkbox"/> Others:	<input type="checkbox"/> Vehicle entering pedestrian area <input type="checkbox"/> Insufficient barrier <input type="checkbox"/> Lack of pedestrian safety <input type="checkbox"/> Difficulty to cross the road <input type="checkbox"/> Others:	<input type="checkbox"/> Narrow pavement area <input type="checkbox"/> Crack of pavement surface <input type="checkbox"/> Stagnant water occurred <input type="checkbox"/> Un-continuous pavement <input type="checkbox"/> Others:	<input type="checkbox"/> Insufficient crossing <input type="checkbox"/> Location of crossing <input type="checkbox"/> Distance from one crossing to another crossing <input type="checkbox"/> Feeling unsafe to cross the road <input type="checkbox"/> Others:	<input type="checkbox"/> Poor lighting <input type="checkbox"/> Insufficient of lighting <input type="checkbox"/> Not properly function <input type="checkbox"/> Feeling unsafe to use the walkway during at night <input type="checkbox"/> Others:	<input type="checkbox"/> Vandalism <input type="checkbox"/> Location not strategic <input type="checkbox"/> Poor maintenance of facilities <input type="checkbox"/> Others:
What things that need to be improved?	<input type="checkbox"/> Continuous shading <input type="checkbox"/> Provide more shading <input type="checkbox"/> Provide convenient shading <input type="checkbox"/> Others:	<input type="checkbox"/> Distance of barrier <input type="checkbox"/> User friendly design barrier <input type="checkbox"/> More barrier <input type="checkbox"/> Others:	<input type="checkbox"/> Enlarge the pavement area <input type="checkbox"/> Do inspection on pavement conditions <input type="checkbox"/> Re-continuous the pavement <input type="checkbox"/> Controlled the stagnant water occurred <input type="checkbox"/> Others:	<input type="checkbox"/> Universal crossing <input type="checkbox"/> Strategic location <input type="checkbox"/> More crossing <input type="checkbox"/> Others:	<input type="checkbox"/> Better lighting <input type="checkbox"/> Provides more pedestrian scale lighting <input type="checkbox"/> Strategic location <input type="checkbox"/> Well maintenance of lighting <input type="checkbox"/> Others:	<input type="checkbox"/> Having CCTV <input type="checkbox"/> Better lighting <input type="checkbox"/> Better seating <input type="checkbox"/> Information board <input type="checkbox"/> Better vandal proofing <input type="checkbox"/> Frequent maintenance <input type="checkbox"/> Others:

Do you have any suggestion?

.....

APPENDIX B

INTERVIEW QUESTIONS

IMPROVING PEDESTRIAN INFRASTRUCTURE IN KUANTAN CENTRAL BUSINESS DISTRICT (CBD) AREA

We are students of Universiti Malaysia Pahang from Faculty of Engineering Technology (FTECH) currently conducting Final Year Project. This survey aims to improve pedestrian infrastructure in Kuantan Central Business District (CBD) area.

A. GENERAL

1. What is your opinion on pedestrian facilities in terms of safety in Kuantan CBD area?
2. In your observation, what pedestrian facilities that are still lacking in Kuantan CBD area?
3. What are your suggestions to improve the pedestrian facilities?
4. Are there any issues/barriers regarding improving pedestrian facilities?
5. As stakeholders, what are your initiatives to improve pedestrian facilities?

B. SCOPES

1. Do you agree that the pedestrian walkway is lack of maintenance in Kuantan CBD area? Why?
2. Do you think that the connectivity of pedestrian walkway in Kuantan CBD area is the best practice for pedestrian?
3. Who is responsible for designing and maintaining the bus stop?
4. What could central and state government do to improve the bus facilities in the next 5 years?
5. Did you think that the pedestrian walk needs to be shade?
6. From your opinion, what types of pedestrian shade that you think is suitable to be implemented at the pedestrian walk at Kuantan CBD area?
7. What is your level of satisfaction on the provision of the pedestrian lighting in Kuantan CBD area? If it is low, what are the suggestions that you would like to propose to improve it?
8. From your point of view, which specific zone/area in Kuantan CBD area that you think is the most crucial for the pedestrian lighting implementation?
9. From your opinion, do you think that the segregation exists between main road and CBD area is suitable or sufficient?
10. In your opinion, do you think that bollard can help to improve pedestrian safety around this mall? If yes, what is the most suitable bollard should be proposed?
11. In your observation, do you think that existing crosswalk give harm to people?
12. Which is the most suitable area to install crossing in this area?