A Study of Illumination Level at Public Transit Infrastructure in Butterworth, Penang.

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Abstract. Illumination level is an important thing in our daily life. Therefore, it is necessary for the building or any infrastructure to achieve the minimum recommendations of illumination. This case study was focus on the evaluation of illumination level at public transit infrastructure which is Pengkalan Sultan Abdul Halim Ferry Terminal. The aim of this study is to evaluate either the illumination level in selected area is comply to the standard of Panduan Teknik JKR or not. Field measurement was conducted, and the reading of lux meter were recorded. The illumination level of the selected location is in good condition during the day. The walkways area achieved 100% of recommendation standard followed by waiting area is about 85%. Only ticket counter in satisfactory level with 86.20% and only 13.80% achieved the minimum requirement. Only walkways achieved 65.4% of satisfactorily standard and 34.6% in bad condition for the night situations. The bad condition of illumination at ticket counter and waiting area during the night. The 100% of the area are in bad condition which is dangerous to the users. From the results, it is suggested to do routine maintenance to improve the illumination level and achieve the minimum requirement of standard.

1. Introduction

Lighting touches every inch of our lives. Thus, lighting directly influences every dimension of human existence. Tanner [1] reiterated, light is one of important things in our life, after our main need food and water in order to control our bodily functions. According to Monteiro [2], most of the lights level at workplaces are not fulfil the standard level and the values are more represent the general and localized lighting. The lighting system is one of the physical factors that contribute to the level of facilities at the public transit infrastructure. The source of illumination is contributed by two parameters which are day light and artificial light. Day light is whereby the sun light will radiate into the building or any area through windows or doors, and artificial light will be used to promote the light during the night without existence of the sun. The artificial lighting system can be dim or light, fully equipped or not fully equipped and then will result in the level of illumination at the public transit infrastructures. Low illumination indicates that the lighting system at a place are required for maintenance and high illumination level indicate that the lighting system at a place are meet the requirement of the standard and in a good condition.
2. Problem Statement
All the buildings were designed according to the standard provided in the country and serve to meet the requirements of the occupants. Public transit infrastructure was designed to facilitate the users while they are waiting for the public transport. As the demand of the travel increase, the demand of the public transport also increases in Malaysia. Therefore, the public transit infrastructure also must have high level of facility. Lighting system is one of components that include in the facility of public transit infrastructure and then it will determine the illumination level of public transit infrastructure. Lighting has a very powerful impact in people’s life and health Samani,[3]. It is also having a very essential impact in people’s productivity and performance. But, the poor lighting system and the lack of attention to improve the lighting facilities or using daylight are critical problems that many organizations and learning environment are face with Samani,[3]. The issues are some of the illumination level at the public transit infrastructure does not complying with the Panduan Teknik JKR due to design features of the building. The illumination level might be affected the safety as it is a public area and also affect health of the passenger at the public transit infrastructure when exposed to the poor lighting system that will make their eyes strain, eyes feel dry, headache or difficult in seeing the object in the screen. For this case study purpose, the illumination level will be measure at public transit infrastructure in Butterworth Penang.

3. Objectives
The aim of the study is to determine either the provided lighting system at public transits infrastructure Pengkalan Sultan Abdul Halim Ferry Terminal is complying according to the standard or not. Thus, the objectives of this study are:

i) To measure the illumination level in the area of public transits infrastructure Pengkalan Sultan Abdul Halim Ferry Terminal.

ii) To evaluate the illumination level in the area of public transits infrastructure Pengkalan Sultan Abdul Halim Ferry Terminal either it is complying according to the standard of Panduan Teknik JKR

4. Scope of Study
The location of the case study is at Pengkalan Sultan Abdul Halim Ferry Terminal Butterworth, Pulau Pinang which served as the central of public transits infrastructure. The focus location were outdoor and indoor area such as ticket counter, waiting room, walkway and platform area. This study was focusing on lighting system that will contribute to the evaluation of illumination level. Field measurements was carried out in order to measure the reading of illumination. Lux Level Meter as the tool to measure the lux value and Panduan Teknik JKR was use as a guideline for the evaluation of the illumination level. Other than that, questionnaire survey will be used as the supporting data for this study. The purpose of the questionnaire survey is to evaluate the comfort and satisfaction level of the users regarding the lighting system at this ferry terminal. From the data collection of field measurement and survey questionnaire, the analysis will be conducted to determine whether the lighting level were complied with Panduan Teknik JKR or not. The analysis is carried by categorizing the illumination level which is good, average and bad illumination using contour technique at each area. The contours were established from the result of field measurement. From the analysis, some recommendation can be produced in order to improve the lighting system at these public transits infrastructure.

5. Literature Review
The measurement of illumination level was conducted at various places and by using various methods. So, the findings also expected to be various. Abd Majid, Abdul Rahim Abdul Hamid, and Singh [4] conducted an investigation of the causes of accidents at construction sites by analysis of the questionnaire survey involving 116 respondents from construction industry within peninsular Malaysia. The targeted respondents were persons who are very expertise in the construction work and familiar with accidents at site. The finding of the investigation shows
that poor illumination was categorized under job site conditions which were one of the causes of the accidents at site. Failure of the management to do the inspection on conditions, workers, materials and equipment lead to occurrence of the accident. The gloomy, dull and dim working spot will result in eye stain especially when working with paper. Referring to Arabi et. Al., [5] which conducted an investigation on how acceptable illuminance level attributes to learning satisfaction in classroom.

The article from Chua, Ali, and Lim [7] has conducted an investigation on how physical environment comfort impacts on office employee’s performance. Field study is done for 3 offices used as office space with approximately 200 to 300 squares meters occupied by government employees and their scope of work include writing and reading, computer task and occasional walking to deliver document between workstation. The sampling location for lux meter is placed at every alternate working desk. From the finding of environmental comforts, it has caused a different impact towards employee’s health impacts such as tired or dry eyes, easily tired and difficulty in concentration are found in building C. Meanwhile, occupants in building A were faced lighting and visual comfort such as easiness in blur vision, tired and tired eye. But, occupants in building B are having comfortable lighting and visual comforts.

From article Juslén, Verbosse, and Wouters, [8] conducted a field study in the food industry by installed localized task lighting in addition to the general lighting installation in the food factory. The method of investigation is through employees’ opinion by lighting questionnaires. The additional task lighting was installed during the maintenance break of production at the end of 2003 and the illuminance was set to maximum. After 5 weeks later, employees filled the questionnaire. The results of the questionnaires showed that even before the change of lighting, operators felt that the lighting level was sufficient to them to carrying out work. However, they are agreed that the lighting was ever better than before after the installation of the task lighting and it helps them to perform their tasks better.

6. Methodology
6.1 Selection of Location
Pengkalan Sultan Abdul Halim Ferry Terminal was selected as study area of illumination level at public transits infrastructure. The three (3) areas were chosen for field measurement which are walkways, ticket counter and ferry’s waiting area. The selection of areas was made by considering the most probably location that will be used by the passenger at the ferry terminal.

6.2 Questionnaire Survey
The purpose of the questionnaire was to evaluate the respondent’s comfort and satisfaction level while they are at ferry terminal regarding to the provided lighting system. The respondents involved were 30 for each area.

Table 1. Table of Likert scale.

| Scale | Level of Agreement |
|-------|--------------------|
| 1     | Strongly Disagree  |
| 2     | Disagree           |
| 3     | No Idea            |
| 4     | Agree              |
| 5     | Strongly Disagree  |

6.3 Lux Level Meter (LLM)
The field measurement being conducted using Lux Level Meter and it must be positioned one meter from the floor level of each point marked. Selected area for the field measurement must be determined
by measuring its length and width by using measuring tape and walking meter. If the selected area cover is less than 100m², the point of measurement will be at 1m apart. While, if the covered area is larger than 100m², the point of measurement will be at 5m apart. The field measurement was conducted during 10 am to 5 pm on the day and 8pm - 10 pm the night to be compared with illumination level that had been stated in Panduan Teknik JKR.

![Field Measurement Flowchart](image.png)

**Figure 1.** The flowchart of field measurement.

| Area                | Number of Points |
|---------------------|------------------|
| Walkways            | 388m²            |
| Ticket Counter      | 40m²             |
| Waiting Area        | 268.8m²          |

**Table 2.** Area and Number of Point for Each Location.

**7.0 Results and Discussions**
This section will explain the result and discussion for the lighting system analysis at Pengkalan Sultan Abdul Halim Ferry Terminal. The data from field measurement was evaluated according to the lighting reading of each location. All the evaluated data transferred in term of percentage and presented in bar chart. Table 3 is the classification of illuminations level at public transit infrastructure based on Panduan Teknik JKR shows that illumination level is vary due to the task or activity that will be carried out in that area.
Table 3. Classification of Illumination Level at Public Transit Infrastructure.

| Area of Public Transits Infrastructure | Bad Illumination (lux) | Average Illumination (lux) | Good Illumination (lux) |
|----------------------------------------|------------------------|-----------------------------|------------------------|
| Walkways                               | 0-49                   | 50-99                       | 100 and above          |
| Platform and waiting area              | 0-99                   | 100-199                     | 200 and above          |
| Ticket counter                         | 0-149                  | 150-299                     | 300 and above          |

Figure 2. Contour of Illumination Level at Walkways of Pengkalan Sultan Abdul Halim Ferry Terminal

Figure 3. Contour of Illumination Level at Ticket Counter of Pengkalan Sultan Abdul Halim Ferry Terminal.
Figure 4. Contour of Illumination Level at Waiting Area of Pengkalan Sultan Abdul Halim Ferry Terminal.

Figure 2, 3 and 4 shows the contour and shaded area of illumination performance during day and night at Pengkalan Sultan Abdul Halim Ferry Terminal. The red colour indicates the bad illumination at the respective area, yellow shows the sign of average illumination while the green zone shows the good illumination area. From the contouring and shaded data, it transfers to the form of percentage and represent in bar chart.

Figure 5: The percentage of illumination level at Pengkalan Sultan Abdul Halim Ferry Terminal during the day.

Figure 5 show that the 100% of green that indicates good illumination level at walkways of Pengkalan Sultan Abdul Halim Ferry Terminal during the day. At ticket counter, the percentage of illumination level is 86.20% which indicates of average illumination level. 13.80% green colour indicate of good illumination level during day. Meanwhile, at waiting area of Pengkalan Sultan Abdul Halim Ferry Terminal, the average illumination is donated by 15% and good illumination is denoted by 85% during day. All the areas of the Pengakalan Sultan Abdul Halim Ferry Terminal show the zero percent of bad illumination level during day. From observation during field measurement, it was found that the ferry terminal was not surrounding by window which directly allow for sunlight exposed during day. Furthermore, the walkways and waiting were evaluated to have good illumination level during the day. Meanwhile, the ticket counter of ferry terminal was evaluated that the average illumination level higher than good illumination level. This is because, the ticket counter was positioned in the middle of the building which limited the to sunlight exposed. Overall, the illumination levels of Pengkalan Sultan Abdul Halim Ferry Terminal were fulfilled the requirement of standard of Panduan Teknik JKR.
Both areas of ticket counter and waiting area are having percentage of 100% which indicate of bad illumination level while zero percent which indicate for average and good illumination level during night. However, the decreasing in percentage of lighting system reading for bad illumination level is shown at walkways compare to ticket counter and waiting area which is only 34.60% during night. Then, the figure is also showing the average illumination of 65.40% at the walkways of the Pengkalan Sultan Abdul Halim Ferry Terminal during night.

The walkways of the ferry terminal have a long length in dimension and small width of 2m to 4m. The height of the lighting system equipped also does not high from floor level. Due to it physical features, the lighting system is found to be effective which show the arrangement of lighting system was within the width of walkways and produce higher percentage of average illumination level rather than bad illumination level during night. The walkways lighting system was complying according to Panduan Teknik JKR during night. The ticket counter and waiting area were evaluated and found that both areas were not complying according to Panduan Teknik JKR. From the observation, the areas of ticket counter and waiting area were not fully equipped with lighting system. Part of the areas was neglected from having the lighting system which caused the areas was dark during night and resulting in the bad of illumination level.

The purpose of the questionnaire was to evaluate the respondent’s comfort and satisfaction level while they are at this public transit infrastructure which regarding to the provided lighting system. Based on the questionnaires 13.30 % of respondents strongly agree and 46.7 % agree to additional illumination. It can conclude that 60 % of the respondent are aware of the lacked
illumination at locations. About 24% of the respondents are not agreeing to add more lighting to the locations and satisfied with the illumination.

8.0 Conclusion and Recommendation

Generally, this study has achieved its objectives as defined. All the selected locations of field measurement are successfully evaluated. The illumination level of each location successfully justified by referring to the minimum standard of Panduan Teknik JKR. Thus, the conclusion that can be drawn from this study are as follows:

a) The illumination level of the selected location is in good condition during the day. The walkways area achieved 100% of recommendation standard followed by waiting area is about 85%. Only ticket counter in satisfactorily illumination level with 86.20% and only 13.80% achieved the minimum requirement.

b) It different for the night situations. Only walkways achieved 65.4% of satisfactorily standard and 34.6% in bad condition. The bad condition of illumination at ticket counter and waiting area during the night. The 100% of the area are in bad condition which is dangerous to the users.

It can be concluded that there are some areas of the Pengkalan Sultan Abdul Halim Ferry Terminal are complying according to the standard of Panduan Teknik JKR during the days and not complying the standard during the night. It is recommended that this study be pursued for all locations of public transit infrastructure. To improve the illumination level, the management of the public transit infrastructure need to pay attention to do routine maintenance in order to solve the earlier stage problems. Lastly, all the data obtained need to proceed with an immediate improvement effort to ensure the improvements in terms of serviceability and safety of users.

Acknowledgement

Financial support from Universiti Teknologi MARA Pulau Pinang Branch for funding the research and publication works is gratefully acknowledge

9.0 References

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