Lighting Heritage Building Practice in George Town, Penang Island

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Abstract. In this technological era, lighting fixtures can be seen anywhere in the city to accommodate its specific functions or to achieve some purposes in any forms and colours. The patterns and arrangements of the lighting fixtures on the buildings and structures at night creating a sense of art which emphasizes the nature or the potential of the buildings. Nowadays, lighting designers tend to put more lighting fixtures into their design to give a better outlook and as an attraction for tourism at night. In some manners, light art is like a rose that has thorns on it. The public nowadays appreciate the beauty of light art without realizing the harm that stays under the exposure of colourful bright light designs. However, light art has already become a piece of puzzle that cannot be missing in the growth of economy of developing country in tourism. The objectives of this study are to highlight the rules and regulations that must be obeyed in applying lighting fixtures on historical buildings and to suggest some recommendations to meet the balance between the beauty of light and the appreciation of historical buildings in George Town.

Keywords: Lighting, historical building, urban lighting, lighting pollution, awareness

1. Introduction
Historical buildings in George Town, Penang Island show its importance and uniqueness in every particular place are being appreciated more by tourists today. Many conservation works and renovation works to add in lighting fixtures has made the buildings become more practical and aesthetic twenty-four seven. Even though the lighting decorations might be an attraction to the tourists but unfortunately some buildings were installed with excess lighting fixtures without realizing it. Excessive lightings will lead to light pollution that might also bring a lot of harms towards human, animals, plants and also the biodiversity of the particular area. Above all of these, does the design of renovation or improvement plans met the guidelines that is fixed by the The United Nations Educational, Scientific and Cultural Organization (UNESCO) on heritage buildings? This paper will further discuss on some effects on lightings at night and also some suggestions towards the lighting fixtures that can balance the function and the aesthetics of the heritage building of George Town, Penang Island.
2. Objectives
1. To identify the good and poor lighting based on the observation and findings for future design references.
2. To highlight the rules and regulations that must be obeyed in applying lighting fixtures on historical buildings.
3. To understand types of lighting existed on historical building and their pros and cons.

3. Research Method
Primary data was collected through observation of the building exterior by the researchers at the site, which is the area around Penang Island City Hall to gauge the nature and extent of the building’s lighting issue. Observation method is used to study the issue of lighting design at the place. Through observation, researchers review the characteristic of the building and the lighting fixtures that were applied to the building, the arrangement of the lighting fixtures and the functionality of the lighting system as well as its impact to the building and the surrounding. Observation had been done on daytime and at night to determine the difference between the appearance condition of building being lit out under daylighting and artificial lighting. Pictorial documentation entailed capturing in digital format the whole architectural structure and focus on the lighting fixture applied on the exterior of the building. Library research method is used to collect data and references regarding the research. This method was used with both electronic and printed repositories of information. Any resources that are related to the issue and the context of the research topic, for instance reference books, journal articles, internet articles and the information collected were evaluated and defined to give definition to the research outcomes. Quantitative method was used to collect data on the illuminance of the lighting fixtures at different angles and distances to the surfaces buildings. The numerical data collected are analysed and used to explain the impact on lighting fixtures to the building and the surrounding. Some statistical analysis study data was used to compare and contrasted with the data collected in order to reiterate the lighting issue being investigated.

4. Description of Heritage Building
The heritage building that is involved in the research is the Penang Municipal Office in Penang Island. The building is the local government headquarters located next to The Esplanade of Penang, which is a waterfront area on the northern coast of George Town. It was the first area where Francis Light landed in Penang in 1786. It is one of the UNESCO World Heritage Site on Lot number 69, Section 19, Georgetown, Northeast District of Penang, Malaysia. The two-stories City wall is a masonry building with interesting timber featuring on its interior and exterior. The building formerly known as Municipal Office, then its name changes into the City Hall of George Town when city status achieved by George Town and its name redefined as Penang Municipal Office after the head office of the Penang Island City Council moved to the building (Tye, 2015). Penang Island City Hall is a Neo-classical style British colonial architecture that constructed in 1903 and opened to public in 1906. The building was listed as a national monument under Antiquities Act 1976 by the Federal Government due to its significant historical and architectural values (Tye, 2015). The building reflects both Edwardian Baroque and Palladian architectural styles. The building is totally whitewashed, grounded opposite to the Padang Kota Lama together with the Penang Town Hall building, they give an elegant feeling to the panoramic view of the Esplanade.
5. Findings and discussion

Social impacts on implementations of lighting fixtures

The implementations of lighting fixtures onto historical buildings has actually lead to contrary effects towards social impacts. Installing lighting fixtures on historical building is beneficial to the society and country by making a new look for the historical buildings and not only functional as an attraction during daytime but also at night. Lighting application also gives a new and unique identity for the building to serve its purpose. This will help in growing the country’s economy through tourism. Other than highlighting the beauty of the detail on historical buildings, lighting fixtures should also play another crucial role which is light up surrounding spaces to avoid the number of crime cases. In contrast, lighting fixtures that lack of considerations may lead to a lot of health issues towards humans, animals, and also plants. For example, cancer, disturbance on circadian rhythm and melatonin production, and optical health issues (Scientific Committee on Emerging and Newly Identified Health Risks).

Major function and goal of implementation of lighting systems

For most kind of lighting systems, the luminous effect is determined by 4 factors: the lighting source’s intensity, directional and characteristic; the geometry where the light interact with the receiving surface; the receiving surface that modify light to becomes secondary light by reflection, redirection and colouring of light; and the person who views the lighting source and illuminated surfaces as he or she moved around (Santen, 2006). The main function of lighting systems is to create a focus to the human eye as an attraction towards the shape and structure of the building. Detailing and the structure of historical building is the soul to proven the presence of histories and timeline. Lighting plays an important role on enhancing the details of the historical building through the contrary effect of light and shadows to carry out the essence and the value of the presence of historical building.

Characteristic of the visual environment

“Our eyes are constructed to enable us to see forms in light” said Le Corbusier. Light is an architectural material, but an intangible one, building form is not perceptible without light to reveal it. The lighting fixtures that were installed on buildings are intended to emphasize the structural form of the building, however the truth is that sometimes it does and sometimes it does not. Distinguishing form through patterns of light tells public how the parts of a building interprets its characteristics. The details of the building were clearly shown under the uniform ambience of daylight in the day (Figure 1 & 3). The fine carving of the Penang Municipal Office cast shadows onto the exterior surface and bring out the Neo-classical style of a British colonial architecture. Daylight reveals the subtleties of the structural form while shadow appearing to cast upon it. The ambience of the Penang Municipal Office is uniformly illuminated during nighttime and the installation of lighting fixtures does create a focus on certain details of the buildings (Figure 2 & 4). However, the arrangement of the lighting projected has caused glare from the reflection on the white surface of the columns which affect the details of the historical buildings hard to be distinguished. In fact, in the spectrum of light wavelength, if the color of a surface is anything other than white, it means that it absorbs light of some wavelengths (Deziel, 2017).
Type of light source and design arrangement
The type of lighting fixture that installed on the Penang Municipal office is LED floodlight. The colour of the projected light is white colour light. According to the guidelines given by UNESCO on heritage buildings, floodlights used on building must be natural white light. White light is defined as the complete mixture of all of the wavelengths of the visible spectrum (Cardenas, 2015). According to Cardenas if the beams of light of all of the colours of the rainbow onto a single spot, the combination of all of the colors will result in a beam of white light (2015). White light is in the range of visible light spectrum which is 400 x 10^-6 mm - 700 x 10^-6 mm. (nanometer (nm) = 1 x 10^-9 m)
Table shows the full spectrum that forms white light (Cardenas, 2015):

| Color   | Wavelength | Color   | Wavelength |
|---------|------------|---------|------------|
| Violet  | 380-450 nm | Yellow  | 570-590 nm |
| Blue    | 450-495 nm | Orange  | 590-620 nm |
| Green   | 495-570 nm | Red     | 620-750 nm |

The design arrangement of the floodlights is located in between of every two columns and also the column of entrance. The placement of the floodlight caused glare that reflects from white color surface of the column. The detail of building facades of Penang Municipal Office was unable to distinguish from certain angle due to over exposure of floodlight.

Key design factors and criterions of lighting systems
It is unnecessary to use high light intensity floodlight to give impact on the details of the historical building facades. Uniformly projected lights such as daylight is more than enough to enhance the beauty of the detail on the building facades by the contrary effect of light and shadows. The light illuminance level for day can meet up to 10,000 lux. However, it might be a different in situation at night. According to the illuminance level which was collected using the lux meter, the illuminance from the spotlight on the field shows an illuminance level of approximately 10 - 40 lux depending to the distance from the source. The ambience of the building was softly illuminated and faded radiantly along the distance. However, the eyes will function differently at night. Illuminance level of 50 lux on the area is already sufficient to distinguish the building and the detail of building facades due to reflective white surface of Penang Municipal Office. Therefore, there are some design considerations that can be considered when implementing floodlight into designs which are type of light source, reflectivity, color, and texture of the projection surface, distance of the surface from the light source, and color filter used.
For the type of light source, lower power input lighting fixtures can be used to reduce the intensity of light and also more energy saving and energy efficiency. Generally, lamps with higher wattage produce more light. Light output could range from 2600 to 135,000 lumens (1 lux = 1 lumen/m²). Color temperatures also affect the brilliance. The surface of the wall of Penang Municipal Office is white in color paint and the most reflective surface among other colour surfaces under the same material and textures. White painted wall can have a better appearance under floodlight compared to metallic material surfaces.
The distance of the surface from the light source affects a lot on the projecting effect of floodlight. The distance of the surface from the light source will increase the illuminance level towards the surface. In this situation where the reflected light on white surface will cause glare that will lead to discomfort for human eyes for long period of exposure. On the other hand, color filters can also be helping in reducing the white light intensity as all color filters (gel and glass) absorb light. The color filters, to some degree, color is traded for brightness. A white light source (at least 3200ºK) must be used, otherwise, the colors will be distorted. Since color light is prohibited in the guidelines, polaroid can be used to reduce 50% of the light intensity towards the surface of the building. This can reduce the glaring effect as well as easier for the eyes to distinguish the detail of the building facades. The public can enjoy and appreciate the beauty of historical building facades and can see it clearly and without discomfort from glaring issue.

Figure 1 & 2: Penang Municipal Office in Penang Island

Figure 3 & 4: Penang Municipal Office in Penang Island
6. Conclusion

Light acquires meaning in architecture relationally. It is related with the transfer of meaning from the initial intention of the designer into the personal expression of the inhabitants. While personal experience for light will be the interpretation for both. The researchers are intended to explore and present light in a cohesive way as it is interconnected closely with architecture and our daily life. Designers must always try to approach light in an integrated way, both conceptually and practically so that light becomes more directly and meaningful. Light is only one of the aspect in architecture realm, but light plays vital and essential roles in revealing a building, its intentions, its structure, its form, its appearance and its meaning. Light always reveals architecture and the best instances, architecture reveals light. The appreciation on the beauty of light must not neglect the balance of the system in the historical area. In this modern and technology edge-leading era, many new solutions will be coming up to overcome the issues that we should be concerned.

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