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Measuring Illuminance Level Based on Wall's Colour

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Abstract: Lighting in a building depends on the activities carried out throughout the building. Natural light from the sun is a free source of light that suits any functions of the building. The selection of wall color also needs to be taken into account since human's eyes reacted to colors and light also influenced by it psychologically. This study is an experimental effort to explore the effect of interior wall coloring on the performance of natural light through windows. A physical scale model (1:10) consists of four spaces with different colors was used to determine the lighting level. The colors chosen were from the group of cool colors, warm colors, neutral colors and colors commonly used in Malaysia. During data collection, the model is placed on an obtructed area in the UTHM Student Residential Area. The results of the study found that a wall painted in white gave a higher illuminance reading than a wall painted in dark color. It shows that it is very important to know the effect of color on the quality of natural lighting, which can give impact towards the room's surrounding and human's performances.

Keywords: Illuminance Level, Lighting Quality, Natural Lighting, Wall Color

1. Introduction

Illuminance is used as a performance indicator to determine the availability of daylight in the interior [1]. Generally, it refers to the amount of light that falls onto a surface per unit area. It is measured in lux (lx), where one lux is equal to one lumen per square meter. It also known as brightness, but this matter has caused various confusions with other uses for the word. In addition, the word "brightness" is not suitable for quantitative description, instead the word is only used for reference to the physiological senses and for non-quantitative light observation [2].

Daylight is essential for human life to help carry out daily activities. It is readily available, environmentally friendly, cool source of light and has greatest colour rendering index. It is also known

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as visible light which is energy, in the form of waves that helps humans and other living things such as the animal to see [3]. Beside that, green plants also need light for the photosynthesis process and some of these green plants are consumable by humans and herbivor animals.The choice of color plays a role in determining the lighting for ach space in a building and it is also very important if you want a space that has a good level of lighting [4]. Color is the property of an object or material determined by the type of wavelength transmitted, emitted, and reflected. Among the basic colors are yellow, blue, and red [5]. Colours are also categorized as warm colours and cool colours as shown in Figure 1. .Human perception can be stimulated by warm colours. While, the calming effect can be found and felt from the cool colours. Moreover, colors that are lighter make the space look more spacious and darker colors make the space look smaller and more closed to the eye [6]. In term of colour reflection, white colours gives a high percentage of reflection which is 70% to 90% compared to black colour of only 4% [7].

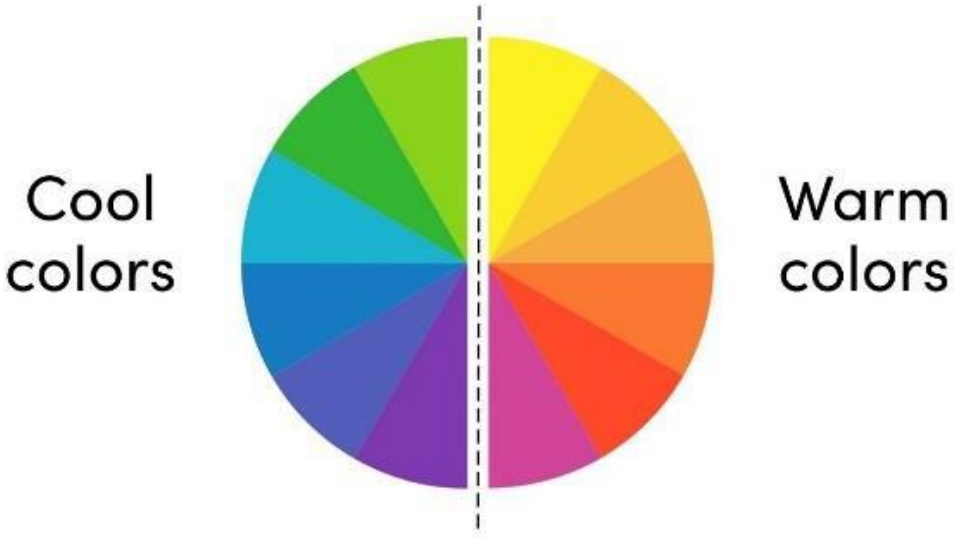


Figure 1 : Color temperature wheel

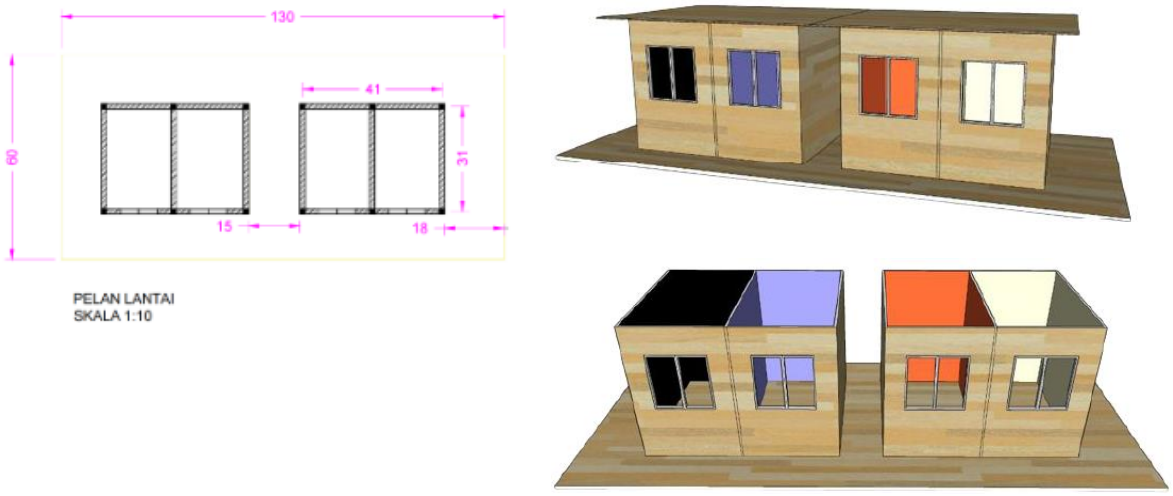
The aim of this study is to explore the effect of interior wall coloring on the performance of natural light from windows. Therefore, four paint colors have been chosen, namely blue representing the cool color, orange the warm color and two neutral colors, which is black and white. Through the data obtained from the experiment, suggestions for the selection of colors suitable for the activity can be made.

2. Materials and Methods

In this study, experiment have been conducted to measure the illuminance based on the wall colour in the room. The experiment began with construction of scaled model using plywood. The data observations were conducted for three days during good weather conditions.

2.1 Materials

The model consist four (4) typical room at scaled 1:10 was developed using AutoCAD in order to visualize the floor plan, right view and front view helped to construct a detailed measurement building. SketchUp was used to create a 3D draft model for the experiment by painting the inside of the box with different colors blue, orange, black and white as shown in **Figure 2.**



(a) Floor plan (b) 3D view

Figure 2 : Design of the model

Next, the scale model ere built by using plywoods. The model was of 0.20m length, 0.31m width and 0.3m height. Each room has an opening to allow daylight to enter the room. The construction of the model were carried out at the Makmal Teknologi Perabot. **Figure 3** shows the construction of the scaled model. Starting by cutting the plywood according to the sizes that has been determined, the parts that have been cut then were put together as a model by using glue and a stapler.Finally, paint is applied to the inner surface of the model. Four colors have been chosen which were blue, orange, black and white.

(a) Cutting plywood to size

(b) Assemble the model

(c) Cutting opening for window

(d) Paint the inside of the model

(e) Scaled model

Figure 3 : Scale model construction

2.2 Methods

The model were placed in an open area with unobstruction from adjacent builiding or object. This is to ensure that the daylight that reaches it is not obstructed by buildings or objects (**Figure 4 (a)**). The indoor and outdoor illuminance were measured simuteneously using lux meter (**Figure 4 (b)**). For that purpose, five (5) lux meters are used, four (4) for indoor measurement and one (1) for outdoor measurement. The experimental set up as shown in **Figure 4 (c)**. The measurements were conducted three times a day at 10am,1pm and 4pm with a time interval of 15 minutes. All the measurement were done for three (3) days.

(a) open area

(b) Lux meter

(c) Experimental setup

Figure 4 : Data observation

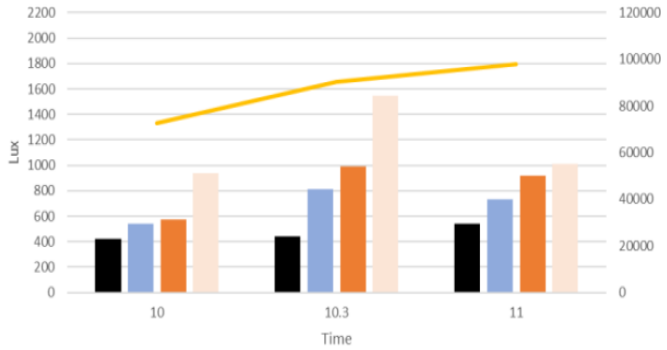
3. Results and Discussion

The results and discussion section obtained the data during the process of data collection and search in the study area that is about the measurement of natural light in the model at UTHM Student Residential College, Pagoh, Johor. The graph shown is taken from the lux meter values of different wall colours and another graph representing the average lux meter of different room colours for three (3) days under natural lighting.

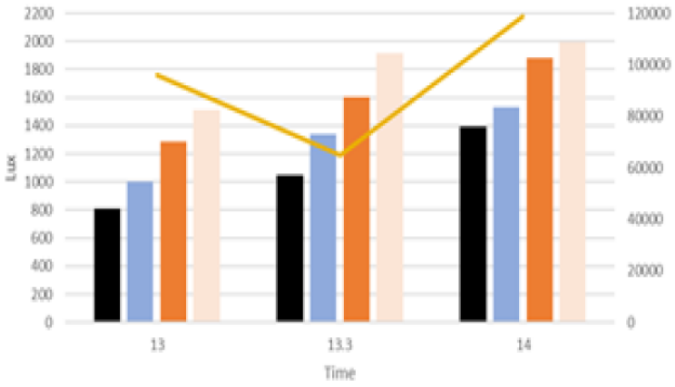
3.1 Result of Observation

Figure 5 shows the comparison of colors, which are black, blue, orange and off white during the observation. The results show that the value of lux increases from morning to noon and begin to decrease when approaching dusk or afternoon. As predicted, the highest lux reading occurs at the peak time between the hours of 1 to 2 in the afternoon probably because at that time the position of the sun is at its apex position over the object. The external lux reading is parallel to the lux reading found in the

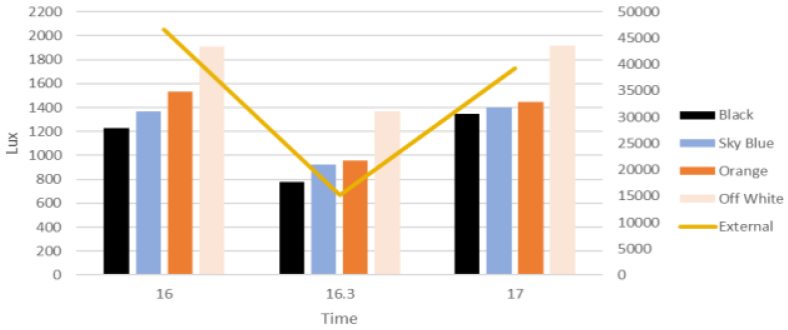
model. Based on the observations that can be seen in the three graphs of the model, off-white faithfully gives the highest lux value which is in the morning, noon and evening compared to the orange and sky blue models. The lowest lux value is black . This is because the off white has a ton of brighter colors than the orange, skyblue and black.



(a) Morning



(b) noon



(c) Afternoon

Figure 5: Illuminance value in morning, noon and afternoon during observation

3.2 Data analysis

The average illuminance level of all colors with time was presented in **Figure 6**. From the graph it can be observed that the off white color has a high lux value followed the sky blue, orange and black. This is due to the reflective properties of white color being higher than other colors [7]. In addition, it

also shows that the value of the lux of lighting begins to rise at peak times, which is at 1 p.m. to 2 p.m. in the noon because at that time the position of the sun is at the top of the object. Then the lux value of its illumination begins to decline as the afternoon approaches.

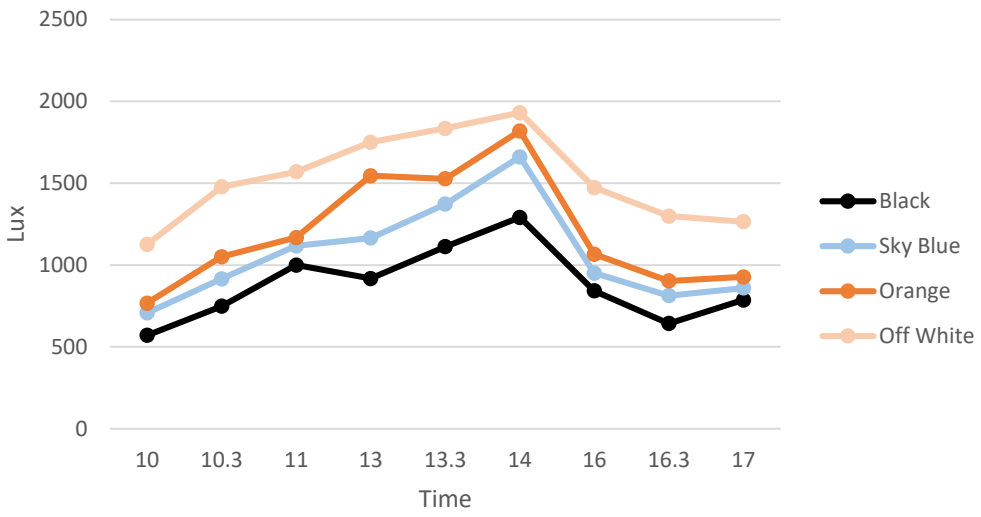


Figure 6: Average illuminance with respect to time

4. Conclusion

In the study, assessment of the level of natural lighting against the color of the walls in a building space was made. This study explores the characteristics of colors that are suitable for use in a building space. The black color indicates the lowest lux meter reading value, because black color has less reflectance to light [7]. Therefore, this space is less prominent because it look small and compact. The off-white color indicates the highest lux meter reading value, which is more receptive to light, this makes the building space brighter and looks brighter. This color also makes the building space look more lavish. Therefore, it is not surprising if this color is oftenly used in a lot of offices space. This color is also used by [8] in their study. The sky-blue color shows a higher lux meter reading value than the black color. This is because the blue color is in a cool color category, as it is less bright but is more faint than the black. The orange color indicates the second highest lux meter reading value from this study. Orange is in a warm color category, as this color is brighter. Hence, the selection of colors during the design stage is very important to ensure the compatibility of colors with the activities carried out in that space.

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