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Internal Illuminance Analysis in UTHM Pagoh Residential College

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Abstract: Daylighting as a source of light which can be obtained freely from the sky helps to enhance the interior spaces for several functions in a building. The study is focusing on the evaluation of daylighting in the UTHM Student Residential College. Windows are a predominant strategy in natural lighting and ventilation at the Student Residential College. The standards recommend an illuminance level on a common area between 300 lx to 500 lx when measured at a working plane of height between 800mm and 900mm. However, the students are without doubt more comfortable in covering the windows with curtains and relying on artificial lightings. This is due to the privacy they get from the outside eyeing view. This study focused on the illuminance level measured on three units of the student residential located at the 1st, 3rd and 5th floor of Blok A17. As a result, the investigation discovered that the illumination reading values on each floor of the houses varied. This study also demonstrates that adequate natural lighting can lessen the reliance on artificial lightings. The result contributed on identifying the problem that causes poor daylighting in the student residential area which could be used as a guide for improving the daylighting strategies.

Keywords: Natural Lighting, Illuminance, Student Residential, Ventilation, Guide

1. Introduction

As we know daylight is the light that enters a space or an area through sunshine and is then reflected off a surface. Natural lighting is the light that comes from the sun and light also is a significant source of energy in human life. Light is used by people to see and carry out daily tasks more clearly and light sources can be found in natural conditions as well as electrical energy [1] [2]. Sunlight is the most powerful and abundant source of light, as well as a renewable and endless source of energy. Consistent exposure to sunshine can help improve the immune system, lowering the risk of sickness, infection, and some types of cancer. Sunlight, a natural source of illumination, is an excellent ray of light with a wealth of colours and many good benefits for human health [3]. In addition, the entire wave that humans need will be filtered by the human skin, which will act as a filter, turning the complete wave into vitamins

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that the body desperately needs and that will help strengthen the human immune system [4]. The amount of natural light that enters the building area can be determined by the number of window openings, which allow light to enter the room and provide convenience while maintaining visual interaction between people and the outside world [5]. This natural daylight enters the space in the residence college directly through the windows but because Block A17 faced the male students' block, some of the female students there had to keep their windows always covered for privacy purposes. As a result, students must constantly use electric lights to obtain adequate lighting and will feel uncomfortable continuing the study session at college. This led to the frequent used of artificial lightings, which raises the temperature in the room and wastes a lot of electricity. Besides that, the ratio of obtaining natural light on the side of the building is influenced by the orientation of the building which causes a large amount of light to enter the building [6]. Light is essential for human vision, particularly while perceiving the environment and carrying out activities [7].

At the same time, the humidity in the space will rise, which could promote the growth of bacteria that are harmful to human health. The natural light quality is far superior to that of any electric lamp used for reading and writing. The sun is the only natural light source that emits both light and heat energy, resulting in natural light [8]. Natural lighting strategies also increase a person's health and the comfort of residential student. Besides that, natural light obtained at an optimal level by the human body can enhance mental and physical growth [9]. The purpose of this study was to comprehend the notion of natural lighting in buildings, as well as to measure performance and compare natural lighting in residential student spaces. The amount of light that reaches a topic or a unit of work surface area is known as illumination and is measured in lux. Lux and Lumen are also used as symbols of emotional, intellectual, and scientific qualities [10]. Through an experiment and physical data gathered, suggestions for improvement were made from the use of materials and encourage the use of natural light in residential college environments. This study will determine how much natural illumination there is in the residential student environment. **Table 1** is for the recommended average lighting levels based on Malaysia & Standard1525:2014 [11].

Table 1: Average illuminance level recommended by MS 1525:2014 [11]

Tasks and applications	Illumination (lux)
a) Lighting for rarely used areas	
Minimum lighting service	20
Indoor walkway and car park	100
Hotel bedroom	100
The inside of the elevator	100
Corridors, passenger paths, stairs	100
Escalators, travelers	150
Entrances and exits	100
Staff locker room, locker room	100
Entrance hall, lobby, waiting room	100
Question station	300
Gate house	200
b) Lighting for interior workspaces	
Reading and writing activities	200
General offices, shops and stores, reading and writing	300-400
Painting office	300-400
Restaurant, canteen, cafeteria	200
Kitchen	150-300
Resting place	150
Bathroom	150
Toilet	100
Bedroom	100
Classrooms, libraries	300-500
Shop/supermarket/convenience store	200-750

2. Materials and Methods

Doing the observation in real weather condition will enable better understood. The observation was taking place at Block A17, Pagoh Residential College. The data was collected at one unit house on 1st Floor, 3rd Floor and 5th Floor. Data observations were conducted during a good weather condition on April 24th, April 27th, and April 29th of 2022. Outdoor and indoor lighting measurements were carried out concurrently. The data was recorded manually using a lux meter.

2.1 Materials

As this study aimed to identify the level of natural illuminance in residential college, some equipment was used in this study as shown in **Figure 1.** The main equipment used which is lux meter (**Figure 1a**). It is used to measure the natural light enter in the room. The tripod (**Figure 1b**) used to ensure that the position of the lux meter is at required height. While the measuring tape (**Figure 1c**) is used to measure the specified distance and fisheye lens (**Figure 1d**) was used to take pictures during the experiment.

(a) Lux meter

(b) Tripod

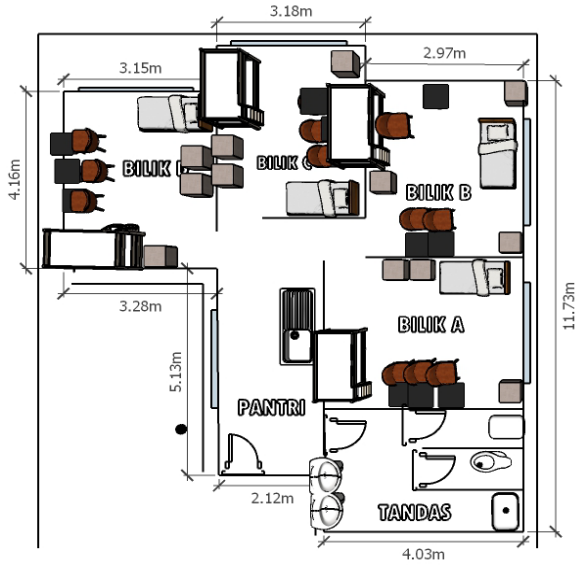
(c) Measuring tape

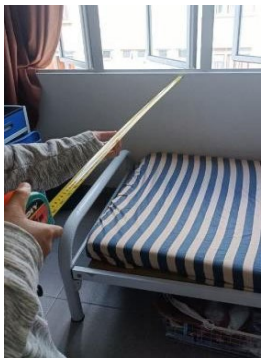
(d) Fisheye lens

Figure 1: Equipment used in the experiment.

2.2 Methods

There were five lux meters used in the experiment. Four lux meters used for indoor and one lux meter for the outdoor measurement. The outdoor and indoor measurement was taken concurrently, at 10:00 am, 1:00 pm and 4:00 pm with a time interval of 15 minutes. Outdoor measurement was placed in an open area which was free of any obstruction. While, for indoor measurement, the lux meter was placed in room A, B, C, D, and the pantry (room E) as shown in **Figure 2a**. The lux meter was placed at 1.5 m from the window as **Figure 2b** and 1.0 m height from the floor. The lux meter placing on a tripod as shown in **Figure 2c**. The room was captured using a fisheye lens camera at 180-degree view.





(a) location of lux meter (b) distance from window (c) height from the floor

Figure 2: Position of indoor lux meter

3. Results and Discussion

This analysis was performed to identify the level of natural lighting in the UTHM Pagoh residential college. Malaysia is a country with hot humid tropical environment that has certain standards, and most structures in our country were built with a considerable distance in a major part of the east and west sides, particularly in tall buildings.

3.1 Outdoor illuminance

Outdoor illuminance means light obtained from outdoor areas. This outdoor illuminance is more associated with natural lighting which is sunlight. The observation was conducted in the morning, afternoon, and evening on three different days. Based on the **Table 2**, it was found that the illumination was higher at noon than in the morning and evening.

In the morning, the illumination on the third day was the highest when compared to the first and second day. On the second day, it was found that the lux meter reading was lower than the first and third day with a reading of 57,600 lux. This is because there were more clouds on the second day that caused the illumination to be lower than on the first and third day.

In the afternoon, the graph shows that the illumination on the first day is the highest with a reading value of 119,100 lux while the illumination of the second day was found to be lower than the first and third day. The reading value on the third day is 110,800 lux.

Finally, the graph shows that the highest illumination in the evening was on the second day with a reading value of 76,067 lux. The lowest illumination was on the first day with a reading value of 32,833 lux. This is because the number of clouds moving in the evening of the first day was more than the second and third day causing the level of illumination in the evening of the first day to be lower if compared to the second and third day.

Table 2: Average outdoor illuminance

Observation	Illuminance (lux)
Day 1	
Morning	63,967
Afternoon	119,100
Evening	32,833
Day 2	
Morning	57,600
Afternoon	89,333
Evening	76,067
Day 3	
Morning	85,300
Afternoon	110,800
Evening	69,867

3.2 Indoor illuminance

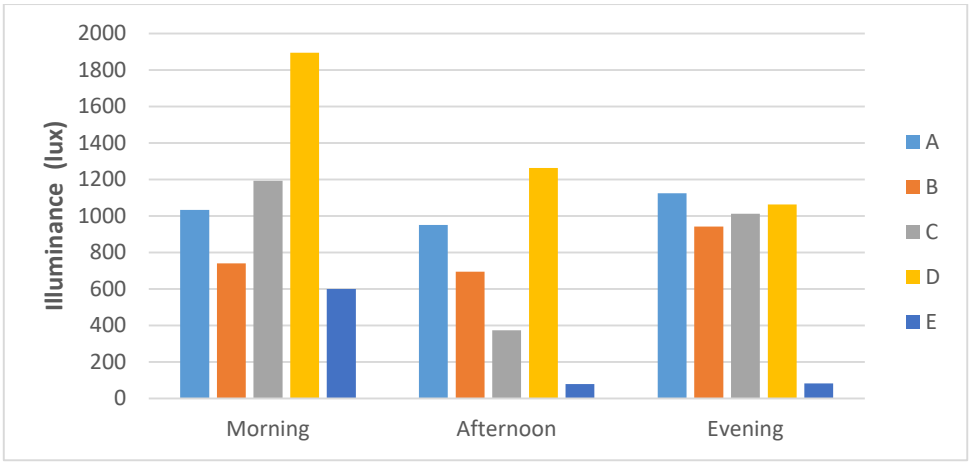
According to Uniform Building by Laws 1984, every room space needs to have window openings to receive natural lighting [12]. The minimum opening of each room is 10% of the floor area. The following graphs show the average lighting readings taken in each room on the 1st, 3rd and 5th Floor.

Based on the graph of the average indoor illuminance in **Figure 3a**, room D in the morning recorded the highest average compared to other times. In the afternoon at the same time, room D also has the highest average indoor lighting. Moreover, in the evening, room A showed a high average indoor lighting between evenings. The average indoor illumination at room E is the lowest for all times which is morning, afternoon, and evening.

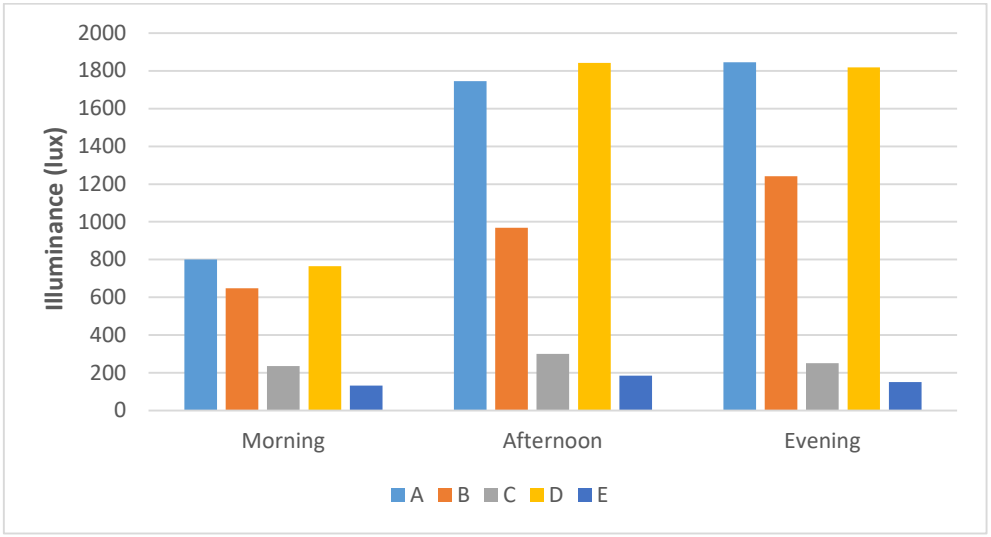
Through the graph in **Figure 3b** which is the graph of the average indoor illuminance for the third level, room A shows the highest average in the evening between morning and afternoon. Among all times, room D also recorded the highest average indoor lighting during the afternoon. The average indoor illumination for room A was the highest average in the morning compared to the other average at the same time. While for space E, for all times, it recorded the lowest average indoor lighting between the same time.

Figure 3c shows that the average indoor illuminance for the fifth level. Room B has the highest average in the morning compared to the afternoon and evening. In the afternoon and evening, room D is the highest average indoor illuminance. In the morning, afternoon and evening, the lowest average indoor illuminance shown in the graph is at Room E.

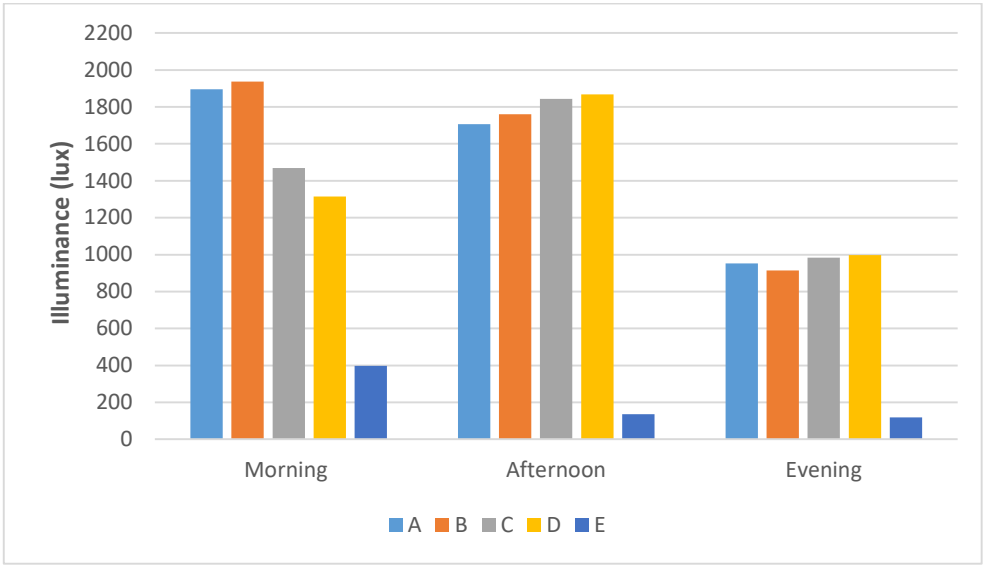
The average illumination in space E is the lowest at all level. However, this illumination reading level still meets the Malaysian Standard (MS 1525: 2014). The table of average illumination level recommended by MS 1525: 2014 states that the range for kitchen which is the pantry is from 150 to 300 lux. For rooms A, B, C and D, all lux readings obtained were in accordance with the Malaysian standards (MS 1525: 2014). It is stated in the table that the recommended lux for general offices, shops and stores, reading and writing is from 300 to 400 lux.



(a) 1st Floor



(b) 3rd Floor



(c) 5th Floor

Figure 3: Average indoor illuminance

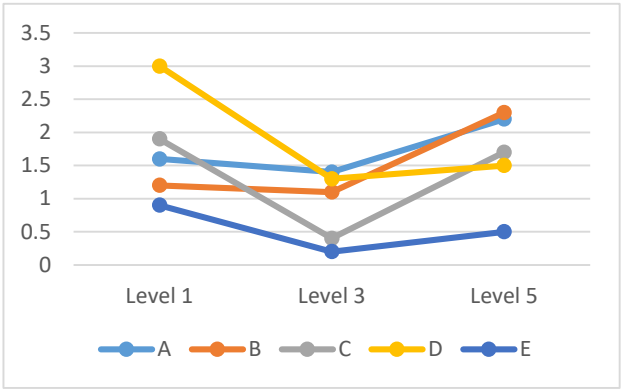
3.3 Daylight Factor (DF)

The daylight factor (DF) is used to calculate the percentage difference between the amount of indoor illuminance and the level of outdoor illuminance simultaneously. DF refers to the ratio of light that a window transmits to the external diffuse illuminance outside the building. The preferable DF in Malaysia shoud be between 1% to 6 % to provide the acceptable indoor illuminance as shown in **Table 3** [11]. DF can be calculated using the following equation:

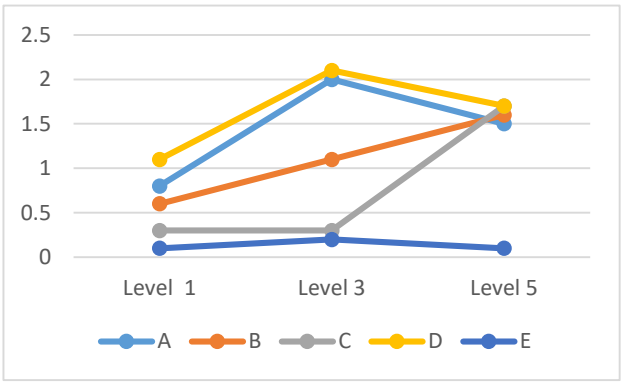
$$Daylight\ Factor = \frac{Indoor\ illuminance}{Outdoor\ illuminance} x100 \qquad \textbf{Eq. 1}$$

Table 3: Daylight factors [11]

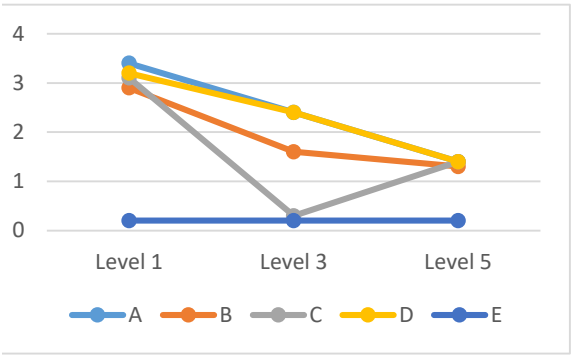
DF (%)	Lighting
>6.0	Intolerable
3.5 – 6.0	Tolerable
1.0 – 3.5	Acceptable
< 1.0	Perceptible



(a) Morning



(b) Afternoon



(c) Evening

Figure 4: Average Daylight Factor

Using **Eq 1**, the DF was calculated in the morning, afternoon and evening for 1st, 3rd and 5th floor level. **Figure 4a**, shows the variation of DF in the morning. It was found that the highest reading was obtained at Level 1 in room D with 3%. The lowest reading was found on the third level in Room E which is 0.2%. In the afternoon (**Figure 4b**), it was found that the variation of DF between 0.1% and

2.1%. **Figure 4c** indicates that the highest DF in the evening fell at level 1 within range 2.8% to 3.5%. The daylight factor of Room E is the lowest in the morning, afternoon, and evening. This is due to the location of the pantry which is located between the walls has made it difficult for natural to reach the space. However, on average the DF percentage obtained were still within the range values in **Table 3**. Referring to the table, percentage of daylight factor in room E is perceptible, while for room A, B, C and D, the percentage of DF is acceptable and tolerable.

4. Conclusion

In conclusion, from this study, the reading level of the value of lighting entering in each space of the houses at Block A17 can be achieved. However, natural lighting could not enter the student room space in Block A17 as the female students had to close the windows for privacy purposes. This is due to the position of A17 Block that is facing the male student's block. Therefore, the female students in A17 block must close the curtains all the time and use electric lights instead. This will also cause a wastage of electricity as students will use electric lights when the windows are covered. The level of lighting in the space of each house needs to be known and if the value of the reading level is less than the set value, actions should be taken by the responsible party. Among the suggestions that can be made is that the windows in each room should be installed with window dimmers or additional elements such as light shelves for privacy purposes and can also reduce too much of incoming light, especially in the afternoon. This study can also identify ways to increase the use of natural light as well as reduce the use of artificial light. This is because sunlight is an energy that will not be depleted even if it is used extensively. In addition, the use of natural light can ensure human health as well as reduce the cost of electricity bills. Therefore, the use of natural light should be practiced in daily life as many benefits can be enjoyed by the consumers.

Acknowledgement

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