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INVESTIGATING DAYLIGHT PERFORMANCE OF CLASSROOMS AT A HIGHER EDUCATIONAL INSTITUTION

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Abstract

Daylight is a significant element in the design of educational institutions, as it provides a friendly environment, encourages healthier conditions and guarantees energy savings. This study focuses on investigating the illuminance level of three (3) existing selected case study classrooms at a higher education institution. Hence, a field measurement for indoor and outdoor daylight level was carried out for five (5) days at all of the selected classrooms. Measurement data were recorded and analysed using Excel graphs. The findings indicate that the daylight performance for all the case study classrooms was below and above the recommended range as set out in the MS1525:2019. The overall findings of this study reveal that classroom design is inadequate to handle daylight in classrooms. The probable explanation for the unacceptable illuminance level results is that the different design of the classroom influences the amount of illumination and the performance of daylight in the classroom. This study has led to the identification of issues that affect low daylight performance in higher educational institutions and should be seen as a reference to promote greater awareness of the advantages of daylight for occupants.

Keywords: *field investigation; daylight; daylight design; education buildings; classroom*

1.0 INTRODUCTION

The weather in Malaysia is distinguished by the elevated temperature and humidity of the year. According to Ibrahim and Zain-Ahmed (2007), Malaysia gets plenty of natural light during the year, and the use of daylight as an energy conservation tool is most important to the Malaysian environment. Daylighting is one of the critical criteria for monitoring energy consumption in buildings. In recent years, the use of daylight to conserve energy in buildings in tropical and subtropical regions has become increasingly prominent (Syaheeza et al., 2018). In Malaysia, sun-exposed building surfaces, such as windows, walls, and roofs, will absorb heat from solar radiation, contributing to a rise in the amount of energy required for cooling persistence. Abidin et al., (2019) highlighted in their research that educational building is one of the types of public buildings where energy demand has been a crucial concern since these buildings tend to expend a significant amount of money annually on electricity use. Therefore, this study aims to investigate the daylighting performance in Malaysian educational buildings.

2.0 LITERATURE REVIEW

The climate in Malaysia is one of the most challenging environments in terms of architecture nature owing to a large percentage of relative humidity and extreme temperatures approaching the ASHRAE comfort mark for much of the year (Al-Tamimi et al., 2011). Fitriaty et al. (2019) pointed out that tropical environments are primarily marked by intense sunlight as well as indirect illumination from intermittent cloud cover. The adequate amount of sunlight reduces the need for artificial light in space, resulting in energy savings and lower energy usage. These researchers also stated that it is possible to supplement and minimize the need for artificial light by acceptably utilizing natural light. According to Li et al. (2006), daylighting may minimize the reliance on artificial lighting, which has been shown to help reduce the cooling load and increase energy need.

The higher educational institution serves complex functions by providing space for various activities. Due to this, lighting is a critical factor because poor lighting is not only detrimental to the visual comfort of the occupants but also might lead to visual fatigue (Susan & Prihatmanti, 2017).

3.0 RESEARCH METHODOLOGY

The indoor and outdoor measurements were conducted simultaneously for all classrooms during the experiment using various instruments as shown in Figure 1.

(a) (b)

Figure 2: (a) Thermal micro climate and photometric-radiometric probe for outdoor illuminance
(b) 4 in 1 metre for indoor illuminance

The position of measurement points in each classroom is shown in Figure 2. Meanwhile, Table 1 shows the summary of the characteristics of the case study classrooms.

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Table 1: Summary of case study buildings

CLASSROOM 1 No. of Storey : 5 Measurement Location : First Floor level Facade : Single loaded window (tinted glazed- East) & single loaded corridor Shading : No shading Size : 11.5 meter (length) x 9 meter (width) Points (indoor) : 25 points	
CLASSROOM 2 No. of Storey : 5 Measurement Location : First Floor level Facade : Single loaded window (tinted glazed-Northwest) & double loaded corridor Shading : No shading Size : 12 meter (length) x 6 meter (width) Points (indoor) : 20 points	

CLASSROOM 3
No. of Storey : 4
Measurement Location : First Floor level
Facade : Double loaded window (clear glass-Southwest & Northeast) & single loaded corridor
Shading : No shading
Size : 10.65 meter (length) x 7.2 meter (width)
Points (indoor) : 24 points

Figure 2: Position of points (a) Classroom 1 (b) Classroom 2 (c) Classroom

4.0 RESULTS AND DISCUSSION

Figure 3 shows the daily average of indoor illuminance measurements in all classrooms for all points starting from 8.00 a.m. until 5.00 p.m. for a-five (5) day measurement period. The highest indoor illuminance level for Classroom 1, as shown in Figure 3a, was at the value of 594 lux on the second day of monitoring period which is at 9.30 a.m. while the lowest was 16 lux at 8.00 a.m. on the third day of measurement. The indoor illuminance level for Classroom 1 had gradually increased from 8.00 a.m. and drastically decreased from 9.30 a.m. until 5.00 p.m. The indoor illuminance level for Classroom 2 recorded the highest value of 412 lux at 4.30 p.m., as shown in Figure 3b. The value kept on increasing from 8.00 a.m. until 4.30 p.m., but the range for Classroom 2 illuminance was still below the recommended guidelines, as stated by MS1525 (2019). Meanwhile, in Classroom 3, the average indoor illuminance had increased from 8.00 a.m. to 9.30 a.m. and rapidly decreased after 9.30 a.m. (Figure 3c). The range of indoor illuminance value for Classroom 3 was between 192 lux to 2059 lux, and it was beyond the recommended guidelines for the classroom, which is from 300 lux to 500 lux.

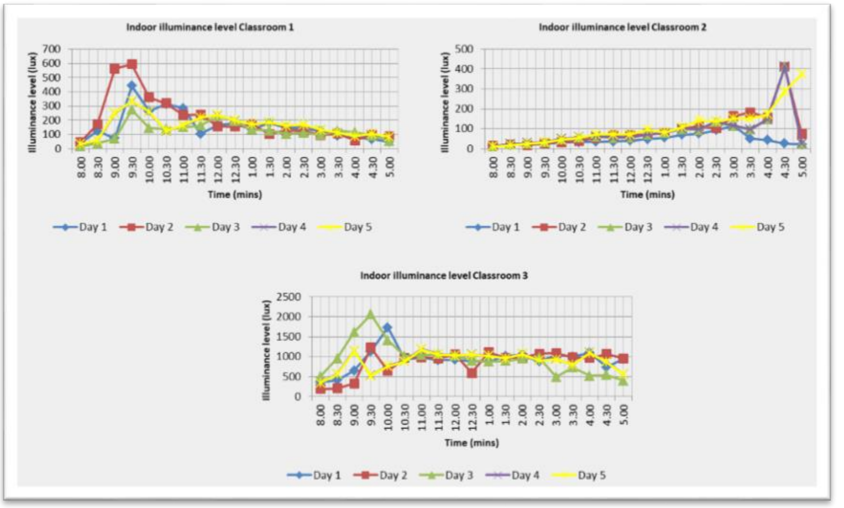

Figure 3: Average indoor illuminance level (a) Classroom 1 (b) Classroom 2 (c) Classroom 3

Table 2 shows the average indoor and outdoor illuminance level for five (5) days of measurement for all case study classrooms. The total average of indoor illuminance for Classroom 1, Classroom 2 and Classroom 3 were 162 lux, 85 lux and 998 lux respectively. Meanwhile, the average outdoor illuminance for Classroom 1, 2 and 3 were 37796 lux, 41395 lux and 44796 lux respectively. These results showed that there was an insufficient amount of indoor illuminance for Classroom 1 and 2, but in Classroom 3, the value exceeded the recommended value stated in MS1525 (2018).

Table 2: Average of indoor and outdoor illuminance

Day	Classroom 1		Classroom 2		Classroom 3	
	Outdoor	Indoor	Outdoor	Indoor	Outdoor	Indoor
Day 1	32683	159	465 65	45	489 27	10 24
Day 2	40694	201	384 20	95	477 16	95 4
Day 3	33106	126	406 82	86	444 71	10 50
Day 4	41242	161	406 97	88	414 41	98 4
Day 5	41257	163	406 09	111	414 26	97 8
Average	37796	162	413 95	85	447 96	99 8

Table 3 exhibited the findings of fieldwork measurement for each of the classrooms and compared with the relevant recommended guideline, which is MS1525:2019. The average illuminance level for Classroom 1 and 2 was lower than the recommended value, while the illuminance level for Classroom 3 had exceeded the recommended value. From these results, it can be concluded that all the case study classrooms were not within the recommended level indoor illuminance, as stated in MS1525:2019.

Table 3: Fieldwork measurement findings

	Classroom 1	Classroom 2	Classroom 3	Results indicator
Indoor illuminance	16 – 594 lux	12 – 412 lux	192 - 2,059 lux	300 - 500 lux (MS1525:2019).
Outdoor illuminance	32,683 – 41,257 lux	38,420 – 46,565 lux	41,426 - 48,927 lux	MS1525 (2019) 30,000lx – 100,000lx, intermediate sky type, 30% to 70% covered by cloud.

5.0 CONCLUSIONS

Based on overall findings, it can be concluded that there is a daylighting problem in the classroom at an existing education institution and it may be one of the reasons for the increasing electricity bill of the said institution. The passive design was not used in the selected classrooms which resulted in insufficient daylight illuminance levels. This situation happened because each of the case study classrooms had a different design that affected the daylighting amount which penetrated the classrooms. Moreover, the problem was the result of the failure of daylighting design at the early stage of construction. In conclusion, the daylight in the classrooms would have been sufficient if good strategy and planning were taken into consideration at the early stage of construction and the buildings in question were well-maintained by the users of the buildings. This study led to the identification of issues that affect low daylight performance in higher educational institutions and should be seen as a reference to promote greater awareness of the advantages of daylight for occupants.

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Saya yang menjalankan amanah,

SITI BASRIYAH SHAIK BAHARUDIN
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Setuju.

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