

# Classroom illuminance: a case in Malaysian university

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**Abstract.** Lighting is an important requirement for people to support their daily activities. Building users in Malaysia commonly rely on artificial lights in the building. However, improper use of artificial light in the room will lead to negative impacts on the occupants' health, comfort and productivity. This study investigates the light levels of the classroom in university. A total of 61 samples were collected and compared to Malaysian Standard 1525:2007, the illuminance for the classroom. The observation was conducted in two sessions a day using lux meter. The results showed that 62% of the classrooms have good illuminance, which complies to the existing requirement of illuminance in Malaysia's classroom, within the range of 300-500lx. The findings of this study provide an overview of the existing illuminance in the classroom in university and serve as a reference to the management for their efforts to improve the indoor environment quality and the student's well-being.

## 1. Introduction

Lighting is one of the energy that stimulates humans sense of vision and it also contains artificial light sources such as lamps and natural illumination of the interior from daylight [1]. Demand for lighting today is increasing in parallels with the country's development and growing population. The use of indoor lighting aims to ensure occupant's safety and health and comfort in performing daily activities. Generally, lighting is divided into two, namely natural light and artificial light. However, today artificial lighting has become the preferred option for most occupants in the building. Indoor lighting is one of the important elements in the Indoor Environment Quality (IEQ) assessment. Indoor Environment Quality was introduced to produce an acceptable indoor environment that supports the occupant's health, well-being and comfort. IEQ was stated in term of occupant's health determined by environmental aspects including lighting quality, acoustical quality and visual, thermal comfort and air quality. The lighting quality is among the main considerations in IEQ measurement that should not be overlooked. Additionally, IEQ elements accounted for 21% of green building evaluation criteria for non-residential building such as academic buildings in higher education institutions. However, IEQ always not being considered as the main priority in most management and development planning [2].

People spend the majority of their time indoors, whether, in school, office or homes and indeed the indoor environment affects human's health, performance and well-being [3, 4]. As highlighted by [5], individuals spent over 80% of their daily time in the building compared to outdoor. The building



users are spending more time in the building by carrying out various activities such as studying, working and resting. [6]. A good lighting performance contributes to psychological and physiological benefits, minimizing overall energy consumption and hence improving occupant's wellbeing, health and safety. For that reason, the indoor lighting should be maintained at the optimum level. Lessor excessive lighting can directly affect occupant health and performance [7, 8]. As according to [7], excessive lighting will affect occupant's health which causes stress on eyes, migraine, fatigue, eye ache and frequent headaches.

Malaysia Higher Education Institution (HEI) aims to build a more sustainable learning environment on campus. A conducive learning environment is necessary. One of the characteristics of conducive environment is to provide appropriate lighting in the building to ensure occupant's health and comfort. A comfortable and good learning environment is able to increase the focus of the student. Lighting illumination is important and bright lighting can improve perceived safety and preference among the occupants [9]. Indoor lighting in the academic building is an important factor in the provision of facilities for the learning space such as to improve student productivity, make learning more effective and improve the focus through the learning process [10]. Students will spend most of their time indoor such as in the lecture room, library, dormitory. Therefore, it is always essential to create a conducive indoor environment for the students to support the learning process. The building operator is responsible to ensure the good performance of the indoor light level that supports the learning process among the students.

Previous studies have highlighted that the buildings and the indoor environment quality are in the poor and unsatisfied condition in regard to the illuminance condition. For instance, a study held by [11] has assessed the IEQ and occupant's productivity in the Council House 2 Building (CH2) in Melbourne, a 10-storey office building. The results showed that the respondents were not satisfied with the lighting provided in their office as the illuminance level in the office was recorded below the requirement, less than 320 lux. Another study was conducted by [12] to assess the lighting condition in architecture studio space in National University of Malaysia. The artificial light is used most of the time in the architecture studio to optimize student vision and comfort; however, the findings showed that the illuminance level was lower than the requirement, which shall in the range of 300-400 lux. Such condition will affect the student ability to perceive visual stimuli in the short term and affects the health of students in the long run. Overall, classroom illuminance is important for student learning and productivity because it can influence and affect student performance, behaviour, concentration and achievement especially while the learning process [12, 13, 14].

A number of previous studies have highlighted that among the common issues in a building affecting the occupant's health and comfort is in relation to the level of illuminance. Previous results have shown that the lighting and the lux level of illumination were not satisfied with the requirements. For instance, in the context of office building [11, 15] and as well as academic building [12, 16, 14, 17]. Most of the previous studies on lighting in relating to illuminance were focused on residential and workplace context, there are minimal studies held in the higher education institutions context. One of the similar studies was held in Malaysian public universities to investigate the lighting performance; the results showed that not all the lux level in the classroom at university within the standard and among them is UTM [14]. Considering the evidence was not comprehend to justify and generalized that the illuminance in the classroom of UTM is not within the standard for the small sample size (only 5 classrooms) included in the study, a study that including more samples to investigate the classroom illuminance in UTM is necessary to reconfirm the scenario. The overall aim of this study is to investigate the classroom illuminance in Universiti Teknologi Malaysia.

## **2. Classrooms illuminance and the measurement standards**

Fluorescent and LED light are among the artificial lightings that commonly use in the classroom. One of the common use measurements for lighting is illuminance. Illuminance is a term that describes the amount of light falling onto (illuminating) and splitting over the surface area. Illuminance is defined as the luminous flux falling on the unit area of the surface that is under consideration.

Standard of lighting measurement is available to provide a reference for an optimum illuminance based on the types of space. Each country worldwide has established a tailored-made standard based on the country's unique climate and geographic. For instance, in Singapore, SS531:2006 was established by the Technical Committee on Lamps and Related Equipment, under the purview of the Electrical and Electronic Standards Committee, the recommended range of illuminance in the classroom is range between 300-500 lux. In United Kingdom, the recommended design illuminance for different types of classroom as in the Code for Interior Lighting is range from 300 lux to 500 lux. In United States, an illuminance standard provided by the Illuminating Engineering Society of North America (IESNA) in the IES handbook provide the basis for lighting design in the United States, the suggested illuminance for a typical classroom is 300 lux –500 lux. Besides, the Illuminating Engineering Society of China has introduced GB 50034-2004 Standard for lighting design of buildings in China which, the suggested lux level for classroom is 300 lux. Then, Japan Illuminating Engineering Society (JIES-008) - Indoor Lighting Standard also highlighted that lux level for classroom in Japan is 200 lux -750 lux, which is slightly higher compared to other countries. Indonesia has introduced Indonesian National Standard SNI 03-6197-2000, the illumination level for the classroom that recommended is between 250 lux to 300 lux.

The standard of lighting measurement used in Malaysia is known as Malaysia Standard MS1525:2007. The Malaysian Standard (MS1525), the code of practice on energy efficiency and use of renewable energy for non-residential buildings have been established and enforced since year 2007 to create a conducive, energy-efficient and environmentally-friendly environment. The indoor lighting requirements vary depending on the task to be carried out which suggest the appropriate light level for various spaces in the building. The illuminance from artificial lighting should comply with the standard under the provision of lighting to avoid its negative impacts on the occupants. For instance, the lux level in a classroom should be maintained within a range of 300 lux to 500 lux. This standard is referred by the building operator in ensuring the appropriate light level in the building.

### **3. Research methodology**

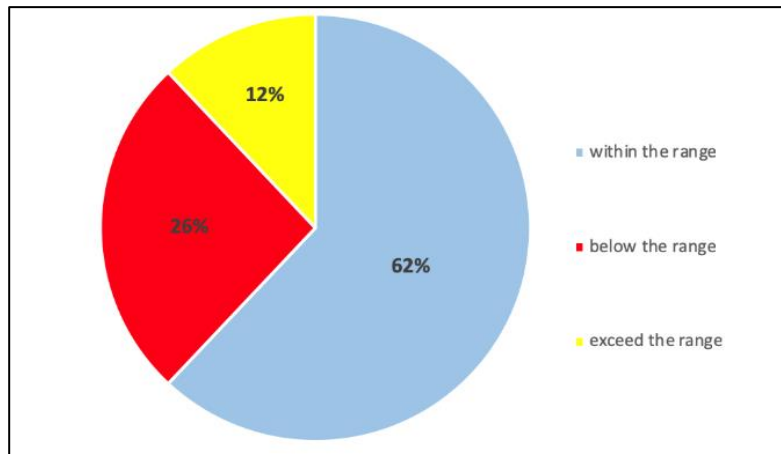
This research adopted a field observation method to gather the empirical data about the illuminance (light level) in classroom. A total of 61 classrooms in the Universiti Teknologi Malaysia, Johor Malaysia has been selected as the sample in this study. The list of classrooms obtained from the Office of Asset and Development, UTM contains information for each classroom such as the room number and location. A Lux Meter, HIOKI (2107) is used to measure the light level in the classroom. An observation form is developed to record the data of illuminance for each sample. The form is used to ensure the measurement procedures to be conducted in a more structured way and to avoid recording a wrong reading of light level. The observation form divided into two sections which are section A and section B. Section A is about the details of classroom from 4 faculty which is Faculty Geoinformation and Real Estate, Faculty of Science, Faculty of Education and Faculty of Built Environment. Then, section B is to record the lux level for each classroom. The observation was conducted in two sessions daily, morning session (8.30 a.m. – 11.30 a.m.) and evening session (2.00 p.m. – 5.00 p.m.). The reading was recorded two times a day for a more representative result. The data collection was completed in fourteen days. Other information included in the observation form including the name of faculty, name of each classroom, the number of lamps in the classroom, the condition of lamp and the illumination data. During the field observation session, the condition of lamps in each classroom was checked and recorded in the observation form. Descriptive statistics is adopted to analyse the data collected. Mean and the range of light level (classroom illuminance) is reported and frequency analysis is used to report the percentage of compliance. Then, the classroom illuminance is compared to the range of light level as stated in the MS1525:2007.

#### 4. Results and discussion

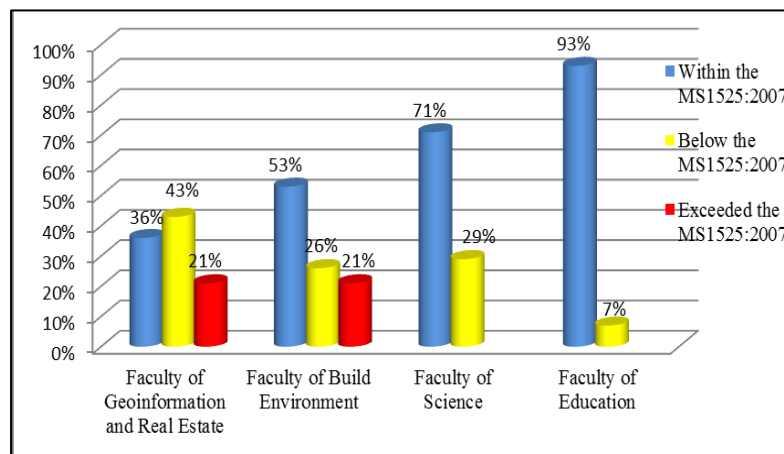
The data gathered from field observation were compiled and compared to the suggested range of light level (300-500 lux). In general, the findings of the study showed that the majority of the classrooms in UTM comply with the existing standard of illuminance level (MS1525:2007) which, range between 300 lux – 500 lux. There were only 38% of the classrooms did not comply with the requirements. This study has found that only 12% (7 out of 61) of the classrooms has illuminance of higher than 500lx while 26% (16 out of 61) of the classrooms has illuminance of lower level than the suggested baseline. Overall, the range of classroom illuminance for the classroom in UTM is 130 lux to 689 lux. Figure 1 shows the overall percentage of illuminance compliance in the classrooms in Universiti Teknologi Malaysia. The results were categorized into three categories, namely “within the range”, “exceed the range”, and “below the range”. The results showed that 62% (38 out of 61 classrooms) of the classroom illuminance complied to the existing standard.

Figure 2 showed the percentage of the classroom’s illuminance level for each faculty. Among the four faculties, the Faculty of Education has recorded the highest percentage of the classroom (93%) that have complied to the illuminance requirement. Only 1 out of 14 classrooms in the Faculty of Education has illuminance of lower than 300 lux. Next, for Faculty of Science, the result showed that only 29% (4 out of 14 classrooms) were below the standard and another 71% (10 out of 14 classrooms) were within the standard. The study found none of the classrooms in Faculty of Science has light illuminance of higher than 500 lux. Faculty of Geoinformation and Real Estate has 43% of its classrooms (6 out of 14 classrooms) illuminance were below the standard; 36% (5 of 14 classrooms) were within with standard and 21% (3 out of 14 classrooms) were exceeded the requirement as in the standard. Then, for the Faculty of Built Environment, the result showed that 53% of the classroom have light level between 300-500lx; only 21% of the classroom illuminance were exceeded the MS1525:2007 standard.

Overall results showed that the condition of the illuminance in the majority of the classrooms in the UTM conforms to the requirement of MS1525:2007. The result of this study is not consistent with the findings of a previous study conducted by [14] held in Higher Education Institution (HEI) of Malaysia which, the study reported that the level of illuminance in UTM classroom did not comply with MS1525:2007. This may due to the minimal number of classrooms (only 5 classrooms) involved as sample in the previous work by [14]. The results of this study reflect a more reliable statistic of classroom’s light illuminance in UTM with higher number of classrooms involved as sample. Based on the observation during the field investigation, some of the lamps in the classroom are not functioning well due to faulty and damaged. This has contributed to poor illuminance in the classrooms. The poor classroom illuminance should not be overlooked as it has been acknowledged as one of the contributors to sick building syndrome. As suggested in a study conducted by [18] to investigate the association of indoor environment and sick building syndrome in two office buildings of Petroleum Industry Health Organization in Tehran city; the study has found that poor lighting was one the causes of sick building syndrome. The sick building has direct adverse impacts on occupant’s health. The building operator must ensure good light level to produce a healthy building which emphasizes on occupant’s well-being. As highlighted by [19] the fundamental basis of future building has now gradually shifting from the current “sustainable and intelligent” design to a “healthy” design.



**Figure 1.** Percentage of UTM classrooms illuminance compliance.



**Figure 2.** Percentage of classroom illuminance in four faculties

### 5. Conclusion

This study has investigated the classroom illuminance in Universiti Teknologi Malaysia. A total of 61 classrooms were included in this study. Based on the MS1525:2007, an appropriate light level for the classroom should be in the range of 300 lux – 500 lux. The Malaysian Standard (MS 1525:2007) was adopted as the benchmark of this study to investigate the compliance of the illuminance level in the classroom of Universiti Teknologi Malaysia. Overall, the findings of the study showed that the majority of the classrooms in UTM comply with existing standard in relation to illuminance, which range between 300 – 500lx. This study has found that only 12% of the classrooms have illuminance of higher than 500 lux while 26% of the classrooms have poor light illuminance. Based on the observation carried out in these classrooms, the overall condition of lighting in the classrooms is functioning well. The low level of illuminance recorded in some of the classrooms is mainly due to the faulty and damaged lamps in the classroom. The findings of this study provide a more reflective understanding on the true scenario of illuminance in the classrooms in Universiti Teknologi Malaysia, which complement to the previous study conducted by [14]. The present study has included more sample, a total of 61 classrooms to provide a reliable understanding about the illuminance in the classrooms in UTM. This study provides more relevant evidence to justify the performance of illuminance in UTM classroom. The generalisability of these results is subject to certain limitations. For instance, the scope of this study was limited to classroom in UTM only. The results of this study reflect the compliance of the illuminance in the classroom in UTM and should not be generalized to other spaces such as offices, library and other

spaces in UTM. Future research can adopt a similar methodology in other spaces and context. Additionally, the data recording was held in two sessions a day, morning session from 8.30 a.m. – 11.30 a.m. and afternoon session from 2.00 p.m. to 5.00 p.m. Future research may increase the frequency to record the light level hourly from 8:00 am to 5:00 pm to get a more detail information on the classroom illuminance.

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## 7. References

- [1] Groth A 2007. *Energy Efficiency Building Design Guidelines for Botswana*. Department of Energy Ministry of Minerals, Energy and Water Resources. 6-9
- [2] Kumar S S and Nandhini N 2017. A study on implementation of indoor environmental quality in conventional buildings. *International Journal of Engineering Technology Science and Research*. 4:2 31-34
- [3] Kuo N W, Chiang H C and Chiang C M 2008. Development and application of an integrated indoor air quality audit to an international hotel building in Taiwan. *Environmental Monitoring and Assessment*. 147(1–3) 139–147
- [4] Di Giulio M, Grande R, di Campli E, di Bartolomeo S and Cellini L 2010. Indoor air quality in university environments. *Environmental Monitoring Assessment*. 170 509–517
- [5] Haryati Shafii 2007. *Persepsi Penduduk Terhadap Tempat Tinggal dan Kualiti Hidup Masyarakat*. (Malaysia: Pusat Pengajian Siswazah Universiti Kebangsaan Malaysia)
- [6] Rabiyyatul Akma D 2014. *Persepsi Pelajar Terhadap Kualiti Persekitaran Dalaman (IEQ) Perpustakaan*. (Malaysia: Master Thesis Universiti Teknologi Malaysia)
- [7] Hwang T and Kim J T 2011. Effects of indoor lighting on occupants' visual comfort and eye health in a green building. *Indoor and Built Environment*. 20(1) 75-90
- [8] Department of Occupational Safety and Health 2016. <http://www.dosh.gov.my/index.php/en/osh-column/osh-articles/1683-alam- sekitar>.
- [9] Nasar J L and Bokharai S 2017. Lighting modes and their effects on impressions of public squares. *Journal of Environmental Psychology*. 49 96-105
- [10] Hakim A M, Sapri M and Baba M 2006. *Pengurusan Fasiliti*. (Malaysia: Penerbit Universiti Teknologi Malaysia)
- [11] Paevere P and Brown S 2008. *Indoor Environment Quality and Occupant Productivity in The CH2 Building: Post-Occupancy Summary*. (Australia: Commonwealth Scientific and Industrial Research Organisation Australia) USP2007/23
- [12] Musa A R, Abdullah N A G, Che-Ani A I, Tawil N M and Tahir M M 2012. Indoor environmental quality for UKM architecture studio: an analysis on lighting performance. *Procedia-Social and Behavioral Sciences*. 60 318-324
- [13] Zakaria S A and Ismail A 2014. Impak cahaya dan pencahayaan terhadap keselamatan warga di sekolah. 64-78
- [14] Yusoff W Z W and Sulaiman M A 2014. Sustainable campus: Indoor Environmental Quality (IEQ) performance measurement for Malaysian public universities. *European Journal of Sustainable Development*. 3(4) 323-338
- [15] Yun G Y, Kong H J, Kim H and Kim J T 2012. Field survey of visual comfort and lighting energy consumption in open plan offices. *Energy and Buildings*. 46 146-151
- [16] Che Nidzam C A, Noraini M N, Adnan M, Putih M and Ibrahim M H 2013. Pengaruh persekitaran fizikal bilik darjah terhadap tahap keselesaan pengajaran dan pembelajaran. *Jurnal Pendidikan Bitara UPSI*. 6 1-6

- [17] Vilcekova S, Meciarova L, Burdova E K, Katunska J, Kosicanova D and Doroudiani S 2017. Indoor environmental quality of classrooms and occupants' comfort in a special education school in Slovak Republic. *Building and Environment*. 120 29-40
- [18] Jafari M J, A A Khajevandi, S A M Najarkola, M S Yekaninejad, M A Pourhoseingholi, L Omid and S Kalantary 2015. Association of sick building syndrome with indoor air parameters. *Tanaffos*. 14 (1) 55–62
- [19] Ghaffarianhoseini A, Alwaer H, Omrany H, Ghaffarianhoseini A, Alalouch C, Clements-Croome D and Tookey J 2018. Sick building syndrome: are we doing enough?. *Architectural Science Review*. 61(3) 99-121

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