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Simulation of Lighting Comfort at Auditorium Hall 1, Shared Facility Pagoh

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Abstract

Lighting level is one of main important aspect of a building, it is a system that function all activities inside the building. Lighting should make the appearance of learning looks better and the occupants feel more comfortable since light has a very carrying ability to dictate productivity and moods of the inhabitants. Inadequate amount of lighting can be glare and in essence makes the eyes physically uncomfortable or leads to reduced visual clarity. This study was to assess whether the lighting level in Auditorium Hall 1 at Shared Facility Pagoh meet the standard requirements and analysed the effect of lighting on visual comfort and perception from student in auditorium hall 1. Methods used were field measurements, questionnaire surveys and simulations using the Dialux software. The field measurement method was using a lux meter to identify the lighting level that must be in accordance with the standard. The result showed that the lighting level range 181 – 243 is lux below than 300-500 lux and did not meet the Malaysian standard (MS 1525). However, simulation method used was Dialux software, while the 105-respondent are participated in questionnaire survey and analysis used quantitative descriptive statistics. The descriptive analysis showed that the mean scores for perception (2.0), comfort (1.9) and acceptability (1.83) ranged from 1.81 to 2.60, indicating low satisfaction among auditorium users regarding visual comfort. In conclusion, the lighting recommendation is optimizing the positioning of lighting fixtures within the auditorium. Upgrade the existing light fixtures with the latest energy efficient LED systems.

1. Introduction

Lighting is a fundamental aspect of architectural design that significantly influences the well-being and productivity of building occupants. In educational environments, where students spend considerable time in lecture halls and auditoriums, effective lighting becomes even more critical. Daylight, in particular, is a vital component that enhances visual comfort and supports cognitive functions. However, while natural light can improve mood and performance, excessive sunlight may lead to discomfort due to glare, ultimately detracting from the learning experience. Therefore, understanding and optimizing lighting conditions is essential for creating spaces that promote both comfort and efficiency.

Existing research highlights the complex relationship between lighting quality and visual comfort. Studies have shown that inadequate lighting can lead to issues such as eye strain, headaches, and reduced concentration [1]. Investigations into daylighting strategies have revealed that while natural light is beneficial, it must be carefully controlled to avoid glare and excessive brightness [2]. Moreover, the use of simulation tools like Dialux has been recognized as a valuable method for assessing lighting conditions and exploring design alternatives [3]. Despite these advancements, gaps remain in understanding how different lighting scenarios impact user satisfaction in educational settings, particularly in auditoriums where diverse activities occur.

The goal of the present article is to investigate the effects of lighting on visual comfort in auditorium hall 1 at Pagoh Education Hub. The hypothesis that optimized lighting conditions significantly enhances user satisfaction by reducing glare and improving overall illumination levels. To test this hypothesis, were conducted three studies: First, were evaluated the existing illuminance levels using lux measurements against Malaysian Standard (MS 1525) requirements. Second, user perceptions of visual comfort were assessed through a questionnaire distributed to auditorium users. Third, Dialux software is utilized to simulate various lighting scenarios and analyze their impact on visual comfort.

For this purpose, this research aims to provide actionable insights into effective lighting design in educational environments. By systematically examining how different variables affect visual comfort and user satisfaction, we hope to contribute valuable knowledge to the field of architectural lighting design. Ultimately, the findings were informing future projects aimed at enhancing learning experiences through improved lighting solutions.

2. Methodology

The lighting simulation comfort used a Dialux software and lux meter for field measurements, at Auditorium Hall 1 Shared Facilities Pagoh, there the specific method was analysed, which detailed in this section.

2.1 Tools & software

This study used two methods, which is questionnaire surveys with 152 respondents, analyzed used SPSS. Employed for statistical analysis of questionnaire surveys. Used for descriptive statistics, cross-tabulations, and generating visual representations of the collected data. The second method, field measurements with lux meter. Used for measuring illuminance in the auditorium. The device conforms to international standards such as BS 667:2005, DIN 5032-7:1985, and CIE Publication No. 69 (1987). It was calibrated annually by SIRIM Malaysia to ensure measurement accuracy. Dialux software is used for lighting simulation and visualization. Capable of integrating real lighting products to model luminance and illuminance calculations. Includes features such as daylight factor analysis and energy efficiency assessments. Integrated with Building Information Modeling (BIM) and CAD tools.

(a) (b)

Fig. 1: Software and tools (a) Dialux software; (b) Lux meter

2.2 Method

2.2.1 Auditorium Hall 1 Shared Facilities

The study was conducted in Auditorium 1, located in the Pagoh Education Hub Shared Facility, at coordinates 2.15320° N, 102.73236° E. The auditorium featured: A seating capacity of 250 people. Projectors and Public Address Systems for presentations. Supporting facilities such as Living Prayer and Dressing Rooms. Administration under the Information Resource & Reference Department (USMR), supported by personnel from three public universities (UTHM, UIAM, and UTM).

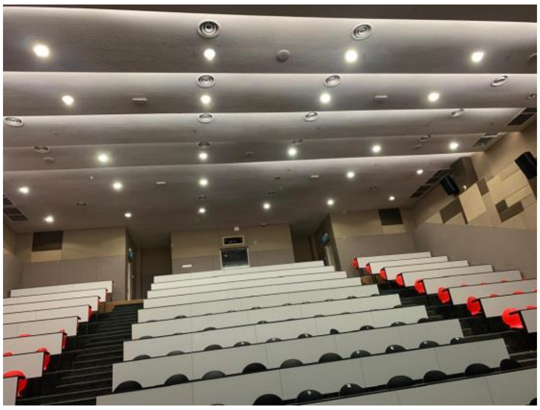


Fig. 2: The auditorium 1 shared facility Pagoh (250 seat capacity).

2.3 Data collection

Questionnaires designed in English and Malay to accommodate respondents from different ethnic backgrounds (Malay, Chinese, and Indian). Digital formats were prepared for distribution. Measurement Guidelines: Followed the [4].

2.3.1 Field Measurements

Procedure:
Preparation: Identified measurement points in Auditorium 1 using the Room Index Formula = (L × W) / (Hm × (L + W)), Divided the auditorium into equally sized squares, as shown in Figure 3.

***Table 1*:** Minimum number of measurement points for measuring average illuminance in rooms of different proportions [4]

Room Index	Number of measurement points
Below 1	4
1 and below 2	9
2 and below 3	16
Above 3	25

Measurement: Measurements were taken using a lux meter at four specified times: 10:00 am, 12:00 pm, 2:00 pm, and 4:00 pm. Each point's illuminance was recorded and averaged to determine the general lighting conditions.

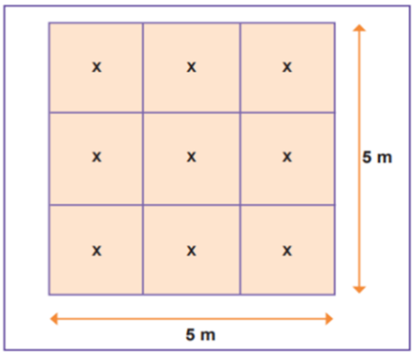


Fig. 3: Lighting measurement at the center of equally divided squares [4]

Standards Compliance: Results were compared to established guidelines to assess adequacy. Measurements included height above the work plane and calculation of reverse indices for optimal analysis.
Equipment Details.

2.4 Questionnaire surveys

Procedure Sampling: Systematic sampling [5] was employed for respondent selection to ensure balanced representation. Targeted users of the Auditorium Shared Facilities as participants. Questionnaire divided into two main sections: Part A: Demographic details of respondents. Part B: Visual comfort evaluation, including subcategories: Perception: Respondents' observations of the lighting environment. Comfort: Levels of ease or strain experienced. Acceptability: Overall satisfaction with lighting conditions. Questionnaires were distributed in both hardcopy and digital formats for convenience. Responses were collected and compiled for analysis. Response Scale: A 4-point Likert Scale was used for closed-ended questions: 1: Strongly Disagree, 2: Disagree, 3: Agree, 4: Strongly Agree. Open-ended questions allowed additional feedback.

2.5 Simulation Dialux software

Dialux used to simulate lighting conditions for verification and visualization purposes. Then use Revit software to redraw the dimensions of the auditorium to make it easier to sketch during the drawing import process into Dialux software. Dialux software supports the design of efficient and aesthetic lighting solutions for a variety of spaces, from domestic areas to large auditoriums and sports halls. With access to an extensive database of lighting products, it ensures compliance with standards and energy efficiency.

3. Result & Discussion

All data obtained from the simulation and questionnaire analysis was presented during this section. This serves as a purpose whether the study is achieving the objective or not.

3.1 Field measurement analysis

The luxmeter readings for Auditorium Hall 1 were collected and simulated using DIALux software to visualize artificial lighting. This software aids in assessing compliance with established standards and identifying areas with maximum and minimum lighting levels. The simulation was conducted once, based on a single day's lux readings, as the auditorium relies solely on artificial lighting.

The study adheres to [6], which outlines energy efficiency and renewable energy use for indoor lighting in non-residential buildings. This standard varies based on area function and working environment. Additionally, principles for Education and Training Institutions recommend enhancing brightness and occupant comfort [7]. Table 2 lists the standard illuminance levels, with MS 1525 serving as the benchmark for this research.

Table 2: Illuminance level from the standard [6]

Standard	Standard Illumination Level
Malaysian Standard (MS 1525)	300-500 lux
IESNA Standard	300-500 lux
JKR Standard	300-500 lux

3.1.1 Data Collection for Auditorium Hall 1

The field measurements revealed that the lux meter readings indicated significant variations in illuminance levels across different seating areas within the auditorium. Specifically, the analysis highlighted a concerning trend of uneven lighting distribution; while the back sections of the auditorium recorded average lux levels of 243 lux, the front areas (Levels 1 to 4) exhibited much lower levels at an average of only 181 lux. This discrepancy raises serious implications for visibility and comfort for audience members seated in these front rows, as these values fall well below the Malaysian Standard (MS) 1525 requirements for indoor lighting, which stipulates a minimum illuminance level of 300 lux for general areas such as auditoriums.

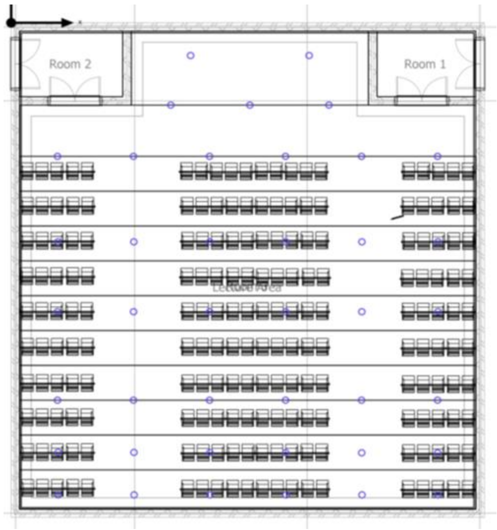


Fig. 4: Auditorium Hall 1 layout

Table 3: Average lux reading on seat level auditorium hall 1.

Auditorium hall 1 seat level	Average lux level
Level 1-4	181 lux
Level 5-8	226 lux
Level 9-12	243 lux

3.1.2 Visualization Auditorium Hall 1

The findings underscore critical limitations in the current lighting design, particularly in relation to compliance with established standards. The average lux readings for Levels 5 to 8 and Levels 9 to 12, although slightly better at 226 lux and 243 lux respectively, still do not meet the minimum requirements. This inadequate lighting in the auditorium could lead to discomfort and poor visibility for attendees, especially during events where clear sightlines are essential.

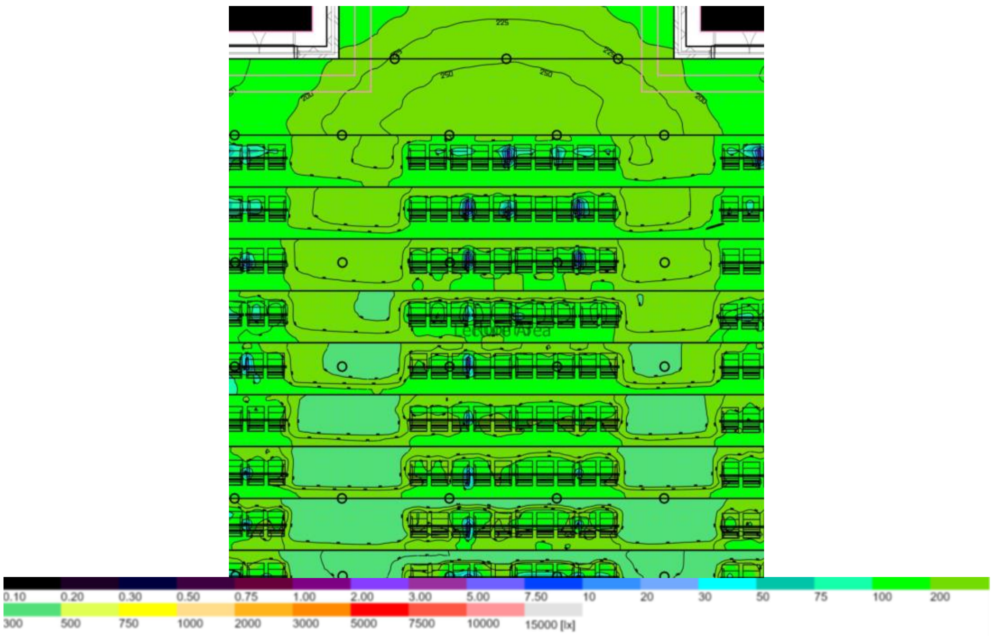
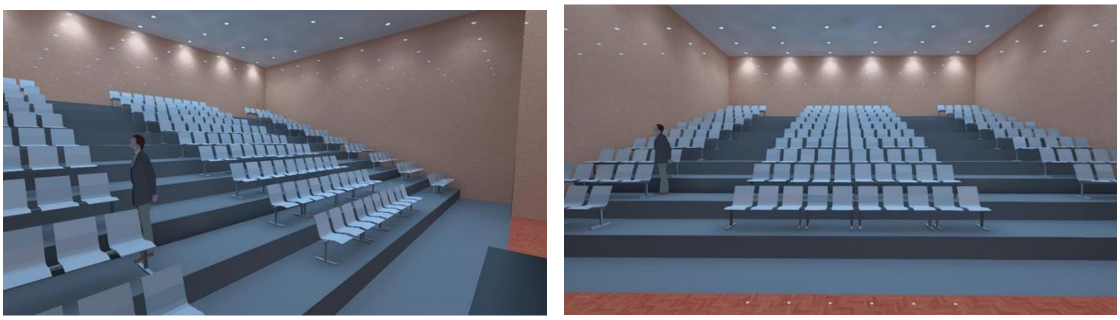


Fig. 5: False colour score at auditorium hall 1

Moreover, visualizations generated through Dialux further illustrated these lighting discrepancies. The false colour score visualization indicated that while illumination increases towards the back of the auditorium, the stage area remains particularly underlit. This is alarming since stages typically require higher illuminance levels (500-750 lux) to facilitate effective performances. The lack of adequate light directed towards this critical area could hinder performers and negatively impact audience engagement.

3.1.3 Lighting Simulation Render

The analysis of Auditorium Hall 1's lighting conditions highlights significant deficiencies in illuminance levels, light distribution, and compliance with the Malaysian Standard (MS 1525)[6]. This standard specifies that general areas should maintain illuminance levels between 300-500 lux, while critical areas, such as stages, require 500-750 lux. However, the current measurements show the stage averaging 181 lux, the middle area at 226 lux, and the back sections at 243 lux, all of which fall below the recommended levels. An illumination gradient was observed, with better lighting towards the back due to improved fixture placement and beam angles, but these improvements still fail to meet the minimum standards.



(a) (b)

Fig. 6: Render simulation (a) Render view 1; (b) Render view 2

Key issues identified caused by poor fixture placement and insufficient luminaires, leading to shadows and low visibility. To address this, it is recommended to replace the existing luminaires with higher lumen-rated LED models with a colour temperature of 4000K-4500K. Additionally, optimizing fixture placement to ensure overlapping beam angles can improve light distribution and minimize shadows, particularly near the stage. These adjustments not only aim to meet the prescribed standards but also enhance lighting efficiency and reduce energy costs. Strategic upgrades will significantly improve visibility, and sustainability within the auditorium.

3.2 Questionnaire Surveys data analysis

A survey was conducted on November 12, 2024, to assess subjective visual comfort related to lighting in Auditorium Hall 1. The survey, adapted from a prior study with modifications for this research, was administered to 107 respondents over a single day. Data collection occurred between 8:00 AM and 4:00 PM, targeting occupants attending scheduled classes. Respondents accessed the survey via a QR code. The study revealed how the distribution of artificial lighting in the auditorium impacted the respondents' visual comfort during the specified period.

Table 4: Cronbach's Alpha value for this study

Part B	Cronbach's Alpha	No. of items	Strength of Association
Perception	0.867	6	Very Good
Comfort	0.952	6	Excellent
Acceptability	0.770	3	Good
Total Value	0.863	15	Very Good

This study, Cronbach's alpha coefficient measures the internal consistency, or reliability, of a set of survey items. This statistic to help determine whether a collection of items consistently measures the same characteristic. Result Cronbach's alpha coefficient for perception, comfort and acceptability is (0.867, 0.952 and 0.770) the score of more than 0.7 is usually considered acceptable. For the total value is 0.863.

Furthermore, in this study the mean score is a vital to provide information about the "typical score" for students' perceptions of the quality of instruction for a specific course. The mean score for the perception, comfort and acceptability in these analysis surveys each shows in the range of 1.81 to 2.60 and means that the interpretation is low category.

4. Conclusion

This finding underscores the need to correct lighting disparities inside the auditorium to establish a setting conducive to both productivity and user comfort and engagement. Next, suggest that it is high time for the entire lighting system to be redesigned and brought up to code for even illumination across the space. Lack of compliance with these standards is not only likely to affect the comfort of the users but also attract regulatory sanctions, underlining the need for remedial measures. This process has proved that by using more developed software and tools such as Dialux, such problems and opportunities can be easily pointed out and therefore solutions on how to address them can be well outlined. The results also show that the proper lighting system design is not only essential for achieving the compliance requirements but also for the comfort and satisfaction of the users of a versatile room such as an auditorium. This study was successfully conducted because its achieved all of the objectives. The study on visual comfort on lighting is based on three objectives generalizes from which are as follows methods of measurement and perception of lighting comfort of auditorium environments and to examine the impact of the lighting measurements on the visual comfort and perception in auditorium workspace. The objective of this study relates to the results of the data collected by the researcher through field measurement, by administering questionnaires and using simulation lighting software. Thus, in another part of this paper, the further discussion of both objectives is carried out.

Acknowledgement

This section is compulsory. Acknowledgements and Reference heading should be left justified, bold, with the first letter capitalized but have no numbers. Text below continues as normal. Example, Communication of this research is made possible through monetary assistance by Universiti Tun Hussein Onn Malaysia and the UTHM Publisher's Office via Publication Fund E15216.

Conflict of Interest

Authors declare that there is no conflict of interest regarding the publication of the paper.

Author Contribution

This journal requires that all authors take public responsibility for the content of the work submitted for review. The contributions of all authors must be described in the following manner:

The author confirms sole responsibility for the following: study conception and design, data collection, analysis and interpretation of results, and manuscript preparation.

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