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Indoor Lighting Assessment in the CeDS Academic Office Space

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Abstract

The assessment of indoor lighting in office environments was critical for ensuring employee comfort, health, and productivity. This study focused on evaluating the lighting quality in the CeDS Administration Office at Universiti Tun Hussein Onn Malaysia (UTHM) Pagoh. It aimed to measure existing lighting levels, assess employee satisfaction with lighting conditions, and determine staff satisfaction with the existing lighting conditions. Surveys were utilized to gather data on occupants' satisfaction, while lighting measurements were conducted at various times throughout the day to capture variations and compare them with the MS1525:2014 standards. The study examined visual comfort, glare, and the impact of lighting on productivity and health. The findings highlighted areas with insufficient or excessive lighting that affected employee satisfaction and performance. Additionally, the results provided insights into how lighting quality influenced workplace comfort and efficiency, emphasizing the importance of adhering to established guidelines. Ultimately, the study offered recommendations to optimize lighting conditions, aiming to enhance employee well-being, reduce health risks like eyestrain and fatigue, and improve overall workplace performance. In the context of indoor lighting, SDG 3 is relevant because poor lighting can cause eyestrain, fatigue, headaches, and negatively affect mental health and productivity. This study supports SDG 3 by assessing and improving office lighting conditions to create a healthier and more comfortable workplace, ultimately enhancing employee well-being and reducing potential health issues.

1. Introduction

Good lighting plays a crucial role in ensuring workplace safety and health by enabling employees to perform their tasks comfortably and efficiently. Spaces illuminated with adequate lighting create a more attractive and comfortable atmosphere throughout the day. It also enables them to clearly see what is necessary to perform their tasks without difficulty. Additionally, quality lighting fosters a pleasant atmosphere and enhances employee's sense of well-being, which can lead to improved productivity and efficiency. On the other hand, poor lighting can make it difficult for employees to see clearly, resulting in visual fatigue and discomfort. This can negatively impact health, causing issues such as eyestrain, migraines and headaches. The OSHA (1984) "with Amendment 2022" also emphasizes the importance of proper workplace lighting to ensure a safe and healthy

working environment. The Occupational Safety and Health Act of 1994 "with Amendment 2022" was established to monitor workplace environments, ensuring they meet the needs and emotional well-being of occupants.

1.1 Objectives and Project Scope

The aims of this study are to evaluate staff satisfaction with existing lighting in the CeDS Administration Office. First, to measure the current lighting levels in various workspaces within the office. Second, to compare these measured lighting levels with the recommended standards to determine whether they meet the required guidelines. Finally, to evaluate staff satisfaction with the lighting conditions, identifying any concerns or areas needing improvement. These objectives will provide a comprehensive understanding of how lighting affects comfort and productivity in the office environment.

This study focuses on the CeDS Administration Office at UTHM Pagoh. It involves surveys and lighting measurements taken at different times of the day. Active staff serve as respondents, providing real user feedback. The study adopts a quantitative approach, combining measurements and perceptions to evaluate comfort and compliance.

1.2 Literature Review

In Malaysia, office lighting isn't just about making things visible however, it's about creating spaces that are comfortable, efficient, and energy friendly. Local standards are in place to ensure that workplaces are well-lit, healthy for employees, and sustainable for the environment. Standards from Sirim and the Energy Commission of Malaysia help guide the right balance of brightness, glare control, and energy use in office lighting. These guidelines aim to create lighting that supports productivity and well-being, while also being mindful of energy conservation. This guide breaks down the key Malaysian standards for office lighting, helping you understand how to design workspaces that are both functional and comfortable.

Energy efficiency and use of renewable energy for non-residential buildings – Code of practice was revised in 2014 and it is one of the Malaysian Standards which was developed by SIRIM [MS1525.2014]. The standard aids engineers and architects in the design of energy management systems, air conditioning and mechanical ventilation systems, lighting and electrical systems, and buildings. Technical specifications for lighting systems' exterior and interior are provided by the standard.

Sick Building Syndrome (SBS) is a name given to a collection of discomforts and illnesses experienced by occupants who spend extended periods in poorly maintained or designed interior environments. While often associated with indoor air quality, lighting plays an important role in exacerbating or reducing SBS symptoms. Inadequate or incorrect lighting can lead to eye strain, headaches, fatigue, and irritability. Harsh or bright lighting especially if it causes glare can contribute to visual stress, while under-bright lighting can impair task performance and induce mental and visual fatigue. Glimmering light, commonly found in antique fluorescent installations, can also enhance displeasure and may even induce migraines in sensitive subjects. Also, natural light or substitute daylight lighting is lacking, which can disturb circadian rhythms and result in sleep issues, diminished alertness, as well as mood disorders such as depression. Low light conditions can also induce loneliness or foreignness, which reinforces the psychological effects of SBS (1). To address these issues, modern lighting design is focused on providing balanced and glare-free illumination to improve human health. These include efficient and flicker-free lighting systems, natural light incorporation, and human-centric lighting tailored to time of day. Reasonable lighting design not only reduces symptoms of sick building syndrome but also contributes to a more comfortable, productive, and caring indoor environment (2).

1.2.1 Level of Lighting Comfort

Visual comfort is greatly influenced by lighting, which affects how comfortably and easily people can see and carry out tasks. Good lighting reduces eye strain, increases productivity, and improves visibility. However, discomfort, headaches, and decreased productivity can result from inadequate illumination, whether it is too bright, too dim, or glaring. Colour temperature, flicker, brightness levels, glare, and homogeneity are important elements that impact visual comfort. Better focus is ensured by glare-free lighting, while balanced brightness helps avoid eye fatigue. Neutral colour temperatures (around 4000K) are best for work situations, and uniform lighting throughout a room prevents sharp contrasts [3]. Furthermore, flicker must be minimized because even slight flickering might result in chronic eye strain. These elements can be addressed by lighting to produce a more cozy and aesthetically pleasing space [4].

1.2.2 Level of Lighting Comfort

An unsuitable indoor lighting situation is one of the many elements that adversely affect eye health [5]. From an architectural standpoint, an attempt has been made to design a lighting environment that supports and preserves the eye health of its occupants. First, in order to maintain sight and avoid overstimulating the eyes, governments and nations have proposed office lighting regulations. Nonetheless, the criteria primarily draw from the outcomes of earlier tests carried out on paper-based work. This indicates that the standards are inappropriate for those who work primarily on visual display terminals, such as computers and cell phones, in modern offices. Visual display terminals have become a social problem because they cause visual display terminal syndrome, which is characterized by impaired vision and eye fatigue. Since each occupant may adjust the brightness of the digital screens, they also act as a barrier to investigating the best lighting conditions for eye health. As a result, people who are in the same lighting situation may experience different visual stimuli from lighting. Future smart buildings should measure and consider each occupant's visual fatigue in order to generate the ideal lighting environment and improve their eye health.

The psychological health and productivity of employees are significantly impacted by office illumination. Workplace productivity and mental health can be improved by lighting that follows these natural cycles. Serotonin levels are raised by bright, natural-looking light, which enhances mood, vitality, and alertness. On the other hand, poor or excessively harsh lightning can lower morale by causing weariness, worry, and discontent. A less ideal working environment might result from glare and flickering light, which are frequently connected to fluorescent fixtures and can increase pain and anxiety.

Additionally, colour temperature has a significant impact on psychological and emotional impacts. Cooler light (4000K–5000K) is perfect for task-oriented areas since it increases concentration and productivity [6]. Later in the day, though, too much exposure to this type of lighting might interfere with the creation of melatonin, which affects sleep and makes you irritable. Warmer tones (2700K–3000K) promote warmth and relaxation but might not be conducive to intense concentration [7]. In order to encourage circadian alignment, dynamic or human-centric lighting systems which modify colour temperature and brightness throughout the day to replicate natural light patterns that have grown in popularity. These technologies make the workplace more balanced and effective while lowering fatigue and enhancing mental clarity.

1.2.3 Lighting well-being During Work

Lighting has a significant influence on our health and well-being in addition to simply illuminating an area. Mood, energy levels, and even sleep patterns can be impacted by the kind, intensity, and colour of light. While inconsiderate lighting design can increase productivity, improve focus, and promote general mental and physical wellness, poor lighting can cause eye strain, headaches, and exhaustion. Circadian-friendly lighting is important because it fits with our natural biological rhythms, according to recent studies. Workplaces can encourage healthier sleep, happier moods, and more alertness during the day by simulating natural light cycles. This guide examines the relationship between lighting and health and wellbeing, offering advice on how to design spaces that promote energy, comfort, and long-term wellbeing.

2. Method and Procedures

This study employed both field measurements and surveys to assess lighting conditions in the CeDS Administration Office at UTHM Pagoh. A lux meter was used to measure light intensity at several points across different office areas at a height of 0.85 meters, with readings taken at various times to capture lighting variation. The average lux values were then compared to the MS1525:2014 standard. To complement the measurements, a structured questionnaire was distributed via email to collect staff feedback. Section A gathered demographic data, while Section B focused on lighting comfort, its impact on productivity, and well-being. The survey responses were analyzed using descriptive statistics and Likert scales to identify satisfaction levels and areas needing improvement. This combined method provided a clear understanding of lighting performance and user experience.

2.1 Field Measurement

Conducting field measurement under real conditions helps in better understanding the light distribution. This study aimed to find the listing level from the artificial lighting in the administrative office of Diploma Studies Centre, to address the specific requirement. The measurement was conducted at the CeDS UTHM Pagoh Administration Office as shown in Fig. 2(a). This office functions as the management and coordination centre for academic, administrative, and student welfare activities. The office comprises several areas, including a waiting area, administrative space, file room/ISO, and a counselling room. There are five staff members working in this office. As it is an administration office, lecturers also conduct their dealings here. Fig. 2(b) shows the position of the lux meter. Place the lux meter sensor flat and facing the light source. above the work surface (usually 0.85 m

from the floor). Place the sensor vertically facing the light source. Make sure there are no obstacles between the light source and the lux meter. Fig. 2(c) illustrates the measurement points in the Administration Office. Choose four to six representative points on the work plane, ensuring they are spaced out and cover the area. If the area is large or irregularly shaped, use multiple lines to obtain an average. When possible, measure at a constant height above the floor. Fig. 2(d) shows the light intensity measurement tool known as a lux light meter. The purpose of this equipment is to measure the level of light intensity measured in lux units. The features of this measurement tool are that the sensitivity level is 1, pocket-sized where it can be carried anywhere but the weakness of this tool is that it is sensitive. The use of this tool is easy and fast. This is because this tool takes less than 5 seconds to obtain a reading of the lighting level. The reading of the lighting level is taken on an optimal surface for use such as on a table or with a measurement of 0.8 meters from the floor surface. To take lighting measurements, begin by removing the sensor cap, ensuring that the sensor is not shaded or blocked. Next, place the lux meter on the chosen measurement point. Wait for the reading to stabilize and then record the lux value. To ensure accuracy, take multiple readings at each point. Finally, calculate the average illuminance for the area by averaging the readings from all measurement points. Fig. 2(e) shows an example of the questionnaire to survey the staff satisfaction with the lighting conditions.

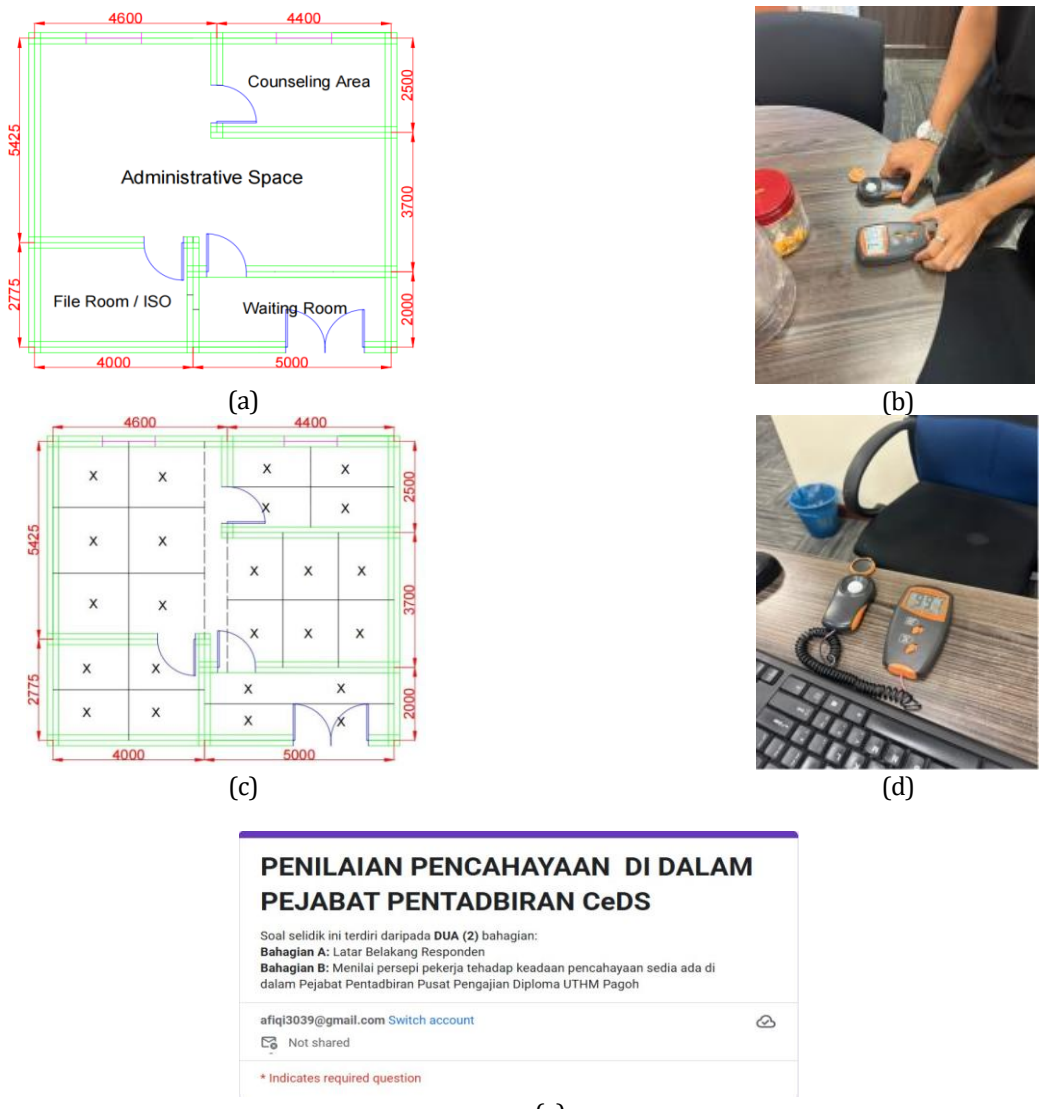

Fig. 2 *Preparation of Field Measurement (a) Layout of Administration Office; (b) Position of Lux Meter; (c) Measurement Points; (d) Lux Meter; (e) Example of the questionnaire*

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2.2 Occupant's Satisfaction Survey

Assessment of the existing lighting in the CeDS administration office is triangulated with occupant's visual comfort survey by task lighting in workspaces. The questionnaires were distributed to the staff through official UTHM email. The questionnaire structured into two main sections to collect both demographic data and insights on lighting satisfaction.

Section A focuses on the respondents' background. This part collects general information such as gender, age, and job position. The purpose is to understand the demographic profile of the participants, allowing for better analysis of the data in relation to different staff categories. Section B assesses the comfort level of respondents with the indoor lighting in the administrative office. It covers several aspects including the general level of lighting comfort, the impact of lighting on employee productivity, and the influence of lighting on well-being during work hours. This section is crucial in identifying specific lighting issues that may affect staff performance and satisfaction.

The primary research from the questionnaire was analysed quantitatively using descriptive analysis with a Likert scale. Descriptive analysis refers to the summarization and presentation of data in a structured format to provide a clear overview of the dataset. The commonly used descriptive statistics that are typically tabulated include the mean which is the average of a set of numbers.

3. Results and Discussion

This result and discussion present the analysis of data collected through lighting measurements and questionnaire surveys conducted at the CeDS Administrative Office, UTHM Pagoh. The purpose of this analysis is to evaluate the existing lighting conditions in the office and assess occupant satisfaction. The relationship towards the results from the field data and the survey are the field data are the proof that explained well about employee satisfaction which is known as survey data. Data was collected with lighting measurements taken at the same time of the day and surveys administered to office staff.

3.1 Light Distribution

Fig. 3 shows the differences in lighting distribution throughout each location. The bar graph displays the illuminance levels recorded at specific positions within five distinct areas: A (File Room), B and D (Administrative Spaces), C (Waiting Room), and E (Counselling Area). While Area B has a greater range from 677 to 1,028 lux, suggesting uneven illumination most likely caused by several light sources, Area A displays consistent lighting with values between 520 and 565 lux. There is an obvious difference in Area C, especially as C4 is noticeably brighter than the rest. Despite being generally well-lit, Area D features one very dull spot (D6 at 703 lux), which may indicate a localized lighting problem. The illumination in Area E is rather balanced, with levels between 719 and 839 lux. This detailed breakdown is useful for identifying areas where lighting adjustments may be needed to improve visual comfort, task performance, and energy efficiency.

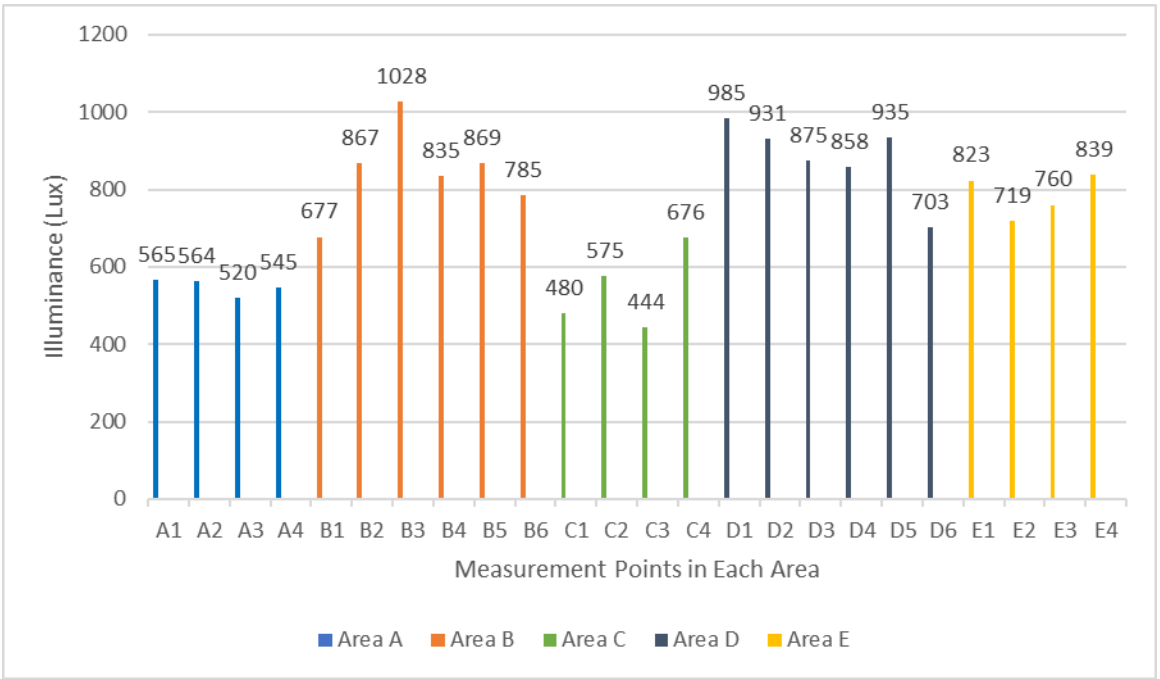

Fig. 3 *Illuminance Levels at Measurement Points in Each Area*

3.2 Comparison with Lighting Standards

Table 1 compares the calculated average lux values in the different locations in the CeDS Administration Office with the recommended light levels under the MS1525:2014 standard, which suggests an ideal of between 300 to 500 lux for general office spaces. Based on the results, Locations A (File Room) and C (Waiting Room) recorded average lux values of 549 and 544 respectively, which are a bit higher than the recommended. These areas are in the "Almost Complies" category, which means that even though the lighting is close to standard, minor adjustments would be capable of making them fully comply. In contrast, Location B and Location D, which are both Administrative Areas, recorded substantially higher lux levels of 844 and 881, respectively, and Location E (Counseling Area) recorded 785 lux. These areas are flagged as having "Excess" light, which means current levels are too high and may lead to visual discomfort or energy wastage. Overall, the table shows that while some areas are near compliance, several others could benefit from lighting optimization to achieve national standards and increase comfort and energy efficiency.

Table 1 *Comparison of the measured average lux values with the recommended lighting levels.*

Location	Average Lux	MS1525:2014	Compliance
A	549	300-500	Almost Complies
B	844	300-500	Excess
C	544	300-500	Almost Complies
D	881	300-500	Excess
E	785	300-500	Excess

3.3 Satisfaction on existing Lighting Condition

There are 15 respondents that were answering this questionnaire. Out of 15 respondents, a total of 8 respondents (53.3%) are administrative staff, while 7 respondents (46.7%) are academic staff. Fig. 4 presents staff mean reaction to three most significant variables of indoor lighting at the CeDS Administrative Office. The biggest mean score of 4.06 was attributed to the effect of lighting on staff productivity, indicating that respondents acknowledge very strongly that sufficient lighting enables them to work more efficiently. Comfort in the level of lighting was accorded a mean score of 3.82, implying that most staff have a tendency to perceive the lighting as comfortable, although it is still room for improvement. Alternatively, the role of lighting in influencing staff well-being at work was scored slightly low at 3.78, reflecting a moderately positive attitude. Overall, the results indicate that while staff are satisfied with current lighting, particularly in relation to productivity, there are areas that can be further improved to boost overall comfort and well-being.

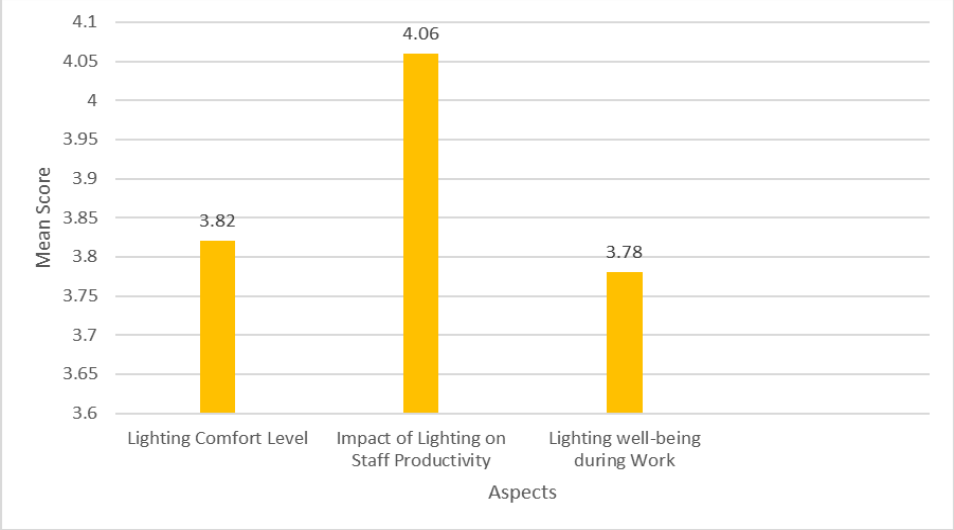

Fig. 4 *Analysis of Mean Score*

4. Conclusion

This study was successful in assessing the lighting conditions indoors at Universiti Tun Hussein Onn Malaysia, Pagoh CeDS Administration Office. The study, through a mix of field measurements and staff surveys, found that there are some areas in the office whose lighting levels are above or very close to the levels specified in MS1525:2014. Although Waiting Room and File Room are close to compliance, the Counseling and Administration spaces have too much lighting, which can lead to visual discomfort as well as energy wastage. Overall staff feedback tends to be positive regarding the current lighting, especially regarding how it has improved productivity, but there are comments to suggest that there can be some room for improvements to enhance visual comfort and well-being. These findings reinforce the importance of maximizing the lighting to create national standard compliance in addition to employee health and well-being. Generally, the research identifies the current state of lighting within the CeDS office and lays the groundwork for possible future improvements. Implementing particular lighting changes would have immense impacts on energy efficiency and the general working conditions of staff. SDG 3 is relevant to interior lighting as inadequate illumination can lead to headaches, eyestrain, exhaustion, and adverse effects on productivity and mental health. By evaluating and upgrading office lighting conditions to provide a more pleasant and healthy work environment, this study contributes to SDG 3 by boosting employee well-being and lowering the risk of health problems.

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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 authors confirm contribution to the paper as follows: ***study conception and design:*** *Muhammad Afiq Iskandar Bin Mohamad Rizuan, Muhammad Danish Ilman Bin Ismayazan, Abid Naufal Bazli Bin Abd Rahman, Aslila Binti Abd Kadir;* ***data collection:*** *Muhammad Afiq Iskandar Bin Mohamad Rizuan, Muhammad Danish Ilman Bin Ismayazan, Abid Naufal Bazli Bin Abd Rahman;* ***analysis and interpretation of results:*** *Muhammad Afiq Iskandar Bin Mohamad Rizuan, Muhammad Danish Ilman Bin Ismayazan, Abid Naufal Bazli Bin Abd Rahman, Aslila Binti Abd Kadir;* ***draft manuscript preparation:*** *Muhammad Afiq Iskandar Bin Mohamad Rizuan, Muhammad Danish Ilman Bin Ismayazan, Abid Naufal Bazli Bin Abd Rahman. All authors reviewed the results and approved the final version of the manuscript.*

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