

RESEARCH ARTICLE

Effect of lighting conditions on administrative staff in a higher learning institution

Akmal Fitri bin Azmy, Nurliyana binti Moh Hussin*, Nurud Suria binti Suhaimi, Norhidayah binti Abdull, and Afiza binti Abdullah Suhaimi

Department of Occupational Safety and Health, Faculty of Industrial Sciences and Technology, Universiti Malaysia Pahang Al-Sultan Abdullah, Lebuhr Persiaran Tun Khalil Yaakob, 26300 Kuantan, Malaysia

Abstract - Lighting conditions play a critical role in influencing employee comfort, health, and productivity in office environments. This study aims to evaluate the adequacy of lighting in administrative offices at a higher learning institution and to examine the relationship between lighting conditions and employees' physical and well-being. A quantitative approach was adopted, involving field measurements using a lux meter and a questionnaire survey. One-sample t-tests were conducted to compare measured illuminance levels against the recommended standard of 500 lux, while Spearman correlation analysis was used to examine relationships between variables. Results indicated that four out of five offices met the recommended lighting standards, while one office showed significantly inadequate lighting. No statistically significant relationship was found between lighting conditions and employees' physical and well-being. The findings highlight the importance of maintaining adequate lighting standards while suggesting that additional factors may influence employee well-being.

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1. Introduction

Lighting is an essential environmental factor that extends beyond visual function, significantly influencing human well-being, productivity, and overall comfort. In office environments, employees typically spend extended periods—often exceeding eight hours daily under artificial lighting conditions. Poor lighting can lead to adverse effects such as eye strain, fatigue, headaches, and reduced work efficiency. Proper lighting design involves not only achieving sufficient illuminance levels but also ensuring appropriate distribution, uniformity, and glare control. Inadequate or excessive lighting may impair visual performance and increase the likelihood of errors and workplace discomfort. A study at the University of Sumatera Utara found that increasing the intensity of office lighting significantly reduced stress levels among administrative staff. The research used a pre-test-post-test design and demonstrated a statistically significant decrease in stress after improvements in lighting conditions [1]. Proper lighting is crucial for visual comfort, which directly influences employee satisfaction and health. Satisfaction with lighting is linked to parameters such as brightness, distribution, and glare, which are essential for maintaining a healthy work environment [2]. Optimal lighting conditions are necessary for visual comfort, which in turn affects productivity. In a study conducted in Bali, it was found that when employees were comfortable with the lighting intensity, their performance and productivity increased. However, other factors, such as furniture arrangement, also play a role [3]. In co-working spaces, lighting design significantly impacts the ambience and productivity. Both natural and artificial lighting contribute to creating a conducive work environment, enhancing both individual and group performance [4]. Poor lighting can lead to visual discomfort and health issues such as eye strain and fatigue. A study in a university library highlighted that inadequate lighting distribution and intensity led to eye fatigue among staff and students, indicating the need for lighting improvements to meet standards [5]. The balance between daylight and electric lighting is crucial for maintaining a positive affective response and reducing electricity consumption. A study involving university students showed that a combination of daylight and electric lighting was preferred for various tasks, suggesting its importance in creating a stimulating environment [6]. While the positive effects of optimal lighting are evident, it is important to consider that lighting alone may not address all workplace issues. Factors such as furniture arrangement, environmental adaptation, and personal preferences also play significant roles in determining overall satisfaction and productivity in administrative settings [2], [3]. Despite the growing body of research on workplace lighting, few studies have examined administrative office settings in Malaysian higher learning institutions, using both objective measurements and subjective assessments. Therefore, this study aims to evaluate the adequacy of lighting conditions in administrative offices and to examine the relationship between lighting conditions and employees' physical and well-being.

1.1 Literature Review

The concept of workplace lighting encompasses a multifaceted approach that integrates technical, ergonomic, and human-centric considerations to enhance employee well-being, productivity, and energy efficiency. Effective workplace lighting design is not only about providing adequate illumination but also about optimising the quality of light to suit the specific needs of the work environment and its occupants. This involves balancing natural and artificial lighting, prioritising visual comfort, and integrating digital and innovative lighting strategies. Human-centric lighting focuses on the non-visual effects of light, such as its impact on circadian rhythms and overall well-being. This approach emphasises the importance of vertical eye-level illuminance and spectral distribution, which are crucial for triggering non-visual effects like mood and alertness [7]. Ergonomic lighting design considers the anthropometric and ergonomic needs of workers, ensuring

*CORRESPONDING AUTHOR | Nurliyana binti Moh Hussin | ✉ nurliyana@umpsa.edu.my

that lighting solutions are tailored to the diverse requirements of individuals in coworking spaces and other work environments [8]. Studies have shown that optimal lighting conditions, characterised by appropriate illuminance levels, colour temperature, and glare control, can significantly enhance employee mood, concentration, and job satisfaction. Integrating natural light with artificial lighting is particularly beneficial for employee satisfaction [9]. The psychological impact of lighting, including colour and distribution, plays a crucial role in creating a conducive work environment. Proper lighting can reduce glare and improve the overall aesthetic and functional quality of the workspace [10].

Lighting in office environments plays a crucial role in influencing occupants' well-being, productivity, and satisfaction. It affects not only the visual comfort and aesthetic appeal of a workspace but also has significant implications for psychological and physiological health. The importance of lighting is underscored by its ability to enhance cognitive function, reduce fatigue, and improve overall work performance. A comprehensive approach to lighting design that considers both natural and artificial light sources is essential for creating optimal office environments. Lighting conditions significantly influence psychological responses, which in turn mediate other human reactions such as physiological responses and work performance. Illuminance and correlated colour temperature (CCT) are key factors affecting visual comfort and fatigue, with psychological well-being being a critical consideration in light design [11]. Proper lighting can enhance occupants' health, motivation, and environmental satisfaction, contributing to a more comfortable and productive office environment [12]. Occupant satisfaction is higher in environments where illuminance levels exceed standard recommendations. The influx of daylight, window size, and architectural design are crucial in enhancing satisfaction and mitigating glare [13]. Lighting quality is more critical in enclosed private offices compared to open office systems, where privacy concerns are less significant than lighting quality [14]. While the benefits of well-designed lighting in office environments are clear, it is important to consider potential challenges and limitations. For instance, achieving the right balance between natural and artificial lighting can be complex, especially in spaces with diverse occupant needs and architectural constraints. Additionally, implementing advanced lighting control systems may face technical and financial barriers. Despite these challenges, integrating human-centric lighting design principles remains a promising avenue for enhancing workplace environments and occupant well-being.

Lighting issues in university administrative offices can significantly impact both staff productivity and well-being. Common problems include inadequate lighting levels, poor light distribution, glare, and inefficient lighting systems. These issues can lead to discomfort, eye strain, and reduced work performance. Addressing these problems requires a comprehensive understanding of lighting standards and the implementation of effective lighting strategies. Many university offices have lighting levels below the recommended standards, which can lead to eye strain and discomfort. For instance, a study found that most offices had illuminance levels below the 500-lux standard set by OSHA, with some offices recording as low as 288.1 lux and inadequate lighting can result in health issues such as eyestrain, blurred vision, and headaches, which can decrease productivity and performance [15]. Uneven lighting distribution and glare are common issues in university offices. Poor layout and positioning of light sources can cause direct and indirect glare, affecting visual performance [16]. In some cases, high lighting levels can cause glare, disrupt activities and cause eye fatigue [5]. This is particularly problematic in spaces with reflective surfaces or inadequate shading elements [16]. Many university offices use outdated and inefficient lighting systems, such as fluorescent lamps, which contribute to high energy consumption and costs [17]. Replacing these with LED lighting and integrating daylight with electric lighting can significantly reduce energy consumption and improve lighting quality. For example, replacing fluorescent lamps with LEDs and installing motion sensors can reduce energy consumption by up to 91.1% [18]. While addressing lighting issues in university administrative offices is crucial, it is also important to consider the balance between daylight and electric lighting. Studies have shown that a combination of both can create an optimal environment for various tasks, enhancing both comfort and productivity [6]. Additionally, upgrading to energy-efficient lighting systems, such as LEDs, can provide significant cost savings and environmental benefits [19].

2. Materials and Methods

A quantitative research approach was employed in this study, integrating both field measurements and questionnaire surveys to achieve the research objectives. The study was conducted in five administrative offices within a university in Pahang, Malaysia. A total of 50 questionnaires were distributed to employees, of which 32 valid responses were obtained, yielding a response rate of 64%. Illuminance levels in each office were measured using a lux meter (LM-120), following the guidelines established by the Department of Occupational Safety and Health (DOSH) [20] to determine the average lighting levels. In addition, a structured questionnaire adapted from the Office Lighting Survey (OLS) was used to evaluate employees' perceptions of lighting conditions as well as their physical and well-being. The Office Lighting Survey is a structured questionnaire designed to assess employees' perceptions and satisfaction with lighting conditions in office environments. The instrument evaluates various dimensions of workplace lighting, including illuminance adequacy, lighting uniformity, glare, visual comfort, and overall satisfaction with the lighting environment. In addition, the OLS examines the effects of lighting conditions on employees' physical and psychological well-being, such as eye strain, headaches, fatigue, comfort, concentration, and mood. By capturing employees' subjective experiences alongside objective lighting measurements, the OLS provides a comprehensive assessment of how office lighting influences health, comfort, and work performance among administrative staff in higher learning institutions. To ensure the instrument's reliability, Cronbach's Alpha was used to assess the internal consistency of the questionnaire items, with results indicating good reliability. For data analysis, the Shapiro-Wilk test was conducted to assess normality, followed by a one-sample t-test to evaluate lighting adequacy against the recommended standard of 500 lux, and Spearman correlation analysis to examine the relationship between lighting conditions and employees' well-being.

3. Results and Discussion

3.1 Normality Test

The Shapiro-Wilk test indicated that the illuminance data were normally distributed ($p > 0.05$), allowing the use of parametric tests for further analysis.

3.2 Lighting Adequacy

A one-sample t-test was conducted to compare the measured illuminance levels with the recommended standard of 500 lx as shown in Table 1. The results showed that Office A recorded a mean illuminance of 220.5 lx, which was significantly lower than the recommended value ($p < 0.05$), indicating inadequate lighting conditions. In contrast, Offices B, C, D, and E exhibited no statistically significant difference from the standard ($p > 0.05$). However, some of these offices recorded mean illuminance levels below 500 lx, suggesting that although they are statistically acceptable, improvements may still be required to achieve full compliance with recommended lighting standards. Overall, these findings indicate that most offices meet general lighting requirements, although certain areas require further enhancement.

Table 1. Descriptive statistics of measured illuminance levels

Office	Mean (lx)	t-value	p-value	Interpretation
A	220.5	-5.72	<0.001	Significantly below standard
B	485.2	-1.23	0.254	No significant difference
C	512.8	0.91	0.391	No significant difference
D	495.7	-0.58	0.576	No significant difference
E	528.3	1.35	0.214	No significant difference

This finding suggests that most offices provide adequate lighting conditions for administrative work, although improvements are required in certain areas. The inadequate lighting observed in Office A may be attributed to factors such as insufficient artificial lighting fixtures, poor luminaire placement, daylight obstruction, or inadequate maintenance of lighting systems. Previous studies have similarly reported that many office environments fail to meet recommended illuminance standards, resulting in visual discomfort and reduced work efficiency. [15] found that illuminance levels below 500 lx were associated with eye strain and headaches among university employees, while [16] reported that inadequate lighting negatively affected visual performance and employee comfort. The findings of the present study therefore reinforce the importance of conducting regular lighting assessments and implementing corrective measures to ensure compliance with occupational lighting standards.

3.3 Lighting Uniformity

All offices achieved the recommended uniformity ratio of at least 0.5, indicating adequate light distribution as shown in Figure 1. This suggests that lighting design in terms of distribution is generally acceptable across the studied offices. Adequate lighting uniformity is essential because uneven lighting conditions can create visual adaptation problems, increase eye fatigue, and reduce occupants' comfort and performance. The acceptable uniformity ratios observed in this study suggest that the lighting layouts and luminaire arrangements in the offices were generally effective in providing consistent illumination across work areas. This finding is consistent with previous research that emphasises the importance of proper light distribution in enhancing visual comfort and reducing glare-related problems. [11] reported that balanced illuminance and proper lighting distribution significantly improved occupants' psychological comfort and reduced visual fatigue. Similarly, [12] found that employees were more satisfied in office environments with well-distributed lighting conditions. Therefore, despite the inadequate illuminance identified in one office, the overall lighting design, in terms of uniformity, appears satisfactory and capable of supporting employees' visual requirements.

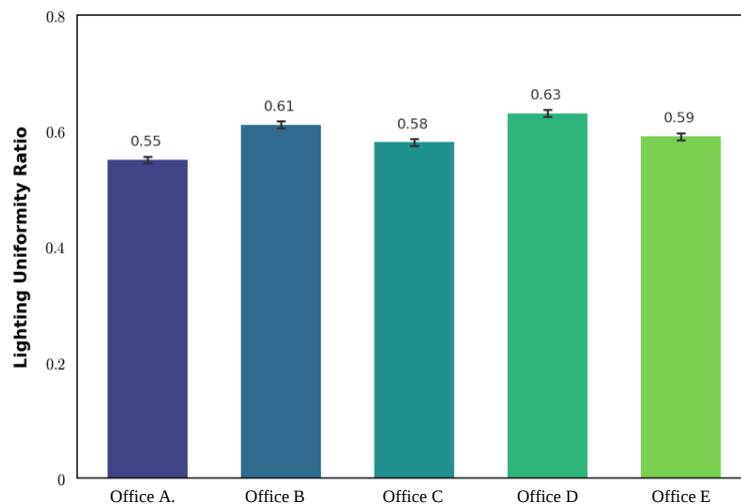


Figure 1. Lighting uniformity ratios by office

3.4 Relationship between Lighting and Well-being

Spearman correlation analysis revealed a weak and non-significant relationship between lighting conditions and employees' physical and well-being ($r_s = 0.18$, $p = 0.31$). This indicates that lighting conditions did not have a measurable impact on employee well-being in this study. Several factors may explain this finding, including that most offices already met adequate lighting standards, which may have reduced response variability, and the relatively small sample size, which limited the statistical power of the analysis. In addition, individual differences in perception, personal preferences, and health conditions may have influenced the results. These findings are consistent with previous studies suggesting that when environmental conditions meet minimum recommended standards, their effects on well-being tend to be less pronounced [21] - [22] (Table 2).

Table 2. Spearman correlation between lighting conditions and employee well-being

Variables	Spearman's r	p-value	Interpretation
Lighting Conditions and Employee Well-being	0.18	0.31	Weak positive, not significant

This finding indicates that variations in lighting conditions did not have a measurable influence on employees' well-being in the present study. Several factors may explain this result. First, most offices already achieved lighting conditions that met or approximated recommended standards, thereby reducing variability in employees' perceptions and experiences. Second, the relatively small sample size may have limited the statistical power to detect significant associations. Third, employee well-being is a multidimensional construct influenced by numerous environmental and personal factors, including workload, ergonomics, psychosocial conditions, job demands, and individual preferences, which were not examined in this study. The finding is consistent with the systematic review and meta-analysis conducted by [21], which concluded that the effects of lighting on well-being tend to be less pronounced when environmental conditions already satisfy minimum standards. Likewise, [22] reported that occupant satisfaction and well-being are influenced by multiple environmental factors rather than lighting alone. However, the present findings differ from those of [1] and [9], who found that improvements in workplace lighting significantly reduced stress and enhanced employee satisfaction and productivity. These discrepancies may be explained by differences in study settings, measurement approaches, and participant characteristics. Therefore, while maintaining adequate lighting remains important for occupational health and visual comfort, improving employee well-being in higher learning institutions may require a more holistic approach that considers ergonomic, organisational, and psychosocial factors in addition to lighting conditions. This study is subject to several limitations, including a relatively small sample size, the focus on a single institutional setting, and the reliance on subjective questionnaire responses, which may introduce response bias. These constraints may affect the generalizability and robustness of the findings. Therefore, future research should consider using larger and more diverse samples across multiple institutions to enhance external validity. Additionally, incorporating other relevant variables such as workload, ergonomics, and psychosocial factors may provide a more comprehensive understanding of employee well-being. Longitudinal studies are also recommended to examine the long-term effects of lighting conditions on well-being.

4. Conclusions

This study evaluated lighting conditions in administrative offices and examined their relationship with employee well-being. The findings indicate that most offices comply with the recommended lighting standards, with the exception of one office that requires improvement. In addition, lighting uniformity was found to be satisfactory across all offices, suggesting that light distribution is generally adequate. However, no significant relationship was identified between lighting conditions and employee well-being. These results highlight the importance of maintaining appropriate lighting standards in the workplace while also acknowledging that employee well-being is influenced by multiple factors beyond lighting alone.

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Declaration of Competing Interests

The authors declare no conflicts of interest.

CRedit Author Contribution Statement

Akmal Fitri bin Azmy: Conceptualisation; Methodology; Validation; Formal analysis; Data curation; Investigation; Resources; Software; Visualisation; Writing – original draft; Writing – review & editing; Funding acquisition; Project administration.

Nurliyana binti Moh Hussin: Supervision, Writing-review & editing.

Nurud Suria binti Suhaimi: Writing – review & editing.

Norhidayah binti Abdull: Writing – review & editing.

Afiza binti Abdullah Suhaimi: Writing – review & editing.

Availability of Data and Materials

Data sharing is not applicable to this article as no new datasets were generated or analysed in this study.

Ethics Statement

This study was conducted in accordance with the ethical principles for research involving human participants. Participation was voluntary, and informed consent was obtained from all participants prior to data collection. Participants were informed of the study objectives, procedures, and their right to withdraw from the study at any time without penalty. The anonymity and confidentiality of all participants were strictly maintained, and no personally identifiable information was collected. The data obtained were used solely for academic and research purposes.

Human Data or Participation

Informed consent was obtained from all participants involved in the study. Participation was voluntary, and all data were collected anonymously and treated confidentially in accordance with ethical guidelines for research involving human participants.

Generative Artificial Intelligence Disclosure

AI-based tools were used solely for language editing and grammar refinement. No AI content generation or data interpretation was performed. All intellectual contributions are original and solely attributable to the authors.

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