Global Journal of Engineering and Technology [GJET].
ISSN: 2583-3359 (Online)
Frequency: Monthly
Published By GSAR Publishers
Journal Homepage Link- https://gsarpublishers.com/journal-gjet-home/

OPEN ACCESS

Evaluation of Illuminance Level in the Offices of Borno State University

By

Ocheni, Abdullahi Ugbede Usman[1], Khalid, Muhammad[2], Kolo, Mohammed[2] Umar, Abubakar Sadiq[2], Jidda, Umar Fatima[2], Samuel, Alheri Koli[3]

[1]Department of Physics, University of Maiduguri
[2]Department of Physics, Borno State University
[3]Department of Physics, Gombe State University

Article History

Received: 17/07/2025
Accepted: 19/07/2025
Published: 22/07/2025

Vol – 4 Issue – 7

PP: - 03-07

Abstract

*This study evaluate the lighting illuminance level in offices' block of Borno State University (BOSU). Lighting is one of the key elements in building infrastructure and among the factors that combine to create healthy work environments that in turn help promote employees' wellbeing and accurate productivity. A standardised TES-1332A digital lux meter was used to assess the lighting illuminance level to ascertain whether offices lighting are within stipulated range by CIBSE guideline. The obtained data were analysed using SPSS statistical package at significance level of 0.05. The corrected model, encompassing Position, Block, and their interaction, demonstrates a collective Type III Sum of Squares of 99796.237 resulting in a statistically significant F-value of 2.373 (p = .016). However, Position and Position * Block interaction show non-significant effects (F = 0.007, p = .932; F = 1.308, p = .270) respectively. Block, on the other hand, exhibits significance (Type III Sum of Squares = 75360.480, F = 4.033, p = .004). The Duncan multiple range test comparison indicates three homogeneous subsets for block 1, 2, and 3. Subsets 1 include Blocks 4 and 2 with a marginally significant p-value of 0.051, suggesting potential differences between them. Subset 2 includes Block 5 and Block 4, with a non-significant p-value of 0.133, while Subset 3 consists of Block 3 and Block 1, with a significant p-value of 0.000, indicating notable differences between the blocks. The study underscores the significance of Intercept and Position in influencing the "Data" variable, while Location, Windows, and their interactions do not contribute significantly to the model.*

Index Terms*- Artificial lighting, Digital lux meter, Illuminance level and Visual comfort.*

INTRODUCTION

Lighting is a fundamental human need for illumination of surrounding by a source to achieve an aesthetic effect. Thus, a good lighting environment provides an appropriate illuminance level for visual performance, safety, and healthy to improve on the physical and mental comfort of beneficiaries which enhance daily task [1, 2] to be carried out accurately and quickly [3]. The lighting sources are either artificial or natural. The incandescent energy is an artificial lighting source created by heat whereas luminescent energy is an artificial lighting source produced from chemical or electrical energy. In contrast, natural sources of lighting are produced by the sun and stars [4]. The influence of artificial lighting is more noticeable than natural daylight [5]. However, day lighting is often used as the main sources of light in buildings during working hours [4] because it provides an advantage of not only visual comfort but also, regulate the body's circadian system and save energy [6].

Hence, lighting is an essential environmental component of landscape projects considered to improve the wellbeing and productivity of the society specifically the occupational environment which affects visibility and performance of visual tasks [7, 8]. However, studies have state that excessive lighting beyond the recommended wavelength pollute the environment and contribute to climate change, negatively impact human health by causing visual discomfort and probable lead to irreversible photochemical retinal damage on direct penetration on human eyes [7, 9, 10]. Conversely, poor lighting result to long term health effect of eyes strain and the biological effect of circadian photoreception system [5], impeding the ability of brain's power effectiveness in data gathering [4]. Understanding the relationship between lighting and behaviour will lead to architectural designs that achieve and implement more effective lighting for the workplace, leading to improved mood and better working ability and performance of the occupants [1]. Typically, the investigation

*Corresponding Author: Ocheni, Abdullahi Ugbede Usman

of workplace illumination risk is associated essentially with the illuminance levels [8]. Studies suggested that whilst lighting alone is unlikely to have a strong effect on performance, it is one of several factors that combine to create healthy work environments that in turn help promote employee engagement, wellbeing and productivity. Adequate lighting works best to improve behaviour, create less anxiety, stress, and improve overall health. In actual fact excessive or inadequate illuminance level is a potential hazard to human vision.

For these reasons, it has become imperative to proceed on the assessment of artificial lighting intensity in the offices in the newly established university to ascertain whether the lighting installations design meets the 300-500 lux standard stipulated by Charted Institution of Building Services Engineers (CIBSE) for general office and International Commission on Illumination (CIE) guideline that is appropriate and adequate for visual comfort and to avoid visual glare.

MATERIAL AND METHODS

A. Material

The instrument used for the measurement is a TES-1332A digital lux meter of size (135 × 72 mm) with attachable photo detector sensor of size (100 × 60 mm) as shown in Figure 1. The measuring ranges are 200/2000/20000/200000 with LCD monitor. The photo detector converts light into an electrical signal, an optical filter that ensures the same sensitivity as the human eye. It is used to measure the brightness of a place in units of "lux". One lux is equivalent to the light intensity of one lumen evenly distributed over one square metre. The digital lux meter used for the measurement is in conforming to internationally recognised specifications of British Standard (BS 667:2005), German Standard (DIN 5032-7:1985) and International Commission on Illumination Publication (CIE Publication No. 69:1987) with an attachable light sensor that is very sensitive to light entering the appliance.

Figure 1. TES-1332A Digital Lux Meter

B. Methods

The study were conducted during working hours for easy access to the offices. The illuminance at the sitting positions in the faculties were sample in 156 positions across five blocks. The offices illuminance levels were obtained from workers designated positions with attached tables. The offices have curtains at the windows so the illuminance levels were assessed with TES-1332A digital lux meter at the positions based on artificial light (lights on, windows' curtains and doors closed) and the photo detector placed horizontally on the table where visual task is normally performed ensuring that the light hits the sensor vertically. Analysis conducted with SPSS statistical package (version 21.0) encompassing Position, Block, and their Interactions.

RESULTS

A total of 156 observation positions in the offices were sample assessed from the five faculty blocks in the university for evaluation of illuminance level of staff. In Block 1 (Faculty of Art and Education), for the 42-sample points of offices assessed, the illuminance ranges from 165 to 546 lux, In Block 2 (Faculty of Agriculture), for the 22-sample points of offices assessed, the illuminance ranges from 124 to 315 lux. In Block 3 (Faculty of Science), for the 42-sample points of offices assessed, the illuminance ranges from 65 to 383 lux. In Block 4 (Faculty of Social and Management Science), for the 24-sample points of offices assessed, the illuminance ranges from 106 to 340 lux. In Block 5 (College of Medical and Health Sciences), for the 26-sample points of offices assessed, the illuminance ranges from 106 to 390 lux. These results attest to nonuniformity in nature of artificial lighting level in the buildings that are sources of distraction and discomfort that might influence the occupant performance. Table 1 is the comparative analysed data using SPSS 21.0 statistical package via ANOVA analytical methods.

Table 1: Analysis of Comparison between Blocks

Source	Type III Sum of Squares	Df	Mean Square	F	p-value
Corrected Model	99796.237[a]	9	11088.471	2.373	0.016
Intercept	7756843.613	1	7756843.613	1660.300	0.000
Position	33.636	1	33.636	0.007	0.932

*Corresponding Author: Ocheni, Abdullahi Ugbede Usman

Block	75360.480	4	18840.120	4.033	0.004
Position * Block	24434.981	4	6108.745	1.308	0.270
Error	682105.321	146	4671.954		
Total	9500239.000	156			
Corrected Total	781901.558	155			

The analysis of between-subjects' effects for the dependent variable "Light on" reveals significant findings. The corrected model, encompassing Position, Block, and their interaction, demonstrates a collective Type III Sum of Squares of 99796.237, with 9 degrees of freedom. The mean square is 11088.471, resulting in a statistically significant F-value of 2.373 (p = .016). Examining individual factors, the intercept displays substantial influence (Type III Sum of Squares = 7756843.613, F = 1660.300, p < .001), emphasizing its role in the model. However, Position and Position * Block interaction show non-significant effects (F = 0.007, p = .932; F = 1.308, p = .270, respectively). Block, on the other hand, exhibits significance (Type III Sum of Squares = 75360.480, F = 4.033, p = .004). The overall model explains 12.8% of the variance (R Squared = .128), and the adjusted R Squared is .074, suggesting a reasonable fit. In summary, the study underscores the significance of the intercept and Block in influencing the "Light on" variable, while Position and its interaction with Block do not contribute significantly.

Furthermore, Duncan multiple range test was conducted to assess the differences in the "Light on" variable across different blocks. The analysis identified three homogeneous subsets labelled 1, 2, and 3. In Block 5, comprising 26 observations, the mean was 208.00. Block 4, with 24 observations, had a mean of 214.42, and Block 2, with 22 observations, showed a mean of 230.77. Blocks 4 and 2 form Subset 1, with a marginally significant *p*-value of 0.051, suggesting potential differences between these blocks. Subset 2 includes Block 5 and Block 4, with a non-significant *p*-value of 0.133. Subset 3 consists of Block 3 and Block 1, with a significant *p*-value of 0.000, indicating notable differences between these blocks. The error term is calculated as Mean Square (Error) = 4671.954. It's important to note that the group sizes are unequal, and the harmonic mean of the group sizes (28.868) is used, introducing a potential for Type I error levels not being guaranteed. The significance level (alpha) is set at 0.05. Table 2 shows output for the analysed variables: Position, Location, Windows, and their interactions.

The offices were constructed to accommodate two sitting positions and arranged in similar setup per block for the assessed locations. So, the readings were marked based on 1st and 2nd sitting positions as shown in Figure 2.

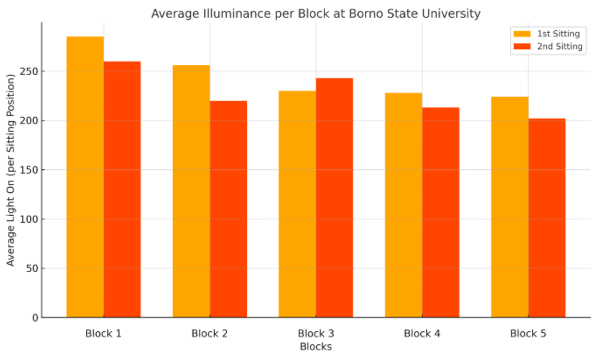

Figure 2: Average Illuminance per Block

The grouped bar chart shows an analysis of comparison of the average illuminance in five blocks (Block 1 to Block 5) in Borno State University. The two bars to each block in the chart represent the 1st sitting position and 2nd sitting position in the offices. It was observed that block 1 had maximum average illuminance of 282.9 lux in the 1st sitting position and 260.1 lux in the 2nd sitting position, which show that it is probably the brightest among the five blocks. Upon a more careful look one can notice that there is always greater illuminance at the 1st sitting position than the 2nd sitting position regardless of the block. This is due to bulb lighting locations and effect of natural light source through the windows. Surprisingly, there is a positive change in the trend in Block 3 with the 2nd sitting (244.0 lux) higher than the 1st sitting (230.3 lux). This is due to structural orientation of the block position.

On the whole, the chart provides a clear indication of spatial (between blocks) and time (sitting periods) variability of use of light. Such variations can be useful when it comes to maximizing energy use, enhancing lighting design and developing sustainable infrastructure.

DISCUSSION

Artificial lighting is a source of light pollution and have been reported as contributing to significant amount of carbon emissions, adding to global warming and which can negatively impact human health, plants and animal [7, 11]. The energy associated with artificial lighting is known as luminous energy, and it causes the sensation of vision when it falls on the eyes.

Excessive luminance level may cause disability glare and others effects such as damage to the cornea, damage to the conjunctiva, damage to the lens, damage to the retina, and damage to the fovea of the retina which occur when light from a very bright source reaches the eyes [3]. The quality of light of any work plane is supposed to at least meet or with the

*Corresponding Author: Ocheni, Abdullahi Ugbede Usman

range of the minimum specification for effective illumination level [8] to undertake safely, accurately, quickly and comfortably task. Occupational studies have also reported that diplopia and inability to concentrate are among the symptoms hampering the effective proficiency among workforce [10]. Some studies have been performed by researchers to assessed the illuminance level conformity with specified standards for visual safety of the occupants. The office workers' visual and non-visual effects of light colour temperature were determined using performance variables of alertness level, visual task performance, typing performance and subjective visual comfort in [12]. Oyeleye and Akanni in [4] evaluated lux level adequacy in school of engineering building and reported that 2.5% of illumination level met the conformed standard whereas 97.5% of the illumination level are below the standard. In [2], Yoon and Kim evaluated the level of visual comfort of 30 students in the Architecture Department via lighting adjustment of three different illuminance (30lx, 100lx, and 150 lx) and colour temperature (2700k, 4000k, and 6500k) settings for selections using a mock-up residence environmental built inside a construction environment laboratory of Kyung Hee University.

CONCLUSION

This research was conducted in other to assessed the lighting illuminance level scenario in offices of the faculties block of BOSU. With 300 to 500 lux as standard recommended illuminance level for offices, the study revealed 17.31% of the offices' illuminance level are within the specified range, 0.64% is above the recommended level and 82.05% of the offices have poor illuminance which are below the range stipulated by CIBSE. Position of the seat is the key factor significantly influencing the illuminance level not necessary the location of the block none the Windows, and their interactions do not show significant effects neither from the analysis. The steady decline of average illuminance level in the offices noticed between Block 1 to Block 5 could also mean that there exists variations in the equipment efficiency or the maintenance rate being undertaken which should require further investigation. It is the opinion of the authors that the lighting installations be re-examined so that the illuminance level in the offices could be within the stipulated range to enhance visual comfort of staff for safe and accurate daily performance of task.

ACKNOWLEDGMENT

Our sincere appreciations go to the staff members in the faculty for granting access to their respective offices for the smooth conduct of this research study.

REFERENCES

1. S. M. Aryani, A. Kusumawanto and J. A. Suryabrata, " Lighting in the workplace as the visual environment that affect the occupant's mood: A literature review," in *Proceedings of the 3rd International Conference on Dwelling Form (iDWELL 2020)*, Department of Architecture, Universitas Indonesia, 2020, October 27-28. https://www.atlantis-press.com/proceedings/idwell-20
2. G. H. Yoon and J. T. Kim, " The effects of illuminance and correlated color temperature on visual comfort of occupants' behavior," *KIEAE Journal*, vol. 14, no. 1, pp. 23-30, 2014. https://doi.org/10.12813/kieae.2014.14.1.023
3. C. Ticleanu, "Impacts of home lighting on human health," *Lighting Research & Technology*, vol. 53, p. 453–475, 2021. https://doi.org/10.1177/14771535211021064
4. M. O. Oyeleye and S. A. Akanni, "Evaluation of lux level adequacy: Case study of school of engineering, Federal University of Technology, Akure," *International Journal of Science and Engineering Investigations*, vol. 8, no. 90, pp. 74-79, 2019. http://www.ijsei.com/papers/ijsei-89019-11.pdf
5. R. Králiková, "Influence of lighting quality on productivity and human health," *Journal of Environmental Protection, Safety, Education and Management*, vol. 3, no. 5, pp. 42-48, 2015.
6. O. Ndiadiamaka, E. O. Nwobodo, M. C. Onuh and D. C. Ikwuka, "Assessment of the effect of blue light on visual activity," *International Journal of Research in Science and Technology*, vol. 13, no. 2, pp. 10-16, 07 march 2023. https://doi.org/10.37648/ijrst.v13i02.002
7. S. M. Simmons, S. W. Baur, W. Gills, D. Burns and H. Pickerill, "Optimizing exterior lighting illumnance and spectrum for human, environmental and economic factors," *IOP Conference Series: Earth and Environmental Science*, vol. 1099, no. 1, p. 012047, 2022. https://doi.org/10.1088/1755-1315/1099/1/012047
8. A. P. Azodo, C. Onwubalili and T. C. Mezue, "Illuminance quality and visual safety assessment of classroom environment in a Nigeria university," in *2ND International Engineering Conference (IECON, 2019)*, Michael Okpara University of Agriculture, Umudike, 2019.
9. Y. Feng, B. Fan, J. Xia and W. W.J., "Test and analysis of glare effect of incoherent directional beam," in *Proceeding of SPIE*, Beijing, 2023. https://doi.org/10.1117/12.2652053
10. Z. C. Zhao, Y. Zhou, G. Tan and J. Li, "Research progress about the effect and prevention of blue light on eyes," *International Journal of Ophthalmology*, vol. 11, no. 12, pp.1999-2003, 2018. https://doi.org/10.1824/ijo.2018.12.20
11. Z. Kong, D. M. Utzinger, K. Freihoefer and T. Steege, "The impact of interior design on visual discomfort reduction: A field study integrating lighting environments with POE survey," *Building and Environment*, vol. 138, pp. 135-148, 2018. https://doi.org/10.1016 /j.buildenv.2018.04.025
12. A. Sivaji, S. Shopian, Z. MohdNor, N.-K. Chuanb and S. Bahri, " Lighting does matter: Preliminary

*Corresponding Author: Ocheni, Abdullahi Ugbede Usman

assessment on office workers," in *The 9th International Conference on Cognitive Science*, 2013. https://doi.org/10.1016/j.sbspro.2013.10.283

*Corresponding Author: Ocheni, Abdullahi Ugbede Usman