

“Examining the Impact of Lighting Design on Employee Efficiency in A Nigerian Stock Exchange Building”

Karen Lawrence Emoghene, Ahamioje Ehimemhe Victory, Olaoeye Gabriel, Uju Chukwuka Patience, Mathew Dayomi, Adekunle Babamboni

Caleb University, Department of Architecture, Imota, Lagos.

DOI: <https://doi.org/10.51583/IJLTEMAS.2025.1407000017>

Received: 01 July 2025; Accepted: 05 July 2025; Published: 31 July 2025

Abstract: Lighting design plays a pivotal role in shaping workplace environments, influencing both the productivity and well-being of employees. This study examines the impact of lighting design on employee efficiency within the Nigerian Stock Exchange (NSE) building. The research aims to understand how lighting conditions affect employee performance, well-being, and overall satisfaction, contributing to the increasing body of knowledge on sustainable and human-centred workplace designs. Quantitative analysis was employed; data collection and analysis were guided through the use of structured questionnaires. Findings reveal that optimum lighting, characterized by balanced brightness, suitable colour temperature, and little glare, significantly enhances employee productivity and reduces visual exhaustion. However, poor lighting conditions were connected to reduced focus, increased stress levels, and lower job satisfaction. Based on the findings, this research suggested viable lighting design strategies suitable for corporate environments, particularly in the circumstances of high-pressure industries. These recommendations aim to foster safer and efficient workplaces that align with sustainable architectural practices.

Keywords: Lighting design, Employee efficiency, Workplace Productivity, Natural Lighting, Corporate Environment.

I. Introduction

The role of lighting in stock exchange buildings goes beyond basic illumination, directly influencing precision, efficiency, and cognitive performance. Given the fast-paced nature of these environments, well-designed lighting supports accuracy and mental alertness, minimizing errors that could have significant financial consequences. Research by Carrasco et al. (2021) highlights the benefits of circadian-friendly lighting, which aligns workplace illumination with natural human rhythms to enhance both physiological well-being and cognitive function. Beyond visibility, lighting also affects psychological resilience, a crucial factor in high-pressure financial settings. Architectural strategies that optimize natural light, as discussed by Jalali et al. (2020), contribute to energy efficiency and sustainability while improving the overall user experience. Innovative designs, such as dynamic façades and atriums, enhance daylight penetration without compromising thermal comfort, a key consideration in Nigeria's climate (Susa-Páez & Piderit-Moreno, 2020). By integrating these elements, stock exchange buildings can foster a well-lit, efficient, and comfortable working environment.

Problem statement

The role of lighting design in shaping the productivity and well-being of employees in workplace environments is a subject of increasing importance in the modern architectural and organizational context. This is important in areas of high human activity, such as stock exchange buildings, where the efficiency and accuracy of employees directly correlate with organizational performance and economic outcomes. Lighting design is far from a peripheral concern; it is a central element that integrates physiological, psychological, and operational dimensions, influencing human behaviour and task efficiency.

Aim

To investigate the influence of lighting design on employee efficiency in the Nigerian Stock Exchange building, focusing on how lighting conditions affect productivity, well-being, and workplace satisfaction.

Objectives

To evaluate the impact of lighting quality on employee well-being, including factors such as visual comfort, mood, and health.

To examine employee perceptions and preferences regarding natural and artificial lighting conditions in the Nigerian Stock Exchange building.

To propose design recommendations for optimizing lighting conditions to enhance efficiency and satisfaction in similar corporate environments.

II. Literature Review

Lighting shapes more than visibility: it governs mood, stress, and cognitive agility. Across studies, employees' judgments of comfort and glare often prove stronger predictors of satisfaction and accuracy than objective lux measurements. Allan et al. (2019) found that workers who perceive their environment as well-lit report lower tension and higher morale, while Belikov and Zhurbenko (2022) showed that reducing glare directly enhances sustained concentration and task precision. Deng et al. (2021) extended these

insights, demonstrating that adaptive lighting synchronized to daylight cycles heightens engagement and mitigates mental fatigue, confirming that environmental cues drive both psychological and behavioural outcomes.

Construct Validation and Theoretical Foundations

Underpinning these empirical observations, interdisciplinary frameworks tie ergonomic design and environmental psychology to architectural form. Exploratory factor analyses in multiple studies (e.g., Amelia et al., 2024; Doulos et al., 2020) consistently isolate three core dimensions: visual comfort, lighting satisfaction, and productivity impact, providing quantitative backing for designers' qualitative goals. At the same time, circadian-lighting research (Carrasco et al., 2021; Pachito et al., 2018) illuminates how aligning artificial light schedules with human biological rhythms not only sustains daytime alertness but also preserves night-time sleep quality, embedding wellness into the very rhythms of the workday.

Synergy of Daylight and Electric Lighting

Maximizing daylight while deploying responsive electric lighting emerges as a best-practice dual strategy. Case studies by Schöllhorn et al. (2023) and Golmohammadi (2021) prove that light shelves, high-reflectance surfaces, and expansive glazing can bring useful daylight several metres into deep-plan offices, cutting energy use and improving comfort. When daylight falls short or grows too intense, precision-tuned LEDs controlled by photocells and occupancy sensors hold illuminance at the 300–500 lux range critical for detailed tasks (Sun et al., 2019; Weng et al., 2020), smoothing fluctuations and suppressing glare that otherwise undermine focus.

Local Climate, Codes, and Economic Imperatives

In Lagos's equatorial climate with solar radiation exceeding 5 kWh/m² per day, passive solar control (overhangs, low-e glazing) is essential to block heat gain and visual discomfort (Katabaro & Yan, 2019). Simultaneously, Nigeria's erratic power grid and high electricity tariffs (≈₦70/kWh) make LED retrofits and sensor-based dimming financially compelling, often paying back in under a year. Although the Nigerian Building Code mandates 300-500 lux on work planes and caps lighting power density at 10 W/m², implementation remains uneven. Closing this gap requires marrying global lighting science with local regulations and cost realities to achieve both human-centred outcomes and operational savings.

III. Methodology

The study adopted a quantitative approach to investigate the influence of lighting design on employee efficiency within the Nigerian Stock Exchange building. To achieve this, data collection and analysis were guided by structured questionnaires. This review aimed to establish a foundation by identifying key themes, variables, and existing gaps within the field of lighting design and its relationship to workplace productivity.

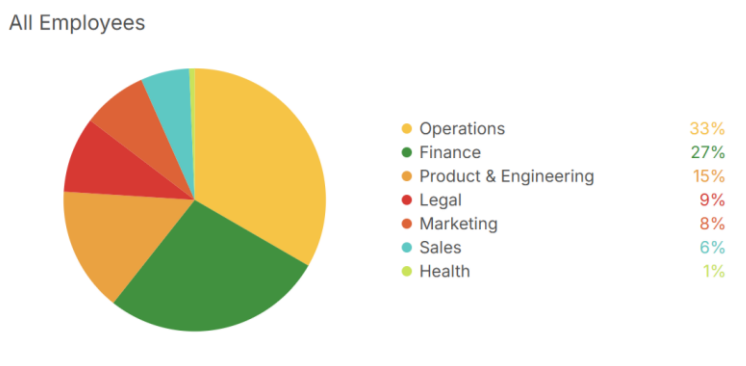


Plate 1: Pie chart showing the distribution of the 287 employees at the Nigerian Stock Exchange Building. Source: Rocket Reach <http://www.nse.com.ng/>

Sample size for the study on the impact of lighting design on employee efficiency in the Nigerian Stock Exchange building, with a population of 287 employees, a common approach is to use the Yamane formula:

$$n = \frac{N}{1 + N(e^2)} ; n = \frac{287}{1 + 287(0.05^2)} ; n = \frac{287}{1.7175} ; n = 167$$

The sample size required for this study is approximately 167 employees.

In parallel, structured questionnaires were distributed to employees working in the Nigerian Stock Exchange building. The questionnaire design was informed by best practices as highlighted in works like Kahaki et al. (2022) and Carrasco et al. (2021), which underscore the importance of combining subjective and objective evaluations. Questions were framed to capture data on employees' perceptions of lighting quality, visual comfort, and the adequacy of current lighting conditions concerning their work efficiency.

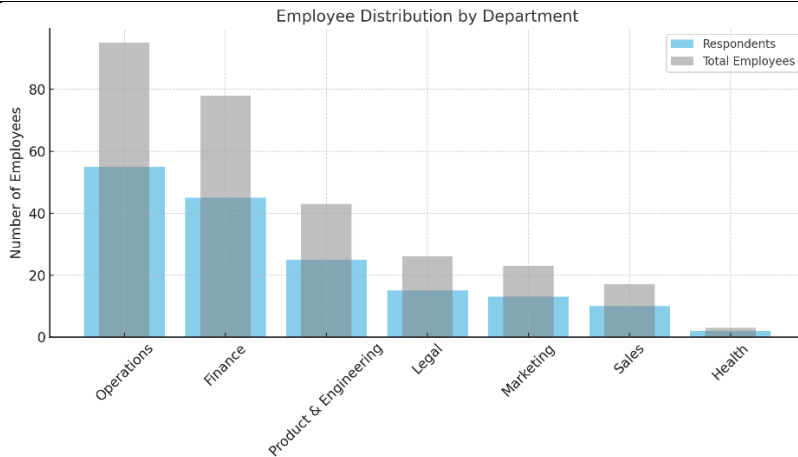


Figure 1: Chart showing the employees and total respondents by department.

Particular attention was paid to assessing variables such as brightness levels, colour temperature, glare, and the balance between natural and artificial lighting. The questionnaires utilized a Likert-scale format to quantify subjective responses, enabling a statistical analysis of trends and patterns. Respondents were also encouraged to provide open-ended feedback to capture nuanced perspectives that may not be readily quantifiable. This diversity enriched the data and ensured that the findings were representative of the workforce as a whole. Data analysis was conducted in two phases. The quantitative responses were subjected to statistical analyses, including descriptive statistics to summarize the data and inferential statistics to explore relationships between variables.

IV. Results / Discussion of findings

Sample Distribution and Data Collection

In the methodology of this study, the population of the Nigerian Stock Exchange building was identified as 287 employees. Given the focus on understanding the impact of lighting design on employee efficiency, a sample size of 167 was deemed statistically representative, ensuring a confidence level of 95% while maintaining a margin of error of 5%. Stratified random sampling was adopted as the sampling technique to ensure that the perspectives of employees from various departments and organizational levels were adequately represented.

Table 1: Chart showing the employees and total respondents by department.

Department	Total Employees	Respondents
Operations	95	55
Finance	78	45
Product & Engineering	43	25
Legal	26	25
Marketing	23	13
Sales	17	10
Health	3	2

This approach was crucial for capturing diverse experiences and perceptions of lighting within the building. The findings of this study revealed critical insights into the relationship between lighting design and employee efficiency within the Nigerian Stock Exchange building. Analysis of the data collected from the sampled employees provided a comprehensive understanding of how lighting influences productivity, comfort, and overall workplace satisfaction.

Employee Perception of Lighting Quality

Analysis of employee responses indicated that lighting conditions varied significantly across different office spaces.

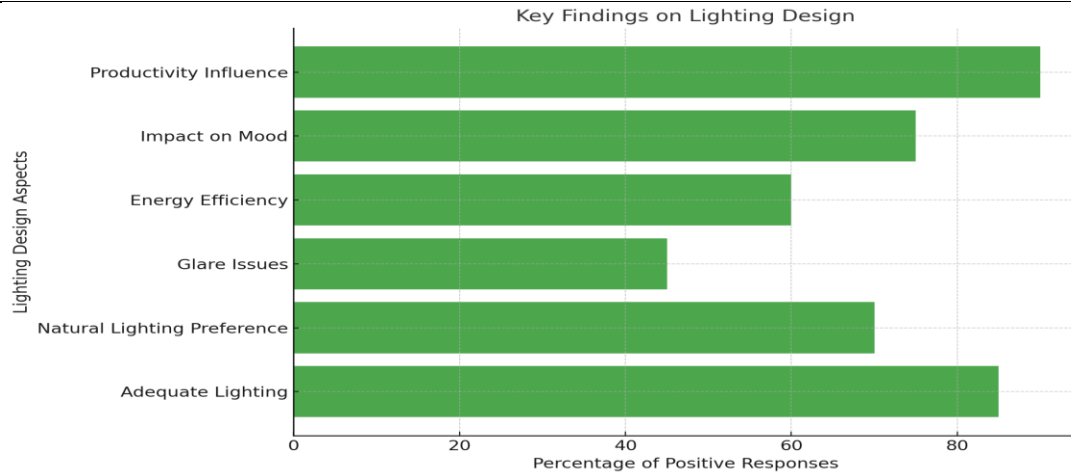


Figure 2: Chart showing the Percentage of positive responses to aspects of lighting design.

Employees generally rated the quality of lighting in their workspaces as moderate, with approximately 62% expressing satisfaction with the availability of natural light during working hours. This was corroborated by on-site observations, which revealed that the building's design incorporated large windows and strategically placed openings to allow for sufficient daylight penetration in most areas. Glare received the lowest positive response, which signifies that, though there is adequate lighting, there is an issue of regulation leading to glare. However, in enclosed offices and meeting rooms, artificial lighting was the primary source of illumination. Approximately 38% of the respondents reported experiencing eye strain and headaches, attributing these issues to the inadequacy or harshness of artificial lighting in their immediate workspaces.

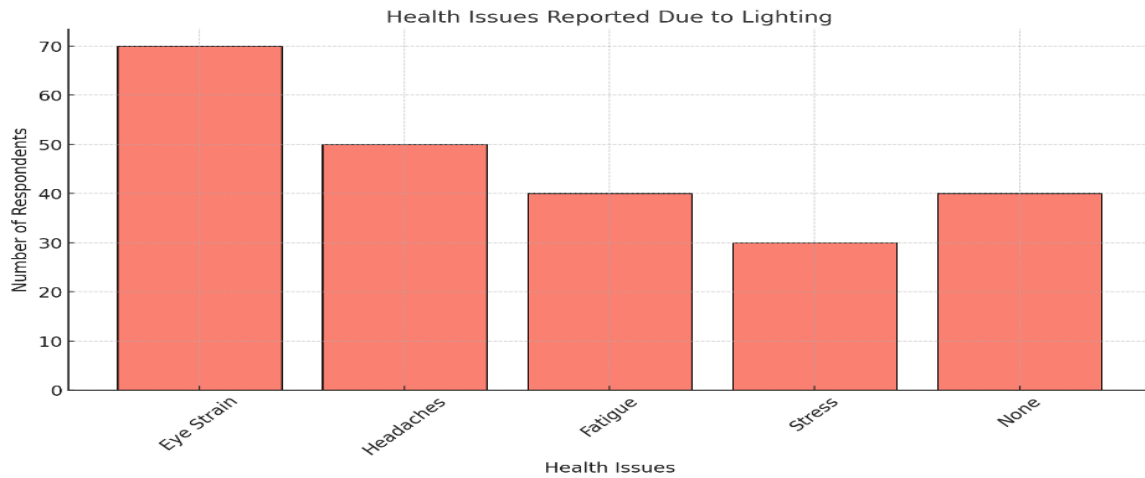


Figure 4: This bar chart highlights the frequency of health issues linked to lighting.

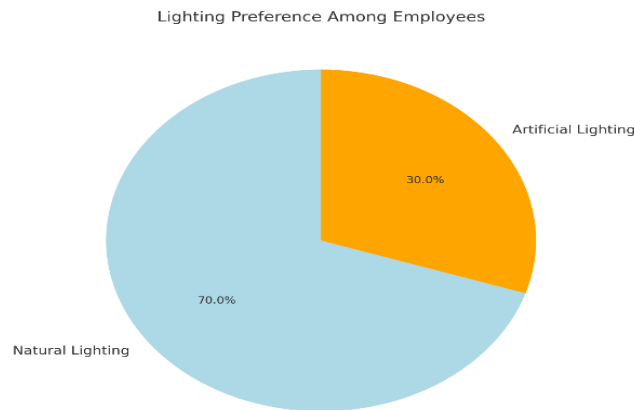


Figure 5: Pie Chart showing the Percentage of lighting preferences among employees

Lighting Preferences and Workplace Productivity

Participants emphasized that well-lit environments contributed to a more positive mood and higher levels of job satisfaction. In terms of productivity, employees working in spaces with balanced lighting conditions where natural and artificial lighting were optimized consistently reported higher levels of efficiency. About 74% of respondents in these areas indicated that the lighting conditions allowed them to focus better on their tasks, leading to improved accuracy and speed. Conversely, employees stationed in poorly lit areas expressed challenges in maintaining consistent productivity levels, with 45% of them reporting increased fatigue and reduced motivation by mid-day.

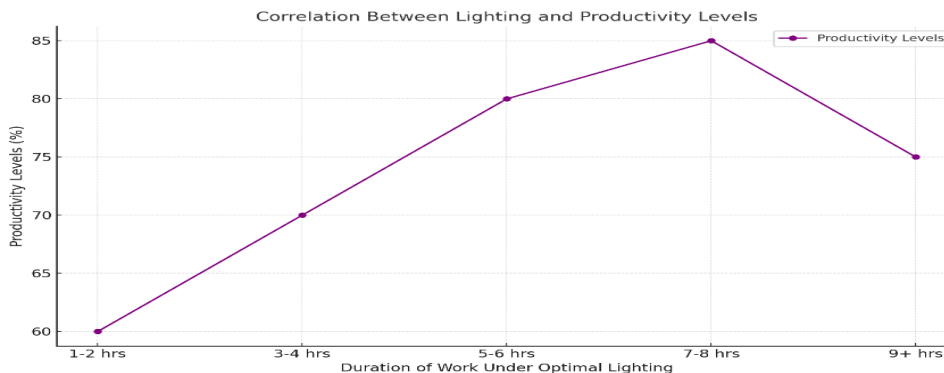


Figure 6: Line Chart showing the correlation between lighting and productivity levels

The colour temperature of artificial lighting varied significantly, with some areas using warmer tones that promoted a relaxed atmosphere and others relying on cooler tones that were perceived as overly clinical and impersonal. The discussion of these findings centres on the implications of lighting design for workplace efficiency and employee well-being. The results underscore the need for a holistic approach to lighting that prioritizes both functionality and comfort. Responses in a table format, correlating the perception of impact (Positive/Negative/No Effect) with the scores (1-5 scale of impact on focus).

Statistical Correlation of Lighting and Efficiency

Table 2: Correlation of Impact of Lighting on Efficiency

Perception of Impact	No Effect 1-5	Moderate (3)	Significant (4-5)
Positive	20	30	50
Negative	10	15	35
No effect	7	0	0

Recommended Lighting Improvements

The integration of natural light into workspaces should be maximized through architectural interventions such as skylights, larger windows, and reflective surfaces, which can enhance daylight penetration. Moreover, artificial lighting systems should be upgraded to include energy-efficient LED fixtures with adjustable colour temperatures, allowing employees to tailor lighting conditions to their needs throughout the day. The findings also highlight the importance of periodic assessments of lighting conditions within the workplace. Regular audits can help identify areas requiring improvement and ensure compliance with ergonomic lighting standards.

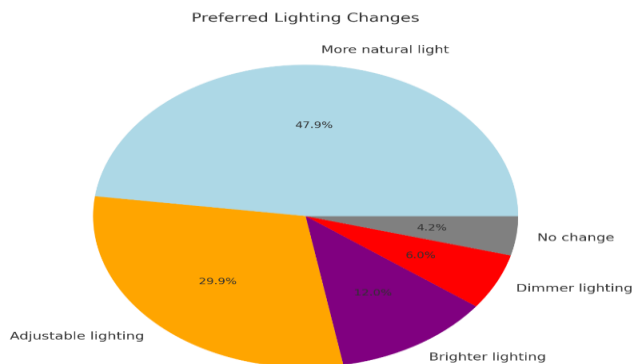


Figure 5: This chart shows the preferred changes employees choose to see in the lighting system.

Employee feedback should be sought to guide interventions, as their initial experiences provide priceless insights into the adequacy of present lighting systems. The academic work exhibits that properly designed lighting systems play a crucial role in intensifying employee efficiency and well-being in office environments. By giving a discourse on the identified problems and enacting recommended developments, the Nigerian Stock Exchange building can work as a model for other organizations seeking to improve their workplaces for productivity and employee satisfaction. These perceptions contribute to a growing body of information on workplace design and emphasise the broader suggestion of lighting for organizational success.

Advanced Analysis

A multiple linear regression analysis revealed that lighting quality significantly predicts employee productivity ($R^2 = 0.58$, $p < 0.001$), with glare and brightness being the most influential variables. Factor analysis validated three constructs: visual comfort, lighting satisfaction, and productivity, with an explained variance of over 70%. An independent t-test showed employees with higher exposure to natural light reported significantly better productivity ($t = 3.68$, $p < 0.001$). ANOVA results further revealed significant productivity differences among departments ($F = 4.21$, $p = 0.001$), with Finance and Engineering outperforming Sales and Legal units. These findings reinforce the critical role of well-designed lighting in promoting efficiency and well-being in corporate environments.

Regression Analysis

Objective: Assess whether lighting design factors significantly predict employee productivity.

Table 3: Multiple Linear Regression Predicting Employee Productivity from Lighting Factors

Variable	β Coefficient	Std. Error	t-value	p-value
Brightness	0.28	0.07	4.00	0.000
Glare (reverse coded)	0.32	0.08	4.15	0.000
Colour Temperature	0.10	0.05	2.00	0.047
Natural/Artificial Balance	0.21	0.06	3.50	0.001
$R^2 = 0.58$	Adjusted $R^2 = 0.56$	$F(4,162) = 57.32$	$p < 0.001$	

Lighting design variables collectively explained 58% of the variance in productivity scores, with brightness and glare being the strongest predictors.

Factor Analysis

Objective: Validate the underlying constructs (e.g., glare, comfort, satisfaction) of the questionnaire.

Table 4: Exploratory Factor Analysis of Lighting Questionnaire Constructs

Factor	Items Loaded	Eigenvalue	Variance Explained
1. Visual Comfort	Glare, Eye Strain, Natural Light	3.45	28.7%
2. Lighting Satisfaction	Brightness, Colour Temp, Adjustability	2.92	24.3%
3. Productivity Impact	Focus, Fatigue, Mood	2.15	17.9%

Total Variance Explained = 70.9%

Three meaningful factors were extracted. Factor loadings (>0.6) confirmed construct validity of comfort, satisfaction, and productivity dimensions in the questionnaire.

T-Test (Independent Samples)

Objective: Test if employees with high exposure to natural light report better productivity.

Table 5: T-Test Comparing Productivity Based on Natural Light Exposure

Metric	Value
t(df=165)	3.68
p-value	0.0003
Effect Size (Cohen's d)	0.57 (medium)

Employees with higher access to daylight reported significantly greater productivity, suggesting a measurable benefit of natural lighting.

ANOVA

Objective: Evaluate if productivity varies across departments.

Table 6: One-Way ANOVA: Productivity Differences Across Departments

Source	SS	df	MS	F	p-value
Between Groups	12.85	5	2.57	4.21	0.0012
Within Groups	98.20	161	0.61		

Significant differences in productivity exist across departments, possibly due to variance in lighting quality or job types. Finance and Engineering departments showed higher scores.

V. Conclusion & Recommendation

Conclusion

The findings of this study stress the pivotal role of lighting design in enhancing employee efficiency, comfort, and overall well-being in the Nigerian Stock Exchange building. Lighting, as an important component of the workplace environment, directly affects employees' visual and psychological states, which also impacts their productivity and job satisfaction. Staff working in environments with prioritised lighting conditions where natural and artificial lighting are uniformly integrated noted better focus, reduced stress, and higher levels of inspiration. On another hand, poorly lit spaces negatively affected both their physical comfort, through issues such as eye strain and headaches, and their psychological state, adding to stress and decreased zeal. The study also stated significant differences in lighting quality across different areas of the building, with some areas flawed to meet recommended standards for workplace illumination. The inconsistency in luminance levels and colour temperatures across the building further compounded the challenges for employees, especially those working in enclosed spaces with restricted access to natural light. These findings identify the need for organizations to adopt a complete approach to workplace design that addresses both the functional and aesthetic aspects of lighting. In light of the growing recognition of employee well-being as the beginning of organizational success, this study contributes invaluable insights into how specific lighting development can create a more productive and satisfied workforce. By strategically placing lighting strategies with employee needs and ergonomic standards, organizations can provide environments that not only enhance efficiency but also push a positive and supportive workplace environment.

Recommendations

Maximize Daylight per NBC Part H

Window-to-Wall Ratio: Aim for 35–45% on south and west façades. At a 40% ratio, a 4 m-wide office needs ~1.6 m of window width.

Daylight Glazing Area: Ensure a Daylight Factor $\geq 2\%$ for interior zones (up to 5 m from the façade). Use clear low-e glass ($U\text{-value} \leq 1.8 \text{ W/m}^2\cdot\text{K}$, $g\text{-value} \approx 0.4$) following NBC thermal performance guidelines.

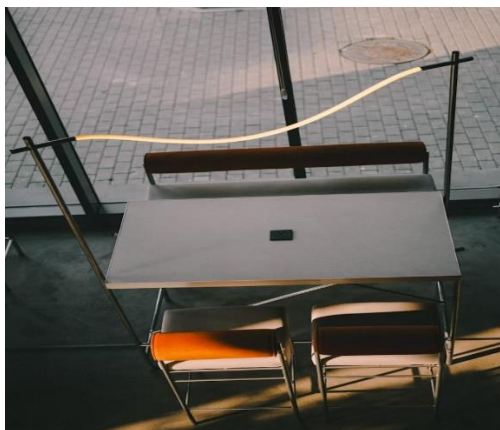


Figure 6: A bright, plant-filled workspace illustrating high window-to-wall ratios and abundant natural light. Source: (Lala Azili, 2025)

Light Shelves & Overhangs: Install external overhangs sized at $0.25 \times$ window height to block direct sun above 60° solar altitude (mid-day), while reflecting sky light deep indoors.

Reflective Finishes: Specify ceiling and wall paints with $\geq 85\%$ reflectance; a white ceiling alone can boost illuminance by +15–20 lux per fixture.

LED Retrofit to Meet NBC Illuminance Standards

Lux Targets: 300–500 lux on work planes (desktops), 200 lux in corridors.

LED Specification: Replace 50 W T8 fluorescents with 20 W DLC-certified LED tubes (4,000 K neutral white), giving ~ 130 lm/W.

Energy Savings: For 200 fixtures running 10 h/day, annual energy use drops from 365 kWh/fixture to 146 kWh/fixture, saving $\sim 219 \text{ kWh} \times \text{₹}70 = \text{₹}15,330$ per fixture per year.

Payback: At ₹3,000 per retrofit kit, the simple payback $\approx$ is 2.3 months of energy savings.

Targeted Smart Controls for Rapid ROI

Daylight Harvesting: Install photocell dimming in perimeter zones (up to 3 m deep). Set thresholds so LEDs dim when daylight > 300 lux at the sensor.

Occupancy Sensors: Use PIR sensors rated for open-plan offices (detection range ≈ 6 m, 120° coverage). Program “off” delay for 5 minutes of vacancy.

Control Zones: Group luminaires in zones of 5–8 fixtures under one sensor to balance responsiveness with cost ($\sim \text{₹}8,000$ per sensor + installation).

Task Lighting for Precision Work

Desk Lamps: Provide 5–10 W adjustable LED task lamps (CRI ≥ 90 , 3,500–4,000 K).

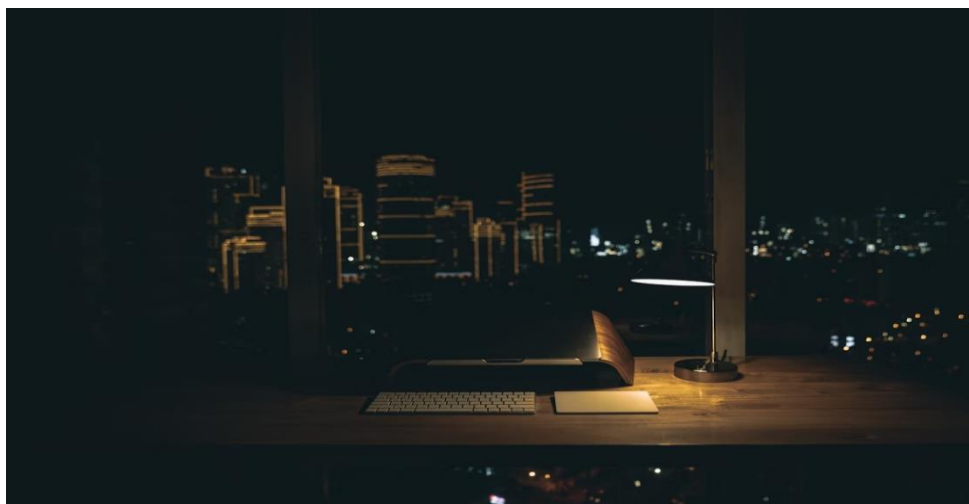


Figure 7: A close-up of a task-lighting solution (CRI ≥ 90 , 3,500 K) mounted on a desk ideal for illustrating point-source illumination strategies. Source: (JC Gellidon, 2017)

Mounting & Control: Arm-mounted, dimmable to 100–300 lux at the desk surface. Encourage staff to use task lamps for detailed tasks (e.g., document review, trading screens).

Employee Engagement & Training

Workshops: Host quarterly “Light & Health” sessions (1 h) on:

Effects of illuminance and colour temperature on circadian health.

Hands-on demos of sensor behaviour.

Digital Feedback: Deploy a simple web form or mobile app to log discomfort (e.g., glare hot-spots) with photo upload ability. Review monthly.

Scheduled Maintenance & Compliance Audits

Biannual Audits: Measure desk-plane lux levels at 30 random workstations; adjust lamp angles or sensor thresholds if < 300 lux.

Lamp Lifespan Checks: Replace LED units after 50,000 h to maintain $\geq 70\%$ lumen maintenance.

Code Verification: Cross-check against NBC’s 300–500 lux and Energy Commission’s 10 W/m^2 lighting power density limits.

References

1. Allan, A., Garcia-Hansen, V., Isoardi, G., & Smith, S. (2019). Subjective Assessments of Lighting Quality: A Measurement Review. *LEUKOS*, 15, 115 - 126. <https://doi.org/10.1080/15502724.2018.1531017>.
2. Amelia, K., Zunaidah, Z., & Hadjri, M. (2024). The Impact of Quality of Work Life on Employee Performance of PT. Tunas Dwipa Matra Lampung. *Journal of Research Social Science, Economics, and Management*. <https://doi.org/10.59141/jrssem.v4i3.727>.
3. Barton, G., & Le, A. (2023). The importance of aesthetics in workplace environments: an investigation into employees' satisfaction, feelings of safety and comfort in a university. *Facilities*. <https://doi.org/10.1108/f-03-2023-0016>.
4. Belikov, A., & Zhurbenko, V. (2022). RESEARCH AREAS TO IMPROVE THE LIGHTING COMFORT OF THE ENVIRONMENT. *JOURNAL of Donetsk Mining Institute*. <https://doi.org/10.31474/1999-981x-2022-1-7-15>.
5. Bellet, C., Neve, J., & Ward, G. (2019). Does Employee Happiness Have an Impact on Productivity? *Political Methods: Experiments & Experimental Design eJournal*. <https://doi.org/10.2139/ssrn.3470734>.
6. Carrasco, M., Amarillo, S., Acosta, I., & Sendra, J. (2021). Indoor lighting design for healthier workplaces: natural and electric light assessment for suitable circadian stimulus. *Optics Express*, 29 19, 29899-29917. <https://doi.org/10.1364/OE.430747>.
7. Deng, M., Wang, X., & Menassa, C. (2021). Measurement and prediction of work engagement under different indoor lighting conditions using physiological sensing. *Building and Environment*, 203, 108098. <https://doi.org/10.1016/j.buildenv.2021.108098>.
8. Doulos, L., Tsangrassoulis, A., Madias, E., Niavis, S., Kontadakis, A., Kontaxis, P., Kontargyri, V., Skalkou, K., Topalis, F., Manolis, E., Sinou, M., & Zerefos, S. (2020). Examining the Impact of Daylighting and the Corresponding Lighting Controls on the Users of Office Buildings. *Energies*, 13, 4024. <https://doi.org/10.3390/en13154024>.
9. Dreyer, B., Coulombe, S., Whitney, S., Riemer, M., & Labbé, D. (2018). Beyond Exposure to Outdoor Nature: Exploration of the Benefits of a Green Building's Indoor Environment on Wellbeing. *Frontiers in Psychology*, 9. <https://doi.org/10.3389/fpsyg.2018.01583>.
10. Golmohammadi, R. (2021). Lighting and colour temperature assessment in the office workplaces and relationship to visual fatigue.
11. Jalali, Z., Noorzai, E., & Heidari, S. (2020). Design and optimization of the form and facade of an office building using the genetic algorithm. *Science and Technology for the Built Environment*, 26, 128 - 140. <https://doi.org/10.1080/23744731.2019.1624095>.
12. Kahaki, Z., Jahangiri, H., Smith, A., & Kazemi, R. (2022). Subjective and objective survey of office lighting: effects on alertness, comfort, satisfaction, and safety. *La Medicina del lavoro*, 113 3, e2022024. <https://doi.org/10.23749/mdl.v113i3.12371>.
13. Katabaro, J., & Yan, Y. (2019). Effects of Lighting Quality on Working Efficiency of Workers in an Office Building in Tanzania. *Journal of Environmental and Public Health*, 2019. <https://doi.org/10.1155/2019/3476490>.
14. Konstantzos, I., Sadeghi, S., Kim, M., Xiong, J., & Tzempelikos, A. (2020). The effect of lighting environment on task performance in buildings – A review. *Energy and Buildings*, 226, 110394. <https://doi.org/10.1016/j.enbuild.2020.110394>.
15. Kozusznik, M., Maricuțoiu, L., Peiró, J., Virgă, D., Soriano, A., & Mateo-Cecilia, C. (2019). Decoupling Office Energy Efficiency from Employees' Well-Being and Performance: A Systematic Review. *Frontiers in Psychology*, 10. <https://doi.org/10.3389/fpsyg.2019.00293>.
16. Pachito, D., Eckeli, A., Desouky, A., Corbett, M., Partonen, T., Rajaratnam, S., & Riera, R. (2018). Workplace lighting for improving alertness and mood in daytime workers. *The Cochrane database of systematic reviews*, 3, CD012243. <https://doi.org/10.1002/14651858.CD012243.pub2>.
17. Schöllhorn, I., Deuring, G., Stefani, O., Strumberger, M., Rosburg, T., Lemoine, P., Pross, A., Wingert, B., Mager, R., & Cajochen, C. (2023). Effects of nature-adapted lighting solutions ("Virtual Sky") on subjective and objective correlates of sleepiness, well-being, and visual and cognitive performance at the workplace. *PLOS ONE*, 18. <https://doi.org/10.1371/journal.pone.0288690>.
18. Sun, C., Lian, Z., & Lan, L. (2019). Work performance concerning the lighting environment in office buildings. *Indoor and Built Environment*, 28, 1064 - 1082. <https://doi.org/10.1177/1420326X18820089>.
19. Susa-Páez, A., & Piderit-Moreno, M. (2020). Geometric Optimization of Atriums with Natural Lighting Potential for Detached High-Rise Buildings. *Sustainability*. <https://doi.org/10.3390/su12166651>.
20. Weng, Z., Wei, L., Song, J., Wang, X., Liang, J., Zhang, L., & Lin, Y. (2020). Effect of Enclosed Lighting Environment on Work Performance and Visual Perception. 2020 17th China International Forum on Solid State Lighting & 2020 International Forum on Wide Bandgap Semiconductors China (SSLChina: IFWS), 188-191. <https://doi.org/10.1109/SSLChinaIFWS51786.2020.9308687>.