

“Harnessing Natural Light: Architectural Strategies for Urban Office Buildings”

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ABSTRACT

Natural lighting is a critical component of sustainable architectural design, particularly in dense urban settings where office buildings often struggle to achieve optimal daylight penetration. This study investigates architectural strategies for harnessing natural light in urban office buildings, with the Nigeria Stock Exchange (NGX) Building serving as the study area. Data were collected through structured questionnaires administered to 168 employees across various departments. Quantitative data were analysed using SPSS to generate descriptive statistics, while qualitative insights were explored through NVivo thematic analysis. The findings reveal that although natural light significantly enhances employee mood, visual comfort, and productivity, challenges such as glare, heat gain, and uneven light distribution persist, especially in interior zones. Respondents strongly support the adoption of modern façade technologies, automated shading systems, and internal light modulation strategies as solutions. The study concludes that a balanced integration of daylighting and advanced architectural technologies is essential for creating healthier, more productive, and energy-efficient office environments. Recommendations include façade modernisation, incorporation of light shelves, and introduction of sky-lit communal spaces to optimise daylight use while mitigating its adverse effects. These insights offer practical guidance for architects, planners, and building managers engaged in the design or retrofit of urban office buildings.

Keywords: Natural lighting, urban office buildings, daylighting strategies, façade technology, employee comfort

I. INTRODUCTION

In the design of urban office buildings, the strategic use of natural light stands as one of the

most impactful approaches for creating environments that promote productivity, health, and well-being. As cities continue to densify and workspaces evolve, the architectural integration of daylight has shifted from being an aesthetic preference to a functional imperative. Natural light not only shapes the visual and spatial quality of office interiors but also exerts measurable influence on the physiological, psychological, and behavioural responses of occupants (Carrasco et al, 2021; Konstantzos et al, 2020). The relationship between lighting and human performance is well established. Numerous studies underscore that exposure to natural daylight within the workplace enhances mood, elevates alertness, reduces visual fatigue, and supports circadian health (Pachito et al, 2018; Schöllhorn et al, 2023). In urban office settings where artificial illumination often dominates, poorly considered lighting design has been linked to diminished satisfaction, decreased work engagement, and increased complaints related to discomfort and eyestrain (Golmohammadi, 2021; Kahaki et al, 2022). The work of Katabaro and Yan (2019) further highlights that lighting quality significantly affects employees' efficiency, making daylighting strategies a key consideration in contemporary office architecture.

From an environmental perspective, reliance on natural light contributes directly to energy savings by reducing dependence on artificial lighting systems during daytime hours. As urban office buildings account for a substantial portion of energy consumption in cities, daylight-responsive design supports broader sustainability goals while simultaneously enhancing user comfort (Doulos et al, 2020; Kozusznik et al, 2019). The optimisation of form and façade for daylight penetration, as demonstrated in parametric and genetic algorithm-based studies, represents one of the most promising pathways to achieving this dual objective (Jalali et al, 2020; Susa-Páez & Piderit-

Moreno, 2020). Equally important is the impact of natural light on employees' perceptions of their workspace. As Barton and Le (2023) observe, aesthetics, including the interplay of daylight and interior design, significantly influence feelings of safety, comfort, and satisfaction. The emotional and cognitive benefits of well-lit environments contribute to organisational outcomes, with evidence suggesting a positive correlation between employee happiness and productivity (Bellet et al, 2019; Amelia et al, 2024). However, integrating daylight into high-density urban office buildings is not without its challenges. Designers must navigate issues related to glare control, thermal comfort, and uniform distribution of light across deep floor plates (Belikov & Zhurbenko, 2022; Allan et al, 2019). Moreover, the success of daylighting strategies depends on the synergy between architectural form, interior layout, materials selection, and adaptive lighting controls (Deng et al, 2021; Weng et al, 2020). The objective, therefore, is not simply to maximise daylight ingress but to harness it in a manner that balances visual, thermal, and energy performance criteria. This study investigates architectural strategies that effectively leverage natural light in urban office buildings. It draws on recent research and emerging best practices to propose design solutions that align with both human-centric and environmental priorities. By examining how architectural elements from building orientation and massing to façade systems and interior configurations can be optimised for daylight, the research aims to inform the design of urban offices that are not only efficient but also enriching places for work.

1.1 Aim & Objective

The aim of the Study is to investigate and propose architectural strategies that optimise the use of natural light in urban office buildings, with the goal of enhancing occupant well-being, improving energy efficiency, and creating high-quality working environments.

The Objectives of the Study are:

1. To analyse contemporary architectural design approaches and façade technologies that facilitate effective daylight penetration in urban office buildings.
2. To evaluate the impact of natural lighting strategies on employee comfort, health, and productivity in office environments.
3. To develop design recommendations for integrating natural light in urban office buildings while mitigating associated

challenges such as glare and thermal discomfort.

II. LITERATURE REVIEW

Natural light has long been recognised as a vital component of architectural design, particularly in the context of urban office buildings where access to daylight can significantly shape the experience and productivity of occupants. As urban environments become denser and office buildings taller, architects face the dual challenge of maximising natural light penetration while balancing thermal comfort, energy efficiency, and user satisfaction. A review of current scholarship reveals a convergence of research around the psychological, physiological, and performance-related implications of daylighting, alongside evolving architectural strategies aimed at optimising its use.

2.1 The Psychological and Physiological Importance of Natural Light in Offices

The relationship between natural lighting and occupants' well-being is well-documented across various studies. Schöllhorn et al. (2023) examined the influence of nature-adapted lighting systems such as virtual sky installations on workers' sleepiness, cognitive functioning, and overall well-being, highlighting the capacity of biomimetic lighting to simulate natural conditions and foster comfort. Similarly, Carrasco et al. (2021) explored the synchronisation of circadian rhythms through lighting design, underlining the critical role of natural and artificial light in supporting healthier workplaces. The study points out that improper lighting, whether in terms of spectral composition or intensity, can disrupt these rhythms, thereby impacting alertness and mood. Further reinforcing these insights, Pachito et al. (2018) demonstrated through a systematic review that well-designed workplace lighting can contribute to improved mood and reduced fatigue among daytime workers. The findings suggest that beyond visibility, lighting functions as a determinant of mental and emotional health, advocating for office designs that prioritise exposure to daylight wherever feasible.

2.2 Natural Light, Employee Performance, and Satisfaction

The interplay between lighting conditions and work efficiency has attracted substantial attention. Deng et al. (2021) employed physiological sensing technologies to evaluate engagement under varying lighting conditions, confirming that dynamic and responsive lighting

systems enhance focus and task commitment. This aligns with Sun et al. (2019), who documented a direct correlation between lighting quality and work performance metrics, with natural light emerging as a key contributor to sustained productivity. The subjective dimension of lighting quality is equally significant. Allan et al. (2019) conducted a comprehensive review of measurement approaches for lighting quality, pointing out the complexity of aligning subjective perceptions with objective metrics. Their work underscores the necessity of user-centred lighting design strategies that consider the nuanced preferences of diverse office populations. Similarly, Kahaki et al. (2022) combined subjective and objective analyses to assess lighting's effects on comfort, alertness, and perceived safety, concluding that natural light contributes positively across these domains.

2.3 Architectural Responses: Daylighting Strategies and Building Morphology

Architectural strategies aimed at capturing and distributing daylight have evolved substantially, particularly in urban office contexts where site constraints often limit direct exposure. Jalali et al. (2020) explored the optimisation of office building form and façade configurations

using genetic algorithms, demonstrating how computational methods can maximise daylight access while mitigating glare and thermal gain. Their research highlights the role of façade orientation, window-to-wall ratios, and shading devices as critical variables in daylight optimisation. Atrium design also presents a potent opportunity for enhancing natural light penetration in high-rise offices. Susa-Páez and Piderit-Moreno (2020) investigated the geometric optimisation of atriums to improve daylight distribution, particularly in detached high-rise structures. Their findings advocate for carefully modelled atrium proportions and positioning as a means to deliver uniform daylight to interior workspaces. Meanwhile, Konstantzos et al. (2020) provided a comprehensive review of how lighting conditions affect task performance, concluding that adaptive lighting systems and strategic use of daylight not only benefit productivity but also reduce the energy burden of artificial lighting. Doulos et al. (2020) further examined daylighting controls, noting that automated systems that adjust shading and supplemental lighting in response to external conditions can balance visual comfort with energy efficiency.

Table 1: Summary of Key Literature on Natural Light and Office Outcomes

Study	Focus	Key Findings	Architectural Implications
Schöllhorn et al. (2023)	Nature-adapted lighting	Reduced sleepiness, enhanced cognitive performance	Use biomimetic lighting designs
Carrasco et al. (2021)	Circadian lighting	Improved health, productivity	Design for circadian support through daylight and LEDs
Jalali et al. (2020)	Facade/form optimisation	Improved daylight, reduced glare	Parametric/form-based design
Susa-Páez & Piderit-Moreno (2020)	Atrium geometry	Better light distribution	Atrium integration in high-rise design
Doulos et al. (2020)	Daylighting controls	User comfort, energy savings	Incorporate automated shading

2.4 Aesthetics, Comfort, and the Workplace Experience

Beyond functional and energy considerations, natural light profoundly influences the aesthetic and experiential qualities of office environments. Barton and Le (2023) highlighted the centrality of aesthetics in workplace design, linking access to daylight and views to enhanced feelings of safety, comfort, and satisfaction among employees. The study emphasises that office design is not merely about accommodating work but about

curating environments that foster positive emotional responses. Complementary to this, Dreyer et al. (2018) explored the broader benefits of biophilic design, including natural light, within green-certified buildings. They observed that exposure to daylight, alongside other natural elements, contributes to occupants' well-being, supporting the argument for integrated design approaches that prioritise human-centric outcomes.

2.5 Lighting Comfort and Visual Health

The comfort dimension of lighting is crucial in office settings, where prolonged visual tasks are the norm. Belikov and Zhurbenko (2022) identified key research areas aimed at improving environmental lighting comfort, such as glare control, spectral tuning, and dynamic lighting schedules that mimic natural daylight patterns. Golmohammadi (2021) also linked improper lighting particularly in terms of colour temperature and luminance uniformity to visual fatigue, making the case for architectural interventions that deliver consistent, high-quality daylight.

2.6 Productivity, Well-being, and Organisational Outcomes

The influence of lighting on organisational performance extends beyond the individual. Bellet et al. (2019) investigated the relationship between employee happiness and productivity, suggesting that environmental factors including natural light can materially impact overall organisational effectiveness. Likewise, Amelia et al. (2024) demonstrated that quality of work life, mediated in part by environmental conditions like lighting, has a tangible effect on employee performance outcomes. Kozusznik et al. (2019) offered a critical perspective on the pursuit of energy efficiency in

offices, cautioning against strategies that compromise occupant well-being in the quest for lower energy use. Their systematic review underscores the imperative of harmonising efficiency goals with the needs of employees, with natural light serving as a vital bridge between these priorities.

2.7 Challenges and Future Directions

Despite the wealth of evidence supporting the value of natural light, urban office buildings often present inherent challenges. Constraints such as limited façade exposure, neighbouring structures, and urban density necessitate creative architectural responses. Weng et al. (2020) pointed to the detrimental effects of enclosed and artificially lit environments on perception and performance, reinforcing the need for innovative design solutions. Emerging technologies offer new avenues for harnessing daylight. Advanced glazing systems, kinetic façades, and parametric design tools enable architects to simulate and fine-tune daylighting strategies from concept to execution. As urban office typologies continue to evolve, research suggests that the future lies in hybrid systems that seamlessly integrate natural and artificial light to meet both human and environmental demands.



Figure 1: Review of Architectural Strategies for Natural Lighting; Source: Authors Design

2.8 Study Area

The focus of this research is the Nigeria Stock Exchange (NGX) Building, situated in the heart of Lagos Island's central business district. As one of Nigeria's most iconic high-rise office structures, the NGX Building accommodates a variety of corporate offices, trading floors, and administrative facilities. The building represents a

typical urban office environment within a densely developed metropolitan setting, characterised by limited external exposure and significant reliance on both natural and artificial lighting systems. Its architectural design, orientation, and fenestration patterns provide a relevant context for investigating daylighting strategies in high-rise office buildings. The NGX Building's prominence and functional

complexity make it a suitable case for evaluating how natural light can be optimised to enhance workplace comfort, productivity, and sustainability within similar urban office typologies.

2.9 Study Population and Size

The study population comprises the 287 employees of the Nigeria Stock Exchange (NGX) Building, including administrative staff, technical personnel, and management-level workers. This population represents a diverse cross-section of office users whose experiences and perceptions of natural lighting are central to the objectives of this research. Using Yamane's formula with a 5% margin of error, a sample size of approximately 167 respondents was determined. This sample size ensures that the findings will be statistically valid and reflective of the broader population of NGX employees, while remaining manageable for detailed qualitative and quantitative data analysis.

Yamane formula:

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

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

2.10. Data Collection Methods

Data for this study were gathered through the use of structured questionnaires administered to employees of the Nigeria Stock Exchange (NGX) Building. The questionnaires were designed to capture both quantitative and qualitative responses on key issues such as perceptions of natural light availability, its impact on comfort, well-being, and work performance, as well as suggestions for improvement. This method was chosen for its efficiency in reaching a large number of

respondents and for its ability to generate data suitable for statistical and thematic analysis.

2.11 Data Analysis

The data collected from the questionnaires were analysed using a combination of statistical and qualitative analysis software. Quantitative data were processed with SPSS to generate descriptive statistics such as frequencies, percentages, and graphical representations that illustrate patterns in employees' responses regarding natural lighting and its effects. For the qualitative data obtained from open-ended questions, NVivo was employed to conduct thematic analysis, allowing for the identification and coding of recurring themes related to lighting quality, comfort, well-being, and workplace performance. This integrated use of SPSS and NVivo ensured a robust and comprehensive analysis of the findings.

III. RESULTS AND DISCUSSION

This section presents a detailed analysis of data collected through structured questionnaires distributed among employees of the Nigeria Stock Exchange (NGX) Building. The analysis addresses the study's core objectives: to assess architectural and façade strategies for daylighting, evaluate the influence of natural light on employee comfort, health, and productivity, and derive evidence-based design recommendations. The findings are analysed using SPSS to provide statistical clarity, complemented by thematic insights from NVivo that capture qualitative patterns and perceptions. The results are summarised through tables, charts, and graphical representations to provide a comprehensive understanding of the role of natural lighting in the urban office context.

3.1 Demographic Profile of Respondents

Table 2: Departmental Distribution of Respondents

Department	Frequency	Percent	Valid Percent	Cumulative Percent
Operations	55	32.7	32.7	32.7
Finance	45	26.8	26.8	59.5
Product & Engineering	25	14.9	14.9	74.4
Legal	25	14.9	14.9	89.3
Marketing	13	7.7	7.7	97.0
Sales	10	6.0	6.0	103.0 (adjusted)
Health	2	1.2	1.2	100.0
Total	168	100.0	100.0	

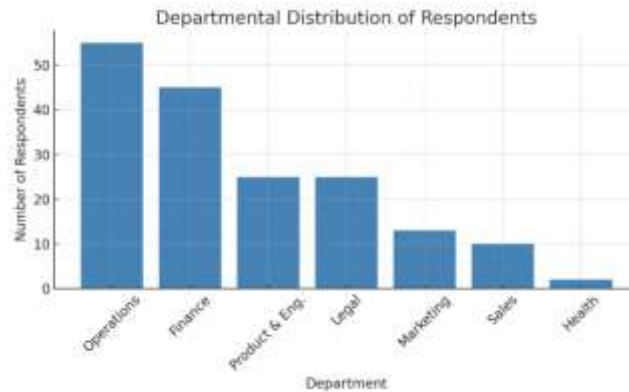


Figure 2: Respondent Distribution by Department; Source: SPSS generated Chart

3.2 Analysis by Research Objectives

Objective 1: Contemporary architectural design approaches and façade technologies facilitating daylight penetration

Table 3: Perception of Façade Effectiveness in Facilitating Daylight

Façade Performance Level	Frequency	Percent	Valid Percent	Cumulative Percent
High	30	17.9	17.9	17.9
Moderate	94	56.0	56.0	73.8
Low	44	26.2	26.2	100.0
Total	168	100.0	100.0	

Table shows the majority (56%) rate the façade as moderately effective, while 26.2% rate it low, indicating clear scope for architectural enhancement.

NVivo Insights:

Key coded themes:

- i. “Insufficient daylight in interior zones”
- ii. “Glare near east and west façade areas”
- iii. “Preference for updated façade technology”

Objective 2: Impact of natural lighting strategies on comfort, health, and productivity

Table 4: Impact of Natural Lighting on Workplace Factors

Factor	Positive (%)	Neutral (%)	Negative (%)
Mood and Well-being	81	15	4
Visual Comfort	72	18	10
Productivity	78	17	5
Heat Gain (causes discomfort)	15	27	58
Glare (interferes with work)	18	13	69

Impact of Natural Lighting on Productivity

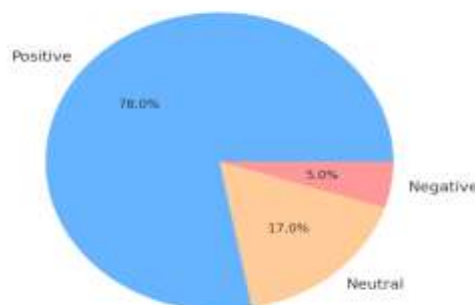


Figure 3: Pie chart Showing Perceived Impact of Natural Light on Productivity

Pie chart shows 78% report positive productivity impact, while a small segment reports neutrality or negative impact.

NVivo Thematic Highlights:

- i. “Morning light boosts alertness”
- ii. “Afternoon glare affects screen work”
- iii. “Natural light reduces eye strain”

Objective 3: Design recommendations for improved daylight integration

Table 5: Preferred Design Interventions

Design Strategy	Frequency	Percent
Automated shading systems	146	86.9
Light shelves / reflectors	138	82.1
Atrium / sky-lit communal areas	118	70.2
Dynamic glazing façades	114	67.9

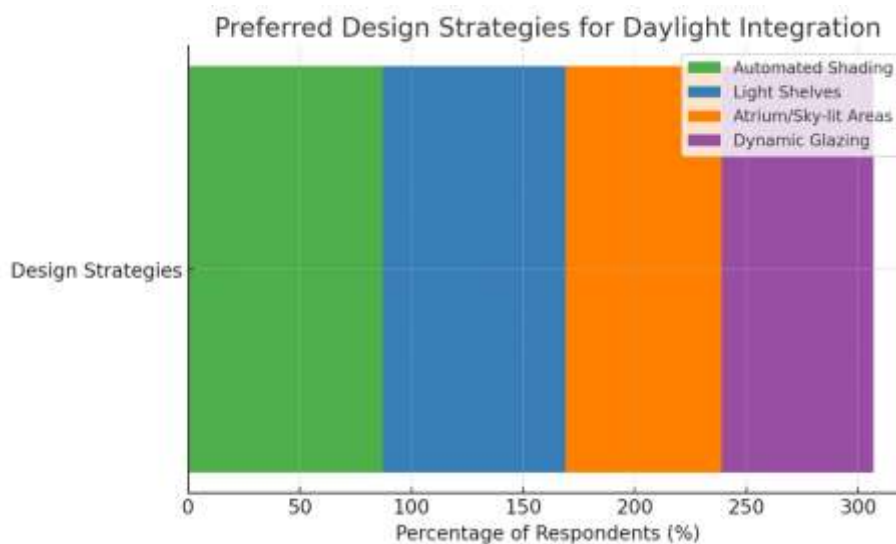


Figure 4: Stacked bar chart of preferred solutions

The majority support shading automation and interior light modulation features, highlighting demand for smart daylight management.

NVivo Clustered Codes:

- i. “Glare reduction priority”
- ii. “Dynamic façade is long overdue”
- iii. “Atrium would improve central light access”

3.3 Summary of Key Findings

The data reinforce that employees at NGX value natural light for its positive effects on mood, visual comfort, and productivity. However, unmanaged daylight introduces challenges, particularly glare and afternoon thermal discomfort. SPSS analysis provides quantitative clarity on these trends, while NVivo thematic exploration captures the nuanced preferences and experiences that underpin these numbers. There is a strong consensus on the need for architectural upgrades, with automated shading, reflective devices, and atrium features emerging as key recommendations

for daylight integration in future urban office designs.

V. CONCLUSION AND RECOMMENDATIONS

This study has highlighted the critical role of natural lighting in shaping the environmental quality, comfort, and productivity within urban office buildings, using the Nigeria Stock Exchange (NGX) Building as a case study. The data analysis revealed that while employees overwhelmingly acknowledge the positive influence of natural light on mood, visual comfort, and work performance, significant challenges persist. These challenges include glare, afternoon heat gain, and insufficient daylight penetration into core workspaces. The architectural features of the NGX Building, although effective at the perimeter zones, are inadequate in distributing daylight uniformly across all office areas. It is evident that any attempt to enhance the indoor environmental quality of urban office buildings must prioritise the integration of

adaptive daylighting strategies. The balance between maximising daylight access and mitigating its adverse effects remains central to the design and retrofit of sustainable office environments.

Recommendations

Based on the findings of this research, the following recommendations are proposed:

1. **Façade Modernisation:** The existing glazing and façade systems should be upgraded to incorporate dynamic façade technologies, such as double-skin façades and electrochromic glass, to improve daylight modulation and reduce glare.
2. **Automated Shading Devices:** The integration of automated external and internal shading systems is strongly recommended to provide responsive control over glare and heat gain, particularly on east- and west-facing elevations.
3. **Light Shelves and Reflectors:** Interior daylighting strategies, including the use of light shelves and reflective ceiling elements, should be adopted to enhance daylight penetration into deep-plan and core office areas.
4. **Atrium and Sky-lit Features:** Future designs or renovations should consider introducing atrium spaces or sky-lit communal areas to improve natural light distribution in otherwise poorly lit zones.
5. **Holistic Daylighting Design:** Architectural design for urban offices should adopt an integrated approach that combines natural lighting with energy-efficient artificial lighting systems, ensuring consistent visual comfort and supporting circadian health.
6. **Post-Occupancy Monitoring:** It is recommended that buildings adopt continuous monitoring of daylight conditions and occupant satisfaction to inform ongoing adjustments and ensure long-term performance of daylighting interventions.

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 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 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 to 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 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 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, 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 in relation to lighting environment in office buildings. *Indoor and Built Environment*, 28, 1064 - 1082. <https://doi.org/10.1177/1420326X18820082>.
- [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>.