24th International Conference on Renewable Energies and Power Quality (ICREPQ'26)
Santander (Spain), 10th to 12th June 2026
E&Q Journal - ISSN:2659-8779. Volume 4. July 2026

Metrics for assessing daylight performance in workspaces: A systematic review of research approaches

Entrena-Martínez, I.[1], Castillo-Martínez, A.[2] and Peña-García, A.[1,*]

[1] Department of Civil Engineering. University of Granada, 18071, Granada, Spain
[2]Department of Mechanical and Mining Engineering, University of Jaén, 23700, Linares, Spain
*Corresponding author. Phone number +34 958 249 435; email: pgarcia@ugr.es

Abstract. The use of daylight is a major concern to save energy and decrease the workload of lighting installations. Over the last decades, the methods assessing daylighting performance in workspaces have transitioned from static metrics based on ideal sky conditions and point-in-time photometric descriptors to dynamic models relying on hourly climate data. In parallel, other approaches have been developed, including occupant-oriented perceptual metrics and non-visual indicators aimed at characterizing the potential effects of daylight on physiological and circadian responses. As a result of the considerable amount and broad variety of metrics currently available, evaluating daylighting performance has become challenging. In order to understand the current state-of-the-art, a systematic review of the recent literature on daylighting performance assessment in workspaces has been conducted. Different daylight adequacy metrics were identified from 44 studies and classified into four categories: static metrics; climate-based dynamic metrics; occupant-oriented perceptual metrics; and metrics for assessing non-visual daylight effects. The results obtained demonstrate the consolidation of climate-based dynamic metrics as the predominant method for evaluating daylighting performance, as well as the still limited integration of perceptual and circadian metrics. Other findings include the need to develop integrative conceptual frameworks that ensure a more coherent evaluation of daylighting performance.

Keywords. Energy efficiency; Indoor lighting; Climate-based daylight metrics; perceptual metrics; circadian metrics.

1. Introduction

Exposure to daylight has played a major role in human evolution, shaping our visual system and driving the development of biological mechanisms modulated by daylight cycles. Natural light is characterized by continuous temporal and spatial variations in terms of irradiance, spectral power composition, directionality, and distribution [1]-[2] that differentiate it substantially from artificial lighting systems [3]. However, the implementation of universally applicable lighting solutions is precluded by the inherent variability of natural light, together with the particularities of human vision, the complexity of visual signal processing in the brain, and inter-individual variations in the interpretation of visual signals and the environment [4].

Conceptual and experimental works reveal that lighting conditions should not be addressed from a merely technical perspective alone. Rather, an integrative approach should be adopted to jointly consider the physical, physiological and perceptual aspects of lighting, especially in human-occupied spaces [5]-[6].

Daylight spectral distribution, high irradiance and temporal signal stability contribute to optimal visual performance. Moreover, natural light elicits non-visual responses such as synchronizing circadian rhythms, regulating hormone production, and influencing alertness and sleep patterns. These effects are mediated by the activation of ipRGC photoreceptors, which are especially sensitive to short-wavelength light [7].

The scientific evidence available highlights the necessity to integrate spectral, radiometric, photometric and temporal parameters in daylighting performance evaluation models. However, numerous and heterogeneous metrics are available, including static metrics, climate-based dynamic metrics, perceptual indicators, and circadian stimulation metrics. Such variety challenges the selection and standardized implementation of metrics in architectural design. This paper presents a classification of the metrics used in recent publications on daylighting performance. Additionally, a summary is provided of the conceptual foundations of natural light adequacy. Finally, conclusions are offered about the utility and efficacy of these metrics in assessing daylighting performance in built spaces.

2. From static to multidimensional approaches to assess daylight performance

The methods utilized to assess daylighting performance in workspaces have transitioned from static metrics based on ideal sky conditions and static photometric descriptors to dynamic models where daylight variations in space and time are considered. The evidence available underlines that the dynamic nature of natural light is not contemplated by traditional methods. The influence of local climate, solar geometry or interactions with built environments is also overlooked [8].

The advent of Climate-Based Daylight Modeling (CBDM) [9] represents a breakthrough, since it incorporates hourly weather data. This new approach has made it possible to evaluate and predict daylight performance under real-life conditions. Novel α-opic-based illuminance metrics [7], added to advancements in visual neurophysiology [10]-[11] demonstrating that spectral composition and vertical eye-level illuminance stimulate biological functions [12]-[13] led to the inclusion of biological responses in studies. Likewise, perceptual criteria have recently been integrated into the definition of daylight adequacy [14].
Figure 1 summarizes the evolution of daylight performance assessment approaches as the integration of new assessment dimensions progressively added complexity. In this setting, the need arises for a structured classification of metrics.

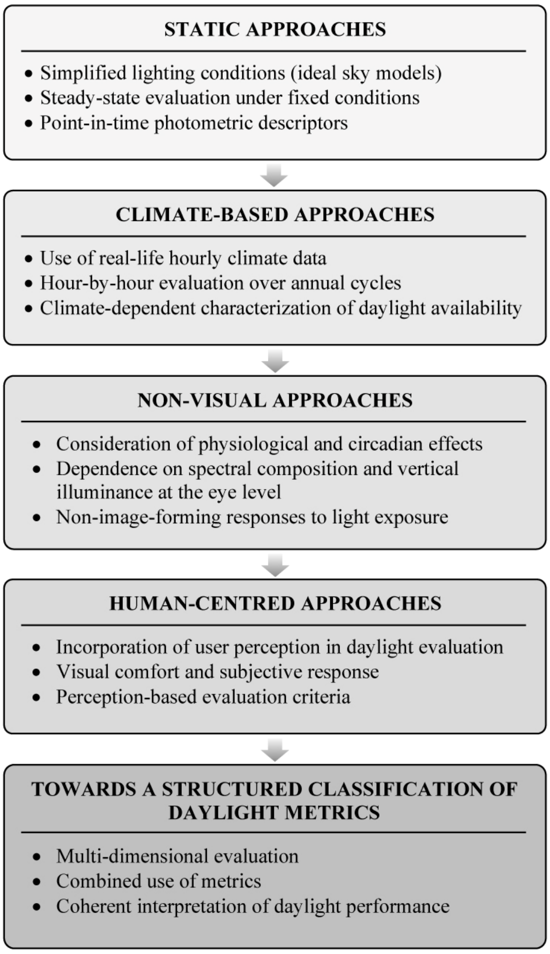

Fig. 1. Evolution of daylight performance assessment approaches.

3. Daylighting performance metrics in the recent literature

Following a thorough review of the 44 works included, the metrics used in the literature on natural light adequacy have been identified and categorized. To provide a snapshot of trends in this field, a systematic search of the Scopus and Web of Science databases was conducted, including journal and conference papers published between January 2024 and January 2026.
The systematic review included studies assessing illuminance under documented daylighting or hybrid lighting conditions. Non-scientific or non-quantitative studies were excluded. Then, metrics were classified into four categories: static metrics; climate-based dynamic metrics; perceptual indicators; and metrics for non-visual effects. A description of the categories identified and the studies where they were applied is provided below.
It is worth noting that a high proportion of the studies applied daylighting performance metrics along with geometric design parameters, material properties, and energy-related variables as input or control variables; however, the latter are not daylighting evaluation metrics in a strict sense.

A. Static metrics

Static metrics are used to characterize lighting at a given point in time or scenario of reference and continue to be applied in studies assessing daylight conditions in workplaces. Average illuminance on the horizontal work plane (Em) is extensively used as a descriptor of daylight adequacy in studies assessing daylight availability or evaluating different lighting design options [12],[14]-[27]. Uniformity (U□) is defined as the ratio between minimum and average illuminance over a working area. This parameter is used in some studies as a complementary indicator to evaluate spatial daylight distribution [15]-[16],[18]-[19],[22],[27].
The recent literature scarcely integrates other metrics such as Daylight Factor (DF) –defined as the ratio of indoor to outdoor light level under standard overcast conditions expressed as a percentage– and its variants, namely Average Daylight Factor (DFavg) and Minimum Daylight Factor (DFm) [15],[19],[25],[28]. These variables are used either as complementary metrics or to compare them to dynamic metrics and demonstrate their validity or limitations when characterizing natural light performance.

B. Climate-based daylight metrics

Climate-based daylight metrics (CBDMs) incorporate hour-by-hour weather and occupancy data to assess daylight availability throughout the year under realistic conditions.
In a limited number of studies, Daylight Autonomy (DA) was used to estimate the percentage of time that illuminance exceeds a defined illumination threshold set based on the use or activities performed in a workspace [8],[14]-[15],[29]-[31]. Albeit historically relevant, the use of CBDMs is currently constrained to methodological analyses or location-specific daylight availability studies. According to García-Martín et al. the development of the novel metric Continuous Overcast Daylight Autonomy (DAo.con) has raised renewed interest in CBDM [30].
The most commonly used daylight autonomy metric is Spatial Daylight Autonomy (sDA). This parameter measures the percentage of area receiving sufficient daylight for a minimum proportion of annual operating hours under real-life weather conditions. Since this metric includes spatial and temporal variables, it is especially useful for comparative and workspace optimization studies [8],[14],[17]-[18],[21]-[22],[25],[30]-[42].

Useful Daylight Illuminance (UDI) is extensively used to quantify the percentage of time that illuminance remains within the useful illuminance range. UDI is rated as insufficient, useful/sufficient and excessive [8],[15]-[16],[18]-[20],[25],[28]-[33],[36],[38]-[40],[43]-[53]. The spatial variant of UDI, Spatial Useful Daylight Illuminance (sUDI) [27], [31], was integrated into a small number of studies; hence, despite being of interest, the use of this metric is still considerably limited.

Annual Sunlight Exposure (ASE) specifically quantifies the percentage of the working plane receiving excessive direct sunlight for a significant number of hours per year. This parameter is frequently used alongside sDA and UDI to assess the balance between daylight availability and excessive daylight levels [8],[17],[19],[22],[29]-[30],[32],[35]-[37],[39]-[40].

Numerous studies incorporated Daylight Glare Probability (DGP) to assess glare. This metric quantifies the likelihood that an occupant will perceive glare from sunlight. It is widely used as a reference metric for assessing visual comfort under a variety of daylighting designs [15]-[16],[18],[20]-[21],[27],[29],[38],[41]-[43], [49]. Vanage et al. combined DGP with a variant, Simplified Daylight Glare Probability (DGPs), a simplified empirical equation relating to vertical illuminance at the eye level of the occupants and glare [51].

Other authors complementarily utilized annual metrics including Glare Autonomy (GA) [29] and, most commonly, Spatial Glare Autonomy (sGA) [21],[27]-[29],[38],[42]–[43]. These metrics quantify the temporal and spatial fraction where target visual comfort requirements are met according to predefined glare thresholds. These requirements are often established based on Daylight Glare Probability (DGP) values, thereby enabling to measure glare on an annual and spatial basis.

To assess specific daylight availability components, some authors recently incorporated aggregated indicators and ratios not fully quantified by standard CBDM. Song et al. integrated Uniformity of Daylight (UOD), a descriptor of annual daylight uniformity, defined as the ratio of minimum illuminance to average illuminance across different positions or areas [41]. Hao et al developed the CBDM-based Visual-effective Frequency (VF) metric to evaluate annual visual performance. The authors defined this metric as the percentage of days in the annual analysis period when the horizontal illuminance at a designated location on the desktop reached or exceeded a standard threshold. The authors used this metric to simultaneously evaluate and compare daily visual and non-visual lighting performance in combination with specific melanopic lighting metrics [12].

C. Metrics for non-visual effects

The increasing attention paid to the effects of daylighting in workspaces has led to the development of new metrics that quantify the effects of natural light on circadian rhythms and other non-image forming effects.

As opposed to studies exclusively focused on horizontal illuminance, some studies included vertical eye-level illuminance (Ev) as an input variable to estimate potential circadian responses [23],[25]-[26].

Novel α-opic-based illuminance metrics, including Equivalent Melanopic Lux (EML) [20] and melanopic Equivalent Daylight Illuminance (m-EDI), have been incorporated [12],[13],[20],[25]. These metrics are based on the spectral weighting of the incident luminous signal according to melanopsin-based sensitivity. Although the two metrics measure melanopic stimulation, they rely on different illuminance reference systems. Whereas EML quantifies melanopic stimulation in terms of illuminance equivalent values, m-EDI expresses this stimulation as equivalent standard daylight illuminance values, which facilitates direct conversion between the two metrics [20].

Based on these melanopic metrics, a variety of derived metrics have been designed to characterize circadian light exposure over defined time periods. An example of these indicators is Circadian Frequency (CF), which quantifies the percentage of days in a year where lighting in an area meets or exceeds a given EML threshold over a specific time period, as calculated from average values [12],[25]. Another metric, the Circadian Stimulus Autonomy (CSA), is used to calculate the percentage of days when a threshold for adequate melatonin suppression is met solely by daylight during a specific time of the day, typically in the morning [30],[40].

Wang et al. proposed the Daylight Vertical Illuminance Availability (DVIA) metric to quantify daylight effectiveness in supplying the required eye-level illuminance [42].

D. Perceptual daylight metrics

In some studies, daylight adequacy was defined concurrently considering photometric and perceptual criteria. Arango-Díaz et al. incorporated the Perceptual Daylight Autonomy (pDA) metric and its spatial variant, Spatial Perceptual Daylight Autonomy (spDA). These metrics help establish illuminance thresholds as a function of the likelihood that a percentage of occupants perceives daylight to be sufficient at a given area. For such purpose, the authors developed perceptual models using field data and local climate conditions [14]. Exterior View Quality (EVQ) was assessed in other studies by considering the presence, depth and characteristics of the external surroundings and their association with occupant-reported satisfaction [25]-[26],[51],[54].

Table I summarizes how each family of metrics is focused on specific daylight performance dimensions. No family provides a comprehensive assessment of daylight performance. This table shows a conceptual classification based on their common use in the literature.

Table I. – Daylight performance coverage by metric families

METRIC FAMILY	TEMP	CLIM	SPEC	PERC	NON-V
Static	N	N	N	N	N
CBDM	Y	Y	N	P	N
Perceptual	P	P	N	Y	N
Non-visual	P	P	Y	N	Y

Note. Temp: Temporal; Clim: Climate-dependent; Spec: Spectral; Perc: Perceptual; Non-V: Non-Visual; Y: Yes; N: No; P: Partial

4. Discussion

The findings of this systematic review confirm that climate-based daylight metrics (CBDMs) are the current reference methodological framework for evaluating daylight adequacy in workspaces. Among them, UDI and sDA were the most used metrics, demonstrating extensive integration into contemporary climate-based daylighting models. This high level of acceptance is explained by their ability to describe hourly variations in daylight.

The prevalence of CBDMs over static metrics is primarily due to them accounting for the dynamic nature of daylight. However, other practical considerations also played a role in the dissemination of these metrics, such as the availability of hourly weather data facilitating their application, or the possibility of using these metrics to assess variations in daylighting performance across different architectural designs. In this line, the wide acceptance of UDI demonstrates its usefulness, since with a single annual indicator, insufficient, adequate and excessive daylight can be identified under realistic conditions.

The results of this study reveal a moderate –albeit significant– use of other CBDM indicators like glare metrics (DGP and sGA), or ASE. This finding demonstrates a growing interest in controlling excessive sunlight exposure and visual comfort when evaluating daylight adequacy.

The lack of standardization in CBDMs usage is noteworthy. Considerable variability was noted in the criteria applied to define excessive or adequate daylight. Additionally, differences were observed in the time periods; sDA, UDI, and ASE thresholds; and glare indicators applied. These inconsistencies are most probably due to investigators' efforts to adapt variables to local climate conditions, as well as to the particular purposes and designs of their studies. Although these adaptations may be necessary, they hinder cross-comparison between studies and limits their use for regulatory and standardization purposes.

The coexistence of such a variety of metrics (static, climate-based dynamic, perceptual and non-visual metrics) demonstrates significant advances in the evaluation of daylighting performance and the fragmentation that characterizes this discipline. Many of the reviewed studies use a combination of metrics, but without establishing a clear hierarchy or conceptual structure that explains how their different purposes and scales are related. Variability across local approaches mirrors the multidimensional nature of daylight availability. These findings highlight the necessity of developing integrative models based on a standardized use of photometric, perceptual and physiological indicators.

Notably, the application of perceptual metrics continues to be limited and secondary to the prevailing photometric indicators. The use of specific metrics such as pDA and its spatial variant is still very limited and mostly exploratory. Although the relevance of occupant perception is widely recognized, it has not translated into a progressive integration of subjective variables into daylight availability evaluation studies. This may be explained by the limited external validity of perceptual models, added to their reliance on contextual and cultural variables.

Likewise, an incipient use of metrics for measuring biological effects of daylighting was observed. A small number of studies integrated α-opic, melanopic stimulation and eye-level illuminance metrics. Moreover, these metrics were used as complementary measures rather than as the primary focus of multimetric studies. The novelty and limited recognition of these metrics may explain their low level of implementation; however, other factors may play a role, including the lack of standard thresholds, difficulties in accurately measuring occupant exposure to natural light, and challenges to their integration in modeling systems and architectural design processes.

In summary, the results of this study reveal the need for standard and integrative daylighting performance evaluation models based on a combination of different types of metrics. The variety of metrics available demonstrates an increasingly deeper understanding of the complexity of daylighting. It is necessary to develop well-structured models that aggregately consider natural light availability, visual comfort, occupant's perception, and non-visual effects. These findings open an avenue for future research and underscore the need to improve the contributions of scientific knowledge to regulatory and architectural design practice.

Figure 2 presents a conceptual diagram of daylight performance showing metric families and their design implications.

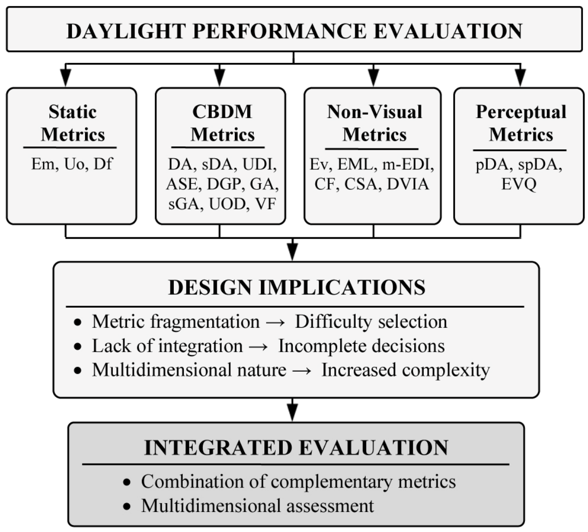

Fig. 2. Conceptual scheme of daylight performance evaluation: metric families and design implications.

6. Conclusions

Given the necessity of methods to optimize energy consumption in electrical installations, this work carries out a systematic review of the recent literature on daylighting performance in workspaces. It provides a structured perspective of the metrics currently used in studies, and its main contribution lies in the classification of documented metrics and the identification of methodological trends in this field of research.

Climate-based metrics are increasingly adopted as the predominant reference approach for evaluating annual daylight performance, albeit their use has not yet been standardized. Perceptual and non-visual metrics still play a secondary role, and their integration with the prevailing photometric metrics is limited.

In conclusion, the main challenge facing daylighting performance evaluation is not the scarcity of metrics, but the absence of an integrative conceptual framework that articulates the different metrics available. This study outlines current trends and provides a foundation for the development of robust evaluation models that improve result interpretability and facilitate their application in architectural design.

References

[1] M. Münch, A. Wirz-Justice, S.A. Brown, T. Kantermann, K. Martiny, O. Stefani, C. Vetter, K.P. Wright, K. Wulff and D.J. Skene, "The Role of Daylight for Humans: Gaps in Current Knowledge", Clocks & Sleep (2020). Vol. 2, pp. 61-85.

[2] M. Spitschan, G.K. Aguirre, D.H. Brainard and A.M. Sweeney, "Variation of outdoor illumination as a function of solar elevation and light pollution", Scientific Reports (2016). Vol. 6, no. 26756.

[3] M. Knoop, O. Stefani, B. Bueno, B. Matusiak, R. Hobday, A. Wirz-Justice, K. Martiny, T. Kantermann, M.P.J. Aarts, N. Zemmouri, S. Appeltk, B. Norton, "Daylight: What makes the difference?", Lighting Research and Technology (2020). Vol. 0, pp. 1-20.

[4] F.S. Webler, M. Spitschan, R.G. Foster, M. Andersen and S.N. Peirson, "What is the 'spectral diet' of humans?", Current Opinion in Behavioral Sciences (2019). Vol. 30, pp. 80-86.

[5] R.P. Najjar, A.S. Prayag, C. Gronfier, "Melatonin suppression by light involves different retinal photoreceptors in young and older adults", Journal of Pineal Research (2024). Vol. 6, no. e12930.

[6] A. Peña-García, F. Salata, "The perspective of total lighting as a key factor to increase the sustainability of strategic activities", Sustainability (2020). Vol. 12, no. 2751.

[7] R.J. Lucas, S.N. Peirson, D.M. Berson, T.M. Brown, H.M. Cooper, C.A. Czeisler, M.G. Figueiro, P.D. Gamlin, S.W. Lockley, J.B. O'Hagan, L.L.A. Price, I. Provencio, D.J. Skene, G.C. Brainard, "Measuring and using light in the melanopsin age", Trends in Neurosciences (2014). Vol. 37, no. 1.

[8] E. Ukpong, F.O. Uzuegbunam, E.O. Ibem, E. Udomiaye, "Daylighting performance evaluation in tropical lecture rooms: A comparative analysis of static and climate-based metrics", Journal of Building Engineering (2025). Vol. 103, no. 112044.

[9] J. Mardaljevic, "Examples of climate-based daylight Modelling", CIBSE National Conference 2006: Engineering the Future (2006). No. 67.

[10] D.M. Berson, F. A. Dunn, M. Takao, "Phototransduction by Retinal Ganglion Cells That Set the Circadian Clock", Science (2002). Vol. 295, pp. 1070-1073.

[11] S. Hattar, H.-W. Liao, M. Takao, D. M. Berson, and K.-W. Yau, "Melanopsin-containing retinal ganglion cells: Architecture, projections, and intrinsic photosensitivity", Science (2002). Vol. 295, pp. 1065-1070.

[12] H. Hao, J. Xu, L.J.M. Schlangen, "Evaluation and optimization of annual light variations for visual and non-visual effects within a ground-floor middle school classroom", Journal of Building Engineering (2024). Vol. 98, no. 111293.

[13] S.W. de Vries, M. Gkaintatzi-Masouti, J. van Duijnhovena, J. Mardaljevicb, M.P.J. Aarts, "Recommendations for light-dosimetry field studies based on a meta-analysis of personal light levels of office workers", Lighting Research and Technology (2025). Vol. 57, pp. 47-70.

[14] L. Arango-Diaz, N.G. Vasquez, B.P. Moreno, "Advancing on a dynamic metric to assess daylight sufficiency based on people's perception of daylight availability in the tropics" Building and Environment (2025). Vol. 282, no. 113209.

[15] E.A.M.S. AL-Mowallad, X. Huang, Z. Lu, X. Li, K. Wu, Z. Zhu, G. Liu, "Assessment and Improvement of Daylighting Quality in Classrooms with Double-Side Windows", Buildings (2024). Vol. 14. no. 3501.

[16] A. Ibrahim, M. Alsukkar, Y. Dong, P. Hu, "Investigations for the daylighting performance of trapezoid profile shadings using multi-objective optimization", Journal of Building Engineering (2025). Vol. 99, no. 111645.

[17] H. Li, J. Jia, H. Yu, X. Wang, "Research on the daylighting metrics of college classrooms based on visual comfort in China", Journal of Building Engineering (2024). Vol. 98, no. 111178.

[18] A. Mesloub, M.M. Alnaim, G. Albaqawy, K. Elkhayat, R. Hafnaoui, A. Ghosh, M.S. Mayhoub, "The Daylighting Optimization of Integrated Suspended Particle Devices Glazing in Different School Typologies", Buildings (2024). Vol. 14, no. 2574.

[19] X. Mo, O. Pons-Valladares, S.I. Ortega Donoso, "Model to Improve Classrooms' Visual Comfort Using Waste-Based Shading and Its Validation in Mediterranean Schools", Sustainability (2024). Vol. 16, no. 10176.

[20] M.C. Noor, F.M. Saradj, S.A. Yazdanfar, "Optimal daylighting design for standard photopic and melanopic equivalent daylight illuminance, and glare minimization in Tehran classrooms", Journal of Building Engineering (2025). Vol. 105, no. 112104.

[21] L. Qi, J. Yang, L. Gong, W. Wu, C. Wu, "The impact of orientation changes in kindergarten activity rooms in different light climate zones of China on indoor daylighting environment", Scientific Reports (2024). Vol. 14, no. 28369.

[22] S. Sebayang, O.C. Dewi, T. Panjaitan, K. Rahmasari, M.R. Darmawiredja, R. Irwansyah, A.D. Ismoyo, A.M. Dugar, "Investigating perforated egg crates as dynamic shading systems for open-plan offices in tropical climates", Journal of Building Engineering (2024). Vol. 96, no. 110462.

[23] M. Tabatabaei Manesh, M. Rajaian Hoonejani, S. Ghafari Gousheh, A. Abdolmaleki, A. Nikkhah Dehnavi, A. Shahrashoob, "AI-driven control algorithm using machine learning and genetic optimization for enhancing visual comfort in adaptive façades", Automation in Construction (2025). Vol. 179, no. 106474.

[24] M.S. Tagueu, L.A. Madjou Tanekou, B. Ndzana, "Contribution of Daylighting to Saving Electrical Energy in Cameroon: Case Study of a Classroom in a Public School", Journal of Engineering (2025). No. 8196538.

[25] J. Xu, Y. Gao, Y. Wu, "The visual and non-visual effects of annual daylighting performance on middle school students: A longitudinal field survey of classrooms in Eastern China", Energy and Buildings (2025). Vol. 331, no. 115364.

[26] H. Xu, L. Zhang, Y. Zeng, L. Bergefurt, J. Xu, "Untangle the Effects of Classroom Environmental Features on Middle-School Students' Mood Perception with Machine Learning and XAI", Sustainability (2025). Vol. 17, no. 9459.

[27] W. Zhang, Z. Ma, H. Qiu, Y. Pan, Y. Shi, L. Zhang, "Machine learning-boosted multi-objective optimization

of integrated shading systems: Enhancing daylight availability, glare protection, and energy savings", Building and Environment (2025). Vol. 280, no. 113124.
[28] Y. Song, H. Wang, "Optimization Potential of Side-Lit Windows for Energy and Daylighting performance of University Classrooms in Shanghai", Buildings (2024). Vol. 14, no. 3947.
[29] A. Alafchi, H. Sanaieian, M. Faizi, M. Mousaeipour, S.M.A. Hosseini, "Multi-objective optimization of parametric shading devices for atrium in libraries: Enhancing daylight and thermal performance in semi-arid climates", Case Studies in Thermal Engineering (2025). Vol. 76, no. 107288.
[30] G. García-Martín, M.Á. Campano, I. Acosta, P. Bustamante, "New Approaches in Dynamic Metrics for Lighting Control Systems: A Critical Review", Applied Sciences (2025). Vol. 15, no. 8243.
[31] J.M. Monteoliva, A. Villalba, S.M. Donato, A.E. Pattini, "Decision tree-based modeling of daylight availability for perimeter offices in the Southern Hemisphere", Journal of Building Engineering (2025). Vol. 114, no. 114287.
[32] S.R. Aritonang, R.A. Mangkuto, Atthaillah, I. Prasetiyo, "Daylighting Design Optimization of Complex Fenestration Systems with External Shading and Horizontal Slats in Tropical Elementary School Classrooms", Journal of Architectural Engineering (2025). Vol. 31(1), no. 04025001.
[33] W. Bai, W. Guo, Y. He, Y. Wu, S. Liang, S. Zhang, "Research on the Optimization Design of the Atrium Space Form in University Libraries Based on the Coupling of Daylighting and Energy Consumption", Buildings (2024). Vol. 14, no. 2715.
[34] Y. Bian, Y. Zhou, S. Yang, D. Lin, Y. Ma, "Using machine learning algorithm to predict lighting energy consumption of daylight-linked lighting systems from spatial daylight autonomy", Energy and Buildings (2025). Vol. 341, no. 115847.
[35] N. de Queiroz, F.S. Westphal, "Graphic tool for thermal and daylighting performance analysis of façades and definition of glazing type and horizontal shading devices in air-conditioned offices across three Brazilian climates", Ambiente Construído (2025). Vol. 25, no. e146292.
[36] J. Jayaram, L. Sundaram, "Evaluating the Effects of Vegetation on Daylight Performance: A Simulation-Based Study of Government School Buildings in the Hot–Humid Climate of Chennai, India", Buildings (2025). Vol. 15, no. 3231.
[37] T. Jebril, Y. Chen, S. Hamed, A. Hajjaj, "Lecture Notes in Civil Engineering - The Effect of Geometry Parameters on Daylighting of School Buildings in the Gaza Strip", Springer Nature Singapore (2024). Vol. 389, pp.553-561.
[38] S. Masoud, Z. Zamani, S.M. Hosseini, M. Mahdavinejad, J. Wang, "Enhancing Classroom Lighting Quality in Tehran Through the Integration of a Dynamic Light Shelf and Solar Panels", Buildings (2025). Vol. 15, no. 2215.
[39] T.K. Mukti, R.A. Mangkuto, N.P.A. Nitidara, "Assessing the future impact of climate change on daylighting performance in tropical school classrooms with various opening sizes and positions", Sustainable Energy Technologies and Assessments (2025). Vol. 82, no. 104515.
[40] C. Muñoz-Viveros, C. Rubio Bellido, A. Pérez-Fargallo, "Evaluation of energy and lighting in schools considering solar protections", Energy Reports (2024), Vol. 12, pp. 1157-1177.
[41] H. Song, Y. Liu, Q. Deng, "A Two-Stage Generative Optimization Framework for "Daylighting Schools": A Case Study in the Lingnan Region of China", Buildings (2025). Vol.15, no. 3821.
[42] M. Wang, X. Peng, Y. Cai, "A multi-metric evaluation of classroom daylighting: Integrating myopia prevention and visual comfort", Journal of Building Engineering (2025). Vol. 99, no. 111616.
[43] S. Cai, L. Li, Z. Gou, "Optimizing open-plan office passive retrofits: A human-centric, climate-adaptive approach to lighting, thermal comfort, and energy savings", Building and Environment (2026). Vol. 287, no. 113894.
[44] T. Chen, L. Tan, "Multiobjective optimization of external shading for west facing university dormitories in Kunming considering solar radiation and daylighting", Scientific Reports (2025). Vol. 15, no. 21876.
[45] X. Du, X. Liu, F. Gao, Z. Zhou, "Energy saving and low carbon oriented renovation framework for educational buildings with Tianjin University case study", Scientific Reports (2025). Vol. 15. no. 28822.
[46] Y. Gao, S. Zhao, Y. Huang, H. Pan, "Multi-Objective Optimization of Daylighting–Thermal Performance in Cold-Region University Library Atriums: A Parametric Design Approach", Energies (2025). Vol. 18, no. 1184.
[47] F. Garzia, S. Verbeke, C. Pozza, A. Audenaert, "Lecture Notes in Civil Engineering - Quantifying Co-benefits of Building Automation: Effects of Shading Control on Visual Comfort, Well-Being, and Productivity in Office Buildings", Springer Nature Singapore (2025). Vol. 555, pp. 285–291.
[48] M.F. Islam, "Lecture Notes in Civil Engineering - Transforming Downtown Vancouver: Smart Glass Solutions for Energy-Efficient Office Building Envelopes and Well-Being", Springer Nature Singapore (2025). Vol. 553, pp. 550–557.
[49] J. Liu, Z. Li, Q. Zhong, J. Wu, L. Xie, "Multi-objective optimization of daylighting performance and energy consumption of educational buildings in different climatic zones of China", Journal of Building Engineering (2024). Vol. 95, no. 110322.
[50] A. Mesloub, R. Hafnaoui, M.H. Hassan Abdelhafez, T.E. Seghier, L. Kolsi, N. Ben Ali, A. Ghosh, "Multi-objective optimization of switchable suspended particle device vacuum glazing for comfort and energy efficiency in school typologies under hot climate", Case Studies in Thermal Engineering (2024). Vol. 61, no. 105039.
[51] S. Vanage, H. Dong, P. Guillante, N. Kunwar, K. Cetin, "Parametric model development for building input variables for lighting and shading controls for different building form factors", Science and Technology for the Built Environment (2025). Vol. 31, pp. 806–839.
[52] S. Xu, Y. Chen, J. Liu, J. Kang, J.F. Gao, Y. Qin, W. Tan, G. Li, "Comprehensive improvement of energy efficiency and indoor environmental quality for university library atrium—A multi-objective fast optimization framework", Frontiers of Architectural Research (2025). Vol. 14, pp. 449-470.
[53] W. Hao, J. Xu, F. Zhao, D.W. Sohn, X. Shi, "Integration of Photovoltaic Shading Device and Vertical Farming on School Buildings to Improving Indoor Daylight, Thermal Comfort and Energy Performance in Three Different Cities in China", Buildings (2024). Vol. 14, no. 3502.
[54] F. Binarti, N. Sekarlangi, M.K.V. Brilianto, B.R. Hakim, "EEG-Based Neurophysiological Responses to Classroom Window Views in Green Campus Settings", Journal of Daylighting (2025). Vol. 12, pp. 359-374.