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Objectif : *Air intérieur, ventilation, climatisation et propagation du Covid-19*

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Google Scholar, Lens et WoS

Anforderungen an die Innenraumluftqualität in Gebäuden: Gesundheitliche Bewertung der Emissionen von flüchtigen organischen Verbindungen (VVOC, VOC und SVOC) aus Bauprodukten.

Bundesgesundheitsblatt - Gesundheitsforschung - Gesundheitsschutz, Vol. **69** n°(6), (2026), 710-728 p.

Requirements for indoor air quality in buildings: Health assessment of emissions of volatile organic compounds (VVOC, VOC, and SVOC) from construction products Version February 2026 Communication from the committee for the health-related evaluation of construction products (AgBB)

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Fugazza, K., Marques, M., Rola, S. M.

Architectural Retrofit and Multidisciplinary HVAC Modernization with BIM Methodology: A Study of the Carlos Tortelly Municipal Hospital.

12th International Conference on Indoor Air Quality, Ventilation & Energy Conservation in Buildings (IAQVEC 2026)

This paper analyzes the architectural retrofit and multidisciplinary engineering modernization of the Carlos Tortelly Municipal Hospital, a medium-sized public hospital inaugurated in 1982 in Niterói, Brazil, with emphasis on the redesign of HVAC systems. The study examines the adoption of Building Information Modeling (BIM) as a methodological framework to support the development of architectural, structural, electrical, hydrosanitary, HVAC, and hospital special systems projects, in accordance with both technical standards and public procurement regulations that encourage BIM use in engineering services. The methodology is based on on-site technical inspections, analysis of existing systems, review of regulatory requirements, and the development of multidisciplinary design workflows. A comparative assessment between traditional sequential design processes and BIM-assisted workflows is presented, highlighting differences in information flow, discipline integration, and project deliverables during the design phase. The proposed BIM-based approach enables a more consistent and compatible engineering project delivery, reducing uncertainties associated with fragmented documentation commonly found in conventional methods.

The results indicate that BIM contributes to improved design coherence, enhanced decision-making during HVAC system modernization, and greater alignment between architectural retrofit strategies and engineering solutions. The study reinforces the relevance of BIM as a strategic tool for hospital modernization projects in hot and humid climates, supporting regulatory compliance, technical reliability, and long-term sustainability in public healthcare facilities.

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Mathew, S., Bandana, J. H. A.

Assessing thermal comfort and indoor air quality in naturally ventilated industrial buildings: Implications for worker satisfaction and building design in the warm humid climate of India.

Materials Research Proceedings, Vol. **67**, (2026)

. Industries play a vital role in national economic growth, yet the quality of their indoor environments is often neglected, adversely affecting worker health, comfort, and productivity. Industrial buildings in India are

commonly designed with minimal attention to sustainability, prioritizing low construction costs over occupant well-being. A review of literature highlights a global research gap in thermal comfort and indoor air quality (IAQ) within industrial settings, with limited studies in tropical climates and low-income countries. This study evaluates thermal comfort and IAQ in naturally ventilated industrial buildings in Kerala's warm-humid climate. A pilot study was conducted in three units of an industrial estate, combining quantitative measurements of thermal parameters (air temperature, relative humidity, air velocity) and pollutants (CO, CO_2, formaldehyde, TVOC, $PM_{2.5}$, PM_{10}) with qualitative occupant surveys using the BUS methodology. Over 2,500 samples were collected across three days in December, alongside responses from 62 occupants. Results showed significant deviations from national and international standards. PMV and PPD analysis, and adaptive thermal comfort analysis revealed non-compliance with ASHRAE 55, with many workers reporting "too warm" conditions and dissatisfaction rates up to 90%. The study also examined building envelope performance, wall-window ratio, ventilation, and orientation, linking poor design with degraded indoor environments. Findings underscore the urgent need for architectural interventions, context-specific guidelines, and a national database on factory thermal environments to guide future industrial design that enhances worker health and productivity.

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Yaddarabullah, Y., Al Faruq, U.

Deployment of a Machine Learning Based Indoor Air Quality Predictor on NodeMCU ESP32 Using EloquentTinyML.

JISA (Jurnal Informatika dan Sains), Vol. **9** n°(1), (2026), 96-102 p.

Indoor air quality monitoring increasingly requires local intelligence because indoor exposure conditions can change faster than centralized systems can respond. However, many machine learning based indoor air quality predictors remain difficult to deploy on microcontrollers due to memory limits, computation constraints, network dependence, and the lack of a reproducible edge deployment workflow. This study develops an end-to-end TinyML framework for deploying a lightweight indoor air quality predictor on a NodeMCU ESP32 using EloquentTinyML and TensorFlow Lite Micro. A synthetic IAQ dataset was generated from eight environmental variables, namely temperature, humidity, PM2.5, PM10, NO2, SO2, CO, and room type, and the indoor air quality score was derived from pollutant weighted features before balancing comfort labels using SMOTE. The proposed compact MLP contains eight inputs, one hidden layer with twelve neurons, ReLU activation, dropout regularization, and a single regression output. Five-fold validation produced an average root mean square error of 5.794, mean absolute error of 4.394, and R2 of 0.877, while the converted model required only 121 trainable parameters. These results indicate that compact TinyML deployment can provide a feasible proof-of-concept for local indoor air quality estimation, although physical sensor validation remains necessary.

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Sinha, R. K., Sao, A. K., Sharma, P., Kumar, R., Karma, A. K., Panjhare, D.*, et al.*

Design and Performance Evaluation of a Solar-Powered Air Purification System Using Activated Carbon.

International Journal of Scientific Research in Engineering & Technology, Vol. **6** n°(3), (2026), 204-215 p.

Air pollution caused by particulate matter, carbonaceous aerosols, volatile organic compounds (VOCs), and gaseous contaminantshas become a critical environmental and public health challenge. Conventional air purification systems often involve high capital costs,complex maintenance requirements, and significant energy consumption, limiting their applicability in rural and low-resource environments.This study presents the design, fabrication, and experimental evaluation of a low-cost solar-powered air purification system employing filterpaper and activated carbon as primary purification media. The developed system integrates mechanical filtration and adsorption mechanismsto remove particulate and gaseous pollutants from combustion-generated air streams. Polluted air generated from coal, wood husk, and cowdung combustion was introduced into the purification chamber using a controlled airflow arrangement consisting of a suction

pump andDC(direct current) fan. Air quality parameters including carbon dioxide (CO_2), formaldehyde (HCHO), and total volatile organic compounds(TVOC) were measured at both inlet and outlet locations using air quality sensors. Experimental results demonstrated significant reductionsin pollutant concentration after filtration, confirming the effectiveness of the proposed system. The integration of solar energy enablessustainable operation with minimal operating cost, making the system suitable for educational, domestic, and small-scale environmentalapplications. Experimental results demonstrated average pollutant removal efficiencies of 30.32% for CO_2, 47.56% for HCHO, and 56.86%for TVOCs. The proposed purification unit provides an economical and environmentally sustainable alternative for localized air qualityimprovement.

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Shan, S., Cheng, B., Sculthorpe, G., Crowder, J., Potyrailo, R. A.

Dynamic Multigas Differentiation Using a Temperature-Modulated Dielectric-Excitation Gas Sensor.

IEEE Sensors Letters, (2026), 1-4 p.

Existing legacy gas sensors are tiny and not cost-prohibitive, but their gas cross-sensitivity limits reliable detection of gases of interest in complex environments. Here, we report multigas differentiation using an individual semiconducting metal oxide (SMOX) gas sensor operated with dielectric excitation and temperature modulation. Dielectric excitation provides a frequency-dependent response, while temperature modulation introduces gas-specific transient signatures that further increase response dimensionality. We differentiate multiple gases under both step changes and dynamically randomized changes in gas concentration. These results provide a practical route for using conventional SMOX sensing elements in modern high-information-content gas sensors for emerging applications.

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Mitchell, P., Forde, M. S.

Evaluation of total VOC exposure and ventilation controls in funeral home preparation rooms: A case study from Grenada.

Journal of Occupational and Environmental Hygiene, (2026), 1-10 p.

Funeral home (FH) preparation rooms pose potential occupational health hazards due to exposure to volatile organic compounds (VOCs) emitted during embalming and autopsy procedures. This analytical observational study assessed indoor air quality (IAQ) hygiene conditions in all three funeral homes operating in Grenada using total volatile organic compound (TVOC) concentrations as an exposure indicator. Air sampling was conducted during 18 embalming and autopsy sessions between February and June 2025 using a GrayWolf AdvancedSense Pro monitor with a photoionization detector. Concurrent measurements of hydrogen sulfide, carbon monoxide, temperature, and relative humidity were recorded. A brief survey was administered to embalmers and support staff to assess work-related health symptoms. Mean TVOC concentrations exceeded the German recommended IAQ hygiene guideline of 0.3?mg/m? in two of the three funeral homes. Funeral home #1 (FH1) recorded the highest geometric mean TVOC concentration (7.7?mg/m?), whereas Funeral home #3 (FH3) maintained the lowest (0.20?mg/m?). Elevated concentrations were associated with inadequate ventilation and smaller room volume. FH3?s continuous fresh air ventilation system-maintained levels below the German IAQ guideline. Self-reported health data from embalmers and reception staff indicated musculoskeletal and respiratory complaints across facilities, though limited sample sizes precluded meaningful comparison between funeral homes or job categories. These results illustrate the practical utility of TVOC measurements in assessing IAQ and provide funeral home directors with valuable guidance on designing and maintaining ventilation systems to safeguard the occupational health of funeral service providers.

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Lubis, M. D., Fachrudin, H. T., Harahap, K. S., Hassan, A. S., Nasir, M. H. B. A., Nasution, A. N. E.*, et al.*

Impact of Green Building Principles in Public Facilities towards Indoor Air Pollution.

IOP Conference Series: Earth and Environmental Science, Vol. **1639** n°(1), (2026)

Indoor air pollution is a serious health problem, contributing to 12% of pneumonia deaths globally. In Indonesia, pneumonia is the third leading cause of death, with indoor air pollution being a significant contributing factor. This situation exposes people to continuous exposure to hazardous pollutants. Many public facilities, such as markets and community centers, operate in areas with poor air quality but have not yet implemented green building principles. The purpose of this study is to determine how three green building principles are integrated to affect indoor air quality in public facilities. This research method uses a qualitative method with literature analysis related to green building principles, specifically waste management, green material cycles, and indoor health and comfort, and their implementation through case studies of public facility buildings. Research data were collected from scientific journals, books, and related technical documents. By integrating waste management, eco-friendly material cycles, and indoor health principles into a comprehensive framework, public facilities can effectively reduce indoor air pollution, specifically by reducing Methane (CH4), Volatile Organic Compounds (VOCs), and PM2-5 to create a healthier and cleaner environment that supports a more sustainable lifestyle for the community.

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Persson, J., Brusberg, O.

Indoor Air Quality Monitoring Using IoT and Real-Time Sensors: A study of CO2, Temperature, and Humidity in Smaller Indoor Environments.

Linnaeus University, Faculty of Technology, Department of computer science and media technology.Thèse 2026

Indoor air quality has a direct impact on human health, comfort, and cognitive performance, particularly in enclosed environments such as classrooms and offices. Despite the availability of IoT-based monitoring solutions, many existing systems are either too expensive or too complex for practical use in smaller indoor settings. This project investigates whether a simple and affordable IoT-based system can reliably monitor indoor air quality in real-time. A prototype was developed using a Raspberry Pi Pico W microcontroller connected to a DHT22 temperature and humidity sensor and an SCD40 CO2 sensor, with data transmitted via MQTT to the Adafruit IO dashboard for visualisation. Environmental data was collected continuously over one week in a classroom environment and compared against both recommended indoor air quality standards and a calibrated reference sensor. The results showed that CO2-levels varied clearly with classroom occupancy, temperature remained stable within recommended ranges, and humidity was occasionally below the recommended threshold. The low-cost sensors showed measurable deviations from the reference instrument but followed consistent trends, suggesting they are sufficient for general indoor air quality monitoring in smaller environments.

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Dong, L.

Indoor Climate and Energy Efficiency in Buildings.

Buildings, (2026)

As global warming challenges persist, balancing indoor comfort with low energy consumption is vital for sustainable development. This Reprint features twelve peer-reviewed articles exploring advanced technologies, design strategies, and behavioral insights to create energy-efficient buildings.nThe compiled research covers diverse building types, from residential homes and dormitories to gymnasiums, entertainment venues, and heritage architecture. Key themes include optimizing indoor lighting and thermal environments via passive design, cross-ventilation, and daylighting. The authors also evaluate innovative carbon-reduction solutions, like semi-transparent photovoltaic skylights, phase change materials, and roof retrofits. Furthermore, this Reprint emphasizes human factors, investigating occupant thermal needs in transitional spaces, student energy behaviors, and post-renovation user satisfaction. It also addresses indoor air quality through empirical studies on particle infiltration. By synthesizing architectural design,

technological innovation, and occupant behavior, this collection provides a valuable resource for researchers and practitioners advancing low-carbon, sustainable built environments.

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Keerthana, G., M, K., M, T. V., Athul, N., Shalitha.

IoT-Enabled Smart Microclimate Control Robot for Sensitive Environments with Real-Time Sensor Monitoring.

2026 6th International Conference on Pervasive Computing and Social Networking (ICPCSN). 06-08 May 2026. Salem, India

Sensitive areas such as hospitals, neonatal care, elderly care, and laboratories demand precise control over the environment. Conventional HVAC systems control the micro-environment of the entire room. However, this approach results in high power consumption, delayed response, and the inability to control the micro-environment. This paper introduces an autonomous Micro Climate Control Robot that can monitor the micro-environment of the 1.5–2 m radius of the concerned individual. The robot uses multi-modal sensing for micro-environmental control. An ESP32 microcontroller with FreeRTOS is used for real-time control. Moreover, the robot uses a rule-based PID control strategy for micro-environmental control. Simulation results show that the robot improves micro-environmental control, reduces power consumption, and responds quickly to environmental changes. The robot provides an innovative solution for precision air quality management and helps to make it a personalized once which will ensure personalized environment for a particular individual.

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Ono, E., Quek, O., Cheung, T.

Linking Occupant Preferences, Space Selection Behavior, and Experienced IEQ to Well-Being in a Flexible Workplace.

Proceedings of the 2026 ACM Sustainability Week

Workplaces are expected to deliver both environmental performance and occupant well-being, yet static assumptions about occupancy and uniform conditions often miss behavioral and environmental heterogeneity. This study examines how environmental preferences, space selection behavior, and experienced indoor environmental quality (IEQ) jointly shape workplace evaluation in a flexible office. Using a field survey (n = 81) and environmental measurements, we integrated person-level TBACN experienced-IEQ features (Temperature, Brightness, Air movement, Crowdedness, Naturalness), clustering, preference–experience matching, and desk-type comparison. Three findings emerge. First, five experienced-IEQ clusters were identified, with ID1/ID5 each 32.1%, ID2 22.2%, and ID3/ID4 9.9%/3.7%; cluster separation was better than permutation null expectations (one-sided empirical $p = 0.002$). Second, higher integrated preference–experience match showed a weak positive association with diversity acceptance (Spearman $\rho = 0.202$, $p = 0.070$). Third, hot-desk users showed higher integrated match (0.585 vs 0.480; two-sample t-test $p = 0.028$) and higher diversity acceptance (5.55 vs 5.13; $p = 0.119$) than fixed-desk users. Together, these findings strengthen an occupant-centric view of workplace performance and point to the next step: adaptive space-operation strategies and longitudinal, multimodal studies that test causal pathways between preference alignment, mobility, and well-being outcomes.

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Sherekar, P. S., Gole, D. N., Ravekar, A. N., Pradeep, T., Kalwaghe, V. S. N., Khandar, M. S.

Low Cost Decentralized Smart Air Purification & Monitoring System.

International Journal for Research in Applied Science & Engineering Technology (2026)

Air pollution has become a serious threat to human health, especially in densely populated urban regions such as Delhi NCR. The increasing number of vehicles, industries, and construction activities has resulted

in high levels of harmful gases and airborne particles. To overcome this challenge, this work presents a low- cost decentralized smart air purification and monitoring system based on Internet of Things (IoT) and blockchain technology. The proposed system uses DHT11, MQ-7, and MQ-135 sensors to continuously measure temperature, humidity, carbon monoxide, and overall air quality. The sensed data is transmitted to a cloud platform and securely recorded using blockchain to ensure data integrity and transparency. When pollution levels exceed safe limits, a low-cost air purification unit is automatically activated to reduce contaminants. The system is affordable, scalable, and suitable for deployment in smart city environments, providing both real-time monitoring and localized pollution control.

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Gentile, V., Perino, M., Stronati, F.

Low-cost & fast-response multi-tracer multi-point gas sensing network for ventilation and interzonal flows measurements.

12th International Conference on Indoor Air Quality, Ventilation & Energy Conservation in Buildings (IAQVEC 2026)

The assessment of ventilation performance and interzonal airflows is essential both for ensuring indoor air quality (IAQ) and for understanding the risk of airborne cross-infection in buildings. Conventional tracer gas methods, typically relying on photoacoustic Gas Analyzers (PGA), remain limited by high costs, logistical complexity, and restricted temporal resolution. This study introduces a novel low-cost, fast-response sensing system designed for multi-tracer and multi-spot applications. The platform integrates Non-Dispersive Infrared (NDIR) detectors and wireless communication, enabling the simultaneous monitoring of different tracer gases—sulfur hexafluoride (SF6), propane (C3Hs), and carbon dioxide (CO2)—across multiple zones. The use of multiple tracers allows the characterization of interzonal mass exchange pathways, while the distributed sensor network provides spatially resolved data with high temporal resolution (theoretically, up to 50 Hz). Laboratory validation against reference PGA and anemometric data confirmed measurement accuracy within ±20% for ventilation rates between 1 and 10 air changes per hour (ACH). Beyond traditional single-zone assessments, the proposed system demonstrates the capability to capture transient airflow phenomena and quantify interzonal exchange rates with a single equipment, offering a practical and scalable tool for real-time IAQ monitoring, ventilation effectiveness evaluation, and infection risk assessment in buildings.

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Nguyen, T.-P.

Multivariable indoor air quality management in smart building based two-stage deep sequential technique and metaheuristic algorithm.

Engineering Applications of Artificial Intelligence, Vol. **181**, (2026)

Indoor air quality (IAQ) has become a critical concern in smart building environments, directly impacting occupant health, comfort, and productivity. Effective IAQ management requires accurate and real-time prediction systems to proactively control ventilation, filtration, and air purification systems. This research proposes an Artificial Intelligence of Things (AIoT)-based intelligent framework for indoor air quality management by integrating a two-stage deep sequential model with a metaheuristic optimization technique. Specifically, a hybrid architecture combining Convolutional Neural Networks (CNN) and Bidirectional Long Short-Term Memory (BiLSTM) is constructed to simultaneously encode spatial feature interactions and temporal dynamics within multivariate IAQ data acquired from Internet of Things (IoT) sensor networks distributed throughout the building. An Enhanced Particle Swarm Optimization (EPSO) algorithm is further integrated to automatically tune the hyperparameters of the CNN-BiLSTM model, promoting faster convergence and stronger generalization capacity. The proposed EPSO-CNN-BiLSTM framework is evaluated using real-time IAQ datasets, and the results demonstrate its superior prediction accuracy compared to traditional models such as Recurrent Neural Networks (RNN), Bidirectional Recurrent Neural Networks (BiRNN), Gated Recurrent Unit (GRU), Long Short-Term Memory (LSTM), Bidirectional Long

short-term memory (BiLSTM), and CNN with ultimate improvements of 74.56% Loss, 68.90% validation Loss, 2.34% Cosine Proximity (CP), 1.71% validation CP, 48.58% Mean Absolute Error (MAE), 50.81% validation MAE, 52.51% Mean Absolute Percentage Error (MAPE), 47.18% validation MAPE, 18.27% Coefficient of Determination (R2), and 15.77% validation R2. This study highlights the significance of AIoT-driven solutions in intelligent building applications and offers a reliable approach for proactive multivariable IAQ control, thereby fostering improved occupant health and reduced energy consumption in indoor spaces. The proposed model can assist building managers and automation systems in maintaining optimal air quality conditions dynamically and efficiently.

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Danielak, M., Warzecha, P.

Natural Convection Cooling for Indoor Thermal Regulation in Buildings.

12th International Conference on Indoor Air Quality, Ventilation & Energy Conservation in Buildings (IAQVEC 2026)

Natural processes offer an effective means of regulating a building's indoor environment, providing both hygienic ventilation and thermal conditioning while reducing primary energy use. Unlike mechanically driven systems—which require electricity and incorporate complex components such as fans—natural convection relies on buoyancy forces generated by air density differences, enabling passive air movement. Although mechanical convection remains the prevailing approach for cooling, practical evaluations comparing it with natural convection are scarce, and documented real-world applications are limited. Moreover, existing studies tend to focus on temperature distribution alone, neglecting broader aspects of indoor environmental quality. This research addresses these gaps by analyzing the vertical and horizontal distribution of indoor parameters in a building hall that employs both gravity-based and mechanically forced convection cooling. The results contribute applied knowledge for the design of low-carbon buildings that integrate energy efficiency with occupant comfort.

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Brockmann, G., Kriegel, M.

A numerical investigation about the influence of combined exhaust positions on ventilation effectiveness.

12th International Conference on Indoor Air Quality, Ventilation & Energy Conservation in Buildings (IAQVEC 2026)

This study investigates the influence of combining multiple exhaust air positions on ventilation effectiveness in mechanically ventilated spaces using a slot diffuser for the supply air distribution in a single main vortex covering the whole room. By systematically testing different paired exhaust configurations, the analysis examines their impact on air change effectiveness (ACE) and contamination removal effectiveness (CRE). The results show that the ventilation effectiveness of combined exhaust configurations generally falls between the values of the individual positions, observed across tested scenarios. To simplify the analysis under a one-vortex airflow characteristic, the ACE of combined exhaust positions can be reasonably approximated by averaging the ACE values of the individual exhaust locations. CRE includes the position of the contamination source. Close distance between the source and the exhaust in line of the airflow pattern increase the CRE.

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Cheung, T., Ono, E.

Occupant Environmental Satisfaction in a Semi-Outdoor Workspace versus Air-Conditioned Offices in Singapore.

E3S Web Conf., Vol. **716**, (2026)

12th International Conference on Indoor Air Quality, Ventilation & Energy Conservation in Buildings (IAQVEC 2026)

This study investigates occupant satisfaction with environmental conditions in a purpose-built semi-outdoor, naturally ventilated workspace in Singapore. A Post-Occupancy Evaluation (POE) survey was used to assess occupants' satisfaction across 19 environmental parameters. These parameters include temperature, humidity, air movement, overall thermal comfort, air freshness, scent, overall IAQ, lighting, light color, window views, overall visual comfort, noise, privacy, communication, furnishings, available space, personal control, cleanliness, and overall environment. Thereafter, satisfaction performance of 14 common parameters from the semi-outdoor workspace were compared against thirteen conventional air-conditioned (AC) offices extracted from the literature. The findings were unexpected. The semi-outdoor workspace showed either higher satisfaction or lower dissatisfaction with temperature, air freshness, scent, window view, available space, and noise level when compared with AC offices. This outcome suggests that occupant expectations in semi-outdoor settings could be different from those in fully controlled indoor environments. The results also indicate that maintaining optimal air speed is a key factor in achieving higher overall thermal satisfaction in semi-outdoor workspaces. On the other hand, satisfaction with humidity, lighting, personal control, cleanliness, and privacy was lower than in AC offices, largely because of the dynamic and less controllable outdoor weather conditions. These results based on user feedback demonstrate that semi-outdoor workspaces are not an impossible option in tropical climates. The study offers valuable insights that can inform the design and operation of future naturally ventilated workspaces in the tropics. By adopting appropriate design strategies, it is possible to reduce energy-intensive reliance on air conditioning while maintaining acceptable levels of occupant satisfaction.

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Scarselli, A., Gherardi, M., Di Marzio, D., Marinaccio, A.

Occurrence of formaldehyde exposures in work activities and its diffusion in the Italian industrial context following the notification requirements.

Annali dell'Istituto Superiore di Sanità, Vol. **62** n°(2), (2026), 121-129 p.

Purpose. The aim of this study is to describe data on occupational exposure to formaldehyde in the context of Italian economic activities.
Methods. Measurement data of airborne concentrations (n=26,216) of formaldehyde in the period 1996-2024 were selected from the national register of occupational exposure to carcinogens (Sistema Informativo Registri di Esposizione Professionale, SIREP). Descriptive statistics were calculated for main exposure-related variables. The number of potentially exposed workers was estimated for the best-characterized sectors.
Results. The overall geometric mean was 0.028 mg/m3. Most of the exposure was found in the wood (n=4,912), chemical (n=4,090), and plastic industries (n=3,925). A different distribution of exposure was found according to gender, as women exposures were more common in the healthcare sector. The estimated number of potentially exposed workers in the selected sectors was approximately 100,000.
Conclusions. The implementation of the new European Union (EU) regulation has enhanced the surveillance system, resulting in noteworthy improvements in the monitoring of occupational exposure to formaldehyde.

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Zhu, N., Zeng, Z., Zhao, X., Yang, Z., Luo, Z.

Performance evaluation and airflow optimization of a wall-integrated PV-PCM-TEC system for office building: A CFD and AHP study.

Energy and Built Environment, (2026)

To mitigate building energy consumption and carbon emissions, a novel photovoltaic-phase change material-thermoelectric cooler (PV-PCM-TEC) system was proposed and integrated into the south wall of an office building in Wuhan, China. This study focuses on evaluating the indoor environmental quality (IEQ)

under different ventilation configurations when such a system is installed. The PCM plate serves as a thermal buffer layer to assist TEC operation, but the primary contribution is a multi-criteria assessment of thermal comfort, air quality, and ventilation effectiveness using CFD and AHP. Using Airpak software, the indoor thermal performance was simulated, including air temperature, Predicted Mean Vote (PMV), CO_2 concentration, and mean age of air (MAA) under various ventilation configurations. The performance of these ventilation configurations was then evaluated via the Analytic Hierarchy Process (AHP). Results indicated that the top-supply with north-side lower return airflow configuration was identified as the preferred configuration, slightly outperforming the second-best case (0.2867 vs. 0.2864). This work provided insights for designing building-integrated PV systems that prioritize both energy efficiency and superior indoor environmental quality.

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Asaad, M., Chakroun, W.

Performance evaluation of a constructal-based tree-branched underfloor air distribution systems: Influence of outlet number on thermal comfort and indoor air quality.

Energy and Buildings, (2026)

Underfloor air distribution (UFAD) systems can improve thermal comfort and indoor air quality (IAQ); however, their effectiveness strongly depends on supply outlet distribution. This study experimentally and numerically investigates the airflow, thermal, and IAQ performance of constructal-based tree-branched UFAD systems with different outlet densities. A full-scale experiment was conducted for a high-density Tree-154 holes configuration in a test chamber equipped with a wall-mounted radiative cooling panel and internal heat load. Measurements of air temperature, velocity, and particle concentration were used to validate a three-dimensional CFD model employing the realizable k-ε turbulence model. The validated model was then used to evaluate two additional tree-branched configurations (Tree-24 and Tree-16) and a conventional UFAD system under identical operating conditions. System performance was assessed using draught rate, cooling effectiveness, and contaminant removal effectiveness (CRE). All configurations satisfied vertical thermal comfort requirements, maintaining head-ankle temperature differences below 3 °C. The tree-branched layouts exhibited higher cooling effectiveness (CE = 2.56–2.86) compared with the conventional UFAD system (CE = 2.17), reflecting enhanced thermal stratification within the occupied zone. In terms of IAQ, the Tree-24 and Tree-154 configurations achieved the highest CRE values and consistently lower occupant exposure over a one-hour averaging period, outperforming both the Tree-16 and conventional UFAD layouts. The results demonstrate that constructal-based outlet distribution can substantially enhance UFAD performance, offering an effective design approach for improving thermal comfort and IAQ in enclosed spaces.

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Chakroun, W., Ghaddar, N., Asaad, M., Hamid, M., Alotaibi, S.

Pulsating impinging jet ventilation combined with a constructal radiation floor cooling system to improve comfort and indoor air quality.

Building and Environment, Vol. **302**, (2026)

This work investigates how pulsation timing affects indoor air quality in a pulsating impinging jet ventilation (PIJV) system combined with a radiant floor cooling panel (RFCP). Experiments were conducted in a full-scale room, and the measurements were used to validate a transient three-dimensional CFD model. The behavior of PM2.5 under different pulsation frequencies were studied, with the airflow rate kept constant in all cases. The experimental results show that pulsation has a limited impact on the thermal field, with all cases maintaining acceptable vertical temperature differences within the occupied zone (1.2–1.5 °C). In contrast, IAQ performance is strongly influenced by the pulsation frequency. Short and balanced cycles, particularly 30:30 and 60:60 (ON:OFF), reduce peak particle concentration by approximately 20–30% and accelerate decay by about 20–40% compared to longer cycles such as 120:120. The 30:30 case demonstrates the most effective performance, with faster contaminant removal and reduced particle

residence time. These trends are consistent with the numerical results, where higher contaminant removal effectiveness (CRE) values are observed for cases with frequent jet reactivation, reaching 3.06 for 30:30 and 1.62 for 60:60, compared to values close to or below 1 for longer or unbalanced cycles. These results show that more frequent jet operation improves mixing and helps remove particles more efficiently, without affecting the thermal conditions. Selecting suitable pulsation timing is therefore important for improving IAQ in PIJV systems.

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Sarker, A., Lesan, M., Chahardoli, S., Bhattacharya, A.

Real-Time Indoor CO2 Distribution Prediction Using CFD and Physics Regularized Kolmogorov-Arnold Network.

12th International Conference on Indoor Air Quality, Ventilation & Energy Conservation in Buildings (IAQVEC 2026)

Carbon dioxide (CO2) is widely used as a practical indicator of indoor air quality and ventilation performance, yet its indoor distribution is often spatially non-uniform because of room geometry, airflow structure, ventilation configuration, and occupant-generated emissions. This study proposes a hybrid CFD-AI framework that integrates baseline computational fluid dynamics (CFD) with sparse sensor measurements through a physics-regularized Kolmogorov-Arnold Network (KAN) to reconstruct high-resolution indoor CO2 fields. The framework was demonstrated in a mechanically ventilated university classroom instrumented with five NDIR CO2 sensors and synchronized HVAC data. A steady Reynolds-averaged Navier-Stokes CFD model with SST k-ω turbulence closure and passive-scalar CO2 transport was used to generate baseline concentration and airflow fields, which were interpolated to sensor locations to define residual targets. The KAN was trained using spatial coordinates, time encodings, HVAC variables, and CFD priors within a composite loss function that combined data fidelity, physics residuals, and spatiotemporal smoothness constraints. Leave-one-sensor-out validation showed strong generalization to unseen sensor locations, reducing MAE from 123.09 to 28.00 ppm and RMSE from 123.39 to 29.20 ppm, corresponding to error reductions of approximately 65-92% across folds. The corrected fields also preserved spatial coherence in breathing-zone CO2 contours. These results demonstrate that physics-regularized residual learning can substantially improve sensor-sparse indoor CO2 mapping and support room-scale ventilation assessment and control.

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Burda, Y.

Reduced-order modeling of microclimate formation in displacement ventilation systems.

Ventilation, Illumination and Heat Gas Supply, Vol. **57**, (2026), 23-39 p.

This study presents a reduced-order thermodynamic model for analysing microclimate formation in displacement ventilation systems under variable airflow rates and thermal loads. The model integrates energy balance, mass transport, and buoyancy-driven stratification effects into a unified computational framework suitable for engineering applications in indoor air quality control and clean room ventilation design. Numerical simulations were performed using Python 3.x with SciPy and NumPy libraries, while results were visualised using Matplotlib. The investigated operating range includes airflow rates from 0.30 to 0.75 $m^3 \cdot s^{-1}$ and heat loads from 20 to 65 $W \cdot m^{-2}$. The results demonstrate stable thermal stratification with vertical temperature gradients ranging from 0.42 to 1.02 $K \cdot m^{-1}$. The contaminant removal effectiveness varies between 0.98 and 1.62, indicating high efficiency of displacement ventilation under optimal conditions. A non-linear decrease in performance is observed at airflow rates exceeding 0.65 $m^3 \cdot s^{-1}$ due to degradation of stratified flow structures. The optimal operating range is identified as 0.45–0.60 $m^3 \cdot s^{-1}$, where the best balance between thermal stability and air quality is achieved. The proposed model provides improved predictive capability compared to conventional simplified approaches while maintaining low computational cost, making it suitable for engineering design and optimisation of ventilation systems.

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Pan, K.-L., Shih, P.-Y., Choo, Z.-S., Hsu, J.-C., Shen, K.-P.

Removal of isopropyl alcohol (IPA) in a semiconductor facility using ozone catalytic oxidation.

12th International Conference on Indoor Air Quality, Ventilation & Energy Conservation in Buildings (IAQVEC 2026)

Isopropyl alcohol (IPA) is a widely used organic solvent in the semiconductor industry and is commonly detected as an indoor volatile organic compound (VOC) that poses potential risks to both manufacturing processes and human health. In this study, ozone catalytic oxidation (OZCO) was investigated as an effective technology for IPA removal through laboratory-scale experiments and real field tests conducted in a semiconductor manufacturing facility. The laboratory results demonstrated that IPA removal efficiency was strongly dependent on ozone dosage, achieving up to 97% removal at an ozone generator power of 80 W under ambient temperature conditions. Carbon balance analysis indicated effective oxidation of IPA, with the majority of carbon converted to CO2, confirming the strong oxidative capability of the OZCO process. Field-scale evaluations further demonstrated stable and effective removal of IPA and acetone, with removal efficiencies of 87-89% and 80-85%, respectively, over repeated tests under actual operating conditions. The results confirm the reliability and applicability of the OZCO system for continuous VOC control. Overall, this study highlights the potential of OZCO as a feasible and practical technology for VOC abatement in semiconductor manufacturing facilities.

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Wen, S., Zhou, N., Zhang, W., Xuan, Y., Wang, J., Zhang, H.*, et al.*

Sensing, prediction, and ventilation for non-uniform indoor environments: A comprehensive review and future research directions.

Energy and Built Environment, (2026)

Non-uniform indoor environments have emerged as a promising paradigm for improving energy efficiency, indoor air quality, and occupant-centric comfort in buildings. Non-uniform indoor environments refer to the deliberate creation of spatially or locally differentiated environmental parameters to meet diverse comfort and health needs while reducing overall energy consumption. This review presents a comprehensive and integrated analysis of the development of non-uniform indoor environments from three interrelated perspectives: sensing, prediction, and ventilation. First, advances in environmental sensing technologies are systematically summarized, including fixed sensor networks, mobile sensing platforms, and multimodal recognition systems. Second, state-of-the-art prediction methods for indoor environmental fields are reviewed, covering physically simplified computational fluid dynamics approaches, reduced-order models, and emerging data-driven techniques, highlighting the transition toward real-time and high-efficiency prediction. Third, ventilation systems for creating non-uniform environments are analyzed across multiple spatial scales, ranging from space-divided ventilation systems to personalized and wearable microenvironmental systems, demonstrating a clear evolution toward occupant-centric and demand-oriented control. Based on the reviewed literature, key challenges are identified in sensor deployment optimization, multimodal data fusion, model generalization and uncertainty quantification, and the stability and coordination of multi-scale airflow organization. Future research directions are proposed, including the integration of sensing, prediction, and control within closed-loop frameworks, the development of digital twin-enabled intelligent systems, and the establishment of evaluation metrics tailored to non-uniform environments. The findings highlight the technological convergence required for future intelligent and occupant-centric indoor environmental control systems.

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Deldoost, Z., Haghighat, F., Nasiri, F.

A Superposition-Based Method for Rapid Estimation of Indoor Airflow Fields Under Occupant Movement.

12th International Conference on Indoor Air Quality, Ventilation & Energy Conservation in Buildings (IAQVEC 2026)

Indoor air quality is strongly affected by the behavior of airborne pollutants such as pathogens dispersed in circulating air. The dispersion of these particles depends heavily on the airflow field and the vortices generated within an enclosed space. While predictable factors—such as ventilation configuration and furniture layout—can be investigated through one-time numerical simulations, unpredictable factors, particularly occupant movement, remain a major challenge. Previous studies have attempted to simulate airflow under specific movement scenarios; however, their results are case-specific, lack generalizability, and require extensive computational resources. To address this limitation, the present study introduces a novel method for rapidly estimating airflow fields influenced by occupant movement. The approach is based on a dataset generated from computational fluid dynamics (CFD) simulations of a moving person at different speeds. These simulations capture the vortical structures created around the body, represented by distributions of velocity vectors at computational nodes. When occupant movement occurs in a ventilated domain, the stored velocity vector distributions can be superimposed onto the baseline airflow field of the empty room. By combining these two components—the airflow induced by the ventilation system and the flow generated by occupant motion— the method reconstructs the overall velocity field around a moving person in a ventilated environment. This superposition technique substantially reduces computational cost by avoiding the need for repeated CFD simulations for every new movement scenario. At the same time, it provides timely and reliable predictions of airflow dynamics under occupant-induced disturbances. The proposed method therefore offers a practical and efficient tool for assessing pollutant transport and infection risk in real indoor environments where human activity introduces inherently uncertain airflow conditions.

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Cetin, Y. E., Wang, Z., Brockmann, G., Kriegel, M.

Ventilation Effectiveness in a Test Room: Experiments and CFD Validation.

12th International Conference on Indoor Air Quality, Ventilation & Energy Conservation in Buildings (IAQVEC 2026)

Ventilation effectiveness is often interpreted under the assumption of fully mixed conditions, yet this assumption breaks down for localized emissions that dominate airborne-infection risk. This study presents controlled experimental and numerical evidence demonstrating how both exhaust placement and point source position strongly influence dilution performance in a mixing ventilated room. Full-scale measurements in a 5.2 m × 4.4 m × 2.85 m test space captured air velocities and CO2 tracer dynamics under different inlet-outlet layouts. These data were used to validate computational fluid dynamics (CFD) simulations, which then enabled assessment of additional source configurations. Agreement between CFD and measurements was generally satisfactory, with minor discrepancies attributable to idealized boundary conditions. The results show that changing the exhaust location fundamentally alters airflow organization, leading to pronounced differences in air-change efficiency and local air quality. While one configuration exhibited near-uniform dilution, the alternative layout promoted short-circuiting and strong sensitivity to source position, resulting in spatially nonuniform exposure conditions. These findings demonstrate that mixing ventilation does not inherently ensure homogeneous indoor air quality. The study provides a reproducible reference case for quantifying imperfect mixing under controlled conditions and establishes a foundation for future infection-risk-oriented evaluation and optimization of ventilation layouts.

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Hupkes, J., Brown, R., Burton, L., Estaquio, R., Lustro, J., Li, Z., *et al.*

Ventilation Strategy Classification in Practice: Evaluating Underfloor Air Distribution Performance in Melbourne's Council House 2.

International Conference on Indoor Air Quality and Climate (Indoor Air) 2026, 14-18/06/2026, Singapore , Singapore.

This study examines ventilation strategies to prevent mould growth in tropical buildings, where conventional approaches developed for temperate climates can worsen, rather than resolve, moisture problems. Using a taxonomy of 22 ventilation strategies, the research classifies natural, mechanical, and hybrid systems based on their temperature and moisture management performance in hot-humid conditions. Analysis of climate data from five tropical locations reveals that hybrid systems with humidity-responsive controls and mechanical ventilation with dehumidification, outperform natural approaches. The study proposes a practical classification framework to guide strategy selection in tropical climates where outdoor humidity frequently exceeds indoor humidity levels, making standard ventilation assumptions invalid.

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Chi, P., Stewart, C., Berta, W.

Where we work matters: A scoping review of literature on the influences of work environments on workers & their work.

Social Sciences & Humanities Open, Vol. **13**, (2026)

This cross-disciplinary review highlights a number of important associations between the physical work environment, workers, and their work across literatures and across settings. While our current understanding of the interplay amongst work attitudes, environment, and performance is far from nuanced and has been delimited by conceptual differences and methodological deficits, what is clear from this review is that where we work matters to individual workers' physical and mental health, to their attitudes about their work, to collaboration amongst workers and their ability to carry out interdependent tasks, and quite likely to the overall performance of the organizations that employ them.

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