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WoS, Google Scholar et Lens

Dorieh, A., Pahlavan, F., Hájková, K., Hýsek, Š., Farajollah Pour, M., H. Fini, E.
Advancing Sustainable Building Materials: Reducing Formaldehyde Emissions in Medium Density Fiber Boards with Lignin Nanoparticles.
Advanced Sustainable Systems, (2024)

Abstract The pressing need to develop eco-friendly polymer materials for building applications has led to increased interest in modifying existing polymer systems. In this study, a sustainable approach to augmenting urea-formaldehyde (UF) resins, widely employed in wood-based panels is introduced. Addressing this, formaldehyde-scavenger demethylated lignin nanoparticles into UF resins, aiming to produce a green and enhanced medium-density-fiberboard (MDF) with minimal formaldehyde emissions is incorporated. The results indicate that increasing concentrations of demethylated lignin nanoparticles in the UF adhesive, there is not only a reduction in formaldehyde emissions from MDF composites but also a significant decrease in thickness swelling. The highest reduction in formaldehyde emission is observed in the MDF composite prepared with UF resin containing 7% lignin nanoparticles (UF-7NL), with an emission of 2.9 mg/100 g, marking a substantial decrease of 74% compared to emission of 11.2 mg/100 g from neat resin. Importantly, this reduction does not compromise physical and mechanical properties of the MDF; they remain comparable to boards bonded with unmodified UF. Molecular modeling revealed that lignin effectively traps formaldehyde, incorporating it as -CH2OH groups, leading to a notable decrease in formaldehyde emission from MDF. This approach offers an eco-friendly modification to a common polymer, showcasing lignin nanoparticles as innovative additives.

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Borjanović, I.
AI-Supported Solution for Proposal to Improve Indoor Air Quality Using Web Application and Airthings Radon Detector.
Sinteza 2024 - International Scientific Conference on Information Technology, Computer Science, and Data Science. 16 mai 20245. Belegrade, Serbie

The device called View Plus Radon Detector made by Airthings, allows measuring indoor air quality parameters. Measurement results can be accessed through the purpose-built online platform – Airthings Dashboard. The Airthings Consumer API enables our custom-made web application to retrieve the results of the latest measurement. The question arises of how to mitigate the effects of poor air quality parameters.We propose the use of a web application called Air Quality - AI mitigation advisor. After retrieving the results of the latest measurement, this web application can send these results for assessment to artificial intelligence. AI has the ability to suggest a sorted list of devices with brief explanations or means to improve air quality in the room where the measurement is taken based on the sent question and air quality parameters.In our work, we provide a description of the system used. We also describe and present the results of an experiment that combines the capabilities of the View Plus Radon Detector, the web application, AI, and statistics with the aim of providing device and means recommendations for improving air quality in the room where the measurement is taken after a series of measurements.

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Montuori, P., Russo, I., De Rosa, E., Di Duca, F., De Simone, B., Triassi, M.
Air Monitoring in Operating Rooms: Results from a Comprehensive Study in the Campania Region.
Atmosphere, Vol. **15** n°(7), (2024)

Ensuring air quality in operating rooms is crucial for the health and safety of healthcare professionals and patients. This study, focused on 141 operating theatres in the Campania Region from 2015 to 2022, highlights the importance of air monitoring in operating rooms. Microclimatic parameters, air exchanges, thermal comfort indices, air pressure differences, and anesthetic gas concentrations were measured using standardized procedures. Results indicate that 19% of microclimatic checks exceeded acceptable limits, with significant non-compliance in air velocity (0.01–0.04 m/s, mean 0.03 m/s) and air changes (1–14 h−1, mean 6 h−1). Additionally, levels of anesthetic gases such as nitrous oxide (54.7–

197.31 ppm, mean 142.92 ppm) and sevoflurane (2.05–19.45 ppm, mean 5.90 ppm) frequently exceeded recommended exposure limits, raising health concerns. These findings underscore the importance of rigorously adhering to environmental standards and continuously monitoring for optimal conditions in operating rooms. The study also stresses the necessity of ongoing education and training for healthcare personnel on preventive measures to reduce risks. In conclusion, maintaining optimal environmental conditions not only safeguards the comfort and safety of healthcare professionals and patients, but also improves team productivity and clinical outcomes. The study advocates for regularly updating national guidelines and rigorously enforcing safety protocols in healthcare facilities.

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Manuel, C. D., Samardjieva, K.
Air quality and biological agent exposure of administrative personnel at a waste sorting plant.
114th International Scientific Conference on Economic and Social Development – Porto, 12-13 July, 2024

The management of waste is an expanding field, and it is acknowledged that the processes of landfilling, sorting, and composting waste materials can affect air quality and produce harmful bioaerosols. While many studies have focused on the health impacts of these activities on the personnel directly interacting with the waste material, information on the air quality of administrative personnel in this industry is scarce. In this study, we have conducted an analysis of the concentration of bacteria, fungi, particulate matter (PM), carbon dioxide, relative humidity, and temperature in two administrative offices and the canteen of a waste sorting plant in the morning and afternoon of the workday in the winter of 2023. Our results show that PM2.5 and PM10 concentrations were below 25 ❍g/m3 with the exception of the canteen, where, on some occasions, the values were higher in the afternoon. The carbon dioxide values were higher in the offices than outdoors and increased significantly with the number of occupants, exceeding 1250 ppm in the afternoon. Temperatures and relative humidity were within the range of 16.6 - 26.4⌗C and 54.5 - 99.4%, respectively, and in some cases the evaluated rooms had high concentrations of fungi. Our findings show that in several instances, the recorded parameter values, as well as their combination, are not within the optimum working conditions. Therefore, this study highlights the importance of a holistic approach to the evaluation of the air quality and the personnel working conditions in waste-sorting centres and allows the proposal of appropriate mitigation measures to ensure a safe and healthy workplace.

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Lucy, K. K., Yuan, S., Gurumurthy, R., Lydia, M. L., Walkiria, P., Katrina, R., *et al.*
Airborne concentrations of volatile organic compounds (VOCs) in hair salons primarily serving women of color.
Journal of Environmental Exposure Assessment, Vol. **3** n°(3), (2024)

Hairdressers are exposed to volatile organic compounds (VOCs) that can pose health risks. Women of color (Black/Latina) represent nearly one-third of all U.S. hairdressers who may be disproportionally exposed to VOCs through occupational and personal use of hair products and treatments specifically formulated for this demographic. Still, data on workplace VOC exposures in this workforce remains sparse. We conducted area air monitoring of 14 VOCs in three salons serving Black women (“Black salons”), three Dominican salons predominantly serving Latino and Black women and 10 office spaces using active integrated sampling across 8-hour work shifts. Most VOCs measured were detected in hair salons (n = 13) and offices (n = 11). Salons had median VOC concentrations 2-175 times higher than offices. Among salons, 95th percentile VOC concentrations were up to 187 times higher in Black salons than in Dominican salons, suggesting that elevated exposures may occur partly from differences based on product use, services rendered, and salon characteristics (e.g., cleaning practices, ventilation). This is the first study to report indoor air concentrations of multiple individual targeted VOCs in U.S. hair salons serving women of color, highlighting the need for comprehensive exposure studies and assessment of potential health risks in this understudied and overexposed workforce.

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Santi, I. M.
An Analysis Of Indoor Air Quality At Cal Poly For Sensor Design.
Faculty of California Polytechnic State University. Thèse 2024

Prior research has shown that indoor air quality (IAQ) impacts cognitive performance. At Cal Poly, many older buildings are unable to maintain appropriate IAQ because of their outdated ventilation systems and the increasing number of students in the rooms. This work analyzes the IAQ of different buildings at Cal Poly, with a focus on Building 20. Carbon

dioxide, temperature, and relative humidity inside classrooms are collected using an integrated circuit sensor and a microcontroller. A total of 38 hours of data was collected, with 22 of those hours in Building 20 specifically. We find that unlike temperature and relative humidity, CO2 levels routinely exceed 1,000 ppm—a concentration that hinders cognitive function. A questionnaire distributed to Cal Poly students suggests that while students can recognize poor IAQ in classrooms, they erroneously attribute these poor conditions to temperature and humidity instead of CO2. This data is then used to propose a system which can collect long-term data based on optimal placement, storage, and power requirements

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Brboric, M., Nakomčić Smaragdakis, B., Šljivac, D., Pavlović, S., Bellos, E., Ilić, M.
Assessment of indoor environmental quality in modern office spaces: impacts on health and productivity.
2st International EUROSA Conference. May 15-18, 2024. Vrnjačka Banja, Serbia

In contemporary office settings, individual offices are being replaced by open-plan layouts, highlighting the need for optimal Indoor Environmental Quality (IEQ) for office workers. Given today's imperative focus on indoor air quality and its impact on human health, this article aims to consolidate research on IEQ in modern offices, encompassing air quality (including VOCs, particulate matter, and inorganic pollutants), thermal comfort, lighting, and acoustics, and their influence on health and productivity. The findings reveal that while many offices meet IEQ standards, some exhibit elevated air pollutant levels, inadequate thermal comfort, and insufficient lighting, contrary to guidelines. Evidence shows associations between IEQ indicators and adverse health outcomes, such as sick building syndrome symptoms linked to airborne particles and CO2. Additionally, poor lighting and acoustics are correlated with worker malaise and stress, while higher productivity is observed under better indoor air quality conditions. This synthesis underscores the importance of monitoring IEQ parameters, mitigating indoor pollution sources, optimizing ventilation, and allowing personalized environmental adjustments to enhance worker health and productivity.

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Abedini, K., Altamirano, H.
Assessment of the Impact of the Office Environment on Productivity Based on Employees' Satisfaction.
HERL: International Conference on "Health & Environmental Resilience and Livability in Cities -The challenge of climate change

Office employees spend the most amount of time in an indoor environment. The indoor environment has a substantial influence on the office occupants' comfort, satisfaction, work performance, and overall productivity. This research aims to investigate the impact of various environmental factors on the productivity of office workers and their overall satisfaction with the workplace environment. Specifically, the study seeks to answer the following research questions: Which environmental factors most significantly affect office workers' satisfaction and productivity? How does satisfaction with the workplace environment differ between two different offices located in different firms? And what is the impact of office satisfaction on employee productivity? For this purpose, a qualitative methodology was adopted, and a set of questions was compiled in a questionnaire and sent to two different offices at the Podium Building Surveying and Kendall Kingscott firms, respectively. The results obtained were analysed using simple statistical tools. The results indicated that employee satisfaction levels were mostly affected by temperature, noise distractions, and personal preferences. Employees at office 2 located at Kendall Kingscott firm were more dissatisfied with their office environment as compared to office 1 at Podium Building Surveying. The reason for this was found to be the lack of an air conditioning system at office 2. The results indicated that productivity is affected by office satisfaction levels as many of the employees at office 2 were found to be dissatisfied with some of the environmental factors (such as temperature, noise, and air quality). Due to this dissatisfaction, office 2 employees were found to be less productive than employees in Office 1. Finally, it was recommended that an air conditioning system is to be installed at office 2 to further enhance employee satisfaction.

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Garzia, F., Pernigotto, G., Menegon, D., Finozzi, L., Klammsteiner, U., Gasparella, A.
Assessment of the potential correlation between Smart Readiness Indicator and energy performance in a dataset of buildings in South Tyrol.
Energy and Buildings, (2024)

The Energy Performance of Buildings Directive introduced the Smart Readiness Indicator (SRI), a common European system for assessing buildings' smart readiness. While not mandatory across the European Union, some countries have initiated trial phases, and several studies already examined its application in different Member States. In this work, we present the findings of an extensive application of the SRI methodology on a sample of 59 recently constructed or recently renovated high-performance buildings in South Tyrol, Italy. Our research focused on two main objectives: (1) characterizing the level of smart readiness of state-of-the-art modern buildings in the Italian Alpine region of South Tyrol, and (2) discussing the potential correlation between the level of smart readiness and building energy performance class. Specifically, the HVAC and building systems with the most widespread adoption of advanced smart technologies were identified, as well as those configurations with traditional control solutions suggesting potential for improvement. The analysis proved that the different building categories present various levels of smart readiness, which is higher for the local office buildings and lower for the residential ones. No particular correlation was found between smart readiness and energy performance class, suggesting the need of adopting the SRI to give a more comprehensive characterization of the building performances.

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Miranda, L., Duc, C., Redon, N., Pinheiro, J., Dorizzi, B., Montalvão, J.*, et al.*
Automatic detection of indoor air pollution-related activities using metal-oxide gas sensors and the temporal intrinsic dimensionality estimation of data.
Indoor Environments, Vol. **1** n°(3), (2024)

Ensuring indoor air quality (IAQ) is crucial for safeguarding health, with daily occupant activities serving as significant sources of pollutants. This study addresses the need to identify and mitigate indoor pollution events caused by activities like cleaning and cooking. Employing metal-oxide gas (MOX) sensors, we propose a method that automatically detects indoor air pollution-related activities through intrinsic dimensionality estimation on time-windowed multivariate signals. The approach was validated using a dataset derived from two months of experiments involving 10 common household activities in a 13 m2 (46 m3) room, utilizing 21 distinct MOX sensor references. The dataset, which included labeled activities, demonstrated the method's superior accuracy compared to existing literature, showcasing its robustness against sensor drift. This research contributes to raising awareness, enabling timely intervention, and facilitating the automation of smart ventilation systems to maintain healthy indoor environments.

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Zhang, R., Zhao, M., Wang, H., Wang, H., Kong, H., Wang, K.*, et al.*
Cabin air dynamics: Unraveling the patterns and drivers of volatile organic compound distribution in vehicles.
PNAS Nexus, Vol. **3** n°(7), (2024)

Volatile organic compounds (VOCs) are ubiquitous in vehicle cabin environments, which can significantly impact the health of drivers and passengers, whereas quick and intelligent prediction methods are lacking. In this study, we firstly analyzed the variations of environmental parameters, VOC levels and potential sources inside a new car during 7 summer workdays, indicating that formaldehyde had the highest concentration and about one third of the measurements exceeded the standard limit for in-cabin air quality. Feature importance analysis reveals that the most important factor affecting in-cabin VOC emission behaviors is the material surface temperature rather than the air temperature. By introducing the attention mechanism and ensemble strategy, we present an LSTM-A-E deep learning model to predict the concentrations of 12 observed typical VOCs, together with other five deep learning models for comparison. By comparing the prediction–observation discrepancies and five evaluation metrics, the LSTM-A-E model demonstrates better performance, which is more consistent with field measurements. Extension of the developed model for predicting the 10-day VOC concentrations in a realistic residence further illustrates its excellent environmental adaptation. This study probes the not-well-explored in-cabin VOC dynamics via observation and deep learning approaches, facilitating rapid prediction and exposure assessment of VOCs in the vehicle micro-environment.

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Zepeda, R.
A Case Study: Impacts of a Building Retrofit on Employee Efficiency and Productivity.
California Polytechnic State University. Thèse 2024

This case study explores the effects of retrofitting building systems on operational efficiency and employee productivity in the contemporary office environment. As concerns over sustainability and the well-being of employees are now at the forefront of modern workplace design, the retrofitting of outmoded building systems has been seen as an option to enhance energy efficiency and occupant satisfaction. This research paper focuses on the recently retrofitted Performance Contracting office building in Benicia, California. As heating and ventilation systems, and lighting are two big contributors to energy consumption in buildings and comfort, analyzing these systems provided insight into its building performance. This paper applies a qualitative and quantitative analysis looking at key metrics such as system performance, indoor air quality, and employee feedback on their productivity and comfort post-retrofit. Research findings indicated that the building retrofit improved employee efficiency, productivity, and comfort.

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Mohamed, O. E., Ahmed, A., Abubker, M.
CFD of the Conditioned Air Distribution in a Hospital Operating Room.
11th International Conference on Fluid Flow, Heat and Mass Transfer (FFHMT 2024). 16 - 18 June 2024. Chestnut Conference Centre - University of Toronto, Canada

A numerical CFD simulation of an actual operating room in an educational hospital aims to determine the optimum interior air conditioning layout to achieve thermal comfort and contaminants removal from the operating room. The simulation investigates changing the location(s) and the size(s) of the supply air diffusers and the exhaust/return air grilles. The study examines four supply air diffusers and return air grilles' locations and sizes. The results reveal that the best locations are the central laminar air supply diffuser with two lower central exhaust/return air grilles.

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Manuel, J. R., Besiktepe, M. B. a. D., Sparkling, P. a. E., Gick, P. N.
Clearing the Air: A Case Study Exploring Indoor Air Quality in a Higher Education Construction Lab.
2024 ASHRAE Annual Conference. June 22-26, 2024. Indianapolis, IN

The construction industry generates a substantial amount of dust, which leads to a notable release of airborne particulate matter (PM2.5), with direct consequences for the environment and the health of individuals near construction sites. In educational settings, construction degree programs replicate the job site environment in a laboratory space, encountering similar limitations as an indoor construction site. This study aims to identify and examine the challenges of maintaining good indoor air quality (IAQ) in indoor construction environments. A case study approach is adopted in the study, for the construction lab of a public university's construction management program, which provides students with hands-on learning opportunities that are an essential part of the program's curriculum. This lab accommodates a wide range of activities that generate dust and airborne contaminants, from building, cutting lumber, sanding, and soldering activities. The particular obstacles encountered by construction activities in upholding IAQ make them a perfect target for this research. This case study tracks levels of various air pollutants, focusing primarily on PM2.5 and total volatile organic compounds (TVOCs), over a specific timeframe with two indoor air quality monitors. Further analysis investigates the connection between these measurements and different lab activities and occupancy patterns. The findings emphasize the need to reconsider and improve the design of educational facilities, especially those that incorporate hands-on training, such as construction labs. By sharing important insights, this study aids to elevate health and safety standards for students and faculty involved in hands-on learning in construction programs. Finally, the study recommends several actions to enhance IAQ in the construction lab by integrating IAQ considerations into the curriculum, educating aspiring construction professionals about the importance of air quality in the industry.

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Surya, Sasikala, T.
CO2 detection in cars using IoT with automated preventive measures.
AIP Conference Proceedings, Vol. **3075** n°(1), (2024)

After a fatal accident or other malfunction, gases may leak from the AC exhaust system, reducing the oxygen saturation level inside the vehicle. The passenger eventually suffocates as a result. This has been a significant factor in many deaths in recent years. This seriously endangers many lives, especially drunken passengers, and unattended children in the car. By helping this project solve the problem, millions of lives will be saved worldwide at no cost. An asphyxiant is a vapor

or gas that causes unconsciousness related to a lack of oxygen or death by suffocation. Chemical chokes and simple chokes are both chokes. Chemical asphyxiants either prevent the blood from absorbing oxygen or prevent the blood from carrying oxygen to the tissues or inside the cell, resulting in suffocation Simple asphyxiants are harmless gases or vapors that become toxic to the body when concentrated to the point of suffocation. Reduce the typical oxygen content of the air from 21 percent down to 19.5 percent or less. We use various sensors to measure concentration levels and highly optimized actuators to take the necessary actions, taking immediate action when necessary.

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Fathi, A. S., O'brien, W.
Considering diverse occupant profiles in building design decisions.
Building and Environment, Vol. **263**, (2024)

The main concern of the designer should be providing a comfortable indoor environment for occupants. Previous studies have focused on enhancing indoor conditions by addressing architectural factors related to the average comfort of users, often neglecting the fact that occupants differ in their needs and preferences in the design phase. However, designing buildings that cater to a diverse range of occupants is fundamental to successful building design. This study develops and demonstrates a workflow to integrate various occupant types at the design stage and evaluate designs based on all four domains of comfort and energy simultaneously. To achieve this objective, the study initially presents an “occupant profile sheet” derived from a survey conducted among building experts. This sheet comprises essential occupant parameters that practitioners should integrate during the design stage, aiding in the classification of occupants into distinct profiles. Next, a parametric workflow that evaluates various design options based on performance metrics for different occupant profiles is developed. Finally, it employed a case study using the proposed workflow to evaluate the impact of considering diverse occupants on the selection of optimal design parameters. The findings highlight the fact that incorporating diverse occupant types in the design process can influence architectural decisions. Overall, the research offers designers a practical guide for accommodating occupant diversity in building design, creating a more inclusive environment for a broader range of occupants.

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Pepe, C., Farooq, A. M., Zanoli, S. M.
Control of Different Parameters for Indoor Air Quality Management Through Natural Ventilation.
25th International Carpathian Control Conference (ICCC). 22-24 May 2024. Krynica Zdrój, Poland

The present paper proposes a nonlinear Model Predictive Control strategy aimed at controlling different parameters associated to Indoor Air Quality in Heating, Ventilation, and Air Conditioning systems. The considered parameters are the carbon dioxide, the formaldehyde and the total volatile organic compounds; they are controlled through natural ventilation. Input disturbance variables such as wind speed and occupancy are considered. A simulation framework is proposed based on the developed nonlinear model of the process. Restrictions on the opening of the windows were included in the model in order to guarantee a major fidelity to the real process. The results obtained through nonlinear MPC for the control of the considered process are shown focusing on the constraints management and on the look-ahead (previewing) of the input disturbance variables. The proposed approach is tested through tailored simulations in different conditions.

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Summa, S., Tarabelli, L., Di Perna, C., Stazi, F.
Data-driven automation of HVAC systems: An experimental study in a university study room.
Journal of Building Engineering, Vol. **95**, (2024)

This study proposes a framework for controlling HVAC systems for university study rooms that includes a data-driven model capable of identifying the probability of user interaction with air conditioning and ventilation systems, depending on the thermal sensation vote (TSV), perceived air quality (PAQ) and microclimate parameters (air and operative temperature, air velocity, relative humidity and CO2). The experimental setup allowed the participants to carry out their usual study/work activities without the need to be supervised. This allowed the occupants not to be psychologically conditioned and made their experience and interaction with the environment/systems as realistic as possible. The analysis of the experimental data showed that the operative temperature mainly influences the thermal sensation of the occupant inside the room, while the perceived air quality depends not only on the CO2 concentration but also on

thermal perception and air velocity. Furthermore, three predictive models (heating, cooling and IAQ) were obtained from the experimental data, indicating the probability of user interaction with the system (R2 between 0.85 and 0.94). The heating phase model was also verified by automatizing the heating system through the developed framework and comparing the user's sensations before and after control (users unaware of the changes). The use of the models increased users' thermal comfort from 39 % to 82 %, confirming the effectiveness of the system.

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Terziev, A., Ivanov, M.
Design and control of warehouse indoor air quality via numerical modeling.
International Conference on Electronics, Engineering Physics and Earth Science (EEPES 2024). Kavala, Greece, June 19-21, 2024

Warehouses are part of the crucial infrastructure of the logistics process of any business. The type of products stored in the warehouse also determines the type of warehouse class. The object of research in the present work is a class A warehouse with a clear height of 10 up to 13 m, equipped with systems for maintaining the indoor air quality within a very specified temperature limit. An air conditioning system is proposed, consisting of roof air conditioners (Rooftop vent), that allow maintaining the microclimate in the specified limits yearly. To achieve the specific requirements, numerical modeling of air distribution in the warehouse was performed, which shows that the use of simplified, systematized methods for the technical design of air conditioners is an unreliable approach. Moreover, the analysis shows that in high warehouses, the stagnant areas that arise cannot be overcome only by rearranging the roofing machines, but also requires the use of additional impulse mixing devices.

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Liang, Y., Jiayu, M., Jiancong, L., Yangbing, L., Liwei, T.
Design of ceiling light with air quality monitoring and heat dissipation structure based on duct technology.
3rd International Conference on Electronic Information Engineering and Data Processing (EIEDP 2024), 2024, Kuala Lumpur, Malaysia

Most air quality monitors and lighting fixtures are currently separate, with air quality monitors typically being stand-alone devices that require separate power supplies and mounting locations. This not only occupies valuable space but also complicates their use and management. The emergence of air quality monitoring ceiling lights in smart homes aims to address this issue. However, many existing ceiling light designs do not consider heat dissipation, which can lead to performance issues, reduced lifespan, and even fire hazards. To tackle these challenges, this study presents the design of an intelligent ceiling lamp for air quality monitoring utilizing air duct technology. Equipped with a seven-in-one air quality sensor, the ceiling lamp collects indoor air data and performs real-time intelligent control and anomaly identification through a cloud-side-end synergy approach. The incorporation of air ducts enhances the sensitivity and accuracy of air quality monitoring, facilitates thermal convection, and improves heat dissipation efficiency, ultimately enhancing performance and longevity. Physical product design and field tests conducted on the cloud-side-end platform demonstrate that the ceiling lamp's air quality monitoring and anomaly identification have an average inference time of less than 1 millisecond with an identification accuracy of over 98%. Furthermore, the air duct design improves thermal efficiency by approximately 28%. Overall, this intelligent ceiling lamp represents a practical, efficient, and intelligent multi-functional indoor lighting solution.

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Upasani, N., Guerra-Santin, O., Mohammadi, M.
Developing building-specific, occupant-centric thermal comfort models: A methodological approach.
Journal of Building Engineering, Vol. **95**, (2024)

This study addresses the research problem of accurately predicting thermal comfort in buildings by developing occupant-centric, building-specific models. Traditional models like PMV and adaptive models often fall short in reflecting individual comfort preferences. This research aims to create more accurate and personalised thermal comfort models by considering human-related factors such as clothing, mood, and activities, along with environmental variables like temperature and humidity. The methodology involved collecting data through two self-reporting campaigns using mobile and smartwatch applications in a university building in The Hague. Regression and classification models were developed, achieving accuracy rates of 72 % and 89 % respectively, which surpass the performance of traditional

models. The findings indicate that human factors significantly influence thermal comfort, with mood and clothing being particularly impactful. Seasonal variations were also accounted for, emphasising the need for periodic data collection to capture changes in occupant behaviour and environmental conditions. The key contribution of this research lies in its ability to enhance the accuracy of thermal comfort predictions, leading to more effective and user-centric HVAC system operations. This approach not only has the potential to improve the comfort of building occupants but also has implications for energy efficiency, as HVAC systems can be better tailored to actual comfort needs.

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Xu, Y., Luo, X., Xia, Y., Cao, G., Wei, X., Zhang, X.*, et al.*
Dynamic coordinated air supply for moving individuals in industrial settings: Effectiveness evaluation and demonstration.
Building and Environment, Vol. **263**, (2024)

Tracking occupant movement and reducing pollution exposure in industrial settings utilizing intelligent ventilation modes without human intervention is a challenge. This work proposes a dynamic coordinated air supply (DCAS) system incorporating static and dynamic ventilation modules, which is capable of switching air supply modes and adjusting air supply parameters in response to changing occupant positions with the assistance of computer vision technology and Internet of Things (IoT). Air movement and pollutant dispersion in an experimental chamber equipped with a DCAS system during occupant movement are analyzed through computational fluid dynamics with overset mesh method. The feasibility of the dynamic simulation method is verified by a walking experiment in the chamber. Three assessment indicators, namely, inhalation exposure, protection factor, and effective protective ratio, are identified to comprehensively evaluate the pollutant removal effectiveness of DCAS. Results show that the static ventilation module can remarkably reduce the occupant's exposure risk within its protective range. The proposed sliding and rotating modes for the dynamic ventilation module are effective in reducing occupant inhalation exposure during movement if the advance operation strategies are specified to eliminate the negative effects of protection lag. In addition, the feasibility of the IoT architecture-based DCAS system is demonstrated in a schematic laboratory. This work helps drive industrial ventilation development toward smart, healthy purposes.

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Athamneh, S.
The Effect of Green Workplace Design on Employee Engagement and Productivity in the Jordanian Public Sector.
Natural Sciences Publishing, Vol. **13** n°(2), (2024)

In this study we explored the influence of Green Workplace Design (GWD) on employee engagement and productivity within the Jordanian public sector. Through surveying 360 participants working in designated GWD buildings, we utilized the Employee Productivity Scale, Employee Engagement Scale, and Green Workplace Design Scale. Our findings indicate a significant positive impact of GWD on both employee engagement (35.2% increase) and productivity (45.5% increase). Interestingly, while heightened employee engagement initially correlated with decreased productivity (19.7% decrease), GWD emerged as a mediating factor, fostering focused and versatile spaces for engagement. This underscores the value of creating work environments that optimize employee well-being, fostering collaboration, knowledge-sharing, and innovation. Importantly, in regions like Jordan with limited light supply and inadequately designed public sector buildings, the implementation of GWD could revolutionize organizational performance, strengthening workplace relationships and communication.

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Saman, T.
Energy optimization of heating, ventilation, and air conditioning systems.
Purdue University. Thèse 2024

The energy consumption in the building sector is responsible for over 36% of the total energy consumption across the globe. Of all the energy-consumer devices within a building, heating, ventilation, and air conditioning (HVAC) systems account for over 50% of the total energy consumed. This makes HVAC systems a source of preventable and unexplored energy waste that can be tackled by incorporating intelligent operations. Since its inception, model predictive control (MPC) has been one of the prospective solutions for HVAC management systems to reduce both costs and energy usage. Additionally, MPC is becoming increasingly practical as the processing capacity of building automation systems increases

and a large quantity of monitored building data becomes available. MPC also provides the potential to improve the energy efficiency of HVAC systems via its capacity to consider limitations, to predict disruptions, and to factor in multiple competing goals such as interior thermal comfort and building energy consumption.

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Zali, Z., Mohd Noor, N. A., Mohd Ariffin, A. A.
Engine Room Indoor Air Quality Assessment Onboard a Medium-Speed Vessel.
In: Engineering Frontiers: A Multidisciplinary Odyssey. Springer Nature Switzerland; 2024. 343-354 p.

Human comfort is important not only in a building but also in the engine room of a ship. This issue has been discussed for a long time to ensure that seafarers onboard ships can work with good performance and comfort. In this assessment, the indoor air quality (IAQ) in the engine room area of 55.2 square meters and 2.54 m high on a medium-sized vessel was investigated. The present IAQ status of this study attempts to provide information in the engine room during the engine running ongoing task. This assessment included visual observations, chemical contaminant parameters (carbon dioxide), and physical condition parameters (air velocity) were measured using a thermal comfort multi-station, TCM. This device was able to record eight indoor parameters, i.e. the air velocity, CO2 level, air pressure, relative humidity, sound level, air temperature, luminance, and globe temperature. The monitoring of CO2 levels in indoor air as well as the air movements in the engine room are used as one part of determining the effectiveness of a ventilation strategy and providing information on indoor air quality in compliance with IAQ standards and guidelines. The recorded data were compared with corresponding parameters in the Code of Practice on Indoor Air Quality set by the Department of Occupational Safety and Health, Ministry of Human Resources, Malaysia, Malaysia DOSH 2010, Guide for Crew Habitability on Ships from American Bureau of Shipping, ABS 2016, and American Society of Heating, Refrigerating, and Standard Ventilation and Acceptable Indoor Air Quality from Air-Conditioning Engineers, ASHRAE 2016. The assessment is conducted to evaluate the exposure of the engine crews to the carbon dioxide contaminant and to recommend further appropriate control measures to prevent or reduce risks. Based on the assessment conducted, it shows that the average 3-h CO2 concentration did not exceed the ceiling point recommended by the Department of Occupational Safety and Health, Ministry of Human Resources, Malaysia, 2010. However, due to the exhaust system leakage factor and the inefficiency of the ventilation in the engine room caused the CO2 gas to accumulate.

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Mohammadzadeh, M. R., Hasani, A., Hussain, T., Ghanbari, H., Fawzy, M., Abnavi, A.*, et al.*
Enhanced Sensitivity in Photovoltaic 2D MoS2/Te Heterojunction VOC Sensors.
Small, Vol. **n/a** n°(n/a), (2024)

Abstract Volatile organic compound (VOC) sensors have a broad range of applications including healthcare monitoring, product quality control, and air quality management. However, many such applications are demanding, requiring sensors with high sensitivity and selectivity. 2D materials are extensively used in many VOC sensing devices due to their large surface-to-volume ratio and fascinating electronic properties. These properties, along with their exceptional flexibility, low power consumption, room-temperature operation, chemical functionalization potential, and defect engineering capabilities, make 2D materials ideal for high-performance VOC sensing. Here, a 2D MoS2/Te heterojunction is reported that significantly improves the VOC detection compared to MoS2 and Te sensors on their own. Density functional theory (DFT) analysis shows that the MoS2/Te heterojunction significantly enhances the adsorption energy and therefore sensing sensitivity of the sensor. The sensor response, which denotes the percentage change in the sensor's conductance upon VOC exposure, is further enhanced under photo-illumination and zero-bias conditions to values up to ≈7000% when exposed to butanone. The MoS2/Te heterojunction is therefore a promising device architecture for portable and wearable sensing applications.

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Zhao, L., Zhou, Q., Li, M., Wang, Z.
Evaluating different CFD surrogate modelling approaches for fast and accurate indoor environment simulation.
Journal of Building Engineering, Vol. **95**, (2024)

Indoor Environment Quality (IEQ) holds significant importance in building design and operation, and the simulation of indoor environments playing a crucial role in enhancing IEQ. Although Computational Fluid Dynamics (CFD) has been

widely employed for simulating building environments, it is computationally demanding, particularly for large spaces. To tackle this challenge, we conducted a systematic evaluation of three surrogate models for accelerating CFD: Proper Orthogonal Decomposition (POD), Artificial Neural Networks (ANN), and a combined POD-ANN approach. Our evaluation criteria focused on assessing the model accuracy, the model size, computational time and extrapolation ability. A validated CFD case model and a real campus building are employed for model evaluation. The findings demonstrate that the top five modes can reconstruct the original data matrix accurately, and the POD-ANN significantly reduces model complexity and computation time by reducing the number of parameters in the neural network, the POD-ANN parameters is only 0.14 % of the ANN, and computation time is reduced by 63 %. In addition, the combination with ANN helps increase the extrapolation ability of POD significantly. In conclusion, this research proves that the POD-ANN can enhance the efficiency of CFD calculations with the advantages of both ANN and POD. By applying the POD-ANN to predict indoor temperature, we achieve faster predictions without compromising model accuracy, and an excellent extrapolation ability is achieved. This approach also reduces model complexity, highlighting its practical value for indoor environment prediction, particularly for large and complicated spaces.

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Wang, H., Mai, D., Li, Q., Ding, Z.
Evaluating Machine Learning Models for HVAC Demand Response: The Impact of Prediction Accuracy on Model Predictive Control Performance.
Buildings, Vol. **14** n°(7), (2024)

Heating, ventilation, and air-conditioning systems (HVAC) have significant potential to support demand response programs within power grids. Model Predictive Control (MPC) is an effective technique for utilizing the flexibility of HVAC systems to achieve this support. In this study, to identify a proper prediction model in the MPC controller, four machine learning models (i.e., SVM, ANN, XGBoost, LightGBM) are compared in terms of prediction accuracy, prediction time, and training time. The impact of model prediction accuracy on the performance of MPC for HVAC demand response is also systematically studied. The research is carried out using a co-simulation test platform integrating TRNSYS and Python. Results show that the XGBoost model achieves the highest prediction accuracy. LightGBM model's accuracy is marginally lower but requires significantly less time for both prediction and training. In this research, the proposed control strategy decreases the economic cost by 21.61% compared to the baseline case under traditional control, with the weighted indoor temperature rising by only 0.10 K. The result also suggests that it is worth exploring advanced prediction models to increase prediction accuracy, even within the high prediction accuracy range. Furthermore, implementing MPC control for demand response remains beneficial even when the model prediction accuracy is relatively low.

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SHEIKHA, A.
Evaluating the impact of hybrid ventilation strategies on reducing the cooling load and achieving thermal comfort of buildings: regarding arid climate of uae.
United Arab Emirates University. Thèse 2024

The hybrid ventilation system has shown considerable potential in managing indoor thermal comfort, preserving indoor air quality, and minimizing energy usage. This is achieved by integrating natural and mechanical ventilation. When natural ventilation is unfeasible, the system smoothly transitions to mechanical ventilation to uphold optimal indoor thermal comfort levels. However, the application of this system in extremely arid regions poses a challenge due to the high energy consumption linked to air conditioning and cooling during the summer. In these areas, air conditioning and cooling alone represent approximately 60% of urban energy consumption. This study aims to assess the viability of hybrid ventilation configurations in an office building situated in the hot, dry climate of Dubai. The primary goal is to decrease energy consumption and carbon dioxide (CO2) emissions without compromising the thermal comfort of the occupants. A dynamic energy simulation was conducted using the EnergyPlus simulation engine. This included necessary data such as location, weather file, building geometry, construction materials, operational details, and internal load. The results were validated against actual consumption data over a year-long period. The findings suggest that the hybrid system could achieve an annual energy reduction of 23%. The system's efficiency rose to 29% during cooler seasons, while it managed to reduce energy use by only 13% during hot seasons. Moreover, the hybrid system helped reduce carbon emissions by 20%. This study underscores the potential of hybrid ventilation systems in energy conservation and carbon emission reduction, particularly in hot, dry climates CO2.

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Lee, J. H., Bryant, A. K., Alajlouni, M. M., Boor, B. E., Tasoglou, A., Liu, S.
Evaluation of Tetrachloroethylene (PCE) and Its Degradation Products in Human Exhaled Breath and Indoor Air in a Community Setting.
Journal of Breath Research, (2024)

Tetrachloroethylene (PCE) is a widely utilized volatile chemical in industrial applications, including dry cleaning and metal degreasing. Exposure to PCE potentially presents a significant health risk to workers as well as communities near contamination sites. Adverse health effects arise not only from PCE, but also from PCE degradation products, such as trichloroethylene (TCE) and vinyl chloride (VC). PCE, TCE, and VC can contaminate water, soil, and air, leading to exposure through multiple pathways, including inhalation, ingestion, and dermal contact. This study focused on a community setting in Martinsville, Indiana, a working-class Midwestern community in the United States, where extensive PCE contamination has occurred due to multiple contamination sites (referring to “plumes”), including a Superfund site. Utilizing proton transfer reaction time-of-flight mass spectrometry (PTR-TOF-MS), PCE, TCE, and VC concentrations were measured in the exhaled breath of 73 residents from both within and outside the plume areas. PCE was detected in 66 samples, TCE in 26 samples, and VC in 68 samples. Our results revealed a significant positive correlation between the concentrations of these compounds in exhaled breath and indoor air (Pearson correlation coefficients: PCE = 0.75, TCE = 0.71, and VC = 0.89). This study confirms the presence of PCE and its degradation products in exhaled breath in a community exposure investigation, demonstrating the potential of using exhaled breath analysis in monitoring exposure to environmental contaminants. This study showed the feasibility of utilizing PTR-TOF-MS in community investigations to assess exposure to PCE and its degradation products by measuring these compounds in exhaled breath and indoor air.

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Rocha-Melogno, L., Xi, J., Deshusses, M. A.
Experimental evaluation of a full-scale in-duct UV germicidal irradiation system for bioaerosols inactivation.
Science of The Total Environment, Vol. **947**, (2024)

Bioaerosols control techniques, especially ultraviolet germicidal irradiation (UVGI) are gaining attention due to increasing needs for controlling of health risk caused by airborne biocontaminants. The effectiveness of a full-scale in-duct UVGI air disinfection system was investigated. One bacterium, a wild type Escherichia coli, and three fungal spores, Penicillium aragonense, Rhodotorula glutinis, and Cladosporium sp., were selected as test organisms and their inactivation under different conditions representative of a real application in HVAC systems were investigated. The results demonstrated that inactivation of airborne E. coli by the UVGI system was extremely effective, with >99.5 % of the input E. coli inactivated at a residence time lower than 0.36 s in the disinfection section. Airborne fungal spores were less susceptible to UV irradiation than E. coli. Under same conditions, viable counts reduction of P. aragonense, R. glutinis, and Cladosporium sp. spores were 53 %, 63 % and 73 %, respectively. The effect of UV light intensity, air flowrate and relative humidity were analyzed separately. A simplified model based on redefinition of the parameters in the classical inactivation kinetic equation was used to simulate the inactivation of airborne contaminants in the in-duct system under different conditions. The results showed that the simplified model was adequate to estimate disinfection efficacy of different bioaerosols by the UVGI system which could be useful for system design. Overall, this study shows that such in-duct UVGI systems can provide significant control of bioaerosols.

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Peixoto, C., Do Carmo Pereira, M., Morais, S., Slezakova, K.
Exploring Airborne Pollutants in Fitness Environments: Implications for Health and Exercise.
Research Square, (2024)

s there are many known benefits of physical activities practising, the need to evaluate pollution levels and personal exposure in different sports environments has become increasingly important. However, the current data are limited, namely those related to exposure levels during different types of sports activities. Thus, this study estimated indoor air levels and inhalation doses of gaseous (total volatile organic compounds – TVOCs, CO2) and particulate (PM10, PM2.5, and ultrafine – 20-1000 nm) pollutants during highly–intense (spinning, dance fitness, and total body workout - TBW) and moderately–intense (body & mind, muscle group-specific and self-defence techniques) groups activities (n = 138).

Inhalation dose was assessed using the USEPA methodology, considering different age categories of practitioners (3 – <61 years old) and genders. The results showed that CO2 concentrations ranged from 1368 mg/m3 (in TBW) -2727 mg/m3 (self-defence-adults), with the protection threshold being exceeded in adult self-defence classes. TVOCs exceeded 4–18 times the protective limits in all classes (2.49 mg/m3 in body & mind – 10.62 mg/m3 in self-defence adults). Across different characterized activities, PM values widely varied (PM10: 20.8–220.8 µg/m3; PM2.5: 9.1–63.5 µg/m3; UFP: 6267–9917 #/cm3) with especially PM10 higher during vigorous human movements; 1.1–4.4 and 1.1–2.5 times exceeding the protective threshold for PM10 and PM2.5, respectively. High-intensity classes resulted in 1.4–1.6 times higher inhalation doses than moderate-intensity classes and the total inhaled dose for men was higher (1–8% in high- and moderate-intensity, respectively) than for women. Finally, the inhaled doses by the child population were up to 2.2 times higher than of adults of both genders. It needs to be emphasized that inhaled dose values indirectly indicate the possible health risk to which users are exposed in terms of pollutant intake (particulate matter and gaseous pollutants), combining exposure concentration, physical effort and duration of activity.

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Jamila, R. M., Narasimman, S., Prasanth, A., Muthukumar, M., Alex, Z. C., Anand, G. T.
Fiber Optic Sensor Coated with Multiple Layers of Hexagonal Boron Nitride Nanosheets (BNNS) for the Detection of Volatile Organic Compounds.
Acs Applied Materials & Interfaces, (2024)

Nowadays, volatile organic compound (VOC) detection is imperative to ensure environmental safety in industry and indoor environments, as well as to monitor human health in medical diagnosis. Gas sensors with the best sensor response, selectivity, and stability are in high demand. Simultaneously, the advancement of nanotechnology facilitates novel nanomaterial-based gas sensors with superior sensor characteristics and low power consumption. Recently, boron nitride, a 2D material, has emerged as an excellent candidate for gas sensing and demonstrated exceptional sensing characteristics for new-generation gas sensing devices. Herein, ultrathin porous boron nitride nanosheets (BNNSs) with large lateral sizes were synthesized using a facile synthesis approach, and their material characteristics were investigated utilizing a variety of analytical techniques, including X-ray diffraction, Fourier transform infrared spectroscopy, ultraviolet spectroscopy, X-ray photoelectron spectroscopy, and scanning electron microscopy. A BNNS-coated cladding-modified fiber optic sensor (FOS) probe was prepared and employed for VOC (ammonia, ethanol, and acetone) sensing across concentrations varying from 0 to 300 ppm. The BNNSs-coated FOS demonstrated better selectivity toward 300 ppm ammonia, and specifically annealed BNNSs displayed a maximum sensor response of 55% along with a response/recovery times of 15 s/34 s compared to its counterparts. The superior ammonia sensing performances could be attributed to the formation of ultrathin nanosheets and a porous surface with slit-like features in hexagonal boron nitride.

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Feng, Y., Chen, H. F., Broderick, N., Hong, S. M., Zheng, Z. H., Xu, B.*, et al.*
A Fiber Sensor for VOC Gas Detection Based on Modulated Aggregation of Fluorescence Indicator.
Ieee Sensors Journal, Vol. **24** n°(10), (2024), 16162-16169 p.

Volatile organic compounds (VOC) are the main source of indoor pollution. Inhalation of excess VOC gas will cause respiratory system damage. Therefore, VOC gas detection is essential for environment monitoring. In this article, an optical fiber device for rapid detection of VOC gas was proposed. Rhodamine 6G (R6G) was taken as the fluorescence indicator. The VOC gas sensor was designed for the modulation of aggregation-caused quenching of R6G. The sensing device was fabricated with three simple steps: in the first step, a multimode fiber was tapered; in the second step, the hydrogel was coated on the tapered fiber tip; and in the last step, aggregated R6G was loaded in the hydrogel. When the senor was probed into a VOC gas chamber, the gas molecules penetrated into the hydrogel and deaggregated the R6G dimer, and then, the fluorescence of R6G was strengthened. With this spectrum change, the concentration of VOC gas could be obtained. Compared with other fiber devices for VOC gas detections, the proposed sensor has the advantages of single-end, low cost, simple preparation, fast response, and large detection range, which means a great potential for in situ detecting applications.

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Yang, Y., Yue, X., Li, C., El-Bahy, Z. M., Melhi, S., Thabet, H. K.*, et al.*
Formaldehyde-free high-strength low-density wood biocomposites via corrugation and self-bonding of wooden cell.

Advanced Composites and Hybrid Materials, Vol. **7** n°(4), (2024)

In alignment with global sustainable development strategies and the growing demand for green manufacturing practices in engineered wood production, an innovative method has been developed for incorporating hot pressing techniques, minimal energy consumption, and the complete elimination of adhesives. This approach achieved a 100% conversion of waste palm wood into sustainable natural biocomposites suitable for use in structures and furniture. Analysis shows that the biocomposites forms strong internal bonding through mechanical “nail like” nanomaterials, ester bonds, and ether bonds. Unlike conventional furniture materials, which rely on hazardous formaldehyde-based adhesives, this biocomposites boasts an internal bonding strength of 1.652 MPa—four times higher than typical materials. Additionally, it is lightweight, with a density of less than 1 g/cm3, offers excellent friction resistance, and is dense with only 0.67% internal porosity. The composite materials eliminate the use of toxic adhesives, addressing concerns regarding potential harmful emissions from formaldehyde-based VOCs and ensuring higher indoor air quality. This surpasses the performance of existing structures and furniture materials that rely on synthetic adhesives. The method achieves a 100% conversion of waste palm wood into biocomposites, offering a cost-effective and profitable alternative. This provides a novel solution for developing new structural and furniture materials.

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Yassin, M. F., Al-Khaldi, B.
Health risks associated with hazardous airborne chemicals in beauty salons: A pilot study in Kuwaiti salons.
Atmospheric Pollution Research, Vol. **15** n°(10), (2024)

The beauty industry has become increasingly popular in recent years, leading to a surge in salon visits for various beauty treatments. However, public concerns were raised about the possible health dangers linked to the widespread use of harmful chemicals in beauty salons. To address these concerns, a pilot study was conducted in Kuwait to evaluate and identify the ten most commonly occurring hazardous airborne chemicals in different beauty salons. Air samples were gathered from inside and outside ten beauty salons situated in diverse regions of Kuwait, covering various periods, including working hours, non-working hours, and a continuous 24-h period. The study used diffusion tubes for sampling and employed the thermo-desorption gas chromatograph/mass spectroscopy technique (TD-GC/MS) to identify the chemical compounds. In addition, the measured concentration of compounds was utilized to assess the potential inhalation health risks associated with both carcinogenic and non-carcinogenic substances, employing the USEPA Cancer Risk Indicator (CRI) and Hazard Quotient Indicator (HQI). The findings indicated that indoor concentrations of hazardous chemicals were significantly higher than those recorded outdoors. A total of 55 hazardous chemicals were detected in the indoor air quality inside beauty salons, and benzene concentrations exceeded ACGIH thresholds, suggesting a potential health concern. Although concentrations of toluene, ethylbenzene, m/p-xylene, and o-xylene remained below NIOSH recommendations, health risk assessments indicated the potential carcinogenicity of three compounds in the indoor air of beauty salons: benzene, ethylbenzene, and 2-ethyl-1-hexanol. Additionally, 15 compounds were identified by non-carcinogenic risk assessments, such as ethyl acetate and 2-ethyl-1-hexanol. These findings emphasize the urgency of implementing measures to address the exposure in Kuwait's beauty salons and conducting further research.

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Niza, I. L., Da Luz, I. M., De Souza, M. P., Broday, E. E.
Hierarchical and two-step clustering to assess symptoms of sick building syndrome in office spaces in an educational building.
Architectural Engineering and Design Management, (2024), 1-18 p.

People spend a significant amount of time indoors, being exposed to situations that might lead to discomfort, illness and loss of productivity. This study addressed the symptoms reported by employees of office spaces within an educational building, focusing on sick building syndrome (SBS), a set of symptoms experienced by occupants of buildings without a known cause. Volunteers were asked to complete a questionnaire reporting their symptoms during the workday. After data collection, hierarchical and two-step clustering were applied to assess the symptoms reported. The main results found were: (I) around 43.06% of people reported at least one symptom of SBS; (II) two-step clustering analysis showed that the main predictive symptoms are blurred vision, eye irritation, exhaustion, drowsiness and weakness; (III) hierarchical clustering analysis observed a high probability of simultaneous symptoms such as exhaustion and drowsiness, nasal irritation or itching and runny nose. At the same time, cough and shortness of breath showed a lower probability; (IV) the dendrogram formed a group predominantly linked to respiratory symptoms and another related to

throat and skin symptoms; (V) the application of cluster analysis has the potential to describe the patterns and groups of identified symptoms accurately. Additionally, the research presented several contributions, such as identifying the most severe symptoms requiring immediate mitigation actions and enabling decisions related to employees' health and well-being by implementing preventive measures to promote a healthier environment.

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Zhao, C., Pan, S., Li, X., Tang, X., Wang, F.
High Sensitivity and Low Detection Limit of Formaldehyde Sensor Based on In2O3@ZnO@ZIF-CoZn Core Shell Nanofibers.
IEEE Sensors Journal, Vol., (2024), 1-1 p.

High sensitivity and low detection limit of formaldehyde sensors are extremely essential for indoor air pollution monitoring. Herein, we propose a controllable strategy for the construction of metal oxide semiconductor@metal organic framework (MOS@MOF) core-shell architectures as the sensing material. In 2 O 3 @ZnO core-shell nanofibers (IZO CSNFs) are prefabricated by combining electrospinning and atomic layer deposition (ALD) technique, where the ALD-ZnO layer can be regarded as template to obtain cobalt-doped ZIF-8 (ZIF-CoZn) sheath. In comparison to initial IZO CSNFs, the response of IZO@ZIF-CoZn sensor toward 50 ppm formaldehyde can be boosted from 6.6 to 39.4 at 260 °C, and the limit of detection can be as low as 2.1 ppb (@ 20% relative humidity). The enhanced performance of the IZO@ZIF-CoZn sensor should result from the highly efficient adsorption/decomposition of formaldehyde on the surface of ZIF-CoZn. In addition, the effects of core-shell structure, cobalt dopants, interference gases, and moisture on the formaldehyde gas sensing are discussed. Our results provide an insight into the enhancement mechanism of the MOS-based gas sensors by utilizing the functionalized MOF sheaths.

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Christopher, A.
Identification and Assessment of Indoor Air Quality Exposures at a Manufacturing Facility.
College of Charleston. Thèse 2024

Compromised indoor air quality in manufacturing environments presents significant public health risks to the workforce. Hazardous materials, such as volatile organic compounds (VOCs) and polycyclic aromatic hydrocarbons (PAHs), threaten employee health and over time, may cause illnesses to arise. In addition to these materials, indoor air quality parameters and design of engineering controls can play a role in determining the health and comfort of employees. Extensive research has demonstrated that prolonged exposure to these substances in occupational settings is linked to an increased risk in the development of several types of cancers. Short-term studies have also identified symptoms such as eye, lung, and skin irritation, as well as nausea and discomfort among employees. This study aims to address employee concerns regarding indoor air quality issues in a manufacturing environment. Additionally, the study looks to quickly provide solutions to the reported problem to limit further employee exposure. Our findings are expected to identify common chemical contaminants associated with materials processed in the area and to indicate levels that reflect a healthy workplace.

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Latini, A.
Immersive Virtual Reality for a Building Occupant-Centric Design.
Springer; 2024.

This book discusses the cutting-edge intersection of Immersive Virtual Reality (IVR) and research on building occupants. It presents an innovative way of using IVR to revolutionise the comprehension of human-dimension responses to indoor built environments. A robust, innovative, and sequential protocol is defined and validated with a Virtual Environment against a real-world counterpart to provide readers with methodological approaches suitable for carrying out rigorous experimental research in building occupant research. This comprehensive guide provides also practical applications of the proposed guidelines to show the potential and effectiveness of IVR for conducting studies in different indoor environmental conditions in a multi-sensory approach. The book serves as a resource for researchers who want to exploit the full potential of VR in collecting reliable data useful for understanding human dimensions within built environments.

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Ma, X., Guo, L.

Indoor Air Quality and Personnel Satisfaction in Different Functional Areas of Semi-Underground Buildings.

Buildings, Vol. **14** n°(7), (2024)

With the increasing application of semi-underground buildings, it is of greater significance to understand indoor air quality and personnel satisfaction in different functional areas within such buildings. In this study, a semi-underground building in Xi'an was taken as an example to test and study the indoor air quality in different functional areas, and a questionnaire survey based on the satisfaction of indoor personnel was conducted at the same time. The comprehensive results showed that the places with the highest concentrations of PM2.5 exceeding the standard limit in the semi-underground building were the milk tea shops, hair salons, and driving schools, presenting 1.01 times, 1.15 times, and 1.08 times the standard limit, respectively. Hair salons were the sites with the highest pollution. The second most frequent pollutants were formaldehyde (HCHO) and total volatile organic compounds (TVOCs). In contrast to the wind speed parameters, the indoor concentrations of pollutants were higher than those outdoors. The upper limits of personnel satisfaction for particulate matter with a diameter less than 1.0 microns (PM1.0), particulate matter with a diameter less than 2.5 microns (PM2.5), and TVOCs were all higher than the standard limits. The upper limits of personnel satisfaction for PM10, HCHO, wind speed, carbon monoxide (CO), and carbon dioxide (CO2) were all below the standard limits. This provides data support and reference values for the widespread development and application of semi-underground buildings.

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Wang, S., Qin, T., Tu, R., Li, T., Chen, G. I., Green, D. C., *et al.*

Indoor air quality in subway microenvironments: Pollutant characteristics, adverse health impacts, and population inequity.

Environment International, Vol. **190**, (2024)

Rapidly increasing urbanization in recent decades has elevated the subway as the primary public transportation mode in metropolitan areas. Indoor air quality (IAQ) inside subways is an important factor that influences the health of commuters and subway workers. This review discusses the subway IAQ in different cities worldwide by comparing the sources and abundance of particulate matter (PM2.5 and PM10) in these environments. Factors that affect PM concentration and chemical composition were found to be associated with the subway internal structure, train frequency, passenger volume, and geographical location. Special attention was paid to air pollutants, such as transition metals, volatile/semi-volatile organic compounds (VOCs and SVOCs), and bioaerosols, due to their potential roles in indoor chemistry and causing adverse health impacts. In addition, given that the IAQ of subway systems is a public health issue worldwide, we calculated the Gini coefficient of urban subway exposure via meta-analysis. A value of 0.56 showed a significant inequity among different cities. Developed regions with higher per capita income tend to have higher exposure. By reviewing the current advances and challenges in subway IAQ with a focus on indoor chemistry and health impacts, future research is proposed toward a sustainable urban transportation systems.

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Nazli, S. N., Vilcins, D., Sly, P. D., Razak, A. A., Sabri, N., Ibrahim, T. N. B. T.

Indoor Air Quality: Bibliometric Analysis of the Published Literature Between 2018 and 2023.

Environmental Quality Management, Vol. **34** n°(1), (2024)

ABSTRACT This bibliometric study employs a rigorous approach to scrutinize and visually represent the existing body of literature on indoor air quality (IAQ). Utilizing the Scopus collection database, we conducted an exhaustive exploration of published research literature in the IAQ field. The study involves a thorough visual analysis using Harzing's Publish and Perish and VOSviewer software programs, examining parameters such as citations, publication year, journals, authors, research institutions, countries, and research topics. A total of 1729 pieces of literature related to IAQ research from 2018 to 2023 were retrieved. The dominant formats were articles and conference papers, underscoring their significance in IAQ documentation. Primary subject areas included «Engineering» and «Environmental Science,» highlighting the multidisciplinary nature of IAQ studies. The upward trend in IAQ publications, reaching 330 articles in 2023, emphasizes the growing importance of this field. However, citation impact varied, emphasizing the need to assess research quality alongside quantity. Global distribution identified leading countries, including the United States, China, and the United Kingdom, which were also top contributors in co-authorship and country-level analyses. The top journals

were «Building and Environment» and «Sustainable Cities and Society,» showcasing varying publication and citation powers. Notable impactful articles in the IAQ domain were led by Agarwal et al. and Van Tran, Park, and Lee. Keyword co-occurrence analysis identified thematic clusters, with keywords such as «Indoor Air Quality (IAQ),» «Air Quality,» and «Indoor Air Pollution» dominating the literature. Through a comprehensive analysis of published literature, this study provides a visual representation of studies with significant contributions to the IAQ field, offering insights into its development and changes from 2018 to 2023. The findings also guide future IAQ research directions.

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Bahrami, A., Haghighat, F., Zhu, J.
Indoor environment gas-particle partitioning models of SVOCs and impact of particle properties on the partitioning: A review.
Building and Environment, Vol. **262**, (2024)

Spending most of our time in a closed environment such as homes, schools and offices makes indoor air quality a cornerstone aspect of our daily life. Semi-volatile organic compounds (SVOCs) are widespread chemicals in the environment and have boiling points ranging from 240 °C to 400 °C. The existence of particle matters in indoor environment amplifies the volatilization of SVOCs and leads to an increase in the overall concentration of SVOCs in the air. This enhancement occurs by facilitating the exchange of SVOCs between their gaseous and particulate phases; a gas-particle partitioning process. Particle properties, including composition, morphology, and size, play a crucial role in regulating the partitioning behavior of SVOCs between gas and particles. For instance, particles with a higher organic content are more readily to absorbing SVOCs compared to inorganic-rich particles. Certain SVOCs are co-emitted with primary fine particles, particularly the particles stemming from combustion-related pollutants. More volatile compounds tend to partition into coarse particles, formed by the growth of primary particles, making them more prevalent in extremely fine particles and coarse particles. On the other hand, less volatile compounds are less likely to volatize from fine particles, making them dominant in this size fraction.

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Niza, I. L., Cordeiro Gomes, G. C., Broday, E. E.
Indoor environmental quality models: A bibliometric, mapping and clustering review.
Renewable and Sustainable Energy Reviews, Vol. **203**, (2024)

Indoor environmental quality (IEQ) plays an essential role within buildings, impacting health, well-being and productivity, considering that individuals spend much of their daily lives indoors. Providing these individuals with a comfortable environment is an important issue. Through a literature review in the Scopus database, one thousand seven hundred and ten articles were identified, of which seventy-eight were selected based on the criteria established. Then, studies on IEQ models were investigated using bibliometric, mapping and hierarchical cluster analysis. The main conclusions of this research are: (I) bibliometric analysis revealed the existence of ninety-five indoor environmental quality models; (II) twelve aspects were identified: tangible aspects (usually measured by an equipment), encompassing thermal comfort, indoor air quality, acoustic comfort and visual comfort; and intangible aspects (mainly obtained by subjective responses via questionnaire), including biophilia and exterior views, cleaning and maintenance, personal control, layout and furniture, location and amenities, colors and textures, friendly atmosphere and pleasure at work; (III) mapping analysis revealed that the indoor air quality aspect is predominant in the models selected; (IV) hierarchical clustering formed five clusters, grouping the aspects thermal comfort and indoor air quality aspects in the same cluster; (V) the visualization of models highlighted the multidisciplinary nature of the indoor environmental quality concept, comprising physiological, psychological and social aspects. These results contributed to verifying the current state of the art and identifying future trends, highlighting a gap related to intangible aspects in the models. Also, improving IEQ by considering occupant behavior can help reduce energy consumption inside buildings.

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Kuruamaddala, S. S. A.
Indoor Particulate Matter Monitoring at SIUE.
Southern Illinois University Edwardsville. Thèse 2024

Indoor air quality (IAQ) is a significant environmental health issue, particularly in densely occupied buildings such as universities where various activities and seasonal factors can affect pollutant levels. This study measured PM2.5 and

PM10 concentrations in three campus buildings at SIUE—Morris University Centre (MUC), Lovejoy Library, and Peck Hall—across different seasons and under varying occupancy and activity conditions. The research aimed to identify and compare the contributory roles of building-specific activities and seasonal variations to the levels of particulate matter, which have direct implications for the health and comfort of building occupants. Advanced statistical analyses, including ANOVA and Tukey's HSD tests, demonstrated significant variations in PM levels between buildings and seasons. The study revealed higher PM concentrations during the fall, attributed to increased indoor activities and reduced ventilation rates. Furthermore, MUC exhibited higher PM levels, likely due to its high occupancy and frequent food preparation activities. These findings underscore the need for adaptive IAQ management strategies that incorporate real-time monitoring and targeted ventilation interventions to mitigate the health impacts of indoor air pollution. The study contributes to the understanding of indoor air quality dynamics, providing a basis for improving environmental health standards in university settings and similar indoor environments.

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Rasheed, E., Wang, K., Hashemi, A., Mahmoodi, M., Panchalingam, K.
Integrating Internet of Things (IoT) Approach to Post-Occupancy Evaluation (POE): An Experimental At-the-Moment Occupant Comfort Control System.
Buildings, Vol. **14** n°(7), (2024)

This paper describes an empirical experiment of Internet of Things (IoT)'s integration in the Post-Occupancy Evaluation (POE) process. The experiment aimed to trial a novel IoT approach to enabling building user responsiveness to prevalent IEQ for individualised comfort. The purpose is to provide a system that mitigates a common issue of centralised air conditioning that limits occupants' control over their immediate environment. To achieve this, an IoT platform was developed with smart IEQ monitoring sensors and wearable devices and trialled with PhD researchers in a shared university workspace. The findings provided empirical evidence of IoT's enhanced benefits to improving user control over their individual comfort and enabling positive energy behaviour in buildings. Specifically, the IoT system provided real-time insight into CO2 concentration data while enabling responsive occupant interaction with their immediate environment and at-the-moment mitigation actions. Outputs of the experiment showed that the perceptions of participants about the stuffiness of the air, productivity, and healthy environment were significantly better after taking the mitigation action compared to before. Also, we found a significant relationship between measured CO2 concentration readings and perceived air stuffiness ($p = 0.004$) and productivity ($p = 0.006$) and a non-significant relationship between CO2 concentration readings and perceived healthy environment ($p = 0.058$). Interestingly, we observed that irrespective of the similarities in recorded CO2 concentration readings being within acceptable ranges (632–712 ppm), the perception of air stuffiness significantly differed ($p = 0.018$) before and after the mitigation actions. The effectiveness of the developed IoT platform was evidenced as most of the participants found the process very easy to participate in with little interruptions to their work as little time was consumed. The results are useful in modifying approaches to building occupant comfort and energy behaviour in commercial and residential settings.

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Richardson, E., Mccauley Krish, K., Cummings, M., Schooping, M., Hopke, P., Tétreault, J.
Interrogating Pollutants in Collecting Institutions During the Implementation of HVAC Energy-Saving Strategies: Lessons Learned and Practical Implications for Optimizing Sustainable Environmental Control.
Studies in Conservation, (2024)

Strategies of outside air reduction, fan speed adjustments, and temporary system shutdowns can be effective ways to maintain or improve the preservation quality of a collection environment while reducing the financial burden and carbon footprint of a collecting institution. However, current criteria guiding safe implementation of energy-saving strategies focus on temperature and RH alone, which ignores risks posed by pollutants. This research aims to address this by monitoring indoor and outdoor-generated pollutants at four collecting institutions before and during implementing energy-saving strategies. Alongside temperature and RH loggers, continuous pollution monitors were located within the mechanical system and collection spaces. Additionally, energy monitors were installed on the mechanical systems serving the collection spaces to quantify the energy consumption prior to and during operation modifications. Initial results indicate pollutant levels remain stable during the test periods, and did not exceed baseline concentrations. In this paper, the lessons learned from this field research are addressed and practical implications for optimizing sustainable environmental controls are given.

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Zhu, Y., Guo, S., Liang, W.

A literature review investigating the impact of temperature and humidity on volatile organic compound emissions from building materials.

Building and Environment, Vol. **262**, (2024)

Volatile organic compounds (VOCs) emitted from building materials can have a detrimental impact on indoor air quality. Temperature and humidity are influential factors that affect VOC emissions from building materials. This study reviewed the individual and coupling effects of temperature and humidity on VOC emissions from building materials. Experimental data, mechanism explanations, and correlations between emission parameters with temperature and humidity were collected. The constants in the correlations were regressed based on available literature data. Formaldehyde and artificial wood-based panels were identified as the primary VOCs and building materials of interest in this research endeavor. In general, both temperature and humidity positively influence VOC emissions from building materials, with temperature exhibiting a more pronounced effect. The logarithm of equilibrium concentration (Cequ), steady-state emission rates (E), initial emittable concentration (C0), diffusion coefficient (Dm), and partition coefficient (K) exhibit a linear relationship with temperature, characterized by an average slope of 0.10, 0.11, 0.04, 0.13, −0.08 respectively. C0 increases with humidity while the influence of humidity on Dm is considered negligible. The applicability of exponential and linear relationships between C0 and humidity was found to be comparable in this investigation. The data compiled in this study could provide valuable support for indoor VOC simulations under varying conditions. Further theoretical studies focusing on the effect of humidity as well as coupling effects on Dm and K are warranted.

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Wang, Z., Liu, C., Yao, P., Fu, X.

Measurement of the indoor environment and heating energy consumption of a passive office building in severely cold region, China.

Indoor and Built Environment, (2024)

Passive ultra-low energy buildings represent an effective strategy for energy conservation and emission reduction within the global building industry. The prolonged and cold winters in severely cold regions of China necessitate substantial heating energy consumption. The study utilized a combination of overall surveys and long-term tracking surveys to evaluate the indoor environment and energy consumption in a passive office building situated in severely cold region under different heating modes over 2 years. The results show that the average temperature and indoor air quality (IAQ) can meet the standards at most moments. However, the average relative humidity tends to fall below the specified lower limit. Nevertheless, the Predicted Mean Vote (PMV) index suggests that the indoor environment provides a comfortable thermal experience for humans. The heat pump air conditioning (HPAC) system operation revealed that when the outdoor air temperature fell below -7°C, the coefficient of performance (COP) of the air source heat pump units would deteriorate. Implementing intermittent heating during the second year can reduce heating energy consumption by 13.4 kWh/(m2·a), resulting in 38.9% energy savings. These findings will serve as a valuable reference for the design and operation of heating systems in passive buildings in severely cold regions.

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Jeong, C. H., Heo, S. K., Woo, T. Y., Kim, S. Y., Park, D. S., Kim, M. J.*, et al.*

Mechanistic indoor air quality model and data-driven calibration for intelligent HVAC AI control system through real-time data in underground buildings.

IOP Conference Series: Earth and Environmental Science, Vol. **1372** n°(1), (2024)

Modeling the dynamics of indoor air quality (IAQ) in subway environments is challenging due to the complex interplay of variables like subway schedules, ventilation, and passenger numbers. This study developed a high-precision mechanistic model for IAQ management and intelligent HVAC control in underground buildings, focusing on Y-station. Global Sensitivity Analysis (GSA) highlighted the significance of the train piston factor during operational hours and the increased sensitivity of penetration and deposition factors when trains are not operational. The model, calibrated in real-time using a Genetic Algorithm (GA), exhibited remarkable accuracy in simulating PM2.5 levels, affirming its effectiveness in forecasting future air quality. The model adeptly captures the complexities of air quality dynamics, providing a comprehensive understanding of temporal IAQ variations. The result demonstrates the model's efficacy as a tool offering a foundation for strategies to forecast IAQ and control the HVAC system in underground buildings.

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Gagliardo, E., Polidori, G., Serpelloni, M.
Mobile Autonomous System for Measuring Pollutants in Indoor Environments.
2024 IEEE International Workshop on Metrology for Industry 4.0 & IoT (MetroInd4.0 & IoT). 29-31 May 2024

The panorama of air quality monitoring is constantly evolving, and its importance has become increasingly fundamental even in indoor environments. Recent studies show the impact of indoor air pollutants on human health. Since individuals spend a substantial part of their lives indoors, more and more attention is paid to guaranteeing the safety and purity of indoor air to safeguard health both at home and in the workplace. In this work, the design and development of an autonomous mobile measurement system dedicated to the sampling and analysis of indoor air quality in closed environments is presented. The system consists of a rover and several sensor technologies to provide a comprehensive assessment of air quality. The system moves autonomously in the closed environment, monitoring pollutants and transmitting data via wi-fi connection to the cloud for analysis and identification of possible dangerous situations. The preliminary tests carried out include the evaluation of various pollution scenarios, such as the presence of smoke, exhaust gases, chemical pollutants, and gas leaks. Furthermore, the autonomous mobile measurement system has been validated during about 12 hours in a real indoor environment. The presented work also offers a critical analysis and interpretation of these results, illustrating the practical implications and effectiveness of the proposed system in real contexts.

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Tarragona, J., Gangolells, M., Casals, M.
Model predictive control for managing indoor air quality levels in buildings.
Energy Reports, Vol. **12**, (2024), 787-797 p.

In recent years, stricter regulations aimed at improving indoor air quality have led to increased energy consumption in ventilation systems. This is particularly noticeable in the service sector, where high occupancy requires frequent air renewal. Therefore, it is crucial to apply control methods in these buildings to ensure proper indoor air quality and comfortable temperatures at minimal energy consumption and cost. However, addressing these operational requirements demands the utilization of advanced control methods and the integration of renewable energy sources. In this context, this article aims to design a model predictive control capable of managing indoor air quality levels to ensure occupants' comfort while minimizing operational costs. The novelty of this work lies in the development, for the first time, of a model predictive control that incorporates solar electricity production, changes in grid electricity prices, occupancy levels, and weather profiles. Additionally, several indoor CO2 concentration limits based on current regulations and building users' activities were employed to evaluate the model performance. Results demonstrated that model predictive control could achieve economic savings of up to 15 % when indoor CO2 concentration must be below 750 ppm compared to binary control modulation with photovoltaic panels. Moreover, the model effectively shifted ventilation necessities to off-peak electricity hours and fully harnessed energy generated by photovoltaic panels. Consequently, the presented model predictive control exhibited promising performance for potential applications in service sector buildings.

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Wang, Z., Tang, H., Zhang, H., Jiang, D., Leng, Y., Wu, Y.*, et al.*
Multi-objectives occupant-centric control of thermostats and natural ventilation systems in cold climate conditions using real-time occupant-related information.
Building and Environment, Vol. **263**, (2024)

Recently, Occupant-Centric Controls (OCCs) have attracted great attention. Many studies have applied OCCs to mechanical ventilation systems, while natural ventilation systems have gathered much less attention. The natural ventilation effect, driven by opening windows or vents, can be effective in improving indoor air quality, however, result in a leakage of interior heating energy in winter in cold climates. Therefore, the controls of thermostats and natural ventilation systems shall be designed well so that satisfying levels of thermal comfort, air quality and energy conservation can be simultaneously guaranteed. This study proposes an OCC and applies it to thermostats and natural ventilation systems for indoor thermal comfort, air quality and heating energy management. The strategy comprises three controllers: occupancy-based on-off controller, controller of setpoint of indoor air temperature and window

openness controller. First, real-time profiles of heat gains from occupants and window openness were collected by employing vision-based detection. Second, a parametric building simulation study was conducted, and then simulation data were generated to develop predictive shallow artificial neural networks for forecasting the indoor conditions and energy performance of the investigated room. Third, the performance of the proposed strategy was examined. Compared to the baselines, the control could offer a decrease in building heating loads by between 43.4% and 63.8 % and an improvement of predicted mean vote levels by 0.36–0.37. The proposed OCC could also maintain indoor CO2 concentrations below 1000 ppm for about 91 % of the studied time, while 84.2 % of the time with several peaks over 3000 ppm in the baseline cases.

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Sinisalo, H.
Museum Professionals' Perceptions of Chemical and Biological Hazards and Risks in Museum Work Environments in Finland.
Collections, (2024)

Limited research has explored museum professionals' perceptions of workplace hazards and risks, despite the presence of various health threats in museum work environments. This study aims to identify perceived chemical and biological hazards and contributing factors in Finnish museum workplaces. Utilizing data from two surveys and qualitative content analysis, it uncovers a range of perceived hazards, often linked to collection storage facilities, historical buildings, and museum collections. Mold, indoor air quality, and dust are central concerns. While recognizing chemical hazards in collections proves challenging, accident-related and ergonomic hazards receive broad recognition. Workplace hazards are perceived to be rooted in systemic and cultural factors, encompassing haphazard management, recurring themes of neglect, limited safety knowledge, and negative attitudes. Enhancing workplace safety in museums necessitates a comprehensive approach, including support and education for leaders and other professionals, improved work practices and storage facilities, and increased budgetary support.

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Lei, L., Li, Z.
A novel dynamic predictive control model for variable air volume air conditioning systems using deep learning.
Journal of Building Engineering, (2024)

Model-based predictive control has proven effective for managing indoor temperature and humidity in variable air volume (VAV) air conditioning systems. However, delays in temperature and humidity adjustments in response to changes in internal and external environmental conditions can impede high-performance operation. This study introduces a dynamic predictive control model for the multi-zone indoor temperature and humidity of VAV systems, designed to predict and control these parameters in real-time. Utilizing the RC network two-node wall structure method and backward finite difference scheme, a multi-zone building model is developed. Coupled with a deep fuzzy cognitive map (DFCM) for temperature and humidity prediction, and controlled by a PID controller, the model dynamically regulates the opening degrees of terminal air dampers and chilled water valves. Implemented on a networked control platform in a large commercial building, the model consistently maintained indoor temperature and humidity within ±0.5°C and ±0.1 g/(kg dry air) of the target values under varying conditions, demonstrating substantial improvements in stability and operational efficiency. The research enhances the predictability and control of HVAC systems through advanced algorithmic integration, improving real-time indoor climate management in complex building environments. This method offers a practical improvement in HVAC control technologies, which could be beneficial for applications in commercial building management systems, providing a useful tool for supporting energy efficiency and sustainability in modern infrastructures.

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Xue, Y., Mou, S., Chen, C., Yu, W., Wan, H., Zhuang, L.*, et al.*
A Novel Electronic Nose Using Biomimetic Spiking Neural Network for Mixed Gas Recognition.
Chemosensors, Vol. **12** n°(7), (2024)

Odors existing in natural environment are typically mixtures of a large variety of chemical compounds in specific proportions. It is a challenging task for an electronic nose to recognize the gas mixtures. Most current research is based on the overall response of sensors and uses relatively simple datasets, which cannot be used for complex mixtures or

rapid monitoring scenarios. In this study, a novel electronic nose (E-nose) using a spiking neural network (SNN) model was proposed for the detection and recognition of gas mixtures. The electronic nose integrates six commercial metal oxide sensors for automated gas acquisition. SNN with a simple three-layer structure was introduced to extract transient dynamic information and estimate concentration rapidly. Then, a dataset of mixed gases with different orders of magnitude was established by the E-nose to verify the model's performance. Additionally, random forests and the decision tree regression model were used for comparison with the SNN-based model. Results show that the model utilizes the dynamic characteristics of the sensors, achieving smaller mean squared error (MSE < 0.01) and mean absolute error (MAE) with less data compared to random forest and decision tree algorithms. In conclusion, the electronic nose system combined with the bionic model shows a high performance in identifying gas mixtures, which has a great potential to be used for indoor air quality monitoring in practical applications.

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Anyaegbuna, B. E., Onokwai, A. O., Anyaegbuna, N. T., Iweriolor, S., Anyaegbuna, I. D., Adegun, I. K.*, et al.*
Numerical analysis on mechanical ventilation impact on indoor air quality in a basement.
Scientific African, Vol. **25**, (2024)

Indoor air quality (IAQ) in confined spaces like bank vaults and basements is influenced by complex factors such as building layout and HVAC systems. This study examines how mechanical ventilation impacts IAQ in a bank building's occupied basement vault, addressing significant challenges posed by pollutant exposure in these air-tight environments. This study advances safe IAQ in confined spaces, crucial for occupant health and safety, using CFD (ANSYS Fluent Workbench 16.0) and CONTAM 3.2 software for multi-zone ventilation and air quality analysis. It analysed three indoor pollutants: Radon (Rn), Carbon dioxide (CO2), and Particulate Matter (PM2.5), enhancing the reliability and applicability of the findings. The findings indicated that the simulated indoor pollutants concentrations did not exceed the indoor air quality guideline levels. The CFD simulations predicted average steady-state values of 27.2 Bq/m3 for Radon, 574.80 ppm for CO2, and 69.36 µg/m3 for PM2.5 in the basement. For different outdoor air floor rates, an optimal ventilation rate of 4.7 ACH and a cooling load of 17 kW were determined to maintain Radon concentrations below 15 Bq/m3. This provides a practical and actionable solution for maintaining safe IAQ in confined spaces, which is a significant step forward compared to similar studies. These results align with other experimental research, validating the use of numerical techniques in indoor air quality studies. By optimizing HVAC systems to maintain IAQ and minimize energy consumption, the study supports SDG 7 (Affordable and Clean Energy) by enhancing energy efficiency, SDG 3 (Good Health and Well-being) by reducing exposure to indoor pollutants, and SDG 11 (Sustainable Cities and Communities) by improving air quality management in confined spaces. The findings are particularly relevant for Africa, offering practical solutions, informing policy direction, and supporting the African Union's Agenda 2063 and SDGs 3, 7, and 11.

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Azuma, K., Kagi, N., Yanagi, U., Kim, H., Hasegawa, K., Shimazaki, D.*, et al.*
O-109 effects of the total floor area of an air-conditioned office building on building-related symptoms: associations with suspended particles, chemicals, and airborne microorganisms.
Occupational Medicine, Vol. **74** n°(Supplement_1), (2024)

Introduction
Building-related symptoms (BRSs) have emerged as an occupational and environmental health issue since the early 1970s. Office environment maintenance may differ according to the total floor area of a building, i.e., the scale of the building.
Methods
In this report, we examined the association between BRSs and the suspended particles, chemicals, and airborne microorganisms in air-conditioned office buildings. The surveys were conducted from January 2018 to March 2020 in 27 offices with 333 employees and in 25 offices with 342 employees during winter and summer, respectively. The office buildings were categorized into small buildings (<2000 m2, 11 offices with 96 employees during winter; 10 offices with 91 employees during summer), middle-sized buildings (2000–3000 m2, 7 offices with 145 employees; 7 offices with 158 employees), and large buildings (≥3000 m2, 9 offices with 92 employees; 8 offices with 93 employees) during winter and summer, respectively.
Results
Significant associations between BRSs and the suspended particles, chemicals, and airborne microorganisms were few in small buildings. Although significant associations between BRSs and suspended particles, aldehydes, volatile organic

compounds, fungi, and bacteria were observed in middle-sized and large buildings during both seasons, as a whole, those concentrations did not exceed indoor air quality guidelines, suggesting being of no toxicological significance. However, the results suggested the possibility of the effects of the combined exposure to multiple aldehydes on upper respiratory symptoms.

Discussion and conclusion

Our data suggests that further research on the total health risk due to multiple low-level indoor pollutants is required.

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Akhras, S., Alkhalil, B.

Optimizing Workspace Comfort and Efficiency: A Comparative Analysis of Displacement Ventilation and Mixed Ventilation strategies in Landscape Offices, considering Thermal Comfort, Air Quality, Energy Performance, and Life Cycle Assessment in HVAC Design.

Dalarna University. Thèse 2024

Purpose: This study conducts a comparative analysis of Displacement Ventilation (DV) and Mixed Ventilation (MV) strategies in landscape offices, considering thermal comfort, indoor air quality, energy performance, and life cycle assessment (LCA) in HVAC design. Methods: IDA-ICE 5 software was used for air stratification analysis of the indoor environment, Magi-CAD for ventilation system design, One Click LCA for calculating the environmental impact, hand calculations and an extensive literature review. Results: The energy performance simulations indicate that DV is more energy efficient than MV. This efficiency is largely attributed to the higher heat exchange capacity of the DV system´s air handling unit, benefiting from the stratification of indoor air temperatures, because for the DV case, the exhaust air temperature is higher than in the MV system, enabling more effective heat recovery. Conversely, the MV system exhibit a more homogeneous air temperature distribution, resulting in a lower exhaust air temperature and consequently less effective heat recovery. Additionally, the supply air temperature for MVS is lower (16°C) than DVS (19°C), leading to increased energy consumption for indoor heating. Regarding environmental impact, the LCA results from stages A1 to A5 (“cradle to practical completion”) show that DVS has a higher Global Warming Potential (GWP) compared to MVS. However, when considering the complete LCA (“cradle to grave”), including energy consumption over the entire lifespan, DVS has a lower GWP than MVS. This outcome is due to the operational energy efficiency of DV, leading to a lower overall environmental impact over the system´s lifetime. Sensitivity analysis confirms also that DV has a lower overall environmental impact, even when accounting for future climate scenarios. Regarding indoor air quality, DV delivers better indoor air quality for the same airflow rate compared to the MV system. MVS requires a higher airflow rate to meet the WELL Building Standard's CO2 level requirements, leading to higher energy consumption and global warming potential. Thus, the DV system maintain better indoor air quality at lower airflow rates, contributing to greater energy efficiency and reduced environmental impact. However, MV systems demonstrate better performance in thermal comfort. The homogeneous air distribution of MV systems results in lower Predicted Percentage of Dissatisfied (PPD) values, enhancing overall occupant comfort. In contrast, DV systems' air temperature stratification characteristics result in cooler temperatures at the floor level, increasing PPD values, and decreasing thermal comfort, particularly in the summertime when temperature differences are more pronounced. Conclusion: DV is more energy-efficient due to higher heat recovery from stratified air temperatures. DV is more environmentally friendly over its lifespan due to lower operational energy use. DV provides better air quality at lower airflow rates, reducing energy consumption and GWP. MV offers a slightly better thermal comfort with more uniform air distribution.

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Abu-Lail, D. M. A., Zoltán, E. S.

The practical implementations of axes in the design of a systematic office layout.

Pollack Periodica, (2024)

In the ever-changing realm of the contemporary workplace, adaptability and flexibility have emerged as crucial attributes for office buildings. The method of axes system design, in conjunction with modular structures, fosters a workspace that can seamlessly adapt to the evolving needs of offices. This system embodies a comprehensive approach to office design, emphasizing the integration of four important principles: modularity, adaptability, interconnectedness, and flexibility. The modular nature of the structural axes design allows for swift and cost-effective adjustments, facilitating customer needs. The dynamism of this system ensures that office spaces are in a perpetual state of evolution, reflecting the changing dynamics of the contemporary workplace as to be shown in this paper.

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Zhang, B.

A Practical Study of LEED Certification for the Shanghai Tower Building Project.

International Journal of Global Economics and Management, Vol. **3** n°(3), (2024), 183-188 p.

This paper examines the effective application of LEED certification in the Shanghai Centre Towers project, analysing its green building practices in all phases of design, construction and operation. By delving into key areas such as energy efficiency, renewable energy use, water management and material selection, it reveals how LEED certification promotes sustainable building development. The results of the study show that Shanghai Centre Tower has not only successfully obtained LEED Gold certification, but also become a benchmark for green buildings, providing valuable experience and reference for future commercial projects.

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Saharuna, Z., Nur, R., Nur, D.

Real time forecasting of indoor CO2 concentration using random forest.

AIP Conference Proceedings, Vol. **3140** n°(1), (2024)

Nowadays, the presence of humans significantly impacts indoor air quality, necessitating continuous monitoring of pollutant gases, especially CO2, for a healthy living environment. The proposed framework leverages machine learning, specifically the Random Forest algorithm, known for its versatility and accuracy, to predict CO2 levels in real-time. By optimizing the window size through extensive experimentation, the framework achieves the lowest Root Mean Squared Error (RMSE) of 12.0045 at 13. On the other hand, Mean Absolute Percentage Error (MAPE) analysis affirm the framework's high accuracy, consistently maintaining a percentage error below 10%.

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Wang, W. L., Liu, X. T., Xiao, Y., Han, S. J., Liu, S. W., Wang, B. G.*, et al.*

Real-time evolution characteristics and potential reactions of contaminants in commuter bus cabin air.

Science of the Total Environment, Vol. **946**, (2024)

Despite the increasing use of motor vehicles, the impact of airborne pollutants and their health risks inside public transportation, such as commuter buses, is not well understood. This study assessed air quality inside an urban commuter bus by continuously monitoring PM10, PM2.5, and CO concentrations during both driving and parking periods. Our findings revealed that the ventilation system of the bus significantly reduced the infiltration of outdoor particulate matter and water vapor. However, CO concentrations were considerably higher inside the bus than outside, primarily due to vehicular self-emission. The ineffection of the ventilation system to remove CO potentially increases long-term exposure risks for passengers. The study identified ozone as a key oxidant in the cabin. Besides vehicle emissions, C3-C10 saturated aldehydes and carbonyl compounds were detected, including acetone, propanal, and hexanal. The presence of 6-MHO, an oxidation product of squalene, suggests that passengers contribute to VOCs load through direct emissions or skin surface reactions. Additionally, human respiration was found to significantly contribute to isoprene levels, estimated at 81.7 %. This research underscores the need for further investigation into the cumulative effects of stable compounds in cabin air and provides insights for developing healthier public transportation systems.

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Alsaadani, S., Hamza, M., Fahmy, M.

Reconciling retrofitting with IEQ to maintain energy, environmental and economic performance: A methodological approach for generic office buildings.

Building and Environment, (2024)

Office building retrofitting may instigate significant reductions in energy consumption and there is growing recognition that buildings' energy, economic and environmental performances (the 3Es) must be considered in tandem. This study aims at maintaining the 3Es when retrofitting office buildings towards nZEB standards. A simulation-based methodology was designed consisting of three generic building forms describing common office building geometries constructed between 1952-1980 in Egypt; linear, square with courtyard and L-shaped. Each accommodated for open, closed and semi-closed office layouts as recommended in architectural manuals, and was oriented in four directions, giving 36 base cases. A combined retrofitting strategy was applied and both base cases and retrofitted cases were simulated in

DesignBuilder using Cairo weather data, which was validated indirectly through real measurements using preliminary simulations that retrieved statistical significance. Results were analyzed for each of the 3Es by comparing base cases to post-retrofitting performances. Results revealed that not all retrofitted cases that demonstrate acceptable environmental performance and/or energy-efficiency are cost-optimal. However, the following patterns were deduced. Square courtyard buildings yield superior performances, and L-shapes tend to perform outside acceptable ranges. Closed plans demonstrate superior energy and environmental performance but poorer economic performance. 17 out of 36 retrofitted cases achieved nZEB, illustrating the potential of implementing nZEB in Egypt. This work may be considered prototypical, encouraging a national office building retrofitting process toward nZEB. However, implications extend beyond the national level, as results may be used to support a kick-off retrofitting programme based on basic office building geometries.

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Al Sayed, K., Boodi, A., Sadeghian Broujeny, R., Beddiar, K.
Reinforcement learning for HVAC control in intelligent buildings: A technical and conceptual review.
Journal of Building Engineering, Vol. **95**, (2024)

Heating, Ventilation and Air Conditioning (HVAC) systems in buildings are a major source of global operational CO2 emissions, primarily due to their high energy demands. Traditional controllers have shown effectiveness in managing building energy use. However, they either struggle to handle complex environments or cannot incorporate learning from experience into their decision-making processes, leading to increased computational requirements. The potential solution to these drawbacks is reinforcement learning (RL), which can overcome them with its versatile and learning-based characteristics. In this context, this study presents a thorough literature review, focusing on studies published since 2019 that applied RL for HVAC system control. It bridges theoretical concepts and literature findings to identify suitable algorithms for each problem and to find gaps. It was found that RL deployment in real buildings is limited (23% of studies), with common training methods revealing fundamental technical problems that prevent their safe use: lack of diversification in exogenous state components (e.g., occupancy schedule, electricity price, and weather) that the agent receives in each episode during training in a way that reflects the diversity or unexpected change in real life. This necessitates repetitive, extensive retraining before real deployment, which is computationally expensive. Future research should focus on applying RL to real buildings by solving the previous problem. The meta-RL emerges as an up-and-coming solution for the generalization capabilities because it trains an agent on a wide range of tasks, making the agent more adaptive and reducing the computational cost. Further research should explore this direction.

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Ibrahim, F., Samsudin, E. Z., Ishak, A. R., Sathasivam, J.
The relationship between occupant behaviour and indoor air quality in Malaysian hospital outpatient departments: A multistage cross-sectional study.
Heliyon, Vol. **10** n°(14), (2024)

Introduction Poor indoor air quality (IAQ) in healthcare settings may adversely impact occupants' well-being and promote transmission of infectious respiratory disease. However, evidence on its potentially modifiable determinants, including occupant behaviour, remains scarce. This study aims to determine the relationship between occupant behaviour and IAQ in Malaysian hospital outpatient departments (OPDs). Methods A multistage cross-sectional study of six randomly selected Malaysian public hospital OPDs was conducted. In stage one, IAQ parameters, including temperature, relative humidity (RH), air velocity (AV), carbon dioxide (CO2), total bacterial count (TBC), and total fungal count (TFC) were measured. In stage two, an observation form based on the Korsavi and Montazami tool for measuring adaptive behaviour was used to examine occupant density, activities, and operation of building envelopes and appliances. Simple correlation, partial correlation, and linear regression analyses were performed to examine the relationship between occupant behaviour and IAQ parameters. Results The IAQ of selected hospital OPDs complied with established standards, except for temperature and AV. Occupant density was positively correlated with temperature and CO2. Meanwhile, occupants' activities including slow walking and brisk walking were positively correlated with temperature, AV, CO2, TBC and TFC. Conversely, occupants' opening of windows and doors were positively correlated with temperature and AV but negatively correlated with CO2, TBC and TFC. Finally, turning on fans was positively correlated with AV but negatively correlated with TBC, whereas turning on air conditioner was positively correlated with CO2. Among occupants' behaviour, opening of windows and doors contributed the most to variation in IAQ parameters. Conclusions The study findings suggest that IAQ in hospital OPDs are influenced by occupant density, activities, and

operation of doors, windows, and appliances. Prospective hospital IAQ guidelines should incorporate policies and measures targeting these factors to ensure occupants' best practices in maintaining healthy hospital indoor air environments.

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Wang, S., Cao, X., Miao, D., Pang, L., Li, J.
A Review of In-Flight Thermal Comfort and Air Quality Status in Civil Aircraft Cabin Environments.
Buildings, Vol. **14** n°(7), (2024)

The civil aircraft cabin is enclosed and highly occupied, making it susceptible to a decline in indoor environmental quality. The environmental quality of civil aircraft cabins not only depends on objective factors such as temperature, relative humidity, and the presence of air pollutants such as carbon dioxide (CO2), carbon monoxide (CO), ozone (O3), particle matter (PM), and volatile organic compounds (VOCs) but also the subjective factors pertaining to the perceptions and health symptoms of passengers and crew. However, few studies have thoroughly examined the air quality and thermal comfort parameters that are measured during in-flight testing in airplane cabins, as well as the passengers' subjective perceptions. In order to evaluate the in-flight thermal comfort and air quality status, this study conducted a review of the recent literature to compile data on primary categories, standard limits, and distribution ranges of in-flight environmental factors within civil aircraft cabins. Following a search procedure outlined in this paper, 54 papers were selected for inclusion. Utilizing the Monte Carlo method, the Predicted Mean Vote (PMV) distributions under different exercise intensities and clothing thermal resistance were measured with the in-cabin temperature and humidity from in-flight tests. Recommendations based on first-hand data were made to maintain the relative humidity in the cabin below 40%, ensure wind speed remains within the range of 0–1 m/s, and regulate the temperature between 25–27 °C (for summer) and 22–27 °C (for winter). The current estimated cabin air supply rate generally complies with the requirements of international standards. Additionally, potential carcinogenic and non-carcinogenic risks associated with formaldehyde, benzene, tetrachloroethylene, and naphthalene were calculated. The sorted data of in-flight tests and the evaluation of the subjective perception of the occupants provide an evaluation of current cabin thermal comfort and air quality status, which can serve as a reference for optimizing indoor environmental quality in future generations of civil aircraft cabins.

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Saini, J., Dutta, M., Marques, G.
Robot-assisted indoor air quality monitoring and assessment: a systematic review.
International Journal of Environmental Science and Technology, (2024)

The degraded air quality has become an international issue with rising cases of respiratory health issues across the globe while contributing to the symptoms of chronic health problems such as cardiovascular disease, lung cancer, and nervous system disorders. Therefore, it is important to leverage the potential of the latest technologies to address the concerns related to degrading air quality. This systematic review is focused on robot-assisted indoor air quality (IAQ) monitoring and assessment. This review is conducted based on the 14 most relevant papers included from 5 different databases, and the available information is synthesized with PRISMA guidelines to find answers to 6 potential research questions. The main contribution is to provide highlights to different types of ground robotic systems used by existing researchers for IAQ assessment. The synthesis shows that commercial robotic units are widely preferred for IAQ monitoring applications in comparison to the self-designed robot systems. The authors in this paper also put emphasis on energy consumption, power requirements, functionality details, and communication technologies used by existing researchers. This paper highlights potential challenges, gaps, and findings of the existing studies while creating a roadmap for future researchers, public health experts, and government agencies working in this domain application.

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Song, Z., Nian, L., Shi, M., Ren, X., Tang, M., Shi, A.*, et al.*
Semi-volatile organic compounds in a museum in China: A non-targeted screening approach.
Science China Technological Sciences, (2024)

Non-targeted analysis (NTA) was conducted to identify semi-volatile organic compounds (SVOCs) in a museum in China using the gas chromatography (GC)-Orbitrap-mass spectrometer (MS). Approximately 160 SVOCs were detected, of which 93 had not been reported in previous studies of museum environments. Many of the detected SVOCs were found

to be associated with the chemical agents applied in conservation treatment and the materials used in furnishings. The results of hierarchical cluster analysis (HCA) indicated a spatial variation of SVOCs in the indoor air in the museum, but there were no obvious temporal differences of SVOCs observed in indoor dust. Spearman's correlation analysis showed that several classes of SVOCs were well correlated, suggesting their common sources. Fragrances and plasticizers were found to be the primary sources of SVOC pollution detected in the museum. Compared with compounds in outdoor air, indoor SVOCs had a lower level of unsaturation and more portions of chemically reduced compounds. This study is the first of its kind to comprehensively characterize SVOCs in a museum using an automated NTA approach with GC-Orbitrap-MS. The SVOCs identified in the current study are likely to be present in other similar museums; therefore, further examination of their potential impacts on cultural heritage artifacts, museum personnel, and visitors may be warranted.

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Wicaksono, M. F., Rahmatya, M. D.
Server security and air quality monitoring system using raspberry pi 4 and telegram.
Journal of Engineering Science and Technology, Vol. **19** n°(4), (2024), 1156-1170 p.

The purpose of this research is to develop a system that uses Raspberry Pi and IoT technologies to monitor server room conditions such as temperature, humidity, air quality, and access rights security. The contribution of this research is that it makes it easier for users to monitor the server room and take appropriate action when something goes wrong. The method utilized in this study is experimental. The output obtained is in the form of a web display and telegram notifications. The brain of this system is the Raspberry Pi 4. The input received is temperature, humidity, carbon monoxide levels, carbon dioxide, and dust particle values. The thing that causes the Raspberry Pi 4 to activate the buzzer and send notifications via Telegram is when the temperature value is more than 230C, the humidity is less than 45% or 60%, the measured carbon monoxide value is more than 50 ppm, or carbon dioxide is more than 800 ppm or the AQI value of dust particles is more than 100. Regarding access rights, users can only enter the server room using a registered RFID card. Access rights violations will be detected by PIR1, PIR2, and Ultrasonic sensors. If this happens, the Raspberry Pi will take a photo with the Pi Camera, activate the buzzer, and send it via Telegram. The entire system testing process is tested into two main parts: temperature, humidity, AQI testing, and security testing related to access rights according to the program scenario and initial objectives. Test results show that every part is functioning 100%. The overall test shows 100% success where the system can do actions according to program conditions and scenarios

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Rozi, C., Tri, J., Nurjazuli.
Several Factors Responsible For Sick Building Syndrome in Urban Settings: Literature Review.
Media Publikasi Promosi Kesehatan Indonesia (MPPKI), Vol. **7** n°(7), (2024), 1717-1723 p.

Introduction: Urban dwellers are more susceptible to the adverse effects of air pollution and climate change. Sick building syndrome (SBS) relates to health issues experienced by workers as a result of indoor activities, air pollution, and climate change. The incidence of SBS is strongly correlated with environmental factors both within and outside the workplace.Objective: To identify current factors associated with the incidence of sick building syndrome in urban areasMethod: Review of the literature compiled in both English and Indonesian from the databases of PubMed, Scopus, and Google Scholar. The literature, which is available in full text publications, was collected during the period of the last five years, from 2019 to 2024.Results: Temperature, relative humidity, microbes, air pollution, psychological factors, light, and ventilation in a room or workplace were some of the variables that affect the incidence of sick building syndrome in urban settings.Conclusion: SBS was related to a number of factors, including temperature, relative humidity, ventilation, lighting, pathogens, and psychosocial factors. These elements may have an individual or combined effect on worker productivity and the development of SBS.

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Zhihao, X., Qianjin, W., Wenli, D., Jialei, G., Shuaiju, W., Lei, G.*, et al.*
Simulation analysis and optimization research on airflow organization in typical ship meeting rooms.
Third International Conference on Electronic Information Engineering and Data Processing (EIEDP 2024) .5 July 2024

Using computational fluid dynamics (CFD) simulations, this study examines airflow organization in modern ship meeting rooms. It investigates indoor and velocity distribution, calculates air age and Predicted Mean Vote (PMV), analyzes indoor thermal comfort, and proposes optimization strategies for ship meeting room air conditioning design.

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Kumar, N., Verma, H., Sharma, Y. K.
Smart Sensors for Environmental Monitoring in Industry 4.0.
In: Smart Sensors for Industry 4.0. 2025. 39-55 p.

Summary The deployment of smart sensors for environmental monitoring in Industry 4.0 is a rapidly growing area of research with the potential to revolutionize industrial systems. In this chapter, we provide an overview of the state-of-the-art techniques for deploying smart sensors for environmental monitoring in Industry 4.0 environments and their potential to enhance the health and safety of workers and the sustainability of industrial systems. We explore various applications of smart sensors for monitoring temperature, humidity, air quality, noise pollution, and other environmental factors that impact the health and safety of workers in industrial settings. We also discuss the challenges associated with deploying smart sensor networks, such as data acquisition, data processing, data management, and data visualization. Additionally, we examine the potential of integrating smart sensor networks with other data sources, such as remote sensing and satellite data, to enhance the accuracy and reliability of environmental monitoring in industrial systems. We also explore the ethical and legal implications of using smart sensors for environmental monitoring and the strategies for ensuring data privacy and security. Finally, we discuss the potential for using machine learning and AI-based techniques to analyze the vast amounts of data generated by smart sensor networks for environmental monitoring in Industry 4.0 environments.

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Anuar, S. M. a. S. M., Rasam, A. R. A., Kamarul, N., Bahrain, M. M., Abdullah, J., Atang, C.
Spatial risk assessment of sick building syndrome in a university space: a gis-based physical context mapping approach.
MALAYSIAN CONSTRUCTION RESEARCH JOURNAL (MCRJ), Vol. **22** n°(2), (2024)

Sick building syndrome (SBS) is common in poorly maintained buildings due to poor air conditioning, ventilation, lighting, and others. Due to the building's construction and age, this study investigates the spatial risk level of SBS at the administration building of the College of Built Environment (CBE) at UiTM Shah Alam using the Geographical Information System-Multi Criteria Decision-Making (GIS-MCDM) method and the JKR's SBS criteria in a physical context. The study interviewed staff and the original owners of the space to obtain the estimated risk level of the SBS, while ArcGIS Pro visualised a 2D risk map based on the floor plan and the risk level. Based on the survey questionnaire, the respondents agreed that ventilation and air conditioning systems are the dominant criteria or factors for SBS. The finding revealed that before the 2020 renovation, there were many issues with ventilation and air conditioning, but after the renovation, the issues decreased. Although the CBE space is still relevant as a secure workplace, SBS still had an impact on some of the CBE spaces. Therefore, regular maintenance activities should be conducted with sustainable solutions towards a healthier campus and a safe space for building construction. The proposed map is also valuable for guidelines in CBE's occupational safety and health administration building.

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Sirror, H., Labib, W., Abowardah, E., Metwally, W., Mitchell, C.
Sustainability in the Workplace: Evaluating Indoor Environmental Quality of a Higher Education Building in Riyadh.
Buildings, Vol. **14** n°(7), (2024)

Sustainable building design has gained global significance as a strategy to address environmental challenges and promote healthier living spaces. This concept is particularly relevant in Saudi Arabia, where there is a growing emphasis on integrating sustainable practices into the design and operation of buildings, especially in educational settings. Amidst the global push for sustainability in workplaces, this study's core lies in assessing and comparing the satisfaction levels with the indoor environmental quality (IEQ) of a Saudi Arabian higher education building against those in international green buildings, considering factors that comprise thermal comfort, air quality, lighting, acoustic quality, office arrangement, furnishings, cleanliness, and maintenance. Employing the Center for the Built Environment (CBE) IEQ survey tool, a comprehensive study was conducted among the building's occupants. A literature review and

benchmarking studies complemented this to gather data on international green buildings. This study aims to assess and compare the satisfaction levels with the IEQ of a Saudi Arabian higher education building against international green buildings. The comparative analysis aims to expose the commonalities and differences in satisfaction levels, exploring how various factors influence overall satisfaction with the IEQ. The research found that there is overall satisfaction with the IEQ parameters of the building under investigation, except with two parameters: acoustics and thermal comfort. The building is generally in alignment with the IEQ of international buildings. This research is presumed to contribute significantly to sustainability initiatives in educational buildings, fostering a healthier and more sustainable workplace environment.

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Pourkiaei, M., Rahif, R., Falzone, C., Elnagar, E., Martin, J., Fettweis, X.*, et al.*
Systematic framework for quantitative assessment of Indoor Air Quality under future climate scenarios; 2100s Projection of a Belgian case study.
Journal of Building Engineering, Vol. **93**, (2024)

Alteration of Indoor Air Quality (IAQ) levels in the context of changing climate is correlated with shifting air pollutant emissions, variations in ambient climate, and the mitigation/adaptation strategies applied in buildings to deal with increasing extreme weather events and energy demands. In this study, firstly, a systematic modeling-based framework for the quantitative assessment of the impacts of future building retrofit and climate scenarios on IAQ is presented. After describing the framework, its practical implementation in a demonstrative case study is presented. The proposed framework includes three main parts: i) IAQ measurements, ii) IAQ model design, and iii) future IAQ state evaluation. Regarding the case study, fabricated indoor monitoring devices (O3, CO, NO, NO2, PM2.5, PM10, VOCs, air temperature, relative humidity, and air pressure) based on Low-Cost Sensors were developed, and calibrated with reference analyzers. An indoor measurement campaign was conducted in a naturally ventilated residential building (+2 exhaust fans) in the Wallonia region, south of Belgium (summer of 2021). An IAQ model was designed in the multizone IAQ and ventilation software, CONTAM. The validation and calibration processes were carried out with the aid of experimental data from the indoor measurement campaign. The calibrated IAQ model showed a total conformity of +95 % from the average concentration perspective. Finally, predicted future outdoor air pollution and indoor and outdoor climate data of the case study were fed to the IAQ model (basis-year 2021), and indoor contaminant levels under different climate scenarios were quantitatively assessed till 2100.

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Cumo, F., Giovenale, A. M., Pennacchia, E., Tiburcio, V. A.
Towards a Healthier Hospital Environment: The Role of Digital Twins in Achieving Optimal Environmental Comfort.
Preprints, (2024)

Indoor environmental comfort is fundamental to human health as people spend 90% of their time indoors. This aspect is even more crucial in hospitals, where the concept of health is closely linked to well-being, ethics, and environmental aspects. Emerging methodologies and technologies such as Digital Twin, Building Information Modeling, the Internet of Things, sensing technologies, and data analytics offer new opportunities to ensure healthier environments and more efficient building management. This paper provides an assessment of how digitalization can support decision-making processes related to maintaining high levels of indoor environmental comfort in hospital settings, particularly by analyzing how real-time data processing and the application of machine learning can promote proactive interventions in these facilities. The methodological approach was based on four phases: defining the objectives of the digital twin, identifying the input data to build and feed the digital model, defining the KPIs to evaluate the system's correct functioning, and identifying the enabling technologies to be integrated into the system to achieve the set goal. The result is a digital twin for managing the operating room and its related services, with the aim of guiding decisions based on accurate data and improving operational efficiency, levels of environmental comfort, and safety regarding the diffusion of medical gases.

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Besis, A., Margaritis, D., Samara, C., Bekiaris, E.
Volatile Organic Compounds on Rhodes Island, Greece: Implications for Outdoor and Indoor Human Exposure.
Toxics, Vol. **12** n°(7), (2024)

Volatile organic compounds (VOC) are considered a class of pollutants with a significant presence in indoor and outdoor air and serious health effects. The aim of this study was to measure and evaluate the levels of outdoor and indoor VOCs at selected sites on Rhodes Island, Greece, during the cold and warm periods of 2023. Spatial and seasonal variations were evaluated; moreover, cancer and non-cancer inhalation risks were assessed. For this purpose, simultaneous indoor-outdoor air sampling was carried out on the island of Rhodes. VOCs were determined by Thermal Desorption—Gas Chromatography/Mass Spectroscopy (TD-GC/MS). Fifty-six VOCs with frequencies ≥ 50% were further considered. VOC concentrations (∑56VOCs) at all sites were found to be higher in the warm period. In the warm and cold sampling periods, the highest concentrations were found at the port of Rhodes City, while total VOC concentrations were dominated by alkanes. The Positive Matrix Factorization (PMF) model was applied to identify the VOC emission sources. Non-cancer and cancer risks for adults were within the safe levels.

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Yu, W., Zhou, Y., Li, Z., Zhu, D., Wang, L., Lei, Q.*, et al.*
When thermochromic material meets shape memory alloy: A new smart window integrating thermal storage, temperature regulation, and ventilation.
Applied Energy, Vol. **372**, (2024)

Traditional windows have poor thermal insulation performance, resulting in significant indoor heat loss in winter and outdoor heat entry in summer. Thermochromic smart windows can effectively block solar radiant heat by automatically adjusting light transmittance, thereby reducing air conditioning loads and leading to significant energy savings. In this study, the poly N-isopropyl acrylamide (PNIPAm)-based thermochromic hydrogel, modified MXene nanoparticles, and NiTi shape memory alloy (SMA) are integrated to endow the smart window with heat storage, temperature control, and ventilation. The smart window achieves 88.6% visible light transmission and 70% solar modulation. The inclusion of MXene nanoparticles further enhances photothermal response efficiency, while the ventilation system ensures efficient and fresh indoor air circulation. Compared to the common glass, the smart window reduces the indoor temperature by 8 °C, demonstrating its excellent temperature regulation ability. Simulation results indicate that in Shanghai, Cairo, Singapore, and Kuwait, the employment of thermochromic smart windows can reduce heating, ventilation, and air conditioning energy consumption (HVAC) by 32.6%, 49.9%, 42.7%, and 34.1%, respectively. This versatile thermochromic smart window is expected to significantly improve building efficiency and occupant comfort, offering a sustainable solution for future building designs.

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Mueller, W., Smith, A., Kuijpers, E., Pronk, A., Loh, M.
Worker perspectives on improving occupational health and safety using wearable sensors: a cross-sectional survey.
Annals of Work Exposures and Health, (2024)

Workplace exposure is an important source of ill health. The use of wearable sensors and sensing technologies may help improve and maintain worker health, safety, and wellbeing. Input from workers should inform the integration of these sensors into workplaces. We developed an online survey to understand the acceptability of wearable sensor technologies for occupational health and safety (OSH) management. The survey was disseminated to members of OSH-related organizations, mainly in the United Kingdom and the Netherlands. There were 158 respondents, with over half (n = 91, 58%) reporting current use of wearable sensors, including physical hazards (n = 57, 36%), air quality (n = 53, 34%), and location tracking (n = 36, 23%), although this prevalence likely also captures traditional monitoring equipment. There were no clear distinctions in wearable sensor use between the reported demographic and occupational characteristics, with the exception that hygienists were more likely than non-hygienists (e.g. safety professionals) to use wearable sensors (66% versus 34%). Overall, there was an interest in how sensors can help OSH professionals understand patterns of exposure and improve exposure management practices. Some wariness was expressed primarily around environmental and physical constraints, the quality of the data, and privacy concerns. This survey identified a need to better identify occupational situations that would benefit from wearable sensors and to evaluate existing devices that could be used for occupational hygiene. Further, this work underscores the importance of clearly defining “sensor” according to the occupational setting and context.

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