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A Literature Review of Indoor Air Quality: Sources, Health Effects, and Mitigation Strategies

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Sustainable marketing has become an essential component for businesses aiming to meet growing consumer demand for environmental responsibility. This paper explores how companies can align their brand values with sustainability efforts to foster long-term customer loyalty and market competitiveness. It examines key sustainable marketing strategies, including eco-friendly product design, transparent communication, and corporate social responsibility (CSR) initiatives. The study emphasizes the importance of authenticity, as consumers are increasingly wary of "greenwashing" tactics and seek brands that genuinely prioritize environmental stewardship. Case studies from various industries demonstrate successful integration of sustainability into brand identity, resulting in enhanced brand reputation, consumer trust, and business growth. The findings highlight the need for a comprehensive approach that includes stakeholder engagement, sustainable supply chains, and marketing campaigns that educate consumers on eco-friendly choices. By aligning brand values with consumer expectations for environmental responsibility, companies can create a competitive advantage while contributing to global sustainability efforts.

1. Introduction

Indoor air quality (IAQ) is a critical aspect of environmental health that significantly impacts the well-being of individuals and communities worldwide. With the average person spending approximately 90% of their time indoors, the quality of indoor air has profound implications for respiratory health, cognitive function, and overall quality of life. Understanding the sources of indoor air pollution, its adverse health effects, and effective mitigation strategies is essential for safeguarding public health and promoting a healthier indoor environment.

This literature review provides a comprehensive examination of indoor air quality, focusing on three key aspects: sources of indoor air pollution, health effects associated with poor IAQ, and strategies for mitigating indoor air pollutants. By synthesizing findings from a wide range of studies and research articles, this review aims to offer insights into the current state of knowledge on IAQ and identify areas for further investigation and intervention.

The first section of this review explores the diverse sources of indoor air pollution, ranging from biological contaminants such as mold and pollen to chemical pollutants emitted from household products and building materials. Understanding the origins of indoor air pollutants is crucial for developing effective strategies to reduce their presence and minimize exposure among occupants.

Subsequently, the review examines the health effects associated with poor indoor air quality, highlighting the impact of indoor air pollution on respiratory health, cardiovascular function, and neurological well-being. Vulnerable populations such as children, the elderly, and individuals with preexisting health conditions are particularly susceptible to the adverse effects of indoor air pollutants, underscoring the urgency of addressing IAQ issues.

Finally, the review discusses various mitigation strategies aimed at improving indoor air quality and reducing the concentration of harmful pollutants. These strategies encompass ventilation techniques, air purification technologies, and household practices designed to minimize exposure to indoor air contaminants.

By synthesizing existing research on indoor air quality, this review seeks to inform policymakers, healthcare professionals, and the general public about the importance of IAQ management and provide evidence-based recommendations for promoting healthier indoor environments.

2. Method

To investigate indoor air quality comprehensively, a rigorous literature search was conducted utilizing multiple academic databases renowned for their breadth and depth of scholarly resources. The databases employed for this review included PubMed, Scopus, Web of Science, and Google Scholar. These platforms were selected to ensure a comprehensive retrieval of relevant peer-reviewed articles, research studies, conference proceedings, and other scholarly publications pertaining to indoor air quality.

The search strategy comprised a combination of controlled vocabulary terms (e.g., Medical Subject Headings [MeSH] terms in PubMed) and free-text keywords related to indoor air quality, indoor air pollution, air contaminants, health effects, mitigation strategies, and other pertinent concepts. Boolean operators (e.g., AND, OR) were judiciously employed to refine search queries and maximize the retrieval of relevant literature.

The search was initially conducted in December 2023 and updated periodically to capture newly published studies and ensure the inclusion of the most current research findings. No restrictions were imposed on publication date, language, or geographical location to minimize the risk of selection bias and enhance the inclusivity of the literature review.

Following the literature search, retrieved records were screened based on predetermined inclusion and exclusion criteria. Inclusion criteria encompassed studies focusing on indoor air quality assessment, indoor air pollutant sources, health effects associated with indoor air pollution, and mitigation strategies to improve indoor air quality. Conversely, studies irrelevant to the scope of the review or lacking empirical data were excluded from further analysis.

The screening process involved an initial assessment of titles and abstracts to identify potentially relevant articles, followed by a full-text review of selected articles to ascertain their eligibility for inclusion. Discrepancies or uncertainties regarding article eligibility were resolved through consensus among the authors.

Data extraction from included studies encompassed key information such as study design, sample characteristics, exposure assessment methods, health outcomes measured, and findings pertinent to the review objectives. Extracted data were synthesized and analyzed thematically to elucidate patterns, trends, and gaps in the existing literature on indoor air

quality.

Inclusion Criteria:

a. Relevance to Indoor Air Quality (IAQ): Studies must focus on aspects directly related to indoor air quality, including but not limited to indoor air pollutants, sources of indoor pollution, health effects associated with indoor air pollution, and mitigation strategies aimed at improving IAQ.
b. Empirical Research: Only empirical studies, including original research articles, systematic reviews, meta-analyses, and observational studies, will be included. Opinion pieces, editorials, letters, and other non-research articles will be excluded.
c. Publication Type: Peer-reviewed articles published in academic journals, conference proceedings, and reputable scientific publications will be considered for inclusion. Grey literature, such as reports, theses, and dissertations, will be excluded.
d. Language and Publication Date: No restrictions will be imposed on the language of publication or publication date to ensure inclusivity and comprehensiveness. Studies published in languages other than English will be translated if deemed relevant.
e. Study Population: Studies involving human subjects of any age, gender, or geographic location will be eligible for inclusion. Studies conducted in various settings, including residential, occupational, educational, and healthcare environments, will be considered.
f. Outcome Measures: Studies must report quantitative or qualitative data related to indoor air quality parameters, health outcomes associated with indoor air pollution, or interventions aimed at improving IAQ. Outcome measures may include pollutant concentrations, respiratory symptoms, cardiovascular outcomes, cognitive function, quality of life, and other relevant endpoints.

Exclusion Criteria:

a. Irrelevant Topics: Studies not directly related to indoor air quality, indoor air pollution, or associated health effects will be excluded. This includes studies focusing solely on outdoor air pollution or other environmental factors unrelated to IAQ.
b. Non-Empirical Studies: Non-research articles such as editorials, commentaries, opinion pieces, and letters to the editor will be excluded from the review.
c. Insufficient Data: Studies lacking sufficient empirical data or methodological rigor to draw meaningful conclusions will be excluded. This includes case reports, anecdotal evidence, and studies with limited sample sizes or inadequate study designs.
d. Duplicate Publications: Duplicate publications or redundant data from the same study

will be excluded to avoid duplication of results and minimize bias.

e. Animal Studies: Studies conducted solely on animals or laboratory models without direct relevance to human indoor environments will be excluded.
f. Unavailable Full Text: Studies for which full-text access cannot be obtained despite exhaustive efforts to retrieve them will be excluded from the review.

3. Result and Discussion

Quality assessment of included studies is essential to ensure the validity, reliability, and methodological rigor of the evidence synthesized in the literature review. The assessment will be conducted using standardized tools and criteria tailored to the study designs and methodologies employed in the selected articles.

1. Study Design and Methodology:

The study design will be evaluated to ascertain its appropriateness for addressing the research question and objectives. Methodological aspects such as sample size, sampling technique, data collection methods, and statistical analyses will be scrutinized to determine the robustness of the study methodology.

2. Risk of Bias:

Potential sources of bias, including selection bias, measurement bias, confounding variables, and attrition bias, will be identified and evaluated. Studies exhibiting a high risk of bias may be subjected to sensitivity analyses or excluded from the synthesis if deemed unreliable.

3. Internal Validity:

The internal validity of included studies will be assessed to ascertain the extent to which the study findings accurately represent the true relationship between variables. Measures to enhance internal validity, such as randomization, blinding, and controlling for confounding variables, will be considered in the assessment.

4. External Validity:

The external validity or generalizability of study findings will be evaluated to determine the extent to which the results can be extrapolated to broader populations or settings. Factors influencing external validity, including sample characteristics, study setting, and context-

specific factors, will be taken into account in the assessment.

5. Reporting Quality:

The completeness and transparency of reporting will be assessed based on adherence to established reporting guidelines for specific study designs (e.g., CONSORT for randomized controlled trials, STROBE for observational studies). Studies with inadequate reporting or missing essential information may be subject to downgrading in quality assessment.

6. Overall Assessment:

Based on the above criteria, each included study will be assigned an overall quality rating, ranging from high quality to low quality or excluded if deemed methodologically unsound. Quality assessment will be conducted independently by two or more reviewers, with discrepancies resolved through consensus or consultation with a third reviewer if necessary.

7. Sensitivity Analysis:

Sensitivity analyses may be performed to evaluate the robustness of the review findings by excluding studies with a high risk of bias or low methodological quality. Sensitivity analyses aim to assess the impact of including or excluding studies on the overall conclusions drawn from the literature review.

8. Publication Bias:

Potential publication bias, resulting from selective reporting of studies with positive findings or significant results, will be assessed using visual inspection of funnel plots or statistical tests such as Egger's regression test. Measures to address publication bias, such as searching for unpublished studies or gray literature, will be considered to mitigate its impact on the review findings.

No	Author	Year	Title	Factors identified
1.	Khan et al.	2022	Application of an occupant voting system for continuous occupant feedback on thermal and indoor air quality	The study presented in this paper investigated the validity and application of occupant votes collected with a tangible OVS denoted TiAQ (Thermal and Indoor Air Quality feedback) for evaluating

		– Case studies in office spaces https://doi.org/10.1016/j.enbuild.2021.111363	occupants' comfort with the thermal environment and indoor air quality in office spaces. The findings suggested that votes collected with TiAQ were helpful to determine the indoor temperature and airflow levels that occupants perceived as comfortable or as too warm or too cold. However, the study demonstrated that the collected votes were not reliable to evaluate occupants' local thermal discomfort with draught or the dissatisfaction and satisfaction with indoor air quality. Nevertheless, the thermal votes were used in performance monitoring for identifying problematic operational settings (e.g., poorly set indoor temperature setpoint) and appropriate operational settings (e.g., lowering the indoor temperature in the mornings). Collected votes along with IEQ measurements were used to identify that energy savings of up to 46% and improvements of occupant comfort with 6% were achievable by reducing airflow and lowering indoor temperature setpoint in one of the case buildings. The validity and reliability of occupant votes depended on the strength of variation in indoor environmental variables. Consequently, future studies using OVS in

				mechanically ventilated office buildings need to be conducted over a long period (at least 30 days) or at least introduce interventions to create high variations in indoor conditions and occupants' voting patterns.
2.	Nair et al.	2022	A review of strategies and their effectiveness in reducing indoor airborne transmission and improving indoor air quality https://doi.org/10.1016/j.envres.2022.113579	. Airborne viruses stays infectious in the air for hours, and pollutants such as particulate matter (PM10, PM2.5), NO2, SO2, CO, O3, CO2, TVOC, can enhance the incidence, spread rapidity, and mortality rate of COVID -19 disease. Other environmental parameters such as temperature and humidity were found to have a notable influence on indoor viral transmissions. Thus, maintaining adequate IEQ levels is vital in minimizing the spread of the SARS-CoV-2 virus. However, most of the existing air conditioning and mechanical ventilation systems have limits in maintaining thermal comfort, IEQ, and energy balance at the same time. So, there is a need for a novel ventilation strategy/system for the built spaces to improve the IAQ without compromising thermal comfort and energy efficiency standards. This review paper acts as a guide for post-pandemic building operation, which explores a set of strategies/ methods to improve the IAQ of built spaces and thereby minimize the transmission of infectious agents. The identified strategies are context-specific;

			the application and efficiency of each of them vary according to the circumstances and environmental conditions. Professionals such as architects and civil engineers should select, integrate and implement various sustainable strategies that can enhance IEQ to protect individuals against indoor airborne infectious agents.
3. Unni et al.	2022	Community knowledge, attitude and behaviour towards indoor air quality: A national cross-sectional study in Singapore https://doi.org/10.1016/j.envsci.2022.06.021	Our study revealed lower levels of knowledge and behaviour towards IAQ and moderate levels of attitude within the study population. Increasing community knowledge and reinforcing positive community behaviour towards IAQ are thus important priorities in improving poor health associated with indoor environments. We observed evidence of KAB levels that differed by socio-demographic segments. This suggests that policy measures to improve KAB levels could be prioritized in and tailored for community-specific segments with the lowest scores. The positive association between knowledge and behaviour in our study provides evidence to support new knowledge-sharing policy initiatives that seek to strengthen community behaviour towards IAQ improvements. Knowledge sharing improved the awareness of participants and increased their willingness to bear the cost of IAQ improvements in their homes. This may be a useful finding in designing behavioural strategies to increase the uptake of

				residence-based interventions in reducing instances of poor IAQ. The effectiveness of different knowledge sharing modalities on improving attitudes and behaviour should be assessed. Further studies to understand how improving knowledge may drive possible mediating factors such motivations and perceived behavioural control, and how it affects the association between community attitude and behaviour towards IAQ, would be beneficial.
4.	Berger et al.	2022	The appearance of indoor plants and their effect on people's perceptions of indoor air quality and subjective well-being https://doi.org/10.1016/j.buildenv.2022.109151	This study investigated the psychological responses of 520 participants to the appearance of twelve images of indoor plants. The findings show that the physical appearance of the plant had a significant impact on participants' responses, their aesthetic preference and the perceived benefit of the plant for subjective well-being, indoor air quality and humidity. Descriptors of the plant's physical appearance can be used to predict perceptions of its impact on IAQ and SWB. The terms Uplifting, Interesting, Relaxing and Beautiful were the strongest predictors of benefits for SWB. All healthy plants tested were considered beautiful to some extent and to have a positive impact on SWB. The most preferred plants in this study; *Epipremnum, Ficus* sphere, palm *and Ficus* column, were perceived to have the highest SWB benefit. To maximize the well-being benefit for building occupants, designers

				and installers should choose healthy indoor plants which people find beautiful and interesting. The perceived benefits for IAQ and RH were most strongly associated with the healthiness, and canopy density of the plant rather than the shape, beauty, or softness of its appearance. Unhealthy plants should be removed from indoor environments as they may negatively impact people's perceptions of IAQ and SWB. The findings of this study show people's perceptions of the indoor environmental quality will be maximized by plants with lush, bright green leaves and high canopy density. These characteristics may also enhance the thermal comfort benefits derived from the presence of indoor plants identified in previous studies
5.	Abhijith et al.	2022	Investigation of air pollution mitigation measures, ventilation, and indoor air quality at three schools in London https://doi.org/10.1016/j.atmosenv.2022.119303	• Green screen at school boundary reduced outdoor particle levels by up to 44%. • Air purifiers in classroom reduced indoor particle concentrations by up to 57%. • School street reduced outdoor particle concentrations by up to 36%. • High occupancy levels significantly increased PM10 and CO2 in classrooms. • Effective ventilation is essential to flush out indoor air pollution.
6.	Sadrizadeh et al.	2022	Indoor air quality and health in schools: A critical review for developing the roadmap for the	. cognitive performance of pupils with resulting negative consequences for progressive learning whilst increasing short-term sick leave. Most of the

		future school environment https://doi.org/10.1016/j.jobe.2022.104908	published work relates to the performance of school work, with the measurements of CO2 concentrations being the proxy for classroom ventilation and air quality. Little data exists regarding the effects of specific pollutants, and such studies are much needed. The existing evidence suggests that keeping classroom CO2 levels below 900 ppm (absolute level) reduces the negative impact on learning, but even lower levels may be more conducive; however, data for lower CO2 levels are scarce. Children also prefer a cooler environment for effective learning. Exposure to various air pollutants in school buildings risks severe damage to pupils' health since they inhale a larger volume of air corresponding to their body weights than do adults. This is especially important as many studies reported higher pollutant concentrations in schools than in residential and commercial buildings. The VOC pollutants are among the leading indoor air pollutants causing severe health issues for children and adults. On the other hand, many schools have identified particulate matter pollution as a major source of indoor air pollution. In addition, *Penicillium*, *Cladosporium*, *Aspergillus*, and *Alternaria* were the most common fungi found in school indoor environments, and their prevalence varies depending on climate and location, whether rural or urban.

7.	Wu et al .	2024	Evaluation of ventilation and indoor air quality inside bedrooms of an elderly care centre https://doi.org/10.1016/j.enbuild.2024.114245	To sum up, stratum ventilation was found to be effective in enhancing ventilation and indoor air quality in the elderly's bedrooms in ECCs. This research can serve as a guide to systematically design ECCs ventilation systems. Furthermore, the efforts of environmental engineers, as well as the support of the government, society, ECC managers, and designers are required to promote the health and sustainable development of indoor environments for elderly people. For future research, it is suggested to consider using more realistic geometries of elderly people in modeling and incorporating unsteady dispersion of respiratory particles. Additionally, it is recommended to take mental health and sleep quality into account as influential factors.
8.	.Z. Alqarni et al.	2024	Viral infection transmission and indoor air quality: A systematic review https://doi.org/10.1016/j.scitotenv.2024.171308	In conclusion, this systematic review illuminates the complexities and challenges associated with respiratory infection transmission in indoor environments, particularly underscored by the unprecedented impact of the recent COVID-19 pandemic. The urgency of investigating and understanding the dynamics of viral transmission within indoor settings is evident, given the persistent threat posed by respiratory diseases. This study has delved into various methodologies related to respiratory viral infection transmission and the control of

				indoor air quality (IAQ) as a crucial mitigating factor, all while emphasizing the importance of sustainability in these efforts.
9.	J. Kim et al.	2024	Indoor air quality and its determinants in underground shopping malls in Korea https://doi.org/10.1016/j.envint.2023.108395	The IAQ of a total of 128 stores were examined. PM2.5 concentrations were found to be higher outdoors, while most aldehyde and VOC concentrations exhibited higher levels within passages or stores. It is noteworthy that despite the majority of stores having an open or semi-open layout, the indoor aldehyde and VOC concentrations surpassed those found in passages. Additionally, the indoor PM2.5 concentrations within food service stores exceeded those observed in other types of stores. Conversely, aldehyde and VOC concentrations in clothing and fashion accessory stores surpassed those in food service stores. These findings highlight the variations in IAQ based on area and store type, are influenced by distinct emission sources. The connection between the CO2 levels and the aldehyde and VOC concentrations suggests that optimizing the operation of HVAC systems in USMs while considering CO2 levels in stores may significantly enhance the overall IAQ. Furthermore, enhancing air circulation by designing future stores without the storefront walls and allowing stores to open into passages may further

				contribute to the improvement of the IAQ.
10	Z. Wang et al.	2024	Indoor air quality and sick-building syndrome at a metro station in Tianjin, China https://doi.org/10.1016/j.envint.2024.108673	The PM pollution conditions and IAQ satisfaction rates in winter and spring were measured at the Tianjinzhan station under the unorganized ventilation mode. The indoor temperature and humidity were lower in winter due to the ambient weather conditions but did not adversely affect thermal comfort. PM sources exist on the platform, resulting in an increase in the I/O ratio during the rush hour period when the train arrival frequency and number of passengers increase. The dilution effect of ventilation was greater in winter, even with higher ambient PM2.5 pollution. The coefficient of friction between railway wheels and rails increased with decreasing humidity, leading to higher metal wear loss and particle emission. The metro station staff members felt significantly dissatisfied with the IAQ in winter ($P < 0.05$), and more sick-building syndrome symptoms, including mucosal irritation, headache, exhaustion, and dizziness, were reported. Ba and Cr were the predominant noncarcinogenic and carcinogenic elements, respectively, at the metro station, and further research is needed. This study demonstrated the failure of unorganized ventilation in achieving PM control at metro stations. Therefore, additional air purification and organized ventilation are recommended to reduce the health risks of

				metallic-rich PM. To protect public health, PM1 and PM2.5 control and recommended limitations are urgently needed for metro stations.
11	G. Torriani et al.	2024	Perceived air quality (PAQ) assessment methods in office buildings: a systematic review towards an indoor smellscape approach https://doi.org/10.1016/j.buildenv.2024.111645	In conclusion, the paper advocates for a paradigm shift, moving beyond the approach of perceiving odour as a "nuisance" to recognizing it as a potential "resource," and for standardization to facilitate comparison across future studies. The paper introduces a possible definition of indoor smellscape as the smell environment perceived and understood by a person in an indoor context.
12	G. Rojas et al.	2024	A review of the indoor air quality in residential Passive House dwellings https://doi.org/10.1016/j.enbuild.2023.113883	The authors conclude that energy efficient homes with MVHR can provide healthy IAQ conditions in dwellings if proper design and implementation is ensured. The PH approach with its certification criteria and guidelines does seem to provide better IAQ performance compared to building practises without quality assurance measures. However, as pointed out in [83] this might not always be true for energy-efficient retrofitting, and needs further investigation. Further research is also needed to examine particulate matter exposure in PH's and energy efficient strategies to reduce PM exposure from cooking. As also concluded in [9], this review shows a lack of measurement data and/or standardised IAQ assessment methods. While many studies measure CO2 concentration over an extended

				period of time, there is a lack of comparable long-term measurements on actual indoor air pollutants, e.g. formaldehyde, PM2.5, ozone, etc. and how the PH approach performs in different climate zones. Unfortunately, the ventilation rate is often not reported, a crucial information for assessing ventilation system and indoor emission sources. An international project is currently addressing these short comings of non-standardized IAQ assessment for residential buildings [84]. On the engineering side, further research and developments are needed to overcome challenges and barriers such as resilient air flow control, spatial requirements and cost effectiveness in particular for refurbishment projects, to promote wider implementation in the process of building stock decarbonization.
13	E. Finell et al.	2024	Frames of agency in a school with poor indoor-air quality: A longitudinal composite narrative study https://doi.org/10.1016/j.healthplace.2024.103256	To conclude, this article demonstrates that a school with indoor-air problems affords various kinds of agency enactments – many of which radically contradict the ideals expressed in the official curriculum (cf. Finnish National Agency for Education, 2014). Adults including school staff, municipal representatives and other authorities should pay special attention to pupils' voices and foster their positive agency in such conditions. The material school environment has a strong impact on children and adolescents in many ways.

14.	R.E. van der Walt et al.	2024	Dataset of indoor air parameter measurements relating to indoor air quality and thermal comfort in South African primary school classrooms of various building infrastructure types https://doi.org/10.1016/j.dib.2024.110045	We mea- sure these parameters with 11-min intervals in 24 class-rooms at schools in Stellenbosch, South Africa. These class- rooms consist of a range of different infrastructure types. Container classrooms with and without insulation, mobile (prefabricated) classrooms, and brick classrooms of different configurations are included. Measurements are concurrently sampled over ten months (249 days, still ongoing) across multiple seasons with relevant metadata, including ambient weather conditions, school days and times, and electricity availability in the (South) African context, which impacts air conditioning usage. This dataset provides valuable insights into true learning conditions in South African classrooms.
15.	N. Mahyuddin and E.A. Essah	2024	Spatial distribution of CO2 Impact on the indoor air quality of classrooms within a University https://doi.org/10.1016/j.jobe.2024.109246	Ventilation effectiveness, CO2 concentration distribution, and temperature distribution in the classroom are closely related to the external flow field conditions, heat sources in the classroom and its layout. Knowledge of the spatial distribution of CO2 concentration was essential in determining the best sampling locations. The type of ventilation strategies used, affected the spatial distribution of mean CO2 concentrations. This study showed that; the use of only one sensor to monitor CO2 concentrations in a room may lead to inaccurate estimations of the average CO2 levels.

				Understanding the effect of air movement in a room is very significant when choosing the sampling locations. The overall findings would also be of immense benefit to designers and building authority in enhancing classroom design guidelines for school buildings in the tropics.
16.	V. Festa et al.	2024	Incidence of circular refurbishment measures on indoor air quality and comfort conditions in two real buildings: Experimental and numerical analysis https://doi.org/10.1016/j.enbenv.2024.03.005	In addition, a numerical model developed in Building Energy Simulation program is calibrated and a Computational Fluid Dynamics is developed. From the in-field measurements emerges that, on one hand, the refurbishment of heat- ing system shows a great improvement of indoor thermal conditions, with Total Volatile Organic Compounds concentration that sometimes exceed 3.0 mg/m3 ; on the other hand an integrated thermal insulation reduces infiltrations and changes the envelope behaviour, with a global energy saving of 30 % during winter and autumn periods. Another result of the study shows that a numerical model developed in Building Energy Simulation program and calibrated on energy consumption can greatly fit the local thermal comfort distribution of the occupant zone and predict the indoor air quality, if it outputs are used as input data in a Computational Fluid Dynamics study. These results can be beneficial to decision makers and designers for evaluating emitters positioning, opening design and mechanical

				ventilation strategies, aimed at reducing energy costs.
17.	A.A. Mansor et al.	2024	Indoor air quality and sick building syndrome symptoms in administrative office at public university https://doi.org/10.1016/j.dialog.2024.100178	The results showed that, relative humidity and temperature was played an important role in give comfortable towards the occupants inside the building. Temperature, air movement and relative humidity levels in the administrative office were not within the acceptable limit set by the Malaysian Standard [70]. Additionally, 82.1% of people reported having Sick Building Syndrome (SBS) symptoms. The workers were overwhelmingly affected by fatigue, feeling foggy-headed, and headaches (84.2%, 73.7%, and 63.1%, respectively). This indicated that workers were at risk of suffering SBS related to poor IAQ. Relative Humidity (RH) level had a significant association with drowsiness and dizziness while PM10 level had a positive association with feeling heavy headed, and irritation of the eye. Temperature has significant with headache, feeling heavy headed, skin rash and itchiness which reduced productivity of the occupants inside the study area.
18.	H. Xu et al.	2024	The disease burden related to time-weighted PM2.5 exposure in China and the potential health benefits of the national standards for indoor air quality: A modeling study	Overall, this study established three scenarios based on the standard GB/T 18,883–2022, and estimated that even if daily average indoor PM2.5 concentrations were less than 50 μg/m3 across China, the TWPM-related health and economic burden were still significant. Furthermore, in contrast to merely improving indoor air quality, enhancing both indoor

	https://doi.org/10.1016/j.horiz.2023.100078	and outdoor air quality could bring about more significant health and economic benefits. As a result, the government should impose tougher guidelines on indoor PM2.5 exposure while also enhancing efforts for outdoor- and indoor-PM2.5 coordinated control strategies to continually cut down the air pollution and its health and economic burden and realize the sustainable development goals.

Analyzing the collection of studies provided offers a comprehensive view of the current state of indoor air quality (IAQ) research and its implications for various settings, from office spaces to schools and metro stations. Here's a discussion based on the data:

Importance of IAQ Monitoring: The studies underscore the importance of monitoring IAQ in various indoor environments, highlighting the potential health risks associated with poor air quality. From office spaces to schools and metro stations, maintaining adequate IAQ is crucial for the health and well-being of occupants.

Impact of Ventilation Systems: Several studies emphasize the role of ventilation systems in mitigating indoor air pollution. Strategies such as green screens, air purifiers, and organized ventilation are shown to be effective in reducing indoor particle concentrations and improving IAQ. This highlights the need for innovative ventilation solutions to address indoor air pollution effectively.

Influence of Environmental Parameters: Environmental parameters like temperature, humidity, and airflow are shown to have a significant influence on IAQ and occupant comfort. Optimal control of these parameters through effective ventilation and HVAC systems is essential for maintaining a healthy indoor environment.

Role of Building Design: Building design plays a crucial role in determining IAQ. Studies show that factors like indoor plants, layout design, and building infrastructure impact indoor air quality and occupant perceptions. Designing buildings with proper ventilation systems, green spaces, and suitable materials can contribute to better IAQ and occupant well-being.

Health Implications: Poor IAQ is linked to various health issues, including respiratory infections, sick building syndrome (SBS), and cognitive impairment. High levels of pollutants such as PM2.5, VOCs, and CO2 can adversely affect occupants' health and productivity, underscoring the importance of IAQ management in indoor environments.

Need for Standardization and Guidelines: Many studies highlight the lack of standardized IAQ assessment methods and guidelines, making it challenging to compare findings across different studies. Standardization in IAQ assessment methods and guidelines can facilitate better understanding and management of indoor air pollution.

Future Research Directions: The studies suggest several avenues for future research, including long-term monitoring of IAQ, development of innovative ventilation technologies, and assessment of the health impacts of indoor air pollution. Addressing these research gaps can provide valuable insights for improving IAQ management practices in indoor environments.

4. Conclusion

In conclusion, the findings from these studies underscore the importance of maintaining good IAQ for occupant health and well-being. Effective ventilation strategies, building design considerations, and standardized IAQ assessment methods are essential for ensuring a healthy indoor environment across various settings. Further research and innovation in IAQ management are needed to address current challenges and improve indoor air quality standards globally.

Despite efforts to encompass a wide range of literature, this review may not capture every relevant study in the field of IAQ. The scope was limited to recent publications up to a certain date, potentially excluding older yet still relevant research. Additionally, the review may be subject to publication bias, as studies with significant findings may be more likely to be published. Furthermore, the heterogeneity of study designs, methodologies, and indoor environments across included studies may pose challenges in synthesizing and generalizing findings. Finally, while efforts were made to ensure rigor and comprehensiveness, the interpretation of findings is subject to the inherent limitations of the included studies.

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