Creating Healthy Workspace: Addressing Sick Building Syndrome in Office Building

Shruti Yadav[1] , Prof. Ar. Sachin Paliwal[2]

School of Architecture, IPS Academy Indore-452012, Madhya Pradesh, India

E-mail – shruti.p.yadav2020@gmail.com

ABSTRACT

This paper emphasizes the critical importance of prioritizing health and well-being in human-centered building design, highlighting their direct relationship to productivity. Primarily through exploring the Sick Building Syndrome (SBS) phenomenon in office buildings. SBS comprises multiple elements that may damage the physical health and emotional balance through the understanding of the integral nature of the biological systems of the human body. This study gives an example of an indoor air quality, and it points out a healthy building design as a need in the future of intelligent, smart, and sustainable building concepts. The exposure of occupants to unhealthy indoor conditions indeed to the level of risk of illness of occupants directly affects their overall well-being as well as their performance in work. The article offers a thorough description of SBS consequences that present themselves in numerous ways, and it suggests some less harmful treatments. It emphasises the need to design spaces, in which the health and satisfaction of the residents is given the first priority, and recognizes how the design of spaces significantly influences the individual health and productivity. By adopting a comprehensive literature review, as well as case studies, and other analytical methods, this paper aims to unravel the causes, effects and solutions of SBS through an in-depth study of SBS in office settings. The objective of the study is to provide valuable insights into SBS, proposing strategies for improving the workplace environment. The work will contribute to the development of knowledge about the design of the building and the health of workers.

Keywords – sick building syndrome, symptoms, indoor air quality, productivity, ventilation, technologies.

INTRODUCTION

Sick Building Syndrome (SBS) is a syndrome that occurs when people spend time indoors, typically in office buildings, and develop a lot of serious health or discomfort symptoms. SBS symptoms are wide and can impact the skin, respiratory, and neurological systems. They include headaches, dizziness, nausea, and eye, nose, or throat irritation. These symptoms, while nonspecific, can cause pain and hinder work efficiency, resulting in higher absenteeism among affected persons. The wide range of symptoms associated with SBS highlights the condition's complexity and the necessity for extensive preventive actions to mitigate its impact on building occupants.

SBS is interconnected to poor indoor air quality (IAQ), which can be caused by factors such as inadequate ventilation, dust, smoke, fumes, or fabric fibers in the air, bright or flickering lights, and cleaning and designing issues. The exact cause of SBS is uncertain, but it has been linked to a variety of indoor factors. According to research, the presence of VOCs, poor ventilation, and mould growth all play important roles in the development and worsening of SBS symptoms.

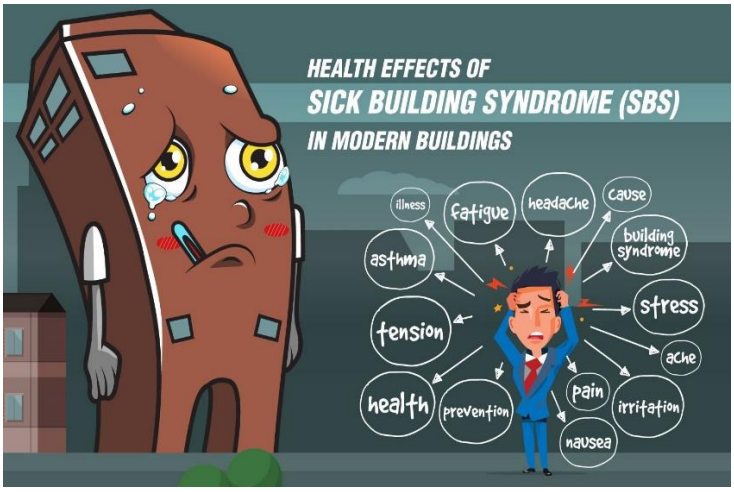


Fig 1:"Design Guidelines for Healthy Workspaces:

A Study from J Art Arch Stud, 2019"

Fig 2: Image from rare Group

These elements can contribute to an indoor environment conducive to health difficulties, influencing occupant comfort and well-being. Poor indoor air quality (IAQ) can cause lung disorders such as asthma and is found in approximately 30% of new and refurbished buildings. SBS symptoms can be reduced by improving ventilation, maintaining a consistent temperature, reducing stress, and taking frequent screen breaks.

Studies have found that a combination of environmental sensitivity and stress can significantly contribute to SBS. Workplace stresses such as workload, dispute, overcrowded workplaces, and low job satisfaction are significantly connected with a variety of SBS symptoms. Besides this, poor social interactions and communication at work are frequently connected to SBS. The interior ambience in office buildings can boost stress-related problems and contribute to the development and appearance of SBS symptoms, affecting the health and well-being of those who work in them.

As a result, addressing the indoor environment in office buildings is critical for preventing workplace illnesses. The goals of this research article are to identify the elements that contribute to SBS and stress-related diseases in office buildings, assess the impact of IAQ on SBS, and provide ways for creating a healthy workspace that addresses SBS.

HISTORY

Sick Building Syndrome has been recognized since the mid-20th century, notably in the 1970s when incidents like the Legionnaires Disease outbreak drew attention to poor indoor air quality. Subsequent studies characterized SBS symptoms and risk factors, leading to increased awareness and efforts to address the issue, which remains a significant concern globally.

CAUSES AND CONTRIBUTING FACTORS

- Poor indoor air quality is a significant cause of Sick Building Syndrome (SBS), which can occur from building design flaws. This involves a lack of fresh air circulation, the accumulation of pollutants, and exposure to toxic chemicals. Mould, dust, materials like volatile organic compounds (VOCs) released by office equipment or cleaning products, and off-gassing from new furniture or carpets are some of the most common indoor air pollutants that cause SBS.

- Inadequate ventilation systems worsen the problem by trapping indoor pollutants and allowing them to accumulate at higher levels. Insufficient airflow can also cause humidity issues, promoting mold growth and creating a breeding ground for germs and other hazardous microbes. Proper ventilation is necessary for maintaining an healthy indoor environment and minimising the risk of SBS symptoms.

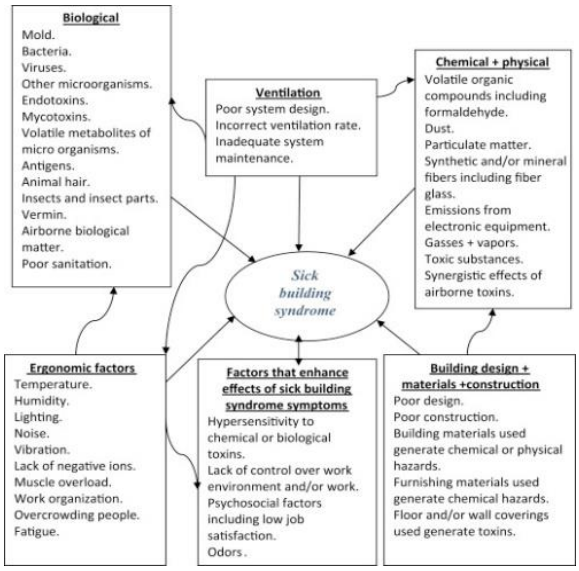


Fig 3: Causes of sick building syndrome, from sciencedirect

Fig 4: Image from ILO Encyclopaedia: Sick Building Syndrome

- Chemical and biological pollutants also contribute to SBS. Chemicals present in construction materials, cleaning agents, and personal care products produce volatile chemicals, which degrade indoor air quality. Biological pollutants such as mold spores, bacteria, and viruses grow in poorly kept buildings, worsening respiratory problems and other SBS symptoms.
- Psychological factors, like high stress levels and insufficient communication, may make the symptoms of Sick Building Syndrome (SBS) more severe. Besides, other environmental factors like ergonomics, acoustics, lighting, and humidity are also very vital in affecting occupant comfort and health. If these factors are not optimal, they will create stress and health issues among occupants of buildings.

STRATERGIES FOR HEALTHY WORKSPACE

Proper ventilation is essential for achieving Indoor Air Quality (IAQ) standards and decreasing the risk of Sick Building Syndrome (SBS) in office buildings. Indoor air could be polluted 2-3 times more than outdoor air, and this only confirms the need for efficient ventilation systems, according to the Environmental Protection Agency (EPA). Mechanical ventilation systems have a primary role in ensuring the exchange of indoor and outdoor air, thereby eliminating contaminants and maintaining air quality. The buildings with advanced ventilation systems that are well-designed and properly maintained have cleaner air inside, thus ensuring the occupants stay healthy and have greater productivity. The ASHRAE recommends a minimum of 8.4 air exchanges per 24 h.The research revealed that the buildings with improved ventilation systems had reduced levels of airborne contaminants and fewer complaints of sick building syndrome among the occupants. On the other hand, in terms of high-efficiency air

filters, HEPA filters have been found to be very effective for capturing airborne pollutants, including dust and allergens, which in turn improves IAQ and reduces the perceived SBS symptoms.

Aspect	Guidelines/Recommendations	Solutions if not met	Organizations
Lighting (Lux)	300-500 lux for general office tasks	Install additional lighting	Illuminating Engineering Society
Ventilation (ACH)	8-12 air changes per hour (ACH)	Increase ventilation rates	American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)
Temperature (°C)	20-24°C	Adjust HVAC settings	Occupational Safety and Health Administration (OSHA)
Humidity (%)	30-60%	Use dehumidifiers or humidifiers	World Health Organization (WHO)
Noise Level (dBA)	< 45 dBA for general office settings	Install noise-reducing materials	American Conference of Governmental Industrial Hygienists (ACGIH)
Indoor Air Quality	CO2 levels below 1000 ppm	Increase ventilation or air filtration systems	Environmental Protection Agency (EPA)

Use of low-emission building materials is an essential tactic in creating a healthful workplace and fighting Sick Building Syndrome (SBS) in office buildings. Such materials provide good IAQ by reducing the emission of toxic chemicals and VOCs. Research has demonstrated that the use of low-emission materials like low-VOC paints and formaldehyde-free furniture could drastically reduce indoor pollutant concentration. This thereby improves the occupants health and their well-being. Furthermore, following to green building standards such as LEED (Leadership in Energy and Environmental Design) encourages sustainable and healthy building methods. Recommendations include using low-emission materials in building and renovation projects to promote a healthier interior environment for employees.

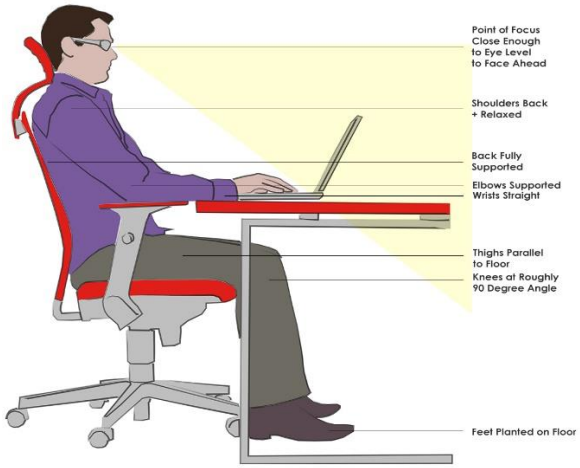


Fig 5: Ergonomic chair

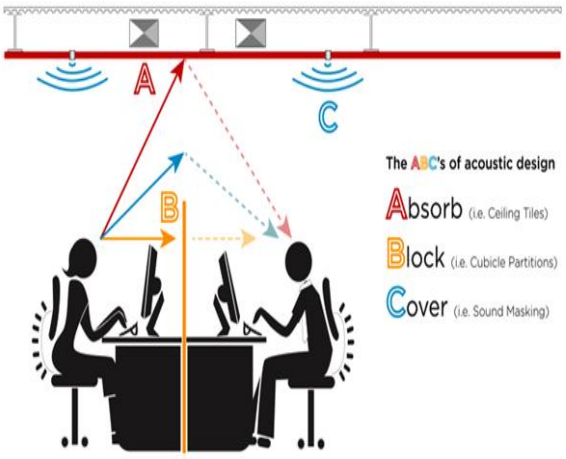
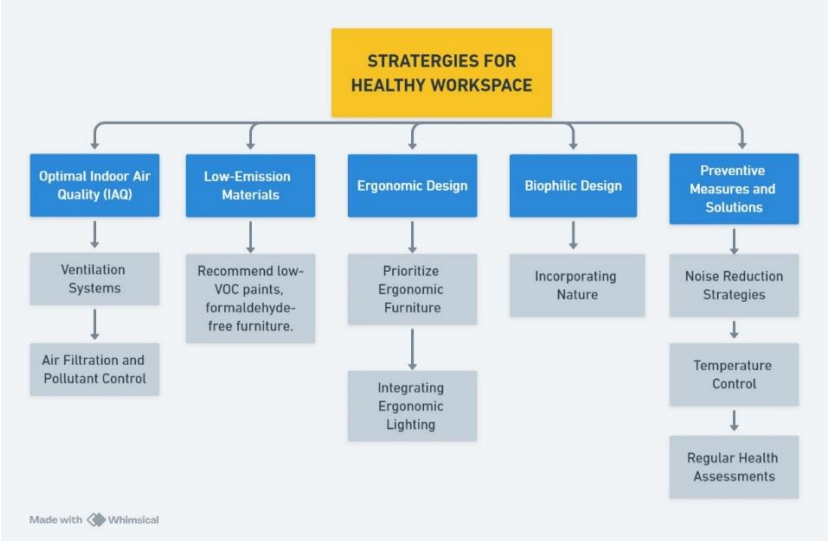


Fig 6: The ABCs of office acoustics from eSiergo

Ergonomic design is essential for enhancing the well being and productivity of employees in dealing with Sick Building Syndrome (SBS) in office settings. Studies consistently show that ergonomic factors play a role in reducing strain, fatigue and musculoskeletal issues among office staff. A research study revealed that employees who used ergonomic chairs reported lower discomfort levels and higher productivity compared to those using non ergonomic seating. It is recommended to have standing desks to promote better posture and reduce sedentary habits along with ergonomic chairs that provide lumbar support. Implementing task lighting and sit-stand workstations in offices is crucial for fostering employee wellness and productivity. Task lighting helps reduce eye strain and improve comfort while sit-stand workstations encourage movement and counteract the negative effects of prolonged sitting. Moreover establishing designated smoking zones with ventilation can help minimize the impact of secondhand smoke, on non smoking employees and maintain the indoor air quality standards. Inclusion of ergonomic lighting design is also important, with standards stating about 500 lux for general office tasks to improve the mood and productivity and enhance the overall well-being. The focus on natural light and proper lighting conditions by reducing the risk of SBS symptoms can be made possible through an environment that is healthier and vibrant.

Incorporating biophilic design principles in office spaces is crucial for creating a healthy work environment and addressing Sick Building Syndrome (SBS). Research shows that including elements such, as plants, sunlight and organic materials significantly enhances the well being and productivity of employees. Research shows that being exposed to greenery boosts cognitive performance, and having plants in offices make people more alert and enhances their memory. Besides, people's circadian rhythms are improved by daylight which in turn provides workers with better sleep quality and higher alertness. Furthermore, the views of nature, whether through windows or indoor green spaces, leads to reduction of mental fatigue and relaxation. It is even the passive exposure to nature views that can help to alleviate stress and elevate the mood.

To fight against Sick Building Syndrome (SBS) and develop a healthy work environment, proactive measures are crucial. First, reducing excessive noise level is vital, and recommended levels of 40-45 dB are good for comfort and productivity of workers. Acoustic panels, sound-absorbing materials and quiet zones improvement reduces noise pollution effectively. Also, the temperatures should be kept within the range of 20-24°C (68-75°F) so as to prevent discomfort and boost productivity. Providing individual temperature controls and routine HVAC maintenance helps to control the heating and cooling. Conducting health assessments regularly is of the utmost importance for early detection of the indoor environment related health issues like respiratory disease, thus assuring employee health and productivity.



EMERGING TECHNOLOGIES FOR SBS MITIGATION

1)Indoor Air Quality Monitoring Systems

- Real-time Monitoring: Incorporate modern sensors to constantly track indoor air quality parameters like VOCs, CO2, humidity, and particle matter.
  Provide real-time data to enable fast corrective measures.
- Smart Ventilation Control: Include the ventilation systems with AI algorithms, which automatically alter ventilation rates depending on occupancy, outdoor pollutant levels, and air quality. Ensuring an optimal air exchange between fresh and stale air, while at the same time conserving energy.

2)Air Purification Technologies

- High-Efficiency Particulate Air (HEPA) Filters: Effectively filtrate airborne particles, allergens, and microscopic dust and thus improve indoor air quality. Maintain filter effectiveness by changing the filter elements on a regular basis.
- Ultraviolet Germicidal Irradiation (UVGI): UVGI equipment that are fit into HVAC ducts can disinfect recirculated air by infusing it with the UV-C rays. These systems focus on destroying airborne pathogens consisting of bacteria, viruses, and mold spores, leading to a cleaner indoor air. As it reduces the risk of airborne diseases transmission, this way helps create a healthier and safer environment.

3) Smart Lighting Systems

- Circadian Lighting: Use dynamic lighting systems that mimic natural daylight patterns to boost alertness, mood and overall mental state. Tunable white LED lights can be adjusted with color temperature throughout the day.
- Occupancy Sensors: Automatically adjust lighting to occupancy, saving up to 80% energy in unoccupied areas.

4) Building Automation and IoT Integration

- Integrated Building Management Systems (BMS):
  Centralize control of HVAC, lighting, security and other building system to optimize energy usage and comfort. Use data analytics to find chances for improvement and send alerts for maintenance problems.
- Occupancy Analytics: Gather spatial occupancy patterns through IoT-based sensors to adjust heating, ventilation, air conditioning, and lighting to match actual data at the moment. Lower energy consumption in unattended areas of buildings through calibration of devices to match actual needs.

CASE STUDY

This case study, explores the relationship between Indoor Air Quality (IAQ) and working performance in an office building at University Tun Hussein Onn Malaysia.

The office building shows signs of being a sick building syndrome (SBS) environment.

Table 2: Demographic of Office Workers

Parameter	**Total**	**Percentage**
Gender		
Male	7	35%
Female	13	65%
Academic Qualification		
Diploma	12	60%
Bachelor's Degree	8	40%
Job Category		
Clerical	15	75%
Managerial	5	25%

Table 3: Likelihood of SBS Symptoms in the Office Building

SBS Symptom	**No. of Occupants**	**Percentage**
Dry Eyes	3	15%
Blocked Nose	5	25%
Sore Throat	8	40%
Headache	11	55%
Lethargy	17	85%
... (and so on)	...	...

Table 3 represents the likelihood of experiencing Sick Building Syndrome (SBS) symptoms among office occupants. Out of the 17 types of symptoms listed, only 4 were experienced by less than 20% of occupants, while

the remaining 13 were experienced by 20% or more. This indicates the presence of SBS symptoms in the office building.

Hansen (1991) suggested that a building could be classified as a sick building if at least 20% of its occupants experience SBS symptoms, which subsequently disappear after leaving the building.

Table 4: Justification of SBS Symptoms that Disappeared After Leaving the Office

SBS Symptom	No. of Occupants	Percentage
Sore Throat	5	25%
Headache	7	35%
Lethargy	15	75%
Running Nose	4	20%
Flu Symptoms	8	40%
... (and so on)	...	...

Table 4 illustrates the SBS symptoms that disappeared after occupants left the office building. The data shows that 10 out of 17 symptoms ceased to be experienced by occupants after leaving the building. Lethargy was the most prevalent symptom, with 75% of occupants no longer experiencing it after leaving. All 10 symptoms that disappeared were reported by 20% or more of the occupants. This suggests that the office building may be classified as a sick building, as a significant portion of SBS symptoms ceased upon leaving.

Table 5: Correlation of IAQ with Working Performance

IAQ Parameter	Correlation (ρ)	Most Correlated Work Performance
Temperature	0.081 - 0.648	Working Ability
Humidity	-0.062 - 0.299	Working Motivation
Air Velocity	-0.026 - 0.27	Working Timeliness

The correlation between indoor air quality (IAQ) factors and working performance was assessed using a Likert scale in a questionnaire survey. The correlation values between temperature, humidity, and air velocity with various aspects of working performance are presented in Table 5.

Table 5 shows that temperature has the greatest influence on working performance, with correlation values ranging from 0.081 to 0.648. A higher temperature correlates strongly with decreased working ability but has no significant correlation with working quantity.

Humidity also influences working performance, with correlation values ranging from -0.062 to 0.299. Higher humidity weakly correlates with decreased working motivation but has no correlation with working timeliness.

Air velocity has a weaker influence on working performance compared to temperature and humidity, with correlation values ranging from -0.026 to 0.27. Higher air velocity weakly correlates with improved working timeliness but has no correlation with working motivation or quality.

In conclusion, the study suggests that IAQ, particularly temperature and air velocity, significantly impacts working performance in office buildings. Dissatisfaction with IAQ, mainly due to temperature and air velocity issues, may affect the productivity of office workers. However, further research and guidelines are needed to address these issues effectively.

CONCLUSION

This research paper highlights the importance of prioritizing health and well-being in office building design to reduce Sick Building Syndrome (SBS) and improve productivity. SBS, which causes various health issues, is caused by poor indoor air quality (IAQ), insufficient ventilation, and workplace stressors. To create a healthy workspace, it is important to: Optimize ventilation systems. Use low-emission building materials, incorporate ergonomic design principles, include elements of nature in the design (biophilic design) and incorporate new technologies like Indoor Air Quality Monitoring Systems, Air Purification Technologies, Smart Lighting Systems, and Building Automation can also help in reducing SBS and creating a healthier indoor environment.A case study showing the connection between IAQ and work performance emphasizes the need to address IAQ factors such as temperature and air flow to enhance productivity. In addition, it is crucial to:

- Conduct regular health assessments
- Implement strict no-smoking policies
- Follow guidelines from government agencies like the Environmental Protection Agency (EPA) and industry organizations such as the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)

By taking a comprehensive approach that combines architectural design, technology, and proactive measures, companies can effectively tackle SBS and promote a workspace that supports employee well-being and productivity. This research provides valuable insights and recommendations for creating healthier office spaces, contributing to the conversation on building design centered around human needs and workplace wellness.

REFERENCES

1. Morrison, g., & nakano, j. (1996). study on sick building syndrome in an office environment. https://www.researchgate.net/publication/324496960_study_on_sick_building_syndrome_in_office_environment
2. Mahbob, n.s., kamaruzzaman, s.n., salleh, n., & sulaiman, r. (2011). a correlation studies of indoor environmental quality (ieq) towards productive workplace. https://www.academia.edu/61086141/a_correlation_studies_of_indoor_environmental_quality_ieq_towards_productive_workplace
3. Correlation of indoor air quality with working performance in office building. journal of arts and architectural studies, retrieved from journal of arts and architectural studies https://jaas.science-line.com/attachments/article/33/j%20art%20arch%20stud.%208(2)%2030-36,%202019.pdf

4. Marmot, a. f., eley, j., stafford, m., stansfeld, s. a., warwick, e., & marmot, m. g. (2006, april). building health: an epidemiological study of "sick building syndrome" in the whitehall ii study. retrieved from ncbi.
5. https://www.ncbi.nlm.nih.gov/pmc/articles/pmc2078095/
6. Norbäck, d., & torgen, m. (1996). sick building syndrome: an emerging stress-related disorder. retrieved from https://www.researchgate.net/publication/8907032_sick_building_syndrome
7. Sekhar, s. c., & raja, m. (2023). sick building syndrome: a literature review of indoor air quality and its effects on health in office building design environment. retrieved from https://www.researchgate.net/publication/370061202_a_literature_review_of_indoor_air_quality_and_sick_building_syndrome_in_office_building_design_environment
8. Aivc. (2005). indoor environmental quality and sick building syndrome: a review of related literatures. retrieved from https://www.aivc.org/sites/default/files/airbase_4213.pdf
9. Beder, a., buyukkoz, b., & arici, k. (2024). work performance, productivity, and indoor air quality. retrieved from https://www.academia.edu/70584433/work_performance_productivity_and_indoor_air?rhid=27110063387&swp=rr-rw-wc-45658171&nav_from=a2b87dd6-1eb5-4ca5-a651-399fd675e837&rw_pos=20
10. Rahman, z. (2020). the relationships of temperature and humidity in airconditioned room to the occurrences of sick building syndrome. *journal of forensic medicine*