

# CRITICAL INDOOR AIR QUALITY ANALYSIS WITH REFERENCE TO DIFFERENT GREEN BUILDING RATING SYSTEMS

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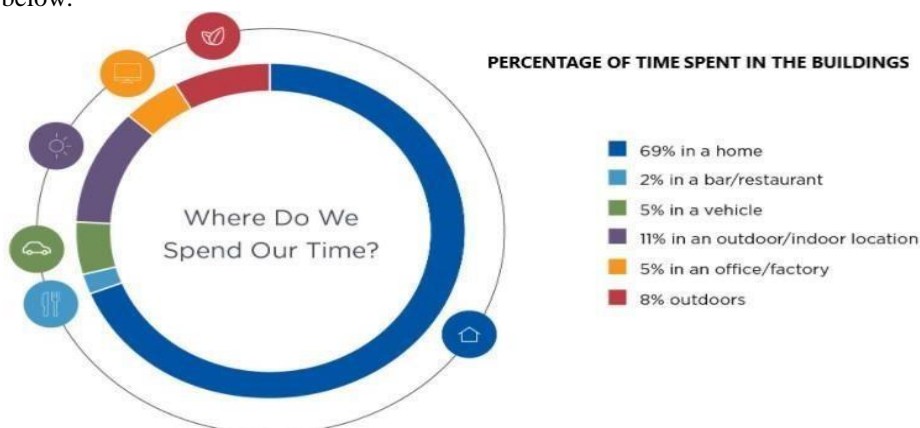
**Abstract:** In today's world, energy consumption by building is more on a larger scale. Buildings designed with poor ventilation systems, inadequate lighting, and dampness, mould, can ultimately lead to different building sick disorders like sick building syndrome and building-related illness. For better IAQ inside residential or commercial buildings, building certification plays an important role not only in maintaining the health of an occupant but also increasing the life span of a building by maintaining the building's health. The major indoor Air pollutant is TVOC, as it can be emitted from all daily use products and can really cause severe health problems. Most of the building certification systems provide a maximum permissible concentration for TVOCs to have a better and healthy indoor environment for the building occupants.

**Keywords-** TVOCs, IAQ, dampness, mould, indoor air pollutant, building sick disorders

**INTRODUCTION;** Different types of building sick disorders like SBS and BRI have been discussed and their long-term impact. There is also a brief description of different types of building certification systems like LEED, FITWEL, WELL, and DGNB. Comparison between different building certification systems has been done for having the best possible rating system for the building and the building occupants. One of the major indoor air pollutants is the TVOC. TVOC concentration results were analyzed for about 32 retail stores in the USA and 31 of them exceeded the maximum LEED recommendation. It was found to be more than 500 ppb and an idea was retrieved that usually hardware stores have high TVOC concentrations as compared to residential buildings. We also come to know about different levels of TVOC during the morning, afternoon, and night. Considering FITWEL building rating system is the best possible building rating system as it gives much preference to both occupant health as well as the health of a building.

## METHODOLOGY

According to the EPA, we spent 90% time indoors in buildings including homes, and workplaces as well. Our main concern is always to have better indoor air quality. If there is poor air quality it can ultimately lead to many health disorders in building occupants like lack of concentration, reduced memory, etc. The impact of indoor air quality inside the building is a serious concern. The building-associated illness is usually an illness that is caused by indoor environmental factors. These are divided into two categories sick building syndrome and building-related illness. There is one more Building disorder which is a multiple sensitivity illness but there is a universal definition present for it and not so common. There are also some major indoor air pollutants that also have negative influences on human health and the environment. Use of toxic building materials, exchange of polluted outdoor air through the HVAC system, use of pesticides, poor ventilation system, air tightness inside the buildings, and major problems of dampness, moulds, and fungi can all lead to health disorders in building occupants. The total time spent by the occupant in buildings is given in the figure below.



**Figure 1 Shows percentage of time spent in different residential and commercial buildings**

All the major indoor pollutants are harmful to occupants' health and are also one of the causes of indoor air pollution. Decreased IAQ can negatively affect human health by causing various building-associated illnesses. Let us have a detailed analysis of SBS and BRI.

### 3.1 Sick Building Syndrome

The effect of symptoms on the health of an individual that is related to individuals staying in a building and having a downgraded internal environment quality is known as the sick building syndrome or the sick house syndrome. It is completely different from that of contagious diseases or poisoning caused by concrete causes like illness due to legionnaires and poisoning by carbon monoxide. Acute health and comfort effects of SBS will appear when patients usually spend a certain amount of time inside the buildings. The effects are either localized in specified areas or widespread throughout the building.

The sick building syndrome is divided into four main categories

1. Mucous Membrane irritation: it includes eyes, nose, skin, and throat irritation
2. Neurotoxic: Involving Headaches, mental fatigue, reduced memory, nausea, tiredness, dizziness, lethargy, and irritability.
3. Asthma and allergy-like symptoms: it involves chest tightness and wheezing.
4. Skin dryness and irritation: Including gastrointestinal complaints and others.

### 3.2 Possible Triggers for Sick Building Syndrome

The causes of SBS can be categorized into two main chemical and biological factors. Some of the common chemical causes of SBS are

1. Poor ventilation system
2. Lack of air circulation that is air tightness inside buildings.
3. Airborne chemical pollution
4. Organic matters from the air conditioning system
5. Increase in Temperature

The Biological causes of SBS are;

1. Pollen from trees and plants is transferred in the building in a multiple numbers of ways e.g., shoes, dead insects, particularly cockroaches, etc.
2. Black mould originating from excessive humidity
3. Acraea which is usually present in rejected human cells and is found in carpets in furniture covers and in beds.
4. Bacteria, fungi, and other Microorganisms, that are harmful to human health which gets accumulated in buildings under suitable conditions for their growth in water pipes and in air conditioners

### 3.3 Prevention of Sick Building Syndrome

There is no specific treatment for Sick building syndrome as it is sometimes nondetectable and lasts in occupants only for a specified period or duration the occupant stays in the building, but we can take some preventive measures like avoiding SBS on a large scale. We can provide a better ventilation system including the HVAC system, avoid air tightness in the building, and also prevent high humidity rates inside the building, using less toxic building materials. Certain research also suggests having a certain IAQ action plan, which can also avoid SBS. Since Sick Building syndrome is not a major health problem to deal with but if its exposure remained for a longer time, it could cause severe health problems in a long run to human health. Designing a better building in a green and sustainable manner can also reduce the effects of sick building syndrome.

### 3.4 Building-Related illness

BRI is an illness and symptom whose causative agent is directly related to the poor air quality inside buildings. It can be caused by some chemical agents like formaldehyde, xylene, pesticides, and benzene. Biological agents are more widespread and can include humidification systems, filters, drain passes, cooling towers, wet surfaces, and water-damaged buildings. Some of the common BRIs are Rhinitis, allergic/nonallergic, Asthma, Hypersensitivity pneumonitis, legionellosis and humidified fever. It can also occur through four main major mechanisms like immunologic, infections, toxic, and irritant.

### 3.5 Triggers for Building-Related Illness

The various environmental factors responsible for Building related illnesses are given by

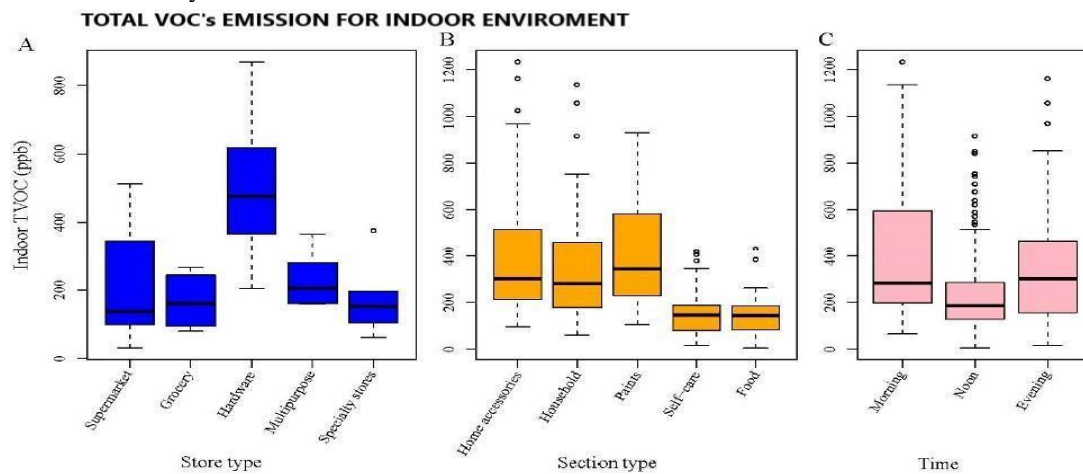
1. Physical environmental factors: these can include temperature, humidity, lighting, air movement, and dust concentration.
2. Chemical factors: These include various pollutants released from human activities and products such as carpets, paints, new furniture, smoking, cosmetics, asbestos, drapes, and insecticides.
3. Biological factors: these can include microorganisms.

### 3.6 Analysis of all building rating systems for IAQ

After having a general analysis of different building rating systems, FITWELL and WELL building rating systems are more concerned about occupants' health and hygiene. Since LEED and DGNB rating systems have also some advantages, but they are mainly concerned with the health of a building rather than the occupant. The health of a building is also an important parameter, if we have a poor building with a poor rating system, it can ultimately lead to different building disorders. All building rating systems have one common agenda to make a smoke-free building. Though still in LEED certification, we have the flexibility of having a smoke free area at least 7 feet or 25 meters away from the main building. Since FITWELL building rating system is not only concerned about the health of occupants but also concerns about the health of a building. The WELL rating system does not lay much emphasis on the health of a building, it is only concerned about the health of an occupant as it is the advanced building rating system. IAQ assessment is much better analyzed in the FITWELL building rating system and any building can achieve the best possible rating not only in terms of building health but also in terms of occupant's health and hygiene.

#### 4. Results

Among these IAQ pollutants, VOCs are the main indoor pollutant as they emit from numerous products and activities like detergents, paints, solvents, tools, clothes, toys, cleaning, and cooking. VOCs are the hydrocarbons that exist as gaseous or vapours at room temperature. The Analysis of total VOC content in USA was found as:



**Figure 2 shows the maximum TVOC concentration in various types of retail stores in USA**

#### 5. Discussion

For the store type, TVOC concentration was found to be 141, 152, 536, 235, and 151 ppb in supermarkets, grocery, hardware, multipurpose, and special stores. Hardware stores have significantly higher TVOC concentrations than other stores, and other types of stores had similar TVOC concentrations. The figure also shows that TVOC concentrations were lowest in the afternoons. The higher concentrations in the mornings and evenings might have resulted from lower ventilation during non-business hours at night for energy-saving purposes. As per the LEED or DGNB rating system, the TVOC's emission should not be more than 500 ppb but for a hardware store, it is almost 868 ppb. Thereby failing in achieving any building certification system. Hence by this, we can also note, how much the building certification system is important mainly for IAQ assessment to provide better comfort to a Building occupant and prevent all types of SBS and BRI diseases.

#### 6. Conclusion

From this research, we came to know about the negative influences of buildings on occupants' health. Different types of sick building syndrome and building-related illnesses were brought to light. The importance of IAQ assessment for different building rating systems. Analyzing different building certification systems based on IAQ parameters. We also came to know about which building certification system is more concerned about occupant's health and the health of the building as well. Different types of major indoor air pollutants were also analyzed as their impact on human health. Certain test results were seen on one of the major indoor air pollutants TVOC emission concentrations in retail stores or a warehouse. We also came to know that TVOC's concentration is found to be more in retail stores, and shopping malls than in residential or commercial buildings. Therefore, building hygiene is also one of the important and major tools for building occupant health. Among the different building rating systems, FITWEL was found to be better which can give the best possible rating for having a better indoor air quality and environment for the occupants. It can be helpful in providing better thermal comfort as it considers all harmful pollutants which can damage human health and life in the longer term. The building rating system not only takes care of the occupant's health but also the health of a building.

Hence in this paper, a better idea of indoor air quality was assessed, and its importance in different rating systems. Major indoor air pollutants and their sources of emission were also analyzed. Indoor air quality is an important tool for any building whether it is commercial or residential. If the building has no better indoor air quality management, it can ultimately lead to different building disorders, health issues, and even sometimes more severe closer to death. Therefore, before designing the building we should always consider any possible building rating system especially for IAQ to protect the health of building occupants, and at least try to achieve a baseline criterion, to have a better and healthy indoor environment for the occupants living in a building.

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