

Causes and remedies of sick building syndrome: a systematic review

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Abstract. Sick Building Syndrome (SBS), a situation where building occupants of specific buildings feels unwell whenever they are in that building, but gets relieved when they exit the building. The effects of SBS is now of great concern to home owners and stakeholders in the building industry, even though some faction still believes that there is nothing like SBS since there is no clinical proof yet for the phenomenon, but still there is need for efficient means and strategies that can be employed to make our building right “well” and eliminate those factors that makes a building sick. To this effect, this study aims to investigate the phenomenon known as Sick Building Syndrome (SBS), identify the causal factors, symptoms and possible ways through which we can eliminate them from our buildings. The study in the quest to achieve the above aim employed the literature review research design (systematic review), with particular reference to works of literature that dwelt majorly on Sick Building Syndrome (SBS), the causes and how it can be curtailed. Evidence in literature revealed that for a fact most building occupants do experience SBS both in the residential and office/commercial buildings, owing to the fact that some of the buildings are exposed to the identified causal effects of SBS such as, poor ventilation, biological contaminants, chemical contaminants (both indoor and outdoor), radiation from electronics, psychological factors etc. this also comes with a lot of symptoms like headache, irritations of nose, eyes, throat, dizziness, dry cough, nausea. Other studies on SBS has dwelt majorly on the symptoms of SBS and definition, but this study tried to identify the causal agents of the phenomenon, which is where this study plays a major role in filling that gap. The research findings from this study ascertained that SBS can be completely avoided when the stakeholders in the construction industry adheres strictly to building guidelines, and in a situation where a building is considered to be sick, there should be proper corrective measures to make the building well and this should be followed with regular building inspection. This study will help inform the government and building stakeholders on ways to tackle SBS, and the things to look out for in building to ensure that the building is fit for people to occupy.

1. Introduction

There has been various believe about sick building syndrome, within the built industry and even the medical line. Some clinicians are of the opinion that there is no such thing as Sick Building Syndrome, because there is no specific medical test that is known or available that can be used to diagnose this ailment known as Sick Building Syndrome (Charles, 2021). These particular group of clinicians were of the opinion that Sick Building Syndrome (SBS) is just an urban myth, while on the other hand, another set believes that there are diseases related to indoor air quality and even the building itself (Hind & Hikmak, 2008).

Sick Building Syndrome (SBS), as the name implies, is a health-related phenomenon that affects the users of a particular building. This comes with a series of symptoms concerning skin irritation, mucous membrane, and other symptoms like headache and dizziness. Which from studies appears when an occupant steps into a building, and gaining relief as soon as the individual exits the building.

Robertson et al, (1985), noted that this phenomenon was initially mistaken to be an issue caused due to the energy use within the building, especially as it concerns the air conditioners installed in modern buildings, although this report was refuted as more studies revealed that SBS can be caused by a lot of factors and not just limited to Indoor Air Quality.

In order to carefully understand the phenomenon called Sick Building Syndrome (SBS), some research questions were drafted, so as to give us an in-depth knowledge about the phenomenon.
What is SBS?

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What are the effects of SBS?

What are the causes of SBS?

How can we curtail or Mitigate SBS?

Can SBS be eliminated from our buildings?

Evidence from published literature noted that in the early 1990's during the energy crises where buildings were sealed up to reduce energy loss, low turnover of air inside buildings to save the cost of energy use in the building, high chemical content in upholstery, carpets and paints, insufficient lighting, increase in the use of computers with increased level of stress and work load for workers in their various working places largely contributed to Sick Building Syndrome (SBS) (Edmond, 1996).

From published literature it was noted that this particular phenomenon was termed "Sick Building Syndrome" in 1982 by the world health organization (Hind & Hikmak, 2008).

According to Redlish et al (1997), SBS symptoms started increasing on a high scale from the early 1970's, with most of its occurrences being in the air tight energy efficient buildings, while the naturally ventilated buildings that follows the laid down principles of design for proper ventilation in residential areas, using the ASHARE guidelines as a template.

Virtually all the works that have been done on SBS, were all culled up from the original studies that were carried out by the WHO, with their core concerns on the symptoms and possible solutions or cure.

Sumedha (1996) described SBS as a health situation attributed to air borne building contaminants, but there has been a misunderstanding between SBS and BRI (Building Related Illness) as discovered by Duncan (2020), Bholah & Subathy (2002). It is necessary to clearly explain the differences between SBS and BRI.

According to the report of a World Health Organization Committee (1984), it was discovered that globally, three out of ten new and renovated buildings may likely have issues of indoor air quality (IAQ). It can be associated with poor maintenance, conversion of building from the original plans, poor design or sometimes indoor air problems as a result of activities in the building. Another essential aspect likely to be affected by sick building is the occupants' health and the property value. Investors in real estate always seek to maximize profit while minimizing risk. Investment in real estate is capital intensive, therefore, investors as well as the property managers must guaranty that the investment is in good condition in order to achieve investment objectives which are to: preserve capital, enhance capital value and secure maximum returns (Akinwale et al 2019).

Hence, property managers should ensure that investment in property continues to command value and at the same time, the occupants must have value for their money. It is based on this foregoing that this study seeks to investigate the effect of sick building syndrome on occupants' health and property. Sick Building Syndrome has been an issue for almost four decades. And was said to have emerged as a result of energy conservation that led to closing up of buildings to prevent energy loss and reduce cost of energy consumption in addition to intensive use of upholstery, computers, photocopiers, air conditioners, carpets and wallpapers (Fotoula, 2011).

Some research has been conducted on this particular phenomenon known as Sick Building Syndrome /Building Related Illness around the world, even in Nigeria where there exists a paucity of research. An example, is the work of Joshi (2008) which identified problems associated with sick building syndrome in 206 buildings. It was discovered from the work that 18 % of the contaminants in the buildings were toxic element from indoor of the office space; these elements include; methyl alcohol from an old photocopy machine, methacrylate from a copier, sulfur dioxide from a heating system, amines used in a humidification system, chlordane used as a pesticide. 10% of the buildings got exposed to pollutants from outdoors such as dust, exhaust. 3% of the buildings were contaminated as a result of the type of building materials used (formaldehyde, fiberglass), while 48% suffered symptoms as a result of poor ventilation and 3% experienced problems due to the biological contaminants in the environments.

In Malaysia, Yau, Chew and Shaifulla (2012) researched on four pharmaceutical companies to determine workers' comfortability in such laboratories. It was discovered that two out of four laboratories had high levels of Volatile Organic Compounds (VOC) which can impair health of the workers in such buildings, while the air conditioning systems provide thermal comfort to the occupants.

Ogunde, Amusan, Tunji-Olayeni, Obembe, Adekeye (2015) carried out a collaborative research as a building technologist with Micro Biologists to examine the stains on the wall. The purpose of the research is to determine whether micro-organisms are present in wall stains. The researchers collected samples from the affected walls which were taken for analysis. It was revealed that active microbes such as staphylococcus aurens, Bacillus spp, and Pseudomonas spp (bacteria), Aspergillus Flavus, Mucor, Penicillium spp, and Cladosporium spp (fungi) were present in the samples. These microorganisms were found growing on cracks in the walls and wooden parts of the building and the researchers concluded that these microbes are injurious to the health of the occupants and are responsible for sick building syndrome.

The aim of this article is to present the causes and proffer remedies for SBS with the use of the following objectives.

- i. To describe SBS (Sick Building Syndrome)
- ii. To investigate the symptoms of SBS
- iii. To examine the causes of SBS
- iv. To identify solutions or remedies to SBS, and
- v. To identify preventive measures against SBS.

The information provided in this article should guide decision makers, policy makers and stakeholders in the building and construction industry, building owners, employers etc. about SBS, and how to effectively correct buildings that are considered to be sick and also more importantly on how to completely prevent the occurrence of SBS in the building.

2. Research method

The study employed the systematic review research design, this method identified, analysed, evaluated and summarised the findings relevant to the study in terms of causes and remedial steps towards the Sick Building Syndrome; thereby making the available evidence more accessible for knowledge acquisition and for decision making.

Data for the study were sourced from high indexed journals that dealt on building issues, Sick Building Syndrome, Housing satisfaction and human health within the built environment, also data were gotten from the data base of some world regulatory bodies, like the WHO, as the data from these bodies helped back up the study. Over 8,082 related published materials were seen under the search word “Sick Building Syndrome” both articles, book chapters, reviews, published thesis and conference proceedings within the year 1988 – 2021. The researchers further sieved the materials to know the ones that are relevant to the present study, this was done by going through the title, abstract, and keywords of the individual materials. The materials that were found not to be relevant to the aim of the study were excluded, while the ones that were found to be relevant to the study were considered to be included into the data collection, from this process the researchers narrowed the articles to be reviewed down to 50 articles that are very relevant to the course of study. From these 50 articles extraction of data was made on what Sick Building Syndrome is, how to curb and how to prevent it entirely. Thereafter information gathered analysed and summarised. In a systematic review, the researcher has the liberty or ability to interpret results using both in qualitative and quantitative methods. Whitemore et al (2005), suggested that, statistical method of data analysis is used where main studies of hypothesis and research design are same with current study, though in this particular study, the evidence from various articles reviewed could not be presented in statistical method, hence the result of the study were interpreted in qualitative method using thematic content analysis. Tables, diagrams, and text were also used for easy understanding of the whole concept and also to draw a better conclusion.

3. Findings

Sick Building Syndrome (SBS) is the condition of poor air quality within an enclosed space, thereby making the occupants of the building to feel unwell when they are inside that particular building or space. Individuals react differently when exposed to certain buildings and spaces with health symptoms like shortness of breath, cough, dry eyes, nose irritation, headache, itchy skin, aggravated asthma, sensitivity to odor, fever, and nausea amongst others. SBS can be experienced in old, new and renovated buildings. The effect is more when a building is newly painted or newly furnished and the chemical components of the paint or the furnishings used are still very much within the immediate space of the building. Also, when a building is not well ventilated, it has the tendency to make the occupants sick or feel unwell.

Table 1. Description of Sick Building Syndrome (SBS) by some Authors is as follows:

Author(s)	Description of SBS	Article
Rostron. (2008)	“Recognised by WHO as a syndrome of complaints covering non-specific feelings of malaise, associated with occupancy of certain modern buildings.”	A Review of the Effects of Sick Building Syndrome on Property and the Occupants.
Hayk. (2018)	“Situations in which building occupants experience acute health issues and or discomfort that appear to be linked or in connection with the time spent in a particular building, with no specific illness or other source of sickness identified”	Sick Building Syndrome.
WHO.	“A medical condition where people in a building suffer from symptoms of illness or feel unwell for no apparent reason.”	Sick Building Syndrome.
Mohammed. (2019)	“As described in ASHRAE is a situation which more	Sick Building Syndrome Hybrid

	than 20% of the occupants of a building complain during a two-week period of a set of symptoms including headaches, fatigue, throat irritation, eye irritation, nausea that is alleviated by leaving the building and is not known to be caused by any specific contaminants.”	Control for HVAC and Effect on Sick Building Syndrome (SBS).
Burge. (2004)	“A group of mucosal, skin and general symptoms that are temporally related to working in a particular building”	Sick Building Syndrome
Jessica. (2012)	“...is the name for buildings that have flaws in their construction, flaws in their heating, ventilation and Air conditioning (HVAC) or contaminants which includes moulds, chemical contaminants from outdoor and indoor sources, hazardous building materials, that causes health challenges for occupants living and working in the same building”	The Experience of Living with Sick Building Syndrome.
Taki & Moore. (1998)	“A series of symptoms or irritation of the skin, mucous membranes and other general symptoms like headache, allergy which appears when an individual is in a poorly ventilated enclosure or building, but gets relieved when the individual vacates the building”	Case Study on Prevalence and Possible Causes of Sick Building Syndrome Symptoms.
US. EPA. (1991)	“situations in which building occupants experience acute health and comfort effects that appear to be linked to time spent in a building, but no specific illness or cause can be identified”	Indoor Air Facts No4. Sick Building Syndrome (revised).
Sarafis, et al. (2010)	“...Situations where the individual feels various symptoms or a general intolerance and malaise and has no concrete identified illness that describes these symptoms.”	Sick Building Syndrome
Duncan. (2020)	“...It is an unofficial health condition characterised by a cluster of illness related symptoms like fatigue, fever, nausea, stuffy or itchy nose, dizziness, cough, headache, but the individual feels better when they leave/exit the space or building.”	What is Sick House Syndrome? Learn the Causes and Solutions.

However, it is worthy to note that Sick Building Syndrome (SBS) is not the same as Building Related Illness (BRI). Therefore, Building Related Illness (BRI) as defined by Hind & Hikmat. (2008) is an illness caused due to been exposed to indoor contaminants resulting to known clinical syndrome. They can be identified, measured and quantified.

Table 2. Differences between SBS and BRI according to EPA (1991), Sumedha & Joshi, (2008) includes:

Sick Building Syndrome (SBS)	Building Related Illness (BRI)
Causes of sickness or symptoms are unknown.	Symptoms are diagnosable and are caused by chemicals, bacteria, fungi et cetera, and are clinically defined.
Complainants get relieved upon leaving the building, at times with lingering effects which may occur like neurotoxins.	Complainants still feels sick even after leaving the building, hence requires some time to recover.
Symptoms include headache, eye-nose-throat ENT irritations, nausea, inability to concentrate at any given task, dizziness, itchy skin, increased sensitivity to odours	Symptoms may include muscle ache, chest pain, fever, chills, aggravated asthma, cancer, pregnancy complications like miscarriages etc.

Irrespective of the controversy surrounding the existence of SBS, there are still specialists who can aid in treating the symptoms of SBS. These include Primary clinic physicians, paediatricians, allergists, immunologist, specialised building inspectors. This list cannot be exhausted, as different individuals experience different symptoms when it comes to SBS. Other specialist can be consulted depending on the symptom faced by the building occupant (Charles, 2021). Also reports can be made to environmental professional agency, occupational safety and health administration, and centre for disease control and prevention. These agencies can help to make right the root cause of SBS in buildings and make the space conducive for living.

Symptoms of Sick Building Syndrome:

Symptoms can be described as physical or mental features which indicate the presence of something especially an unwanted or undesired situation. Due to the effect of Sick Building Syndrome, a list of symptoms was discovered to have been experienced by complainants. Some experienced these symptoms within few hours of staying in the building, while others stay for longer hours in the building that is termed to be sick before feeling unwell. Individual reactions to sick building vary and almost all the complainants feel better once they leave the building, while others may take days before full recovery.

Table 3: The following Authors suggested a number of symptoms associated to sick building syndrome.

Symptoms of SBS	Author(s)
Dizziness	Kristeen (2018), Ellen (2018),
Headache	Sumedha (2008), BSI (2021),
Sneezing	Duncan (2020), MSI (2016),
Breathing Difficulties	DBL (2020), Redlich (1997),
Nose Irritation (bleeding & itchy nose)	Jose, et al (2009), Abbritti, et al (2006),
Throat irritation	Olli & Fisk (2004),
Fatigue	Stenberg, et al (1994),
Nausea	Hind & Hikmat (2008), EPA (1991),
Chest Pain	NHS (2020),
Fever	Charles (2021), Dana (2017),
Eye irritation	Luxafor (2020), Edmond (1996),
Skin irritation (dry or itchy)	OHS (2016), Wikipedia (retrieved 2021),
Chills	Sarafis, et al (2010), Jessica (2012),
Dry cough	Burge (2004), Mohammed (2019),
Hoarse voice	Hayk (2018), Akinwale, et al (2019),
Loss of attention at the work place	Chandrakumar, et al (1994), EPA (2006),
Poor productivity at the work place	Seppanen, et al (2002), Rostron, (2008), Abigail (2008),
Difficulty in concentration	WHO (2009), Crook & Burton (2010), Fisk, et al, (2009),
Sensitivity to odour	Gustafsson (1991), and Bholah & Subratty (2002)
Personality changes	
Aggravated Asthma attack	
Irritations and Allergies	

It is vital to have a record of where and how the symptoms came to be, and also to note where and when the complainant got better.

Causes of SBS: It has been observed that certain things can give rise to SBS. The presence of some of these factors that will be shown below are considered to be responsible for SBS.

The major causes of SBS as noted in published literatures can be categorized into: Chemical contaminants (indoor & outdoor), biological contaminants, inadequate ventilation, psychological factors, electromagnetic radiations, low humidity, poor acoustics, poor lighting system, poor ergonomics, absence of sunlight. These causes were as noted by; Sumedha (2008), Ellen (2008), Kristeen (2018), BSI (2021), MSI (2016), DBL (2020), Olli et al. (2009), EPA (1991), NHS (2020), HSC (2018), Charles (2021) and Wikipedia (retrieved 2021).

Some known sources of indoor chemical contaminants are namely: Volatile Organic Compounds such as ozone from photocopier and fax machine, formaldehyde from furniture and floors, cleaning agents, carpets made of chemicals, adhesive agents, pesticides, fumes from lead paint, wall papers and furniture polish, smoke from tobacco, synthetic fragrance, smoke from cooking stove, oven heater, fire place, heated & unventilated spaces, repairable particulate matter.

Sources of outdoor chemical contaminants includes carbon monoxide from the exhaust of vehicles, bathroom and kitchen building exhaust, plumbing vents, by products of combustion from the surroundings, wrongly placed windows, openings and air intake vents which will randomly allow entrance of contaminants into the internal spaces.

Biological contaminants include fungus, moulds, bacteria, viruses, pollen, insects and bird droppings. They can breed on moist surfaces or areas like drain pipe, ducts and several other places.

Poor ventilation system contributes largely to SBS especially where, there is poor circulation of fresh air within the building or a non-functional HVAC (Heating Ventilation & Air Conditioning).

Poor inter communication within staff members and excess work load, are associated to the psychological factors contributing to SBS.

The radiations of electromagnets that ionizes the air which is linked to cancer released from television, computers, poor earthen and microwaves do contribute to SBS.

Remedies and Prevention of SBS: From studies and investigations, various authors have identified measures to be taken in order to proffer solution to Sick Building Syndrome. Works from the following Authors were reviewed namely: Kristeen (2018), Rostron (2008), Akinwale, et al. (2019), Olli, et al. (2004), Sumedha & Joshi (2008), Redlich, et al. (1997), Duncan (2020) and Ellen (2018). They suggested that:

- ❖ Increase in cross ventilation and air distribution within the building space goes a long way to control air quality within the indoor space of a building.
- ❖ Some plants have the ability to enhance mood, concentration, productivity of the building occupants, can also reduce stress and fatigue. These plants are natural purifiers as they can absorb harmful toxins in the atmosphere within a space, and this goes a long way to control the air quality within that space. Some of these plants listed below can also be used to improve the quality of air within the interior spaces. Plants like English Ivy "*Hedera helix*", Bamboo palm "*Chamaedorea seifrizii*", Chinese Evergreen "*Aglaonema modestum*", Rubber Tree "*Ficus elastic*" and a whole lot of other plants has proved effective in purifying the indoor air quality (Igwe, Ezema, Okeke & okpalike, 2021).
- ❖ The thermal comfort of the interior spaces in buildings are very important, having the right temperature and humidity levels of 40% to 70% will help prevent the breeding of biological contaminants.
- ❖ The floors and walls of buildings should be kept clean; this should be done regularly by moping, removing of cobwebs and other means.
- ❖ For public spaces, there should be provision for smoking areas, as this helps restrict smoke to only the smokers within the smoking designated space area.
- ❖ There should be regular maintenance and inspection of the HVAC system in buildings.
- ❖ Ensure that window in buildings are openable, so as to let in fresh air.
- ❖ When suitable, it is advisable to consider open designs.
- ❖ Incorporation of terrace garden and skylights in our designs are of great importance.
- ❖ Avoid the use of substances that has contaminants or that has been proven to be harmful to human health in the interior spaces of the building, like asbestos, insecticides, adhesives etc.
- ❖ Building occupants should always allow buildings to gas off before packing in, especially remodelled building and newly constructed buildings, as this will help reduce the effect from chemicals used in furnishing and finishing the buildings.
- ❖ Energy saver bulbs (LED) should be used in buildings, as it reduces the amount of energy being consumed in the building.
- ❖ Building occupants should always endeavour to replace old laptops and desktops screens with modern ones, this helps reduce electromagnetic radiation within the building space.
- ❖ There should be more sensitization on the causes and effects of SBS, especially to building owners, employers and others.
- ❖ For those staying in buildings that are already noted to be sick, there should be adequate support and measures to ensure that the building is corrected/ healed and also see that the occupants are better off.
- ❖ Right choice of building materials should be prioritised during construction; this will help ensure the wellbeing of the building occupants.
- ❖ Citing and locating of buildings should be properly considered as this helps to enhance the productivity of the users.
- ❖ Accumulated pollution within an enclosed space should be let out of the building, and fresh air allowed into the space.
- ❖ The building in general must undergo regular inspections by environmental regulators, so as to ensure the safety and wellbeing of the building occupants.

4. Discussion

From the findings of the systematic review carried out on the causes, effects and remedies of Sick Building Syndrome, some connections were made in form of conceptual framework, bringing together the connections and variables that were noted in the phenomenon of SBS.

Figure 1 shows the relationship and paths on the investigation carried out on how SBS functions.

Therefore, SBS can be said to be a condition, where occupants of a building feel uncomfortable and experiences health issues while they are in a particular building due to the various sources of contaminants within and outside the building envelope that triggers symptoms and some health issues, this is particular to individuals. This phenomenon

or situation can be prevented when proper measures are taken into consideration during the course of construction of a new building or remodelling of an existing facility or building.

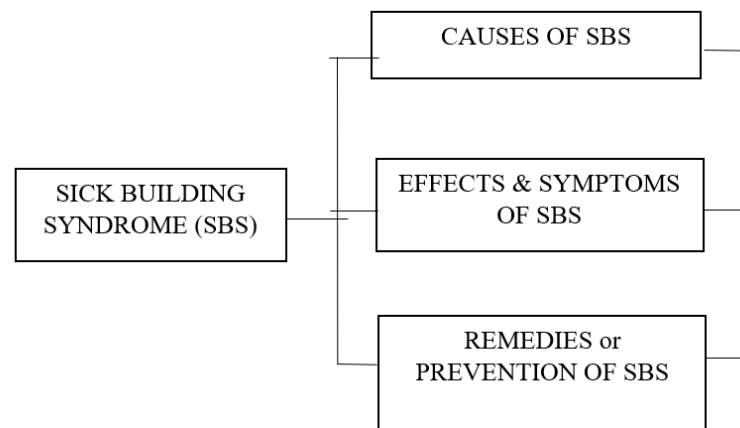


Fig. 1. the relationship and paths on the investigation carried out on how SBS functions

There are lots of theories that suggest causes of Sick Building Syndrome. However, recurrent evidences indicate that inadequate ventilation, contaminants from indoor sources and also outdoor sources are responsible for SBS. The contaminants could be chemical or biological (MSI, 2016). Sumedha & Joshi (2008).

American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE) revised ventilation standards to mitigate poor indoor air quality due to inadequate ventilation that are been experienced by home owners and occupants. The minimum standards for outdoor air flow rate are 15cfm/person: 20cfm/person in office spaces: 60cfm/person in smoking lounges (EPA, 1991). Building construction experts must consciously incorporate adequate spaces for openable windows and well sited designs should be such that, adequate ventilation into the interior spaces from the exterior is sufficient for proper indoor air quality and eliminating pollution (Sumedha, 2008). When a room or any interior space is poorly ventilated, staying inside of it comes with a series of concern for the occupants' health. This situation adds to sick building syndrome. Also, in a space where the HVAC systems are not functional especially within a poorly ventilated space, are bound to health problems at the presence of any form of contaminants. Furthermore, chemical contaminants from outside like combustion by products from car exhausts, plumbing vents, asbestos and dust amongst others; once they have access to the interior of buildings, can also cause discomfort to the occupants of a building. It is also necessary to open up the building (windows and doors) when there is a concentration of contaminants within the interior space. It has been observed from studies, that indoor contaminants are produced from Volatile Organic Compounds (VOC) from things like upholsteries, photocopiers, cleaning agents, adhesives, carpets, glue, furniture et cetera are some of the known sources of VOC (Jessica, 2012). By products from stove, oven, synthetic fragrance, tobacco smoke, some building materials and others also add to the causes of SBS (Kristen, 2011).

Note that VOC are organic chemicals with high vapour pressure at room temperature. VOC includes various chemicals that can easily cause irritation of the eyes, nose, throat, headaches, fatigue, shortness of breath, skin problem, nausea. High VOC will cause liver, lungs, kidney and central nerve system damages. It is also paramount to be careful about the choice we make in house furnishing/ building materials, personal care products and general indoor usage for healthy living. The temperature and humidity of the internal space should be appropriate enough to prevent the breeding of biological contaminants like moulds, fungus, bacteria et cetera. Due to the factors responsible for SBS, irritation of the eyes includes itchy eyes, watery eyes, eye redness, eye pains, blurred vision and light sensitivity which also come with headache. For nose irritation it includes: stuffy nose, running nose, itching nose, sneezing, cough, sore throat (throat irritation- an itchy feeling in the internal part of the throat, and most often it comes with difficulty in swallowing food). These symptoms were observed to be experienced in sick buildings. The occupants feel better when they exit the specific building that is sick. Therefore, it is important that buildings should provide comfort for its occupants.

It is necessary to look out for sources of contaminants whenever there is a walk-through inspection in a building. The ventilation sources in the building should be checked, look out for the air movement within the building, temperature of the internal spaces, humidity, presence of CO₂ to ventilation system efficiency, the condition of the

HVAC system, biological organisms and the presence of particles in the surrounding air. In addition, ensure proper lighting and avoid noisy environment (OHS, 2016).

Joseph, et al (2017) noted in their work that a healthy building is a building which during its construction, ventilation, air quality, air movement, water quality, thermal comfort, lighting system, occupants view of the environment, dust and pest eradication, noise, humidity of the environment, safety and security were all considered and made right. In any building where all these considerations were made (whether home or office building), will not be prone to making the occupants sick.

Stakeholders in the built industry must not relent in ensuring that buildings are healthy and functional at all times, taking stern steps through inspections and also giving guidelines and standards which every building must meet for it to be occupied.

5. Conclusion

SBS as described by Duncan (2020) is an unofficial health condition, characterized with a cluster of symptoms like headache, fever, nausea, irritation of the eyes, nose, and throat, cough, post nasal drip et cetera which an occupant of a particular building feels, but gets relieved after leaving the building. No particular factor is solely responsible for SBS. A list of concerns are determined to be the source of SBS which includes: poorly ventilated spaces, biological contaminants like moulds, indoor and outdoor chemical contaminants, electromagnetic radiation from electronics, poor lighting system, noise from the external surroundings of the building amongst others. SBS can be prevented or controlled through a lot of means like ensuring healthy construction by building construction stakeholders, regular inspection of buildings to determine the existence of any factor that may lead to SBS and to eliminate such. Create awareness on SBS to building owners and occupants, so that they can pay closer attention to the wellness of building occupants and provide corrective measures that can be applied on sick buildings.

Further research should be carried out on production of specific clinical diagnosis for SBS, even though some groups believe that SBS does not exist. It however remains factual that situations in sick buildings make the occupants unwell but are then relieved once they leave the building.

References

1. 5 signs how sick building syndrome is killing your health and office productivity. Retrieved from <https://www.luxafor.com/5-signs-sick-building-syndrome-is-killing-your-health-and-office-productivity> (2020)
2. Abbritti, G. Muzi, G.. Indoor air pollution and health in offices and other non-industrial working environments Pm N/M. retrieved from <https://pubmed.ncbi.nlm.nih.gov/17017378> (2006)
3. Abigail, R.. Overview of environmental lung diseases. Retrieved from WWW.merckmanuals.com (2018)
4. Akinwale, O.M., Oluwunmi, A.O., Utom, J., & Fadahunsi, J.. A review of the effects of sick building syndrome on property and the occupants (JRBE). Vol. 7 No. 1, (2019)
5. Bholah, R., & Subratty, A. Indoor biological contaminants and symptoms of sick building syndrome in office building in mauritius. International journal of Environmental health research Vol. 12, P. 93-98. (2002)
6. Burge, P.S. Sick Building Syndrome, occupational and environmental medicine. Retrieved from research gate, <https://www.researchgate.net/publications/8907032>. www.occenvmed.com (2004)
7. Chandrakumar, M., Evans, J., Arulanantham, P.. An investigation into sick building syndrome among local authorities, employee annals of occupational hygiene, 3f(s), 789 (1994)
8. Charles, P.. Facts you should know about sick building syndrome. www.medicinenet.com/sick-building-syndrome/article. (2021)
9. CIB healthy buildings, Vol.3, P. 88. Systems, materials and policies for healthier indoor air quality. Swedish council for building research 021: (1988)
10. Crook, B., & Burton, N. Indoor moulds. Sick building syndrome and building related illness. Fungal biology review. 1-8. (2010)
11. Dana, S.. Ventilation- is your house making you sick? Retrieved from <https://www.baywardscore.com/articles/is-your-house-making-you-sick> (2017)
12. Duncan, K.. What is sick house syndrome? Learn the causes and solutions. Available at <http://www.hfienberg.com/what-is-sick-house-syndrome-learn-the-causes-and-solutions> (2020)
13. Edmund, H.. Sick building syndrome. Emedicine health. Available @ <https://www.emedicinehealth.com> (1996)

14. Ellen, R.. The best air purifying pants for your home, curled from <https://www.healthline.com/health/sick-building-syndrome-prevention>. (2018)
15. Environmental Protection Agency (EPA): Indoor air facts: sick building syndrome (SBS) retrieved from www.epa.gov/iaq (2006)
16. Fisk, W., Mirer, A. & Mendell, M.. Quantitative relationship of sick building syndrome, symptoms with ventilation rates. *Indoor Air*, Vol. 19, P. 159-165. (2009)
17. Fotoula, P.B.,. The Sick Building Syndrome (SBS). *Health Science Journal* 5(2). Available @ www.hsj.gr/medicine/the-sicksyndrome (2011)
18. Gustafsson, H.. Building materials identified as major source for indoor air pollutants. A critical review of case studies. Swedish council for building research, Stockholm (Sweden) (1992)
19. Hayk, S.A. Sick building syndrome. Retrieved from research gate. (2018)
20. Hind, M. and Hikmak, H. Sick building syndrome (SBS) in apartment buildings in Jordan. *Jordan journal of civil engineering*, Vol. 2 No.4. (2008)
21. Homod, R., Sahari, S.. "energy savings by smart utilization of mechanical and natural ventilation for hybrid residential building models in passive climate." *Energy and Buildings*, 60(2013) 310-329. (2013)
22. Igwe, A., Ezema, E., Okeke, F., Okpalike, C. Architectural mitigating strategies for air pollution in the built environment. (2021)
23. Indoor air facts No. 4 (revised). Sick Building Syndrome United States EPA. Research and development. (1991)
24. Jessica, S. The experience of living with Sick Building Syndrome. NOVA university of applied science. (2012)
25. Joseph, G. The 9 foundations of a healthy building. School of public health, center of health and global environment. www.forhealth.org. (2017)
26. Josi, R., Symptoms, preventions among office workers of a sealed building versus, a non-sealed building. Association of indoor air quality (2009)
27. Joshi, S. J. The sick building Syndrome. *Indian Journal Occupational & Environmental Medicine* 12(2): 61-64. Available @ <http://www.nbi.nim.nih.gov/pmc/article/pmc2796751> (2008)
28. Key signs that your house may have toxic moulds. The income service club. <https://www.hsewarranty.com/blog/key-signs-your-house-may-have-toxic-moulds> (2018)
29. Kristeen, C. Sick Building Syndrome. Health line articles at <https://www.healthline.com/health/sick-building-syndrome>. (2008)
30. Mohammad, A. Sick building syndrome, hybrid control for HVAC and effects on sick building syndrome. Retrieved from research gate www.researchgate.net/publication/336577787. (2019)
31. Occupational health and safety, Sick Building Syndrome. What it is and tips for prevention. (2016)
32. Ogunde, A.O, Amusan, L, Mosaku, T, Tunji- olayeni, P, Obembe, O, Adekeye, B. Sick Building Syndrome: Towards Safer and Healthier Living and Working Environments in Buildings (A Case Study of a Higher Institution in Nigeria). In proceedings of International Conference on African Development Issues (CUICADI) 2015: Social and Economic Models for Development Track. (2015)
33. Olli, A. & Fisk, J, Summary of human responses to ventilation. Wiley online library. *Indoor air?* Volume 14, issues 7, P.102-118. <https://doi.org/10.1111/j.1600-0668.2004.00279> (2004)
34. Redlich, C., Spacer, J., & Cullen, M. Sick building syndrome. *Occupational medicine*, V.349, P. 1013-1016. (1997)
35. Redlish, C.A. et al.. Sick Building Syndrome (PM) PubMed. Available at <https://pubmed.ncbi.nlm.nih.gov/9100639> (1997)
36. Richard, J.S and Estella, L.. Case study, Sick Building Syndrome in a humid climate. Center for environmental research and technology. The university of Tulsa. Proceedings of the seventh symposium on improving building systems in hot and humid climates. (1990)
37. Robertson, A., Burge, P., Hedge, A., Sims, J., Gill, F., Finnegan, M., Pickering, C. and Dalton, G., 'Comparison of health problems related to work and environmental measurement in two office buildings with different ventilation systems', *British Medical Journal*, vol. 291, 373-376. (1985)
38. Rostron, J.. Sick Building Syndrome. A review of causes, consequences and remedies. *Journal of retail and leisure property* Vol. 7 (4), P. 291-303. (2008)
39. Sarafis, P., Satriadou, K., Dallas, D., Stavrakakis, P., & Chalarts, M.,. Sick building syndrome, *Journal of Environmental Protection and ecology II*, No2, P. 515-522. (2010)
40. Sepanen, O. Fisk, J. Association of ventilation system type with SBS symptoms in office workers. *Indoor air* 12(2). 98-113. (2002)

41. Sepanen, O., Risk, W.. Summary of human responses to ventilation. *Indoor air*. V. 14, P. 102-118. (2004)
42. Sick Building Syndrome. Designing buildings. The construction wiki. Available at http://www.designingbuildings.co.uk/wiki/sick_building_syndrome (2020)
43. Sick Building Syndrome. NHS retrieved from <https://www.nhs.uk/conditions/sick-building-syndrome> (2020)
44. Sick Building Syndrome (WHO report) World Health Organization regional office for Europe CEPIS
45. Sick Building Syndrome symptoms, causes and prevention tips, buildings services team. (2021)
46. Sick Building Syndrome, a review of the evidence on causes and solutions, health and safety executive, UK, (1999).
47. Skov, P., Valbjorn, O., & Pederson, B., Influence of indoor climate on sick building syndrome in an office environment. *Scand journal of work environmental health*, V.16, P.365-371. (1990)
48. Stenberg, B.. The sick building syndrome (SBS) in in offices, a cases referent study of personal, psychosocial and building related risk indicators. <https://pubmed.ncbi.nlm.nih.gov/7721522>. (1994)
49. Sumedha, M. and Joshi, T.. The sick building syndrome, *PMC. Indian journal of occupational and environmental medicine PMC*. 12(2)61-64. Doi:10.4103/0019-5278.45262, available <http://www.ncbi.nlm.nih.gov/pmc/article/pmc2796751> (2008)
50. Taki, A.H. & Moore, T.. Case study on prevalence and possible causes of sick building syndrome, symptoms. Department of building studies, De Montfort University, Leicester Lei 9BH, UK. (1998)
51. Web MD. Is your house making you sick? Retrieved from <https://www.webmd.com/women/features/reduce-toxins-in-your-home>. (2005)
52. Wittemore, R., Knafl, K & Gray, E. The integrative review: updated methodology, *journal of advanced nursing*, Vol. 52(5), P.546-533. (2005)
53. World Health Organization. WHO guidelines for indoor Air quality: dampness and moulds. (2009)
54. Yau, Y. H., Chew, B. T., & Shaifullah, A. Z.A.. Studies on the indoor air quality of Pharmaceutical Laboratories in Malaysia. *International Journal of Sustainable Built Environment*, 1(1), 110-124 (2012)