ANALYSIS OF THE CAUSES, EFFECTS AND REMEDIES OF SICK BUILDING SYNDROME (SBS)

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Abstract

Buildings are essential part of human existence, regarded as life supporting machine and rank second to food. However, inspite of the significant importance of buildings to mankind. Today, we find that people living or working in some buildings are becoming ill, especially in modern buildings with closed mechanically ventilated systems. The symptoms seemed to disappear soon after they left the building. These signs suggest that some conditions within and outside the building caused the occupants to suffer from Sick Building Syndrome (SBS). Consequently inspite of investigations, articles, conferences and journals, yet little has been proven about the causes of SBS. This paper therefore, aimed at examining the causes, effects and remedies of sick building syndrome. The study relied on collected secondary data which included the most relevant and current within the discipline from text books, academic articles and journals. The paper identified that inadequate ventilation, chemical contaminates from indoor and outdoor cases, biological contaminants and lack of building maintenance are some of the major causative factors of SBS. While the major effects are headaches, dry eye and eye strains, drowsiness, asthma, upper respiratory infections, joint pains, swelling of the legs, pregnancy problems including miscarriage and cancer. The paper recommended among others that education of building occupants and everyone involved with the design, construction and maintenance of buildings. This will in turn enhance and promote efficient communication with each other to work more efficiently together to prevent and solve the effects of SBS.

Key Words: *Sick building syndromes, contaminant, occupants, and causative factors.*

1.0 Introduction

Buildings are regarded as enclosures designed and constructed to provide minimum level of comfort for the occupants. Buildings also provide safety, protect the occupants from effects of weather and give internal comfort (Ogunoh, 2008)

According to Obiegbu (2003) a building is an essential modifier of micro climate, a space isolated from climate, temperature and humidity, fluctuations, sheltered from prevailing winds and precipitation, and with artificial means. Fadamiro (2002) also emphasized that buildings are enclosures for space designed for specific uses, meant to control local climate, distribute services and evacuate wastes.

Building being an essential part of human existence is regarded as a life supporting machine and ranks second to food. That is why people and building are inseparable. This is what prompted Akinsola (2006) to say that the existence of building structure is a basic necessity in every society, that their presence in most cases determines the level of growth and development in any developing society. While World Health Organization (WHO) (1989) maintained that housing is a residential environment which includes in addition to the physical structure that man uses for shelter, all necessary

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services, facilities, equipment and devices needed or desired for the physically, health and social well being of the family. Akinsola and Ojewole (2008) state that housing condition play a major role in individual health states and also in environmental health as a wide variety of housing features may influence the physical, social, and the mental well being of occupants.

However, inspite of the significant importance of building to mankind; Today, we find that people living or working in some buildings are becoming ill, especially in modern buildings with closed mechanically ventilated systems. This phenomenon according to Wan, (1992) came to be known as " Sick Building Syndrome" or SBS. According to Broderbund, (1999) Sick Building Syndrome (SBS) is used to describe cases in which building occupants experience general non specific symptoms of malaise such as irritation of the eye, nose, and throat, lethargy and dizziness. Sick Building Syndrome is also used to describe situations in which building occupants experience acute health and discomfort effect that appear to emanate from the building. A building is therefore, referred to as sick building if 20% of its occupants suffer from the symptoms of the syndrome and get relief soon after leaving the building (Okolie, shakantu & Obodo, 2009).

The term sick building as argued by Freckles (2003) is often used as a misnomer as buildings do not actually get sick but people do. He went further to say that in cases of SBS the cure involves a diagnosis of the problem of the building, sorting its remedy and applying it. However according to the United State Environmental Protection Agency (2006), there are no specific illnesses or cause that can be identified, that the complaints may be localized or a particular floor in a zone or may be widespread throughout the building. This shows that SBS is associated with non specific symptoms; it has attracted different experts with numerous research projects, disparate theories, journals and articles, and conference papers. Yet little has actually been proven about the causes of SBS. Therefore, the aim of this paper is to identify the evolution of SBS, causes, effects and remedies of sick building syndrome.

2.0 Evaluation of sick Building Syndrome (SBS)

Sick Building Syndrome (SBS) originated as a result of the measures taken to conserve energy, triggered by energy crises in the 1970's, consequently, led to alteration in building and ventilation design. Iyagba, (2006) asserted that the pressing need to save energy led to an architectural resolution that was geared to seating buildings up tight. He went further and noted that buildings were designed to be energy efficient with recalculating air conditioning systems and unopenable windows. This allowed the off gassing from the construction materials to remain longer and in higher concentrations than in lesser air tight buildings (Wan, 1992).

This innovation resulted in unacceptable conditions at work and even at home (Iyagba, 2006); He therefore warned that the incidence of people getting sick or having symptoms of ill health at work in closed mechanically ventilated buildings increased and this attracted considerable attention around the world. This shows that SBS has been increasing in frequency since 1970's as older buildings that are naturally ventilated are replaced with modern buildings that typically use air conditioning system and can be thought of as "airtight". According to the report on Sick Building Syndrome by Molina,

Pickering, Valbjorn and Bortoh, (1989) since the seventies and the oil crisis, energy saving measures have led to a reduction in the ventilation of rooms. That the use of synthetic materials which emit various chemical substances has led to an increase in the concentration of indoor pollutants.

3.0 Causes of Sick Building Syndrome

Sick Building Syndrome is a worldwide Problem and is emerging as a severe problem in buildings. That is why it is currently the subject of numerous investigations and conferences, yet as Okolie, Shakantu and Obodoh, (2009) put it, little has actually been proven about the causes of sick building syndrome. According to Molina, Pickering, Valbjorn and Maurizio, (1989), the cause of SBS which is probably multifactorial, is not usually accompanied by any organic lesion or physical sign and is, therefore, diagnosed by exclusion. However, they maintained that SBS has been found in all the major cities of the Western world, among people who work or live for several hours a day in an artificial atmosphere, and can be diagnosed only after eliminating all other building related illnesses.

In another development, Research has consistently shown that the following design elements appear to increase the prevalence of SBS: wall to wall carpets, large areas of upholstery, large amount of shelving and horizontal surfaces, crowding, office size, poor lighting, poorly designed work stations, air quality and poor environmental control by individuals (Best & Valence, 1999). They state further, that the most significant determinant appears to be HVAC design: 50% of problems are due to poorly designed operated or maintained heating, ventilation and air conditioning systems. The United States Environmental Protection Agency (2006) lists four causes of sick building syndrome as:

- Inadequate ventilation
- Chemical contaminants from outdoor sources:
- Chemical contaminants from indoor sources; and
- Biological contaminants.

However, there is a consensus of opinion among authors that SBS is influenced in Part by indoor surface Pollution such as dust, fibers and micro organisms deposited on or in surfaces of buildings (Raw, Rays & Whithhead, 1993; Akin & Brooks, 2005; Firor, 2006)others as stated by the United State Environmental Protection Agency (2006) include;

(a) Poor design concept of building in areas of illumination, ventilation, production and installation of air conditioning system;

(b) Poor and uninformed occupant activities in buildings

(c) Use of building materials that are hazardous to occupant health and

(d) Operation and maintenance of building in manners inconsistent with their original design or prescribed operating procedure.

Evidence has shown also that the following are some of the sources of SBS and are discussed below:

(1) Outdoor chemical contamination

These include exposure to a chemical or other toxic substance outside the buildings such as fumes from motor vehicle exhaust, generating sets, contraction activities, plumbing vents and poor location of high voltage air conditioning (HVAC) system inlet vents.

(2) Indoor chemical contamination

Exposure to chemical or other toxic pollutant generated within the building, such as adhesives for carpeting, upholstery, manufactured wood products, methylacohol from spirit duplicator, methacrylacde from a copier, sulphur dioxide from a heating system, amines in a humidification system, chlordane used as a pesticide. Others are carbon monoxide, nitrogen dioxide as well as irrespirable particles which come from un-invented kerosene and gas space heaters; woodstove, fire places and gas stoves. All of these can emit Volatile Organic Compounds (VOCS); which have been shown to cause chronic and acute health problems at high concentration.

(3) Contamination due to building materials.

Some of the materials used in construction of buildings are hazardous to occupants of buildings

The main sources of pollution are released from building fabric and furnishings eg. Floor tiles, asbestos, adhesives, other solvent vapors' and organics from various sources.

(4) Biological Contaminants

These are problems that cause buildings to become toxic problems due to a reaction to micro organisms in the building environment. These include pollens, hypersensitivity pneumonitis, bacteria, viruses, moulds and other Bio. aerosols are common in every home. Bird and insect droppings can be a source of biological contaminants; some of these contaminants like mildew could also breed on damp surfaces (www.google. co. uk).

(5) Ventilation

Inadequate ventilation system is regarded as the most significant factor affecting building which are sealed and have mechanical ventilation or air-conditioning. Lack of fresh air contributes to sick building syndrome and it is required to supply air for respiration, dilute carbon dioxide (CO_2), odours, generator, cigarette smoke, and other contaminants. According to Environmental Protection Agency (EPA), (1990), inadequate ventilation may also occur if heating, ventilation and air conditioning system do not effectively distribute air to the occupants of a building and this is thought to be a very significant factor in SBS. As Iyagba (2005) puts it, the practice of tight control over the indoor environment poses problems if the ventilation or air conditioning system is in any way imperfect.

(6) Lack of Maintenance Culture.

Buildings and their surrounding environments are complex in nature. They trap and concentrate pollutants as well as generating pollutants. Lack of maintenance culture is one of the major causes of sick building syndrome. Therefore, during the design and construction of buildings, access to all components especially Heating

Ventilation and Air conditioning (HVAC) systems should be provided for inspection, repair, and cleaning. From literature, it shows that neglected or deferred maintenance can actually be a significant source of radon. Radon is an uranium decay product which is naturally present in the soil. From the soil, it moves into the soil voids by diffusion and into soil water, from where it can migrate through building foundation and ground floor cracks etc into the building. The effects of radon on building occupants are those associated with ionising radiation (X- rays and gamma rays): cancer and damage to reproductive organs and to the fetus. To effectively remedy SBS' efficient maintenance management and monitoring are essential in order to control ventilation rates and air quality levels of the building and to maintain a healthy environment.

7. Re circulation of air and pollutants

Many buildings are now designed to reduce the intake of fresh air from outdoors because it is cheaper to re circulate air that has already been warmed in winter or cooled in summer than to take in outside air and heat or cool it repeatedly (Sawor, 1995). During the construction, insulation and furnishing of buildings many synthetic materials are used. These materials emit varieties of toxic chemicals and volatile organic compounds such as formaldelhyde. According to Okolie, et.al.,(2009), the increasing use of machines also add to indoor air pollution eg. Ozon from photocopiers, noise from printers and electromagnetic radiations from visual display units. Air conditioning systems could also harbor pollutants or micro organisms within their vents or ducts thereby adding to the contaminants in the work place (Okolie, et. al., 2009). Improving ventilation of a building can help to reduce the amount of contamination with chemical or micro organisms (BBC News, 1999).

4.0 Effects of Sick Building Syndrome (SBS)

●Research has shown that there is considerable evidence that sick building syndrome do affect the wealth of building occupants, which range from irritation and discomfort to disability or life threatening disease. According to the study conducted by Iyagba (2005), he listed six symptoms of sick building symptoms as.

- Building and watering eyes and nose.
- Building intrachea and cancer.
- Inability to concentrate
- Nausea and nosebleeds.
- Muscle cramp and joint pain, hoarseness, cough, sore throat.
- Sensitivity to odour and headache.

In another development, SBS related symptoms are likely the results in which the occupants of a building exhibit a pattern of lethargy, headaches, dry eye and eye strain, aching muscles, upper respiratory infections, catarrh and aggravated breathing problems.

Molina et.al., (1989), State that, the symptomatology of this syndrome is varied, but listed five symptom complexes, which may occur singly or in combination with each other as:

1) Nasal Manifestations:

The symptoms most frequently experienced are nasal irritation with rhinorrhoea and nasal obstruction, usually described as 'nasal stuffiness:

2) Ocular manifestations

Dryness and Irritation of the mucous membrane of the eye

3) Orpharyngeal manifestations

Dryness and Irritation of the throat

4) Cutaneous manifestation

Dryness and irritation of the skin occasionally associated with a rash on exposed skin surfaces.

5) General manifestations

Headaches and generalized lethargy and tiredness leading to poor concentration

Additional symptoms of the syndrome include, heart palpitations, exhaustion after normal activities, swelling of the legs, trunk and ankles, chronic fatigue, pregnancy problems including miscarriages and menstrual irregularities.

However, research cited so far revealed that SBS has measurable effects on the productivity of workers, work stress and other psychological and social or institutional factors. For example, in the United State, It has been estimated that SBS costs approximately US$3 billion in lost annual Productivity, whilst in Australia it is estimated to cost industry several hundred million dollars each year (Dingle, 1995).

According to fish (2000), SBS symptoms are hindrance to work and can cause absences from work. In this regard, organizations will therefore face difficulties in achieving their set adjectives due to the loss of productivity. Another aspect of the effect of SBS is medical legal battle between building owners, workers, tenants etc in terms of not providing a safe working environment. That was why World Health Organization (WHO) (1986) Lamented that “energy efficient but sick building often cost society far more than it gains by energy savings " and” people's confidence in the effectiveness of health and building authorities may be seriously harmed if SBS becomes a common Phenomenon. In a nut-shell SBS reduces worker productivity and causes workers absenteeism.

5.0 Remedies

Literature has revealed that solutions to problems caused by SBS usually include increased day lighting and natural, rather than mechanical and ventilation.

●The United States Environmental Protection Agency (2006) prescribes a number of provisions that can be utilized to resolve the problem of sick building syndrome and these include:

- Increased in ventilation rates and air distribution;
- Purification of air;
- Removal of modification of the pollutant sources; and
- Education and communication.

Studies have shown that SBS problems can be greatly reduced if a building incorporates

natural ventilation in all or part of its design. Best and Valence (1999) advised that good maintenance, frequent and effective clearing are also important. The Maintenance and cleaning of HVAC systems is clearly another critical factor.

It is obvious that increasing the ventilation rates and air distribution, modification or normal of the pollutant source, through periodic maintenance can also solve the problems of SBS. According to Wolverton Johnson and Bounds (1989), house plants together with the medium in which they grow can reduce components of indoor air pollution, particularly volatile organic compounds (VOC) such as benzene, toluene, and xylene Plants can also remove, CO_2, which is correlated with lower performance, from indoor areas (Wolverton et.al., 1989). The effect according to Wolverton and Wolverton (1996) has been investigated by NASA for use in spacecrafts. Studies have also shown that plants appear to reduce air bone microbes, molds and increase humidity.

Still on the mitigation and control strategies of SBS, Iyagba (2005) identified four basic methods of control:

- Source management
- Ventilation
- Education
- Exposure control.

Based on this, it is apparent that comprehensive maintenance management strategy an effective factor for solving SBS. This view holds a strong validity in the sense that when building and its surrounding environment becomes dilapidated and unhealthy. Depression of the quality of life follows with promotion of irresponsible social behaviours and employers significant economic and productive losses. Housing conditions play a major role in individual health status and also in environmental health, as a wide variety of housing features may influence the physical, social and the metal well being of occupants (Akinsola & Ojewole 2008).

Other important factors to solving the complexities of sick building syndrome are design, selection of materials, and constructability maintainability of buildings. Infact, it is axiomatic that buildings that are better designed, constructed and well maintained will promote higher productivity and reduce unproductive period related to SBS, workers illness, network as a result of inaccuracies in completed work. Consequently, there is strong evidence that building design, constructability and maintainability have effect on the occupants of the building. This is in line with Bokini (2007) that some particular designs have also been found to create problems to the occupants of the building, due to the types of materials used. Therefore, attention must be given to planning, selection of materials during the design, construction phases and maintenance for varying cycles of building performance and use during the lifetime of buildings.

6.0 Conclusion and Recommendation

The paper concluds that sick building syndrome is used to describe situations in which occupants of buildings experience acute health and discomfort effect that appear to emanate from the building. The paper therefore, identifies the major effects of

SBS as: headaches, dry eye and eye strain, sore throat, drowsiness, catarrh, asthma, upper respiratory infections. Others are muscle cramp and joint pains, swelling of the legs, truck and ankles, pregnancy problems including miscarriages and cancer. It was identified that SBS originated as a result of the measure taken to conserve energy, triggered by energy crises in 1970's, consequently, led to alteration in building and ventilation design. It was however, discovered that inadequate ventilation, chemical contaminants from outdoor and indoor cases, biological contaminants and lack of maintenance culture are found to be some of the major causative factors.

The paper recommends among others that education of building occupants and everyone involved with the design, construction and maintenance of buildings in the subject matter is important. This will enhance and promotes efficient communication with each other to work more effectively together to prevent and solve the effects of SBS.

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