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Investigation into the Effects of Sick Building Syndrome on Building Occupants: A Case Study of Commercial Bank Buildings in Awka Nigeria

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Abstract:- In 2012, occupants of some commercial bank buildings suffered from non-specific symptoms of malaise during the time they occupied the buildings. The symptoms seemed to disappear soon after they left the buildings. These signs suggest that some conditions within the buildings predisposed the occupants to Sick Building Syndrome (SBS). This paper examines the factors underlying the outbreak of SBS in commercial Bank buildings within the Awka urban environment of Nigeria. Conditions within two bank buildings were examined for factors that cause SBS. Data were generated from questionnaires distributed to fifty randomly sampled occupants of the buildings. The phenomenon obtaining in the buildings under scrutiny were analyzed using tables, bar charts, frequency distributions and chi-square test. The findings show that there was poor indoor air quality in the buildings under scrutiny. Furthermore, the obtaining conditions in the buildings were of stuffy, cold, and unpleasant odour (perfumes and smoke) in the working environment. These findings seem to point to an environment rife with indoor air pollution. Using the world health organization's definition of SBS, it can be suggested that the investigated buildings did harbor indoor conditions that can be described as causing the symptoms of SBS to the occupants. It is recommended that both occupants and facilities management team work together to improve the buildings' interior environment in terms of air quality and other causative conditions of SBS.

Keywords:- Air quality, Environment, Occupants, Pollution, Sick Building Syndrome,

I. INTRODUCTION

The term 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 (Broderbund, 1999). These acute health and comfort problems appear to be experienced by the sufferers during the time they occupy or spend in a building and disappear soon after they leave the building. There are no specific illnesses or causes that can be identified. The complaints may be localized on a particular floor in a zone or may be widespread throughout the building (United State Environmental Protection Agency 2006). Additional symptoms of the syndrome include nose bleeding, dry cough, burning in trachea, dry or itchy skin, nausea, heart palpitations, shortness of breath and/or exhaustion after normal activities, muscle cramps and joint pains, tremors, swelling of the legs, trunk and ankles, difficulty in concentration, chronic fatigue, sensitivity to odours, pregnancy problems including miscarriages and cancer.

A building is referred to as 'sick' if 20% of its occupants suffer from the symptoms of SBS and get relief soon after leaving the building. The effect of the syndrome is reduction in worker productivity and an increased absenteeism including employee sick leave applications (Atkin and Brooks, 2005). Caution should be taken that complaints may also result from other causes. These may include illnesses contracted elsewhere, acute sensitivity e.g. to allergies, job related stress, or dissatisfaction and other psychological factors.

The phrase sick building; argues Freckles (2003), is often used as a misnomer as buildings do not actually get sick but people do. Freckles (2003) goes on to say that in cases of SBS, the cure involves a diagnosis of the problem of the building, sorting its remedy and applying it. The aim of this paper is to identify the causes and effects of sick building syndrome in the Awka urban environment and explain why occupants of investigated buildings experience acute health problems and discomfort during the time they occupied the buildings.

II. REVIEW

2.1 Causes of Sick Building Syndrome

In spite of the numerous investigations, journal articles and conference papers, little has actually been proven about the causes of SBS. Different experts have disparate theories. One school of thought suggests that the main cause is chemical, while another proffers fungi as primarily to blame or physical factors such as humidity, temperature or lighting or the air-conditioning systems. The United States Environmental Protection Agency (2006) lists four causes of SBS 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, Roys & Whitehead 1993; Atkin and Brooks, 2005; Firor, 2006). The majority of the above causes result from a number of sources as stated by the United States Environmental Protection Agency and these include:

- Poor design concept of buildings in areas of illumination, ventilation and in the production and installation of air conditioning systems;
- Poor and uninformed occupant activities in buildings;
- Use of building materials that are hazardous to occupants' health; and
- Operation and maintenance of buildings in manners inconsistent with their original design or prescribed operating procedure.

These show that the sources are mainly influenced by architectural properties, as well as organizational and facilities management processes. Some of the sources of SBS are discussed below.

2.1.1 Chemical Contaminants from Outdoor Sources

The air that enters a building from outdoors can be a source of indoor air pollution, especially in a situation where fumes from motor vehicle exhaust, plumbing vents and building exhaust (e.g. bathrooms and kitchens) find their way into a building due to poorly located inlets, vents, windows, other openings and poor location of high voltage air conditioning (HVAC) system inlet vents (Burge, 2004).

2.1.2 Chemical Contaminants from indoor sources

Most indoor pollution comes from sources within the building. Examples of these sources include adhesives for carpeting, upholstery, manufactured wood products, chemicals from copy machines, pesticides and cleaning, formaldehyde ozone and high level Volatile Organic Compounds (VOCs). A major contributor or source of high level VOCs is environmental tobacco smoking in addition to other toxic compounds and respirable particulate matter (Health, 2006). VOCs have been shown by researchers to cause chronic and acute health effects at high concentrations. Some are known as carcinogens, (combination of products such as carbon monoxide, nitrogen dioxide as well as respirable particles) which come from un-vented kerosene and gas space heaters; woodstoves, fire places and gas stoves.

2.1.3 Biological Contaminants

These include pollens, bacteria, viruses and moulds. These contaminants may breed in stagnant water that has accumulated in dust humidity and drain pans or where water has collected on ceiling tiles, carpeting or insulation. 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).

2.1.4 Inadequate Ventilation

The design of air-tight buildings with windows that do not open results to insufficient air necessary to maintain the health and comfort of building occupants. 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 (EPA, 1990).

2.1.5 Poor Maintenance Culture

One of the major causes of SBS is poor maintenance culture. According to Iyagba (2005), one of the greatest economic and social problems of a nation is the general absence of a maintenance culture. Buildings in Nigeria lack adequate maintenance, care or attention. Though unfortunate, it is a glaring fact that these buildings are in very poor and deplorable conditions of structural and decorative disrepair.

2.1.6 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 (Sawnor, 1995). Many synthetic materials are used in construction, insulation and furnishing. These materials emit varieties of toxic chemicals and volatile organic compounds such as formaldehyde. The increasing use of machines also adds to indoor air pollution e.g. ozone from photocopiers, noise from printers and electromagnetic radiations from visual display units. But with the present design of buildings that allow only very little fresh outdoor air intake, chemical pollutants are not diluted but are rather re-circulated by High Voltage Air Conditioning Systems. Air conditioning systems could also harbor pollutants or micro-organisms within their vents or ducts thereby adding to the contaminants in the work place. Improving ventilation of a building can help to reduce the amount of contamination with chemical or micro-organisms (BBC News Online, 1999).

2.2 Control of Indoor Air Quality

The control of pollutants at their source is the most efficient strategy for maintaining clear indoor air. But it is not always possible or practicable. Thus, ventilation either naturally or mechanically is the second most effective approach to providing acceptable indoor air. In the past, most buildings had operable windows that opened and aired stuffy rooms. But today, most new office buildings are constructed without operable windows; instead, mechanical ventilation systems are used to ensure exchange of indoor air with a supply of relatively clean outdoor air. With whatever method, adequate ventilation is essential to help flush buildings of pollutants such as carbon dioxide, nitrogen oxides, formaldehyde, which if left to accumulate can be harmful.

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

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

III. METHODOLOGY

To investigate why the occupants of examined buildings suffered from non-specific symptoms of malaise during the time they occupied the investigated buildings, the study adopted the survey research approach using two Commercial Banks (Red Bank and Blue Bank) in Awka, Anambra State Nigeria as case studies. The Banks were so named to protect their privacy. The staff of the two banks formed the population of the study. A sample size of fifty (50) was chosen using Yaro Yamane's model, while the simple random sampling technique was used to select the fifty (50) respondents (i.e. twenty-five from each bank). Questionnaires were structured to contain four sections and distributed to the 50 respondents. The four sections were as follows:

- Subjective evaluation of the working environment;
- The health impaired symptoms noticed while in the building;
- Workers' degree of control over their working environment; and
- Evaluation of occupants' activities.

Data retrieved from forty five (45) respondents or 90% of the samples were subsequently presented in tables and bar charts while frequencies were used to analyze and answer the research questions. The hypothesis of this study postulates that occupants' activities have significant effect towards indoor air quality. The data collected were subjected to inferential statistical tests using the chi-square technique. The details of questionnaire distribution are shown in Table 1.

Table I: Questionnaire Distribution

Bank workers	Guaranty Trust Bank Awka			Spring Bank Awka		
	No. Distributed	No. returned	%	No. Distributed	No. returned	%
	25	23	92%	25	22	88%

Source: Field survey (2012)

IV. DATA PRESENTATION AND ANALYSIS

Data obtained from the field survey study were presented in tables and bar charts while frequencies were used to analyze and answer the research questions. This was to ensure that the results were properly evaluated and understood. The questions from the various sections and responses were presented and analyzed as follows:

4.1 Subjective evaluation of the working Environment

Do you experience the following conditions in your working environment? Please tick (V) where appropriate

Table II: Response on subjective evaluation of working environment (Red & Blue banks)

Item	Conditions	Frequency of response			
		Always	Often	Sometimes	Never
A	Inadequate air supply	-	7	33	5
B	Too cold	10	20	13	2
C	Stuffy	5	16	25	-
D	Too dim	15	20	10	-
E	Unpleasant odour	20	13	8	4

Source: Field survey (2012)

Table 2 shows that the respondents were subjected to different conditions in their working environment and to varying degrees. Most respondents (33 persons) were subjected to inadequate air supply, while some (20 persons) felt it was much too cold. Others were subjected to stuffy, dim and unpleasant odours; sometimes, often and always respectively.

4.2 Health – Impaired Symptoms

Do you experience any of the following complaints in your working place? Also, indicate if the problem is consistently more common in the afternoon than in the morning by stating either YES or NO in the column provided.

Table III: Response to Health- Impaired Symptoms.

Item	Conditions	Frequency of response				
		Always	Often	Sometimes	Never	More common in the afternoon
A	Dry or sore throat	-	10	33	2	40
B	Skin dryness	13	20	10	2	42
C	Headache	10	23	11	1	45
D	Drowsiness	-	30	12	3	46
E	Running nose	5	5	35	-	44

Source: Field survey (2012)

Table 3 presents workers' responses to health impaired symptoms. The responses show that more people (33) experienced dry or sore throat in the afternoon. The majority (20 persons) experienced skin dryness more in the afternoon. Furthermore, most people (23 persons) experienced headache, drowsiness (30 persons) and running nose (35 persons) in the afternoon.

4.3 Degree of control over the environment

To what extent do you have control over the following conditions in your working place?

Table IV: Responses on the degree of control over the working place.

Item	Conditions	Frequency of Response				
		None	A little	Some	Mostly	Complete
A	Temperature	-	-	-	7	38
B	Ventilation	-	35	2	6	2
C	Humidity	-	36	3	6	-
D	Lighting	-	5	23	12	5
E	Noise	-	34	10	1	-

Source: Field survey (2012).

Table 4 shows that workers in the study area had different degrees of control of the conditions in their working environment. 38 respondents (38) had complete control over temperature while most of them had little control over ventilation, humidity, lighting and noise.

4.4 Evaluation of occupants' activities

How often do you react to Perfume and smoking?

Table V: Response on occupants' reaction to perfume

	Frequency of Response				
	Always	**Often**	**Sometimes**	**Never**	**Freq. Total**
GTB	2	2	8	3	15
Spring	1	2	6	1	10

Source: Field survey (2012)

Table VI: Response on occupants' reaction to smoking

	Frequency of Response				
	Always	**Often**	**Sometimes**	**Never**	**Freq. Total**
GTB	1	4	2	4	11
Spring	3	1	3	2	9

Source: Field survey (2012)

Red Blue

Figure 1: Multiple Bar Charts for Response to reaction to Perfume.

Red Blue

Figure 2 Multiple Bar Charts for Response to reaction to Smoking

The hypotheses for the study were stated in Null (Ho) and Alternative (H_1) forms respectively. The statistical tool used was Chi-square test statistic; it is a non-parametric statistical tool and distribution free. This means that it can be used in the analysis of data for different populations (Eze and Obiegbu, 2005). In this analysis, the two-way classification of chi-square contingency table was explored.

4.5 Hypotheses

H_0: Occupant activities have no significant effect on indoor air quality.

H_1: Occupant activities have significant effect on indoor air quality.

Table VII: Grouped response on occupant activities towards indoor air quality

Bank	Effect	No effect	Total
Red	19	7	26
Blue	16	3	19
Total	35	10	45

Source: Field survey (2012)

Level of significance 5%
Expected values (eij) are computed as:

$$Eij = \frac{\text{Row total x column total}}{\text{Grand total}}$$

$$e_{11} = \frac{26 \text{ X } 35}{45} = 20.22$$

$$e_{12} = \frac{26 \text{ X } 10}{45} = 5.78$$

$$e_{21} = \frac{19 \text{ x } 35}{45} = 14.78$$

$$e_{22} = \frac{19\text{x}10}{45} = 4.22$$

Table VIII: A 2x2 contingency table on grouped response of occupants' activities Towards air quality.

Bank	Effect	No effect	Total
Red	19 (20.22)	7(5.58)	26
Blue	16(14.78)	3 (4.44)	19
Total	**35**	**10**	**45**

Source: Field survey (2012).

$$\mathbf{(19\text{-}20.22)^2 + (7\text{-}5.58)^2 + (16\text{-}14.78)^2 + (3\text{-}4.44)^2}$$

$$\mathbf{= 7.0668}$$

Table 8 indicates that x^2 calculated (**7.0668**) is greater than x^2 table value (**3.84**). This shows that the null hypothesis (occupants' activities have no significant effect on indoor air quality) is rejected; meaning that the alternative hypothesis (occupants' activities have significant effect on indoor air quality) is accepted.

V. DISCUSSION

It is inferred from the data analysis that occupants' activities affect the indoor air quality of the building and therefore contribute to SBS. This inference agrees with the United States Environmental Protection Agency (2006) that poor indoor air quality could compound SBS. A closer look at the data analyzed shows that major causes of SBS include: inadequate air supply, cold spaces, stuffy air, dim lighting and unpleasant odours (perfumes and smoke) in the working environment.

VI. CONCLUSION AND RECOMMENDATION

The study identified the major effects of SBS as health-impaired symptoms like sore throat, skin dryness, headache, drowsiness and running nose. It was however discovered that certain conditions like ventilation, humidity, lighting and noise cannot be controlled by occupants of the building and these result into occupants suffering from SBS.

It is therefore recommended that occupants' education on the subject matter is necessary so as to reduce the negative effects of human activities to the indoor air quality and health of the building occupants. If this is done, occupants could reduce causative behaviours and activities and improve indoor air quality.

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