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SEMINALING HEALTH CONDITIONS ASSOCIATED WITH BUILDINGS AND LIFE EXPECTANCY OF NIGERIAN CITIES RESIDENTS

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ABSTRACT *Health issues associated with buildings is an observable fact in research and a concern for longevity. Amongst the outcome of building related concerns on residents are health issues such as Sick Building Syndrome (SBS) and Building Related Illness (BRI), but if not detected and treated early enough would ultimately result to reduction in life expectancy ratio of urban residents. Therefore the core of the paper was to examine health questions associated with buildings in order to identify and document it as one of the causes of reduction in life expectancy ratio in Nigerian cities. The paper has provided some form of remedy to the growing occurrence. Hence, the research was conducted using descriptive and experimental/observatory approaches. The result of the findings documented in the paper will improve consumers, manufacturers and property developer choices.*

KEYWORDS: Seminaling, Health Condition, Buildings, Life Expectancy Ratio And Nigerian Residents

INTRODUCTION

In recent years, a large number of incidents have been reported, where challenge on occupants' health and comfort have been linked with buildings where they spend time. These health issues have been Sick-Building-Syndrome (SBS) or Building-Related-Illness (BRI) (WHO, 2008). Research has shown that building materials play a significant role in the cause of SBS and BRI (Gustafsson, 1992). In the case of BRI, the cause of illness is directly linked to the building and in many instances to the building material. While for SBS, it is difficult to find a direct connection between a single cause and the health/discomfort challenge. It has been observed that pollutants from building materials, is one of the causes of health/discomfort challenges amongst several others. Thus, indoor air pollution (IAP) caused by building materials, and other sources in the indoor space can be considered as possible causes of both BRI and SBS. However, the way building materials are handled is a major determinant of natural environment and people's health. So, that why the study focuses on how sick building and building related illness affects and reduces life expectancy (longevity).

LITERATURE/THEORETICAL UNDERPINNING

Health Conditions Associated With Buildings

According to life wellness (2004), the health conditions associated with buildings can be classified into three; Sick Building Syndrome (SBS): this is the first type of classification. SBS explains a situation in which the building occupants experience acute health or comfort-related effects that seem to be linked directly to the time spent in the building. SBS defines a range of health challenge that can occur through exposure to pollutants inside a home, office or other building. It usually related to poor Indoor Air Quality (IAQ) and can be caused by mold, radon, smoke/chemical, biological and environmental pollutants (Purushottam, 2001). The symptoms of SBS includes headache, ear/nose/throat/skin irritations, nausea, dry cough, fever, fatigue, dizziness, sensitivity to odours, difficulty in concentration, hoarseness of voice, allergies, cold, flu-like symptoms, increase incidence of asthma attacks and personality changes, reduced work efficiency and increases absenteeism. Most times occupants report relief soon after leaving the building, although lingering effects of neurotoxins occur (EPA 2003c). The second classification is Building Related Illness (BRI). It occurs when diagnosable illness symptoms are identified and traced directly to airborne building contaminants (Intrinsik, 2010). The symptoms are cough, chest pain, shortness of breath on mild exertion, edema, palpitations, nosebleeds, cancer, pregnancy challenges and miscarriages, extrinsic allergies alveolitis, legionnaire's disease, humidifier fever, pneumonia and occupational asthma. These symptoms have clearly identifiable causes and can be clinically defined (Wolverton, 1990). The recovery time after leaving the building may be prolonged. The third type of classification is Building Associated Symptoms (BAS). The symptoms are common amongst the urban poor rather the rich, clerical jobs personnel than managerial personnel because of better working conditions. It is common in females than in males probably because females are more in secretarial jobs and more susceptible to the effects (EPA 2003q). The symptoms are rife in air-conditions buildings than in naturally ventilated buildings and are common in public buildings than in private buildings.

Underlying Factors Causing Health Conditions in Buildings

There are diverse contributing factors primarily responsible for SBS, BRI and BAS this includes; built environment, building laws and regulations, haphazard informal settlements, non-functional building design, biological and chemical contaminants from VOCs and emissions from building materials and the environment (UNEP, 2013). **a. Built Environment:** When an environment is not properly laid-out/planned, the result is sprawling building and ultimately slums and this is typical of most Nigerian cities. The effects of such unplanned environment lacking basic infrastructure like water, electricity and waste disposal are SBS, BRI and BAS, which makes the environment unhealthy and ultimately reduces life-expectancy ratio. **b. Psychological Factors and Building Laws and Regulation:** Research has shown that poor interpersonal relationship, excessive work stress or dissatisfaction and poor communication are often associated with SBS. Most property owners in Nigerian cities, due to *"Omo-onile"* syndrome, ignorance and greed, ignore building laws and regulations during the sales and construction of properties. Set-backs and access road are sold. Successively, there are congested built environment with poor ventilation, inadequate daylight, poor road network and drainages. Therefore the residents suffer from SBS, BRI and BAS which are threat to their longevity. **c. Haphazard Informal Settlements and Non-Functional Building Design:** The issue of urban poverty and housing stock shortage has resulted in haphazard informal settlement in Nigerian cities, with a follow-on effect of poor housing quality. SBS, BRI and BAS are results of poor housing quality. In Nigeria, the causal factors of non-functional building designs, includes zero profession consultation, poverty, poor awareness/orientation amongst others. However the indicators of non-functional design include inadequate ventilation, poor natural daylight, poor acoustics, poor furnishing/equipment, poor ergonomics and poor building materials usage. An example of a non-functional architectural plan is “the central corridor house” otherwise known as “face me I face you” as shown in figure 1. This house type dots the residential landscape of Nigeria major cities. It is preferred by residents (urban poor) because it is cheaper to rent and by commercial home owners because it is easy to build, cheaper to maintain and guarantees quick return on investment. But occupants of “the central corridor house” suffers from SBS, BRI and BAS which are threats to their longevity.

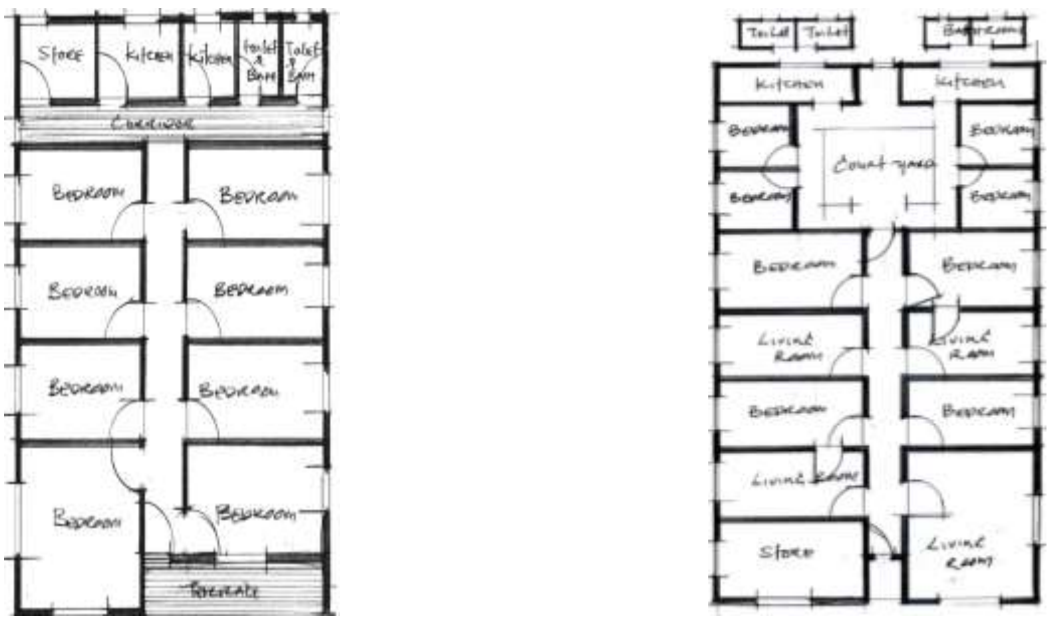

Fig1a & b: **A Typical Floor Plan of a Central Corridor House (“Face Me I Face You”)**
Source**:** Ekhaese, 2011

d. Biological Contaminants includes pollens, bacteria, viruses, fungus, molds, etc. and can breed in humidifiers stagnant water, drainpipes and ducts or water collected on ceiling tiles, insulations, carpets and upholstery. Insects and birds droppings can be a source of biological contamination. These contaminants causes fever, chills, cough, chest tightness, muscle aches and allergic reactions. In high occupants density offices, airborne diseases spreads rapidly from one worker to another and air-conditioning systems circulate pathogens inside buildings (Bass, et al., 2001). **e. Chemical Contaminants from Building materials:** Exposure to building materials emission affects the skin, mucous membranes in the eyes, nose, throat, and sensory system. The emissions may be caused by formaldehyde compounds and VOCs such as acetone; benzene; toluene; cyclohexane; nhexane; styrene; chlorinated and other solvents in building materials like paints, stains, adhesives, binders, walling, flooring, ceiling, door and window materials. Chemicals emission may affect the mucous membranes directly by sensitizing effects, allergens, infectious agents and other irritating substance such as fiber glass and styrene interactions on airway irritations and between bacterial and viral infections interactions (U.S. CDC, 2011). And chemical emission effects on nervous system can be caused by neurotoxin in indoor environment, but the general effects have only been shown at exposure levels in occupational settings (U.S. EPA (2010c). For instance, Paint as a building material contains lead that is hazardous to health. Human exposure to lead is estimated to account for over 143 000 annual deaths and 0.6% of the global burden of disease (IAQ Publications, 2009). Lead is a toxic metal and cumulative toxicant that affects the environment and multiple body systems, including the neurological, haematological, gastrointestinal, cardiovascular and renal systems. Children are particularly vulnerable to the neurotoxic effects of lead, and even low levels of exposure can cause serious and irreversible neurological damage. Childhood lead exposure is estimated to contribute to about 600 000 new cases of children with intellectual disabilities every year (WHO, 2005). In children, even low levels of lead increase a child's risk of developing permanent learning disabilities, reduced concentration and attentiveness spans, and behaviour concerns. Adverse health effects may occur before the appearance of any symptoms such as loss of appetite, difficulty in sleeping, irritability, fatigue, headache, moodiness, joint and muscle aches, and metallic taste in the mouth. High levels of lead concentrations can result in severe damage to blood forming, nervous, urinary, and reproductive systems of the body. Lead poisoning from leaded paint occurs as result of inhaling leaded paint or lead-contaminated dust into the body. Immediate symptoms of exposure to polluted air include throat irritation, dizziness and headaches. Long-term health risks may include respiratory disease, heart disease and cancer. Research has shown that Students with healthy air are more proficient at retaining information For employers, improving indoor air quality directly correlates with higher productivity and a more satisfied workforce. VOCs from building materials causes poor air quality for occupants, reduce utility value for building owners, causes temperature and odor in inside the Building, environmental issues, reduce occupational safety and Residential Structures. Figure 2 shows the Environmental exposure pathways

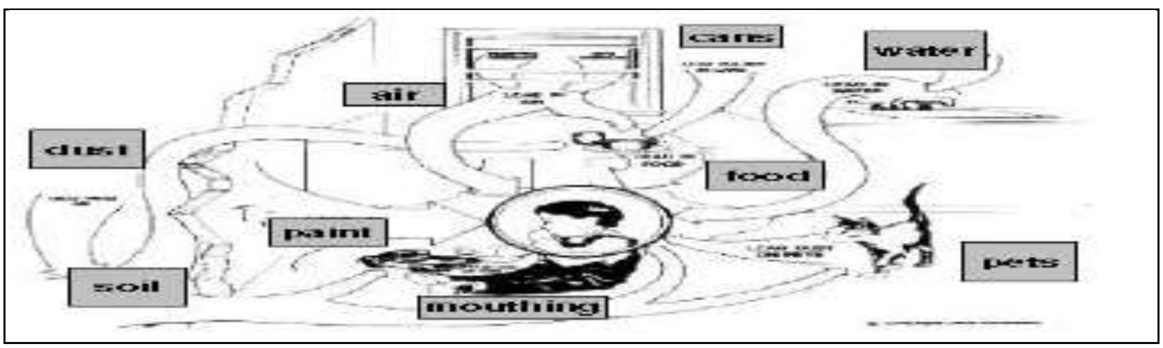

Figure 2: Environmental exposure pathways
Source: WHO, (2008)

STUDY METHODOLOGY

After outlining various causes of health conditions associated with buildings, the study identifies internal spaces in residential houses, offices and institutional building in order to measures the effects of Building materials emissions on occupants health. The paper has adopted the evaluation method to detect the chemical contaminants in building materials. In this study, residential buildings are owner occupied/rented house, child care centers, and similar facilities. Non-residential structures include schools, office buildings, etc. The area for evaluation and chemical analysis includes: Walling and Flooring Material, Surface Preparation and Finishes like: Paint, Hazardous Air Pollutants, Binders, Heavy Metal-Containing Pigments and Additives, Plumbing and solder, etc.

FINDINGS, DISCUSSIONS AND RESULTS

The study focuses on emissions from building material like volatile organic compounds (VOCs) and Indoor air pollutant (IAP) which are hazardous air pollutant (HAP). To examine life expectancy of Nigerian cities residents, the paper has identify the illnesses associated with building, causal factors and health implications of such illnesses, in other to determine its preventions and possible remedy that will increase the average life expectancy of Nigerian cities residents. Most building materials emit VOCs and IAP such as acetone, heptane and many other metabolic products like formaldehyde, paints and lacquers and toxins. VOCs emission is five times more inside the house than outside. The adopted procedure will enable building materials to be classified into emissions levels. This will improve indoor air quality and reduced energy wastage, promote sustainable development and improve health and comfort thereby increase longevity.

Steps for Evaluation of Building Materials Emissions

According European Collaborative Action (1997) the evaluation of building materials emissions and the effects on health and comfort can be divided into five main steps. A procedure for chemical analysis of VOC emissions has been established for emission factors of each VOCs and TVOC (Total Volatile Organic Compounds).

Step 1; Small test chamber measurements of chemical emissions from solid materials have shown acceptable results, measurements of emissions from pasty/liquid materials still show unacceptably large disparities.

Step 2: The evaluation process requires the definition of an exposure scenario which is relevant for the evaluation. For indoor spaces where people spend time, the scenario should provide standard values for all exposure related environmental parameters, such as room area and volume, type and amount of materials and/or activities in the spaces, ventilation and temperature. Based on the selected scenario, the emission rates determined in step (1) above, and on time activity patterns, models may be used to estimate exposures of occupants to chemicals. Although exposure models for relatively complex scenarios have been proposed, only models for simple scenarios have been validated.

Step 3: chemical exposures estimated in step (2) have to be evaluated to the potential health effects and relevant toxicological data collected. Currently, limited data exist on individual compounds effects, on compound mixtures effects and on validated methods for the estimation. This situation requires a number of approximations and introduction of safety margins. The proposed evaluation procedure is for building materials, because the availability of chemical emission data for these materials creates the possibility of testing the consequences of the proposed toxicological evaluation. However, it can be applied to other building materials with minor modifications. VOCs may have effects on the human senses even at concentrations that are not detectable using the current chemical measurement techniques utilized in step (1). So, sensory effects of VOCs and

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their mixtures is unpredictable from concentration measurements and such effects play a key role in humans reaction to indoor VOC pollution (NRDC, 2003b).

Step 4: Sensory evaluation by test sections is required to assess the perceived quality of VOC emissions. While in chemical characterization, widely applied, generally accepted and incomplete validated methods are obtainable. Sensory evaluation of building materials emissions is an on-going discussion with no generally accepted methods existing. In particular, modeling of perceived air pollution in real environments based on sensory emission measurements is an unresolved challenge. Difference in quantity of available knowledge becomes visible in study where sensory evaluation has been treated in a section, whereas by contrast, chemical evaluation can be found in different studies related to emission measurement, modeling and evaluation.

Step 5: A rule/scheme should be developed on the use of information obtained in steps 1-4 to characterize/label building materials based on VOC emissions impact on human health and comfort. (ECA, 1991)

Effects of Voc Emissions Evaluation on Human Health

Analysis has shown that Indoor air pollution (IAP) in buildings such as residences, offices and schools, is widely recognized as an environmental risk to human health. IAP may consist of complex mixture, volatile organic chemicals (VOCs), Environmental Tobacco Smoke (ETS) and other combustion products (see table 1) which may affect the respiratory, immune, reproduction and nervous system, the skin, mucous membranes and increase the risk of cardiovascular diseases (Intrinsik, 2010).

Table 1: Health Aspect of Indoor Air Pollutants

Indoor air pollutant	Definition	Health impact
Radon	A radioactive gas that is released by uranium, a natural substance found in soil and rock. Radon is captured in indoor air by moving through the ground to the air above.	Impacts: • Damage to lung cells • Leads to lung cancer
Environmental tobacco smoke (ETS)	Mixture of smoke from the burning end of a cigarette, pipe, or cigar and smoke exhaled by the smoker (also second hand smoke or passive smoking).	ETS is particularly harmful to infants and children and effects include: • Asthma • Sudden Infant Death Syndrome • Bronchitis and pneumonia • Other respiratory diseases Passive smoking may also lead to: • Lung cancer • Eye, nose and throat irritation • Potential effects to the cardiovascular system
Cooking pollutants	Cooking with solid fuels on open fires or traditional stoves.	Impacts on children: • Respiratory illnesses including pneumonia Impacts on adults: • Respiratory diseases and infections • Increased susceptibility to asthma • Changes in lung function
Volatile organic compounds (VOCs)	Compounds that vaporize (become a gas) at room temperature. Common sources which may emit VOCs into indoor air include housekeeping and maintenance products, and building and furnishing materials.	Some VOCs are known carcinogens and other harmful effects to health include: • Eye, nose, and throat irritations • Headaches • Dizziness • Visual disorders • Memory impairment
Asbestos	Natural material that is made of tiny threads, or fibres and used as fireproof material indoors and in consumer products for example ironing board covers. The fibres can enter the lungs as a person breathes.	Impacts: • Asbestosis • Cancer

Source: Lavin, et al., (2006)

Thus VOCs emitting from building materials have been evaluated for toxic effects and Available information is derived from observations and studies on humans/experimental animals exposed to single chemicals at concentrations ranging from below “No-Observed Adverse Effects Level” (NOAEL) up to exposures that have caused death within minutes. For single substances, few toxicological data are available for the vast range of VOCs derive from building materials. The toxicological evaluation of chemicals requires that dose-effect and dose-response relationships are established and are used to identify the thresholds of toxic action or 'No Observed Effect Levels' (NOELS). For exposure estimates and assumptions on the sensitivity of exposed population, thresholds are used for defining “Occupational Exposure Limits” (OELs), “Air Quality Guidelines” (AQGs) or other regulatory/guideline values for individual chemical compounds.

Exposure limits are usually expressed as concentration thresholds, as shown in table 2, where concentrations are mainly averaged over daily exposure duration (8 hours for OELs, 24 hours for AQGs) and the days of exposure per week (5 days for OELs, 7 days for AQGs) are considered. Most contemporary OELs are health based and set from NOELs with safety factors. Non-occupational air quality guidelines are available for only a few indoor pollutants (U.S. EPA, 2010c). The setting of such guidelines is a tedious process that will take years. Until then, OELs are the best available starting point for deriving substitutes of indoor guideline values for VOCs. However, indoor exposure may last 24 hrs./day, 7 days/week and the exposed population includes infants, elderly, sick and healthy adults, with additional safety factors required (WHO, 2005). When dealing with building materials emissions, multiple chemical exposures is the rule and interactions considered.

There are few available data on toxicological interactions obtained from controlled multiple exposures, although in early toxicological studies additive joint toxicity was found for most combinations of commercial organic chemicals (Plusquellec, et al., 2010). accordingly, several organizations including the (American Conference of Governmental Industrial Hygienists (ACGIH) have adopted the additive approach for deriving OELs for mixtures as a "rule of thumb" (ACGIH, 1996). Research showed scientific arguments fovouring additivity for respiratory tract effects of non-carcinogenic pollutants at low concentration found indoors (Nielsen et al., 1995). Therefore, it is reasonable to adopt the "additive" approach for complex low level exposures which may practically and probably give a reasonable degree of protection (UNEP, 2013).

Table 2: Residence exposure Time of Hazardous Air Pollutants

HAP Group	Indicator Pollutant(s)	Residence Time*	Likely Range of Transport
Mercury	Methylmercury	7–10 days	Local, regional, global
Metals	Arsenic	7-9 days (lifetime)	Local, regional, global
	Beryllium	10 days (lifetime)	Local, regional, global
	Cadmium	1-10 days (lifetime)	Local, regional, global
	Chromium	Up to 7-10 days	Local, regional, global
	Nickel	Up to 30 days (half-life)	Local, regional, global
	Manganese	Several days (half-life)	Local, regional
	Selenium	1-10 days	Local, regional, global
	Lead	Up to 10 days	Local, some regional
Radioisotopes	Uranium, Radium	Not reported	Local, regional, global**
Dioxins/Furans	Chlorinated dibenzo-p-dioxins	0.5 - 9.6 days (lifetime)	Local, regional, global
	Dibenzofurans	4 days (half-life)	Local, regional
	Chlorodibenzofuran (CDFs)	More than 10 days (half-life)	Local, regional, global
Aldehydes	Formaldehyde	<20 hours (half-life)	Local
Volatile Organic Compounds	Benzene	4–6 hour (half-life in presence of NOx and SO_x)	Local
	Xylene	8–14 hours (half-life)	Local
	Toluene	13 hours (half-life)	Local
	Ethylbenzene	2 days (half-life)	Local
Acid Gases	HCl/HF	1-5 days (half-life)	Local, regional, global
	HCN	530 days (half-life)	Local, regional, global
Polycyclic Aromatic Hydrocarbons (PAHs)	Benzo-a-anthracene, Benzo-a-pyrene, Fluoranthene, Chrysene, Dibenzo-a-Anthracene	Up to several days (lifetime)	Local, regional, global

Source: ATSDR, (2011)

Applying this approach for determining the toxic potential of compounds mixture, and individual compounds concentrations divided by respective air quality guideline values added. Typically indoor air contains VOCs each at a low concentration (few micrograms/m3). In view of the limited number of VOCs for which experimental toxicological data exist and OELs have been established, various models have been proposed for predicting toxicological data. These include Quantitative Structure-Activity Relationship (QSAR) models and "guesstimates" based on the similarity of chemical structures. When exposure limits are not available for a chemical substance, it seems to be reasonable to use as a provisional proxy-estimate of exposure limit established for the most similar chemical compound. Among the methods suggested to predict toxic properties of chemicals, a mouse assay has been used for detecting upper respiratory tract irritation (U.S. CDC, 2011). This approach has limited use for predicting more general toxicological properties. A practical way to assess exposure to VOCs is measuring the total concentration of VOCs. TVOC have been measured for various purposes using different techniques which give different results. A new definition of TVOC is presently being developed by an ECA "European Collaborative Actions" expert group; to substituted the existing one. There is a consensus that it is impossible to define an effects based threshold for TVOC. However, there is an agreed need for improved source control to reduce the pollution load on the indoor environment from health, comfort, energy efficiency and sustainability viewpoints. Therefore, TVOC levels in indoor air should be kept "As Low As Reasonably Achievable" (ALARA) and should not exceed the typical levels currently found in non-industrial buildings, i.e. 0.1 - 0.5 mg m" (OMOE, 2009). In order to maintain levels at the lower end of this range, the contribution from a single material should be limited. In a test, 5 mg m" after 3 days, should have fallen to 0.2 mg mm3 after 28 days. Such limits are intended to encourage the production of low-emitting materials. When assessing health risks from chemical exposures, the duration of exposure (whether short or long term) must be consideration. In the case of building materials emissions, consideration should be given to both immediately after the application exposures and exposures occurring weeks/months later, which is representative of long term emission that may continue throughout the lifetime of material. Many health effects are chronic and are induced either by bioaccumulation of toxicant reaching a critical level in the target organ/tissue, or by repeated exposure causing acute incidents which ultimately result to a chronic response (Health Canada, 2010e). In developing the evaluation procedure adopted, the following groups of VOCs have been distinguished: (a) Known/suspected human carcinogens - The carcinogenicity of chemicals to humans can be derived either from human studies/extrapolated from animal studies. For such assessments, the chemical substances have been classified by different organizations into various groups expressing different potential risks for man. The criteria for such classifications were not universally agreed upon, and has resulted in the development of different classification schemes, example, E.U., IARC and U.S. EPA. The cancer risk linked to exposure of carcinogens can be quantified by using the "unit risk" concept (U.S. EPA, 2010c). Unit risks is the excess risk caused by exposure to the unit concentration (LPG m-3) of a substance over a lifetime. Although there are uncertainties in the accuracy of "Lifetime Unit Risk" (LUR) estimates, the LURs can be helpful in public health as it allow at least a relative quantitative assessment of risks. Since the evaluation procedure adopted, it was considered appropriate to use the EU scheme which classifies the carcinogenic substances in three categories (EPA 2003m). For the substances belonging to categories 1 and 2, the unit risk concept applied and considered relevant to this study are those potentially present in VOC emissions.

Sensory Evaluation of Building Materials Emissions

The use of human observers is an indispensable tool for the measurement of sensory effects of indoor air quality because chemical analysis cannot be used to predict how chemicals will be perceived. Chemical methods of characterization are usually unsuitable or insufficient for integrating different types of sensory exposures and effects. So, sensory methods are the only tools available for evaluating perceived air quality. Ideally, the final goal of the sensory evaluation of building materials emissions is to predict from laboratory evaluations guidelines what would provide the criterion for labeling/classification of material. Models are required for predicting human reactions to real life exposures from the results of laboratory tests of individual materials. These models are required to transform sensory source characterizations in small scale settings into sensory characterizations of indoor air quality in full scale, to predict the relation between sensory responses and air pollutant concentrations. To predict the sensory perception of emissions from a combination of sources using individual measurements for each contributing source to predict occupant responses in buildings using laboratory test panel responses. At present no widely accepted and validated models exist. Only in exceptional cases will laboratory evaluations be useful for an estimate of building material emission consequences for perceived air quality in actual environments. Hence, there are no guideline/target values for sensory effects of material emissions, but several approaches are described in literature and used in practice to study the perceived air quality of building material emissions (Gustafsson, 1992). It is intended to measure a broader perceptions range and the approaches are not inter-calibrated. Discomfort (or acceptability) attributed to air quality reflects not only perceptual information but also depends on psychological and social values. So reliable measures of discomfort (or acceptability) are not easily achieved since the outcome, depends on context factors and calibration is difficult. However, a reasonable assumption is that the perceived intensity of odours plays major role in the generation of odour discomfort. Therefore the procedure adopted for this paper, is a simplified, provisional approach to evaluation of sensory emissions from building materials.

Testing Of Sensory Irritation and Odour/Perceived Air Quality

The general requirements for sensory emission tests include: material specimens size and supply, Minimum airflow and test specimen area: Test chamber cleanliness and Exposure equipment. The evaluation procedure proposed is to identify "healthy" building materials. The indoor materials emissions should not induce sensory irritation. Due to the large variations of residents' sensitivity, the requirement needs to be specified in terms of a defined maximum percentage of inhabitants that perceive sensory irritation from the material emission. In view of the lack of sensory emission standards methods, it is appropriate to base the evaluation criterion on the recommendation of World Health Organization that indoor air pollution sources should not cause more than a maximum of 10 % of building occupants to perceive sensory irritation. (WHO, 2005) Accordingly, a material will only be eligible to receive label based on the procedure, if not more than 10 % of the test panel members (i.e. one out of 10-15 panel members) assessing the material emission perceived sensory irritation. Chemical emissions are usually highest for new materials and reduce with time, but because the people installing materials should be protected from irritation, the sensory irritation test should be done early in the test procedure and the test panel members should be protected from inhaling carcinogenic compounds. So, the test has to be performed on the third day, after the introduction of the test specimen in the test chamber. Still, the material has to be tested with clean air flow through the test chamber corresponding to an area specific ventilation rate q, [m3 h-'m-] and the same as selected for the evaluation of chemical emissions. The test conditions are intended to reflect low-medium ventilation rates. The perception of sensory irritation, contrary to perceived odour, may increase with exposure time. There is neither any standard method for characterized odour /perceived air qualities caused by material emissions nor are there guideline/limit values for the sensory effects of these emissions. Moreover, in contrast with sensory irritation, odour and air quality causing discomfort for some people may be perceived as indifferent or even pleasant by others. Hence, it is inappropriate to exclude materials from labeling based on simple detection of sensory characteristics. Alternatively, strong and longer lasting odours may be intolerable to most people and the presence/strength of odorous emissions may be an argument for the choice of building materials by consumers. Therefore, the evaluation procedure of material emissions described has to include 28th day after the introduction of test specimen in the test chamber, a sensory test of odour/perceived air quality. The result of the test should enable consumers to compare the emissions from different materials, or to rank the materials, based on odour detectability, perceived odour intensity, percentage of test panel members dissatisfied with the perceived air quality/equivalent quantities. So the authority establishing/granting a label should select and prescribe an appropriate test method to study odour and perceived air quality of building material emissions.

REMEDIES

The research examined remedy firstly as the solution to SBS, BRI and BAS for Nigerian city residents, this includes; Maximum natural daylight, Maximum ventilation, Eliminate pollution source, Removal/modification pollutant source identified, Formulate Policies to control haphazard informal settlement, Establish machineries to drive policies compliance and implementation, Institute task force to drive strict building laws and regulation compliance, Ensure sustainable and eco-friendly materials usage, Remove lead from paint, De-lead the houses, and Develop community consumer initiatives and regulatory processes to support the reforms, (Ettinger A.S., et al., 2002). And secondly as prevention and management which includes; **Education and Communication:** are key aspects of any air quality management programme. To effectively prevent/manage the health challenges caused by SBS, BRI and BAS, educational/awareness programmes should be organized frequently by concerned agencies to enlighten all parties in building industry (U.S. CDC, 2006). **Legislation:** Habits and sources of pollutions that distort airflows and ventilations in indoor spaces should be stopped. Laws prohibiting the use of building materials and environment containing pollutants should be enforced. **Research:** continuous research on health and built environment to manage issues surrounding public health should be encouraged. **Ventilation Rate and Air Distribution:** Buildings in tropics (e.g. Nigeria) should be designed to allow cross and true ventilation. Where it is near impossible unplanned environment, heat ventilation and air-condition (HVAC) system should be operated to ensure that the desired ventilation rate is attained. If there are strong pollutants inside the buildings, the air should be expelled outside. The American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE) recommend a minimum of 8.4 air exchange per 24hours. **Air Cleaning and Control:** Air cleaning can be performed by ensuring uncongested interiors, terrace garden, community spaces, use of glass and skylights for natural light, indoor plants to absorbs carbon monoxide and formaldehyde from the air, and Air filters to remove pollutants. **Removal/modification of Pollutant Source:** This is done through routine maintenance, replacement of damage/affected building materials in floors, ceilings, roofing and walling, unplug idle devices, use vent contaminants outside and use pollutants sources in low/no occupancy periods and allow time for building materials in new houses to be off-gas pollutants before occupancy. **Environment Beautification with Air Cleaning Plant:** With technological advancement and energy efficient, buildings are becoming airtight drain of germs and toxins. Sick building causes an estimated loss of productivity and medical costs over $61 billion per year. National Aeronautics and Space Administration studies found that plants work in a symbiotic relationship to remove air pollutants produced by people, industries etc. Every tropical foliage and flowering plants works to remove pollutants from the interior spaces and some plants are better at removing certain toxins (Wolverton, 1990). Therefore the environment should be beautified with air cleaning plant both inside and outside to prevent and manage air pollution.

CONTRIBUTION TO RESEARCH AND PRACTICE

The study has evaluate building materials in order to determine the chemical emissions and this was intended to help prevent building associated health issues and improve life-expectancy amongst Nigerian. Therefore the research result and documentation would help all key actors in the building industry to make informed choice relation to usage of building materials.

CONCLUSION

The research has shown that BRI, SBS and BAS are consequence of indoor air pollutants from building materials which are threat to health and longevity. Since building materials are product of chemical compounds and reactions, it becomes imperative to have a working knowledge of materials used for building construction. The paper has itemized and evaluates the causes and effects of SBS and BRIs as emissions from building materials. In the process, a generally applicable non-validated evaluation procedure for building materials emission was adopted. Hence, exactness of such procedures still requires further research. Meanwhile, the used of several buildings materials for construction without estimating their impact on health and comfort has resulted in the use of evaluation procedure proposed by Steering Committee of the European Collaborative Action (ECAIAQ). The study employed the evaluation scheme to compare, classify and label building materials based on their VOC emissions, and to inform the consumer of building materials that will likely have adverse affect their health and sensory comfort as far as chemical emissions are concerned. Thus reduce the risk to health and threat to life caused by poor choice of building material amongst Nigerian urban dwellers . It is primarily expected to inform occupants, home owners, government, environmental health personnel and policy-makers who are not laboratory specialists

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