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PERCEIVED INDOOR AIR QUALITY OF FRESH CEMENT-SAND SCREEDED CAMP DORMITORY IN OSUN STATE NIGERIA

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Abstract – Building materials and construction products constitute potential sources of indoor pollutants especially when they are still fresh in construction or new in installation. Studies have affirmed the possibility of emission of toxic substances into such spaces. Occupying a building of this status might impact user's health and comfort negatively. This study seeks to understand the perception of the occupants with respect to the indoor air quality within fresh cement-sand screeded camp dormitory. Structured questionnaire was administered on 50% of the respondents residing in the religious dormitory during a week long program in early April 2021. The result of the analysis shows that the overall assessment of ventilation of the dormitory to be good, to the tune of 37 (41.6%). 15 (16.9%) adjured the air flow to be very good while 19 (21.3%) were neutral in their opinion. Other indoor air quality parameters were mostly adjured neutral. It is therefore recommended that Ventilation design for residential dormitory and any other similar scheme is of paramount importance and as such Architects should consciously address it based on the users' population per floor area and the expected indoor activities.

Keywords: Cement-sand screeding, Dormitory, Indoor air quality, Perception

1. Introduction

The importance of indoor air quality has been noted on human comfort, health and performance of indoor activities. This is due to the fact that human being spends most time indoors (Kraus and Senitkova, 2019). Indoor air quality has a direct link to the concentration of pollutants in the indoor spaces. Meanwhile, the quality of the indoor environment depends on the level of ventilation intensity. Efficient ventilation design will dilute, remove or reduce the concentration of indoor-generated pollutants from the indoor environment.

There have been several investigations on the different subjects on the quality of indoor air in various building types especially residential buildings. However, only few studies have explored residential dormitory. For instance, Albadra et al., (2020) focused on refugees' camp dormitory in three continents excluding Africa. Isa, (2010); Kocaman., Sezer and Cetinkol, (2017) and

Yang, Shen, and Zhi Gao, (2018) all explored Students dormitories in different Universities. None of these studies undertook investigation in religious camp dormitory with different spatial organization and high users' population compared to other forms of dormitory. Therefore, current study seeks to investigate the perception of the occupants with respect to the indoor air quality within the fresh cement-sand screeded camp dormitory.

According to Kraus and Senitkova, (2019), exploring Chemical and sensory assessment of an indoor environment will contribute to the knowledge of the state of the indoor environment and provide useful information for design and construction guideline for similar development in the future.

2.0 Literature review

Perceived Air Quality (PAQ) is an important factor in assessing the indoor environment since it employs sensory quality assessment based on air acceptability, odour intensity and percentage of dissatisfied. Temperature, relative humidity and air quality affect the user's sensory system using receptors and create the overall impression of perception of the quality of the indoor environment (Kraus and Senitkova, 2019)

Sources of indoor pollution include tobacco smoking, dampness, cooking, indoor burning of solid fuels, dust, chemicals from building materials and coatings, furnishings, aerosol sprays, and cleaning products. Based on the submission of notable environmental assessment schemes like LEED, indoor air quality is determined by the

nature of pollutants, sources, construction materials, building designs and locations.

Indoors building materials, products and equipment, such as paints, carpets, PVC, solvent, adhesives and coatings have been noted to be prominent source of Volatile organic compounds emission in the indoor space (*Mtani, 2019;* Kraus and Senitkova, 2019).

WHO, (2010) certifies that major sources in non-smoking environments air pollution appear to be building materials and consumer products that emit formaldehyde. This applies to new materials and products; however, it can last several months, particularly in conditions with high relative humidity and high indoor temperatures WHO, (2010). The re-emission of adsorbed VOCs by the building materials can dramatically increase VOC concentrations in the indoor environment for months or years after a source event (Mtani, 2019). The places high responsibility on the Architects and designers on building material specifications that can assist in eliminating odour and harmful pollutants, increase thermal performance, and reduce indoor pollution. Architects and designers can select materials that do not produce irritating odour or VOCs, (Mtani, 2019).

Table 1: Indoor air pollutants, their sources and risks on humans under short -term or long-term exposures

Indoor air pollutants	**Sources of Indoor air pollutants**	**Risks pose on humans under short-term or long-term exposures**
Carbon Monoxide (CO)	Carbon Monoxide (CO) Produced by incomplete combustion of fossil fuel.	Stops your body from using the oxygen it needs to work normally. (Headaches, dizziness, nausea, confusion, fast heart rate.)
Radon	It is found everywhere in low levels. It is made naturally as the uranium in the earth breaks down.	Increases your risk of getting lung cancer.
Nitrogen Dioxide (NO2)	A common oxide of nitrogen. It is a toxic and corrosive gas.	Exposure to very high doses of NO2, such as at the site of a building fire, can lead to pulmonary edema (potentially fatal liquid build-up in the lungs) or lung injury. Moderate exposure can lead to acute or chronic bronchitis. Low-level exposure can impair lung function for people who are already at risk, such as asthmatics, people with chronic obstructive lung disease, and children.
Secondhand smoke	Incompletely burned tobacco products.	Eye, throat and nose irritation. In the long-run it can cause the same health effects as smoking, like wheezing, pneumonia, bronchitis, lung cancer.
Lead particles	House paint	Brain, nervous system, kidneys, and red blood cells damage. If children are exposed, they can develop short attention span, behavioral problems, lower IQ levels, and delayed growth.
Asbestos	Used for a group of minerals found naturally all over the world.	In the long-term, exposure to asbestos can lead to various lung disorders, including lung cancer, and asbestosis (an inflammatory condition of the lungs that causes coughing, trouble breathing, and permanent lung damage.)
Mold	Are types of fungi that grow indoors and outdoors.	Mold can trigger an allergic reaction in some people. Symptoms can include nasal stuffiness, eye or throat irritation, swelling, coughing or wheezing, headaches or skin irritation.
VOCs	Perfumes, hairsprays, furniture polish, cleaning solvents.	Eye, nose, and throat irritation; headaches, loss of coordination, nausea, and damage to the liver, kidney, and central nervous system
Formaldehyde	Particle Board, interior grade plywood, furniture.	Coughing, wheezing, chest pains, and bronchitis
Pesticides	Insecticides, disinfectants, consumer products, dust from outside.	Cancer, inability to breathe, weakness of muscles, apaxia and neurological problems

Source: Manar Fawzi Bani Mfarrej et al., (2017)

Human exposure to harmful indoor substances has been conceived in two perspectives: they are: instantaneous and chronic exposure (Śmiełowska, Marć and Zabiegała, 2017). Wolkoff, (2013) put these ideas as acute perception (on entering a building) and delayed perception (that may build up over the time). In the context of health effects, the type of volatile chemical compounds to which a person is exposed is also important.

Also, it has been noted that an increase of the room temperature in the course of the day may constitute additional risk factors (Wolkoff, 2013). Exposure to indoor pollutants is potentially associated with sick building syndrome (SBS) and this becomes obvious when occupants of such building experience health problems of unknown causes (Khalafalla et al., 2018). It has been speculated that daily repeated exposure to low-dose indoor pollutants may increase the sensitivity of the airways (Wolkoff, 2013). Exposure to indoor air pollutants can produce a variety of respiratory health symptoms depending on the mode, duration and concentration of exposure. The development of respiratory health symptoms is also influenced by the health status, age, smoking status and work-related activities in the indoor spaces (Jalaludin, Nordiyana and Suhaimi, 2014).

3.0 Materials and method

The aim of this study is to assess users' perception of indoor air quality of fresh cement-sand screeded camp dormitory. The study was carried out between late dry season and early rainy season in April 2021. Questionnaires were administered on 50% of the respondents who were resident in the camp dormitory during the yearly religious event. This amount to a total of 107 questionnaires. Out of this number, 89 questionnaires were retrieved making 83%. The questionnaire solicited information on three major aspects: respondents demographic and health history, perception of dormitory air quality parameters (air movement, air temperature, relative humidity, odour and dust) and feeling of any negative experience during the period of occupation and just after existing the dormitory. The information gathered were subjected to descriptive statistical analysis using SPSS.

4.0 Results and discussion

4.1 *Respondents' socio-demographic characteristics and health history*

Respondents' gender analysis reveals that, 29 (32.6%) are male and 60 (67.4%) are female. The highest age range of the respondents indicates 42 (47.2%) to be between 21-25 years. This is due to the fact that the respondents were essentially University undergraduates. Out of the respondents, 67 (75.3%) have been staying in the dormitory more than four hours as seen in table 2. Respondents length of stay will inform good assessment of the indoor environmental condition.

On previous allergy to unpleasant environmental odour and dust, 62 (69.7%) were not allergic to unpleasant environmental odour while 27 (30.3%) were. 57 (64.0%) were not allergic to unpleasant environmental dust, while 32 (36%) were.

Table 2: Duration of stay in the dormitory

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0-29mins	1	1.1	1.1	1.1
	30mins - 1Hr	11	12.4	12.4	13.5
	1-2 Hrs	3	3.4	3.4	16.9
	2-3Hrs	2	2.2	2.2	19.1
	3-4Hrs	5	5.6	5.6	24.7
	Above 4 Hrs	67	75.3	75.3	100.0
	Total	89	100.0	100.0	

Source: Authors field work, 2021.

Table 3: Any previous diagnosis of asthma or cancer?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	2	2.2	2.2	2.2
	No	86	96.6	96.6	98.9
	3	1	1.1	1.1	100.0
	Total	89	100.0	100.0	

Source: Authors field work, 2021.

Table 4: Description of current state of health

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very healthy	70	78.7	78.7	78.7
	Slightly healthy	8	9.0	9.0	87.6
	Neutral	8	9.0	9.0	96.6
	Slightly illed	3	3.4	3.4	100.0
	Total	89	100.0	100.0	

Source: Authors field work, 2021.

As shown in tables 3 and 4. Great numbers of the respondents 86 (96.5%) have never been diagnosed with either asthma or cancer previously. In the same vein, 70 (78.7%) remarked that they were very health while the study was being carried out. These results indicate that the assessment of indoor air quality of the respondents have no serious link with any previous ailments or the other.

4.2 Respondents' assessment of the indoor air quality parameters of the dormitory

Table 5 shows highest respondents' assessment of the overall ventilation of the dormitory to be good, to the tune of 37 (41.6%). 15 (16.9%) adjured the air flow to be very good while 19 (21.3%) were neutral in their opinion.

The air temperature assessment of the dormitory was noted by the most of the respondents' 25 (28.1%) to be neither cold nor hot but neutral. Meanwhile, 21 (23.6%) said it was slightly warm while 11 (12.4%) informed that it was slightly cool, see table 6. Explanation for this divergent view could be based on the time each respondent filled the questionnaire. Also, perhaps due to the fact that the dormitory is cited very close to swampy area which could influence the local climate at different time of the day.

Table 5: How would you rate overall air flow in this space?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Excellent	9	10.1	10.2	10.2
	Very good	15	16.9	17.0	27.3
	Good	37	41.6	42.0	69.3
	Neutral	19	21.3	21.6	90.9
	Very poor	7	7.9	8.0	98.9
	7	1	1.1	1.1	100.0
	Total	88	98.9	100.0	
Missing	System	1	1.1		
Total		89	100.0		

Source: Authors field work, 2021.

Table 6: How would you rate overall air temperature in this space?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Hot	2	2.2	2.2	2.2
	Warm	9	10.1	10.1	12.4
	Slightly warm	21	23.6	23.6	36.0
	Neutral	25	28.1	28.1	64.0
	Slightly cool	11	12.4	12.4	76.4
	Cool	20	22.5	22.5	98.9
	Cold	1	1.1	1.1	100.0
	Total	89	100.0	100.0	

Source: Authors field work, 2021.

Table 7 below reveals that the largest respondents 69 (77.5%) were neutral in their view about the assessment of the relative humidity of the dormitory. In the same vein, as indicated in table 8, most of the respondents 50 (56.2%) were neutral in their opinion about the odour/smell of the dormitory. However, 22 (24.7%) felt that the odour was good while 14 (15.7%) noted that it was very good. The popular opinion about the dust equally shows the same trend, most respondents 27 (30.3%) were neutral, 25 (28.1%) indicated that it was slightly dusty, while 20 (22.5%) observed that it was highly clean. There is tendency of being bias responses in the opinion of the respondents. See table 9.

Table 7: How would you rate overall air humidity in this space?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Humid	3	3.4	3.4	3.4
	Slightly humid	5	5.6	5.6	9.0
	Moderate	69	77.5	77.5	86.5
	Slightly dry	6	6.7	6.7	93.3
	Dry	5	5.6	5.6	98.9
	Very dry	1	1.1	1.1	100.0
	Total	89	100.0	100.0	

Source: Authors field work, 2021.

Table 8: Rate your perception of odour/smell in this space

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very good	14	15.7	15.7	15.7
	Good	22	24.7	24.7	40.4
	Neutral	50	56.2	56.2	96.6
	Bad	3	3.4	3.4	100.0
	Total	89	100.0	100.0	

Source: Authors field work, 2021.

Table 9: Rate your perception of dust in this space

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Highly dusty	2	2.2	2.2	2.2
	Slightly dusty	25	28.1	28.1	30.3
	Neutral	27	30.3	30.3	60.7
	Slightly clean	15	16.9	16.9	77.5
	Highly clean	20	22.5	22.5	100.0
	Total	89	100.0	100.0	

Source: Authors field work, 2021.

4.3 Respondents' feelings of negative experience in and just after exiting the dormitory.

Out of the six negative feelings investigated in the study, only three received a fairly positive response. These are feelings of fatigue, dizziness and dust irritation. Others, breathing difficulty, efficiency decrease and irritable feeling were either rare or very rare to most of the respondents. Table 10 shows that most respondents very rarely felt fatigued 34 (38.2%). But 21 (23.6%) sometimes feel fatigued. This suggest a situation of appreciably good ventilation design in the dormitory such that the impacts of the freshness of its wall screeding construction and incomplete state of floor finish could hardly be felt.

The same trend was observed in the assessment of the feeling of dizziness and dust irritation as shown in tables 11 and 12.

Table 10: Frequency of feeling of fatigue in this space

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very often	5	5.6	5.7	5.7
	Often	7	7.9	8.0	13.6
	Sometimes	21	23.6	23.9	37.5
	Rare	21	23.6	23.9	61.4
	Very rare	34	38.2	38.6	100.0
	Total	88	98.9	100.0	
Missing	System	1	1.1		
Total		89	100.0		

Source: Authors field work, 2021.

Table 11: Frequency of feeling of Dizziness in this space

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very often	5	5.6	5.6	5.6
	Often	4	4.5	4.5	10.1
	Sometimes	15	16.9	16.9	27.0
	Rare	24	27.0	27.0	53.9
	Very rare	41	46.1	46.1	100.0
	Total	89	100.0	100.0	

Source: Authors field work, 2021.

Table 12: Frequency of feeling of Dust irritation in this space

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very often	3	3.4	3.5	3.5
	Often	5	5.6	5.9	9.4
	Sometimes	22	24.7	25.9	35.3
	Rare	20	22.5	23.5	58.8
	Very rare	35	39.3	41.2	100.0
	Total	85	95.5	100.0	
Missing	System	4	4.5		
Total		89	100.0		

Source: Authors field work, 2021.

Respondents assessment of the feelings of negative experience just after exiting the dormitory equally follow the same trend for those feelings reported. Most of the respondent's feelings of fatigued stayed the same after exiting the dormitory 61 (68.5%), 19 (21.3%) felt better of after exiting the dormitory.

Table 13: How would you describe your feeling of fatigue just after existing the dormitory

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	More severe	4	4.5	4.5	4.5
	Stay the same	61	68.5	68.5	73.0
	Better	19	21.3	21.3	94.4
	Completely disappear	5	5.6	5.6	100.0
	Total	89	100.0	100.0	

Source: Authors field work, 2021.

Table 14: How would you describe your feeling of dizziness just after existing the dormitory

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	More severe	3	3.4	3.4	3.4
	Stay the same	67	75.3	75.3	78.7
	Better	14	15.7	15.7	94.4
	Completely disappear	4	4.5	4.5	98.9
	42	1	1.1	1.1	100.0
	Total	89	100.0	100.0	

Source: Authors field work, 2021.

Table 15: How would you describe your feeling of dust irritation just after existing the dormitory?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	More severe	1	1.1	1.2	1.2
	Stay the same	65	73.0	75.6	76.7
	Better	17	19.1	19.8	96.5
	Completely disappear	3	3.4	3.5	100.0
	Total	86	96.6	100.0	
Missing	System	3	3.4		
Total		89	100.0		

Source: Authors field work, 2021.

5.0 Recommendation and conclusion

Based on the findings reported above, the authors submit as recommendation as follows:

- Ventilation design for residential dormitory and any other similar scheme is of paramount importance and as such Architects should consciously address it based on the users' population per floor area and the expected indoor activities.
- Natural ventilation should be of high priority even if the client has the means to finance other ventilation design means especially in religious dormitories.
- Effective ventilation design in a dormitory should prioritize functional and efficient window design type with appropriate material over the crave for aesthetics to the deprivation of functionality. However, a good blend of both is desirable where achievable without a compromise of functionality.

In conclusion, sustainable development goal drives at achieving optimum quality of the internal environment with minimum operational and investment costs. Chemical and sensory assessment of the indoor environment of existing buildings is an important source of essential information for the design and construction of new buildings and their sustainability.

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