# ASSESSMENT OF NATURAL VENTILATION ON HUMAN COMFORT: A CASE STUDY OF BELLS UNIVERSITY ARCHITECTURAL DESIGN STUDIO (GLASSHOUSE)

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**Abstract**

Natural ventilation can provide building occupants with thermal comfort and a healthy indoor environment. The time students spend in a studio environment affects the school's internal environmental quality (IEQ), which affects student health, attitudes and performance. The study also assesses the glass house's current natural ventilation (M.Sc. Studios) in a view to recommend additional natural ventilation options. The study utilizes both quantitative (questionnaires) and direct observation. The questionnaires were distributed among the primary users of the space which includes MSc students and lecturers. After data analysis, the efficacy matrix was created as an average of all respondents. It was discovered that natural air had a substantial impact on the Master's students. Findings revealed that with optimal ventilation, you can reduce the concentration of pollutants inside and improve the air quality (IAQ) inside the building as they are more likely to become fatigued or lose focus when working in a hot studio. In this study, we examined ways to make Glass House a conducive learning space for both current and prospective students. Design studios must adhere to strict construction standards to ensure students have a conducive learning environment. The study therefore recommends more shrubs, understory trees; canopy trees and ground cover are to be planted around the building to provide some coolness to the building also Photochromic glazing, which changes transparency depending on the intensity of the light and thermochroic glazing that becomes darker when it is hot could be introduced.

**Keywords: Natural ventilation, Sustainable architecture, Indoor atmospheric conditions, stack cross-ventilation, Spatial anthropometry**

## 1.0 Introduction

Ventilation in architecture entails bringing in outside air and dispersing it throughout the area. The three most common varieties are mechanical, natural, and mixed-mode. A comfortable atmosphere depends on managing the air exchange and circulation with the outdoors. The deliberate process of introducing "clean" air—typically outdoor air—while removing stale air is another definition of ventilation.

## 2.0 Literature Review

### 2.1 What is an Architectural Design Studio?

An architect's studio also called an architectural studio is a room designated for drafting designs for various kinds of structures and the areas around them. Every architect employed by a typical architectural firm will have access to a studio space of some sort. There is often only one architect in the studio, which offers freedom from several outside distractions. Examples of architectural studios demonstrate how multiple architects can collaborate in the same space at the same time.



### 2.2 What is Indoor Air Quality (IAQ)?

The phrase "Indoor Air Quality" (IAQ) describes the air quality inside and outside buildings and other structures, focusing on how it affects the health and comfort of occupants. By identifying and managing common indoor pollutants, you can reduce the chance of indoor health problems. The health effects of exposure to indoor air pollution can be immediate or years later.

Pressure differences are used by natural ventilation systems to circulate fresh air inside structures. Pressure variations can be brought on by the wind, the buoyancy effect brought on by temperature or humidity variations, or both. In both cases, the ventilation will be strongly influenced by the size and position of the building's openings. You can think of a natural ventilation system as a circuit that considers both supply and exhaust equally. Openings such as transom windows, louvres, grills, or open plans are utilized between rooms to complete the airflow circuit through a building (Heracleous .C, Michael . A, 2019).

## 3.0 Study Area

Glasshouse is a building located at Bells University of Technology, Ota, Ogun State, where both master's level students of architecture receive lectures.

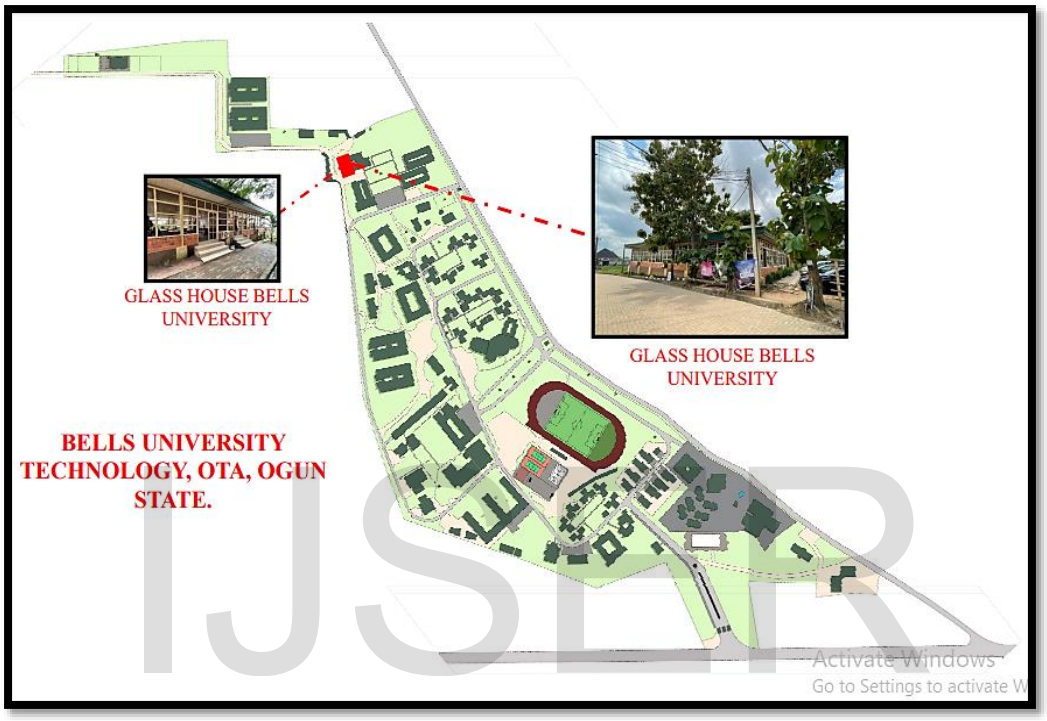


**Plate 1: Map of Bells University of Technology, Ota showing highlighted location of Glasshouse. Source: Researcher's Fieldwork, 2022**

The building has a panoramic view of its environment because it features a lot of glazing, supported by steel frames, which can be seen in the image below. Ogun State is a State located in southwestern Nigeria, as stated in its geographical description. The Atlantic Ocean borders it on the south, the Republic of Benin on the west, Lagos State on the east, Oyo and Osun States on the north.

## 4.0 Types of Natural Ventilation Effects

The leeward side and the top of the building contain vents that allow air to escape, and the windward side has openings in the wall that let air in. The heated inside air may ascend and escape from the ceiling or ridge and enter via lower openings in the wall as a result of temperature differences between the warm interior air and the cool external air. Similar to how a

pressurized column of dense, evaporative cooled air can give room while lighter, warmer, humid air can exhaust towards the top, buoyancy brought on by changes in humidity can similarly achieve this. Below is further information on the various effects of natural ventilation.

### 4.1 Wind

Wind has an impact on buildings because it generates positive and negative pressure on the leeward and windward sides of a structure, respectively. Any opening to the windward side will allow fresh air to enter, which will then be expelled from the leeward side to balance the pressure. On occasion, wind flow will be stronger against a building wall than perpendicular to it. In this circumstance, wind ventilation may still be created via architectural features or the way a casement window opens. The space between the windward inlets and the leeward exhaust ports must be kept free of obstructions. Walls that oppose the airflow should not be present in a room. To encourage more mixing and increase the ventilation, the appropriate design, on the other hand, prohibits inlet and outlet windows from being directed across from one another (you should not be able to look through the building, in one window and out the other).

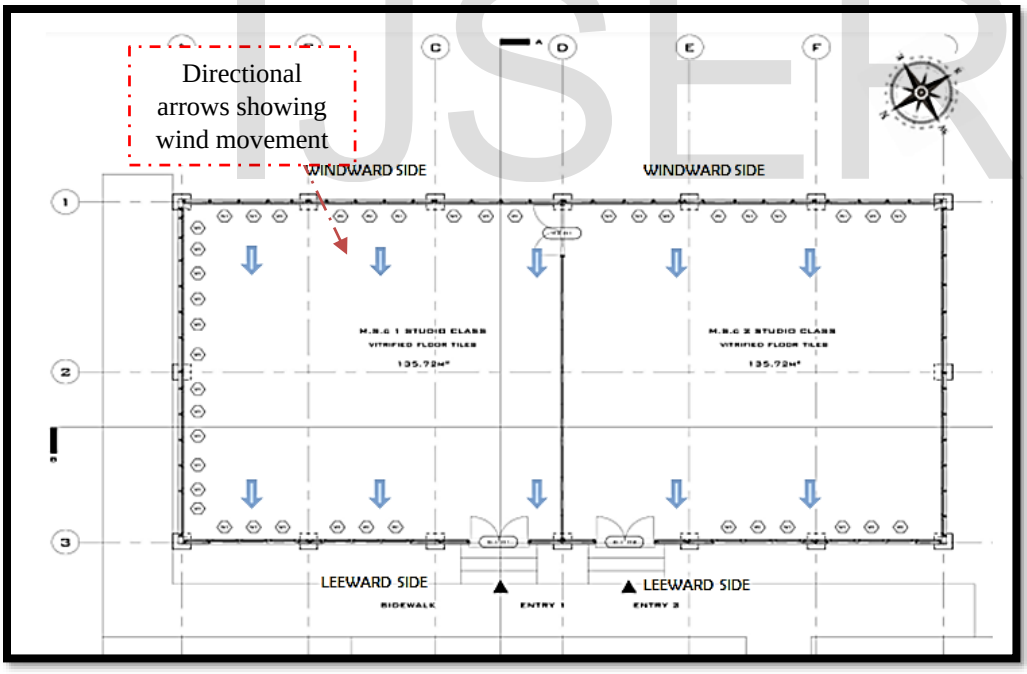


**Plate 2: Wind direction from the windward side of the building to the leeward side of Glasshouse building. Source: Researcher's Fieldwork, 2022**

### 4.2 Buoyancy

What is buoyancy ventilation?

The upward force that an object experiences from the air it displaces is known as buoyancy. In essence, your object (i.e., weights) is displacing air, which makes them lighter since the air is pulling up on your weights with a force equal to how much air they displaced. (Richard Hogan,2021).

### 4.3 Stack Effect

Tall buildings experience the stack (or chimney) effect when the interior temperature is significantly lower than the exterior temperature. Due to the fact that hot air rises, the interior air is buoyant and presses upward to leave the structure through a variety of openings on the top floors. Because there is no stack cross ventilation in glass houses, the hot air cannot leave, which results in a very humid environment that makes students sweat and feel uncomfortable. Due to the stack effect, the heated air that has risen then falls back down and combines with the fresh air that is coming in. Awning windows should be inserted at the top casement of the curtain walls to allow hot air to escape. Higher headroom of about 3500mm will help with the atmospheric condition of the building.



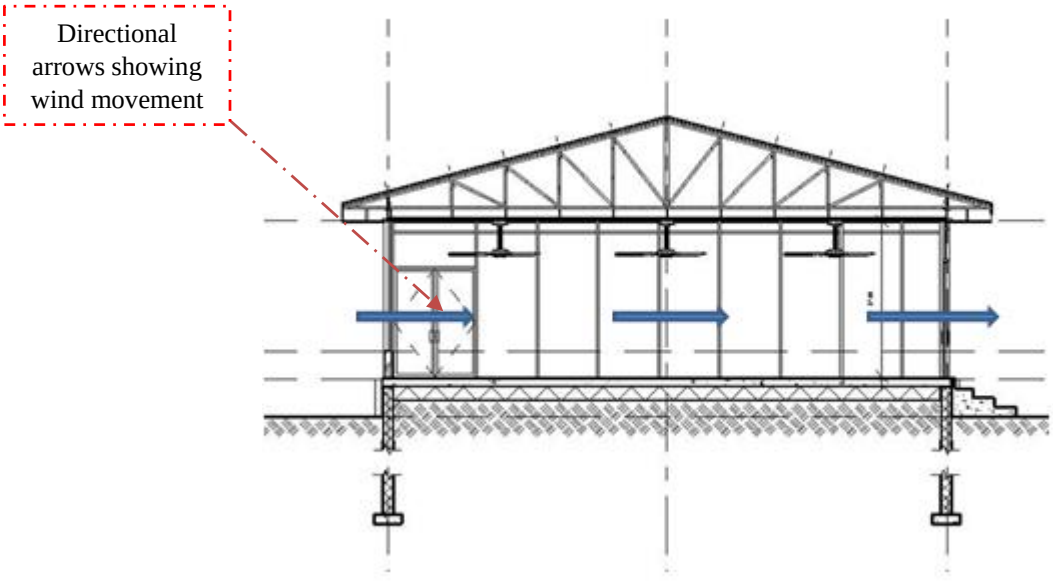


**Plate 3: Wind direction within the studio. Source: Researcher's Fieldwork, 2022**

## 5.0 Methodology

The study makes use of both quantitative studies and direct observation. The foundation of data collecting for analysis is made up of primary and secondary sources. Direct observation served as the foundation for the data's primary source, while a structured questionnaire served as its secondary source.

### 5.1 Data Analysis and Results

**Table 1: Identification of the natural Means of Ventilation at Glass House (MSc.1 Design Studio), Bells University, Ota, Ogun State.**

| Natural Ventilation Methods | Type | Frequency | Height(mm) | Width(mm) |
|---|---|---|---|---|
| Large Sliding Windows | Sliding Window | 14 | 1500mm | 2550mm |
| Large Casement doors | Double Swing | 2 | 2100mm | 1800mm |

**Source: Researcher's Fieldwork, 2022**

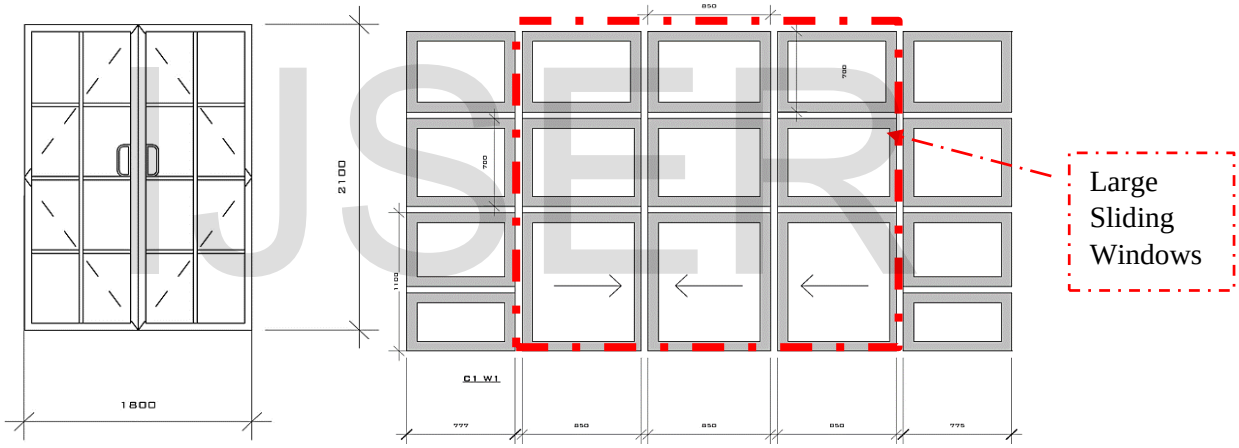


**Plate 4. Large double swing casement doors and the sliding window of the Glass house.**

**Source: Researcher's Fieldwork, 2022**

A comprehensive description of the natural ventilation techniques used in the glass house, together with their type and frequency, are shown in Table 1 above. There are 2 double swing casement doors and 14 large sliding casement windows.

### 5.2 CASE STUDY

**Plate 5: Exterior View of Glasshouse. Source: Researcher's Fieldwork, 2022**

**Plate 6: Interior View of Glasshouse. Source: Researcher's Fieldwork, 2022**

**Plate 7: Sliding Window, Means of Natural Ventilation in Glasshouse.Source: Researcher's Fieldwork, 2022**

**Plate 8: Large Double Swing Casement Doors at Glasshouse.Source: Researcher's Fieldwork, 2022**

Questionnaires were carefully created, which were then used to evaluate the effectiveness. The sample size, 51 respondents, includes MSc students, lecturers, and regular building occupants.

The following results were obtained from 51 respondents which show bar charts and pie charts which indicate the various comfort and learning levels that impact the users of glass house.



**5.3 Demographics**

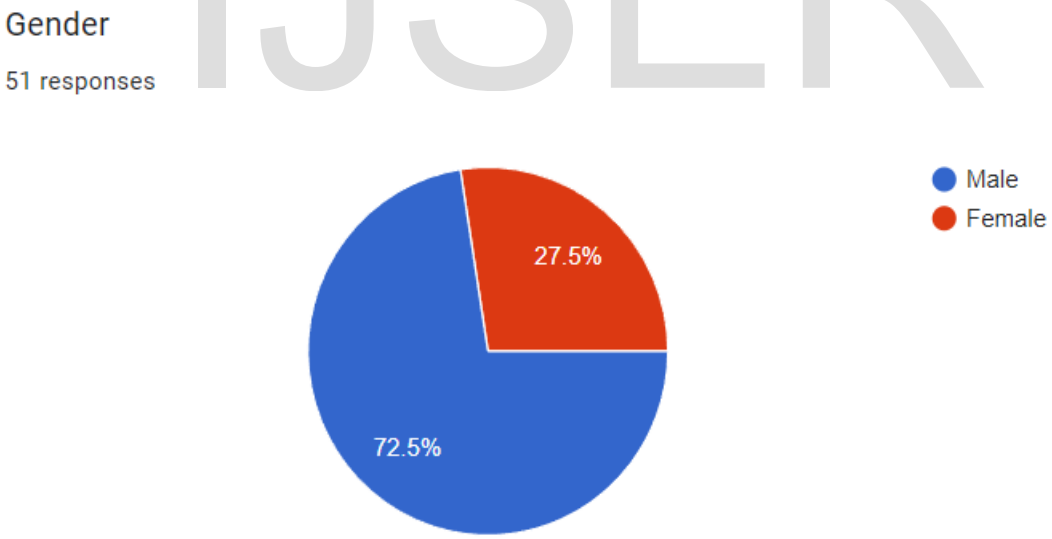


**Plate 9: Pie Chart – Gender. Source: Researcher's Fieldwork, 2022**

A high percentage of master's students who use the glass often are male (72%) compared to female students (27.5%).

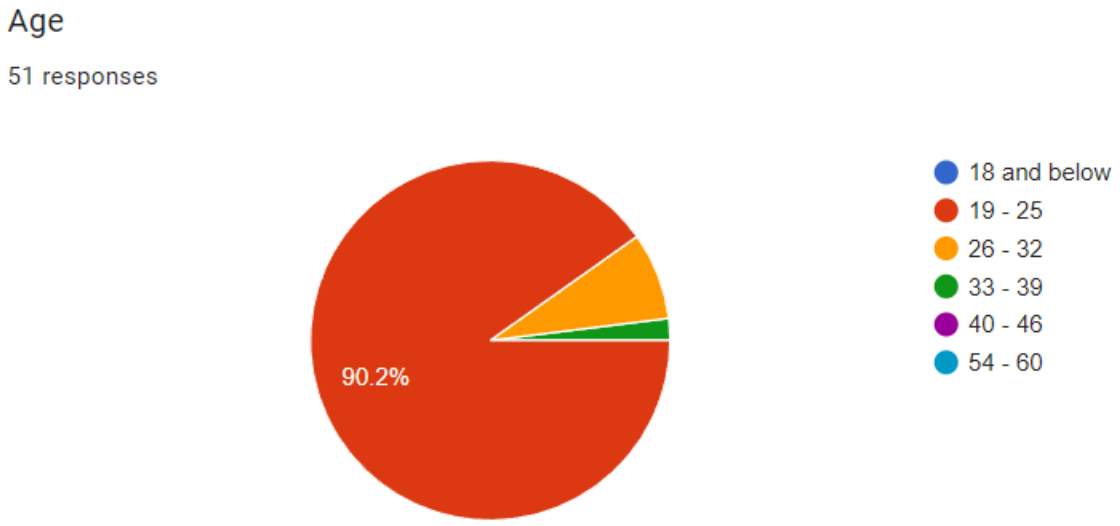


**Plate 10: Pie Chart – Age. Source: Researcher's Fieldwork, 2022**

A high percentage of master's students between the ages of 19-25 are predominant in the M.S.c level with a (90.2%) population.



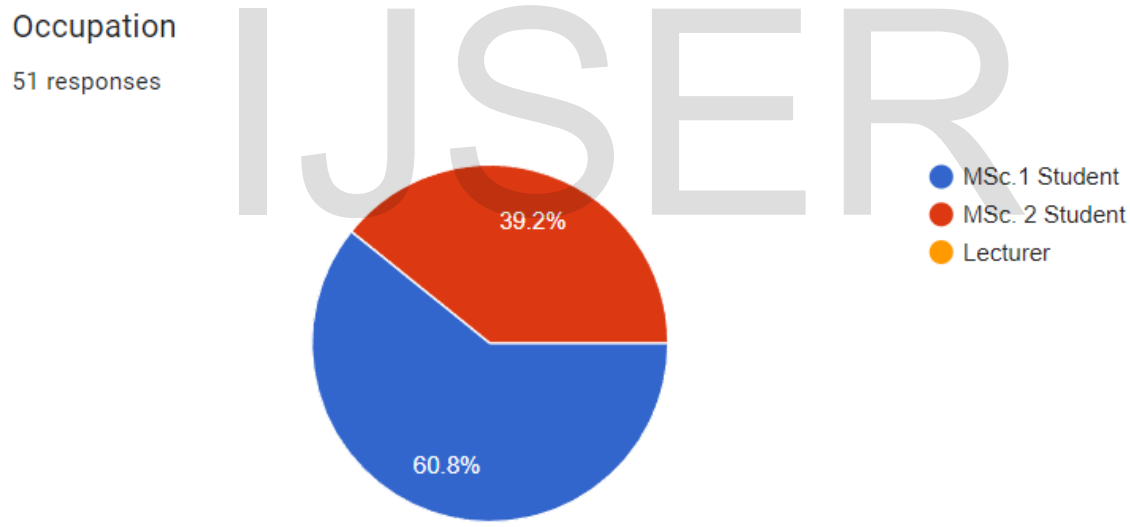


**Plate 11: Pie Chart –User. Source: Researcher's Fieldwork, 2022**

A high percentage of master's students in M.S.c 1 was recorded with a (60.8%) population while M.S.c 2 has a population of (39.2%).

## 5.4 Ventilation Impact Analysis

**Question 1**

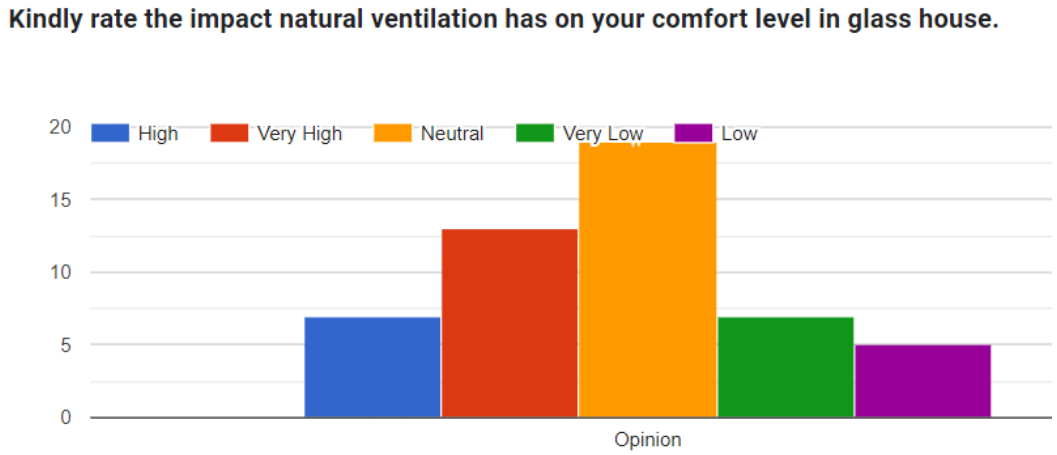


**Plate 12: Bar Chart – Kindly rate the impact natural ventilation has on your comfort level in glass house. Source: Researcher's Fieldwork, 2022**

**Question 2**

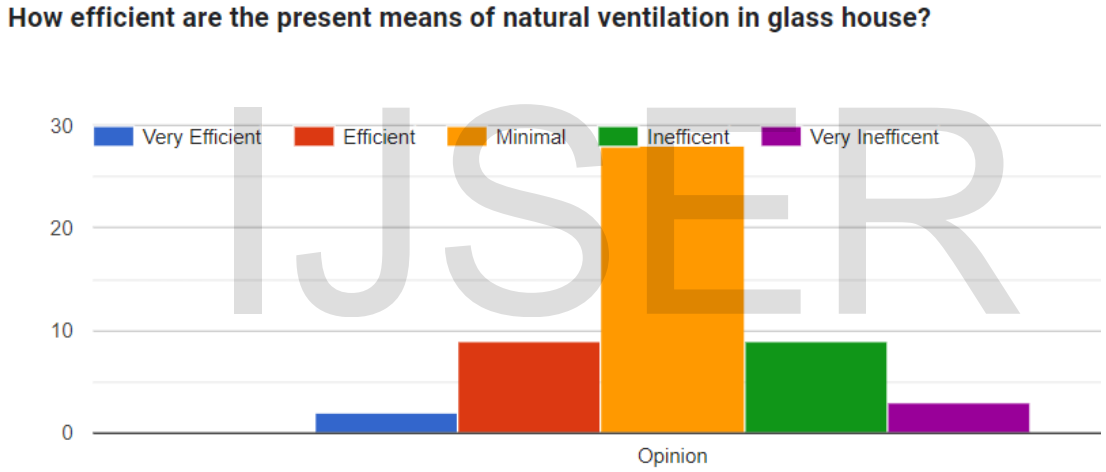




**Plate 13: Bar Chart – How efficient are the present means of natural ventilation in glass house. Source: Researcher's Fieldwork, 2022**

**Question 3**

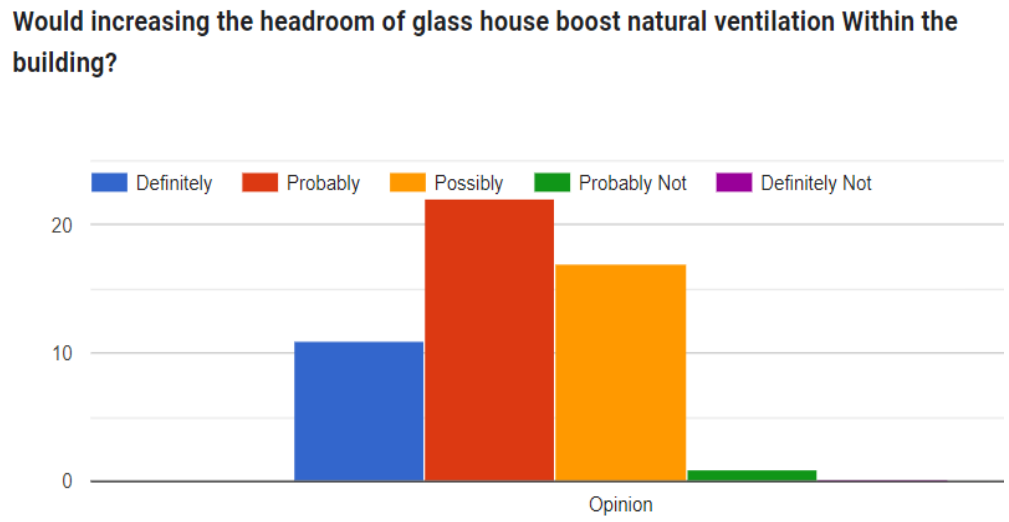


**Plate 14: Bar Chart – Would increasing the headroom of glass house boost natural ventilation within the building. Source: Researcher's Fieldwork, 2022**

**Question 4**

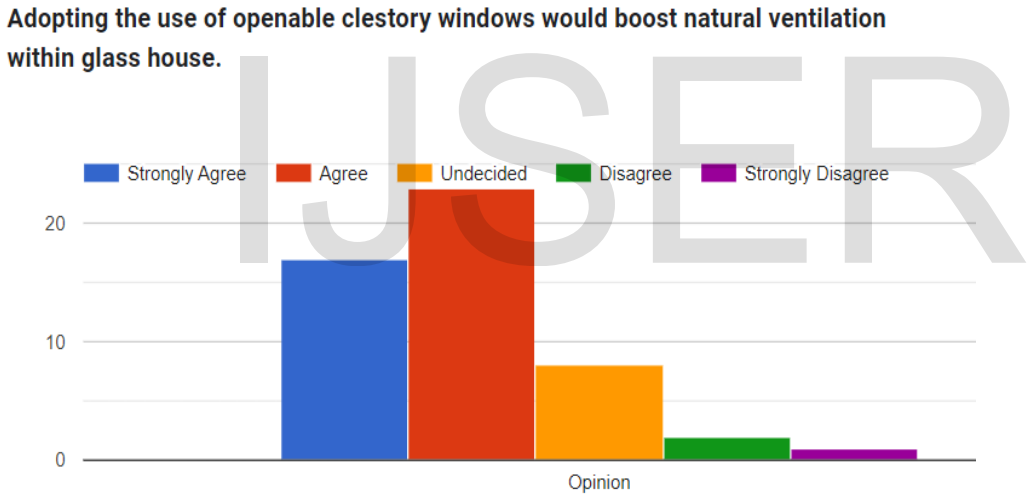




**Plate 15: Bar Chart – Adopting the use of openable clerestory windows would boost the natural ventilation within glass house. Source: Researcher's Fieldwork, 2022**

**Question 5**

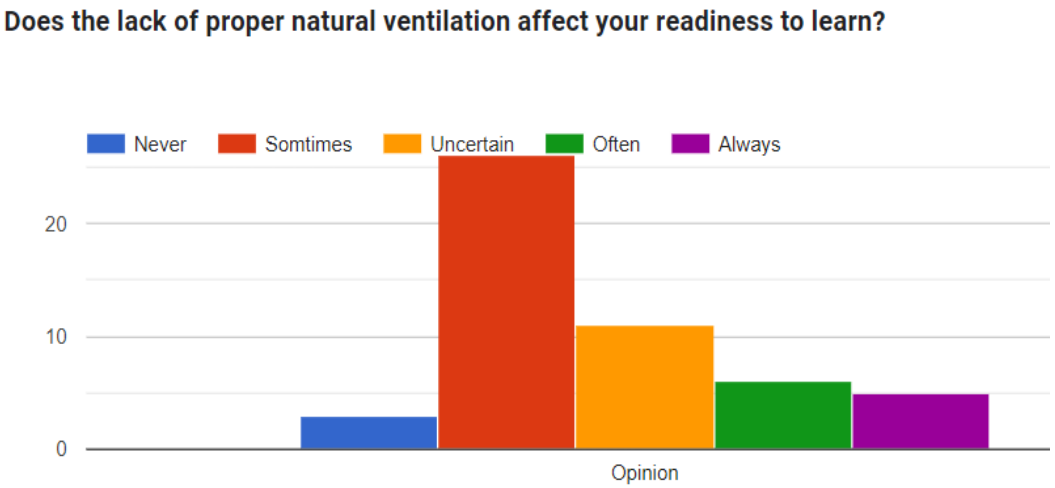


**Plate 12: Bar Chart – Does the lack of proper natural ventilation affect your readiness to learn. Source: Researcher's Fieldwork, 2022**

## 6.0 Conclusion & Recommendations

Certain significant observations were made in light of the data's results. The first is that the building itself is not well positioned and due to the curtain walls around the building the studio is exposed to direct sunlight which increases temperature and poor air quality. The risen hot air then descends back down and mixes with the incoming fresh air. It should also be noted that, during the rainy season, the weather around and within the glass house is somewhat tolerable; this also depends on the temperature of the day.



In light of the identified problems, the following are recommendations that should be considered.

- **WINDOWS**

  **Problem 1:** The curtain walls around the building are transparent which allows direct travel of sunlight and heat into the space hence increasing the temperature in the studio.

  **Solution 1a:** The best type of glass to use is "tinted glass" which is a good insulator and it reduces the discomfort of the sun's glare.

  **Solution 1b:** Windows with high-performance solar glazing and "spectrally selective" coatings, which keep the sun's heat outside yet permit daylight to enter.

- **SHADING**

  **Problem 2:** The trees planted to provide shade to the building are longer than the building and the leaves are scanty which provides less shade.

  **Solution 2:** More shrubs, understory trees, canopy trees and ground cover are to be planted around the building to provide some coolness to the building.

- **PAINTS AND GLAZES**

  **Problem 3:** The paint used is a good conductor of heat, which contributes to the production of heat within the space.

  **Solution 3:** It is time to start using paint with unique pigments made to reflect solar light. For instance, EXCEL CoolCoat and barium sulfate paint. Compared to ordinary paint, these can lower the surface temperature by more than 10 degrees Celsius.

  **Problem 4:** The curtain wall glazing allows direct sunlight and it is the fastest medium for the transfer of heat.

  **Solution 4:** The introduction of photochromic glazing, which alters transparency based on the brightness of the light, and thermochroic glazing, which darkens when heated, is also a possibility.

  **WINDOW BLINDS**

  **Problem 5:** The window blinds used at the studio are made from cotton fabric, which does not give proper closure from the direct sunlight.

  **Solution 5:** The use of honeycomb blinds, which have air pockets in them, which forms a barrier for increased insulation and energy efficiency, to prevent air from escaping between the blind and the window, it must fit tightly against the frame of the window.



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