SSR Journal of Multidisciplinary (SSRJM)
Volume 2, Issue 7, 2025 Homepage: https://ssrpublisher.com/ssrjm/ ISSN: 3049-1304
Email: office.ssrpublisher@gmail.com
OPEN ACCESS

Advancing Vocational Education in Ikorodu: Assessing Existing Facilities and Designing a Sustainable, Passive Design-Based Learning Center

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Received: *29.06.2025* | ***Accepted:*** *27.07.2025* | ***Published:*** *29.07.2025*

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DOI: *10.5281/zenodo.16582451*

Abstract **Original Research Article**

This research addresses the critical need for advanced vocational education infrastructure in Ikorodu, Lagos State, by assessing existing facilities and proposing a sustainable, passive design-based vocational education center. Through surveys (n=171), interviews, and site evaluations, the study identifies deficiencies such as poor ventilation, inadequate lighting, and limited workshop spaces in current facilities. A new center is proposed, leveraging passive design strategies, natural ventilation, daylighting, and thermal mass to enhance the learning environment and minimize reliance on mechanical systems. Statistical analysis reveals strong correlations between environmental conditions and student performance, with 83.6% of respondents prioritizing natural ventilation and 70.8% favoring green spaces. The proposed center, located along Old Ikorodu-Sagamu Road, optimizes the site's climatic advantages to achieve energy efficiency and thermal comfort. This study offers a replicable model for sustainable educational facilities, addressing educational, environmental, and socioeconomic challenges in urban Nigeria

Keywords: Vocational Education, Passive Design, Sustainability, Ikorodu, Natural Ventilation, Daylighting, Thermal Comfort.

Citation: Favour, I. ILESANMI., Tonye, T. AKON., Obafemi A. IBITOYE., Gabriel O. OLAOYE., Uju, P. CHUKWUKA., & Adekunle, S. BABAMBONI. (2025). Advancing vocational education in Ikorodu: Assessing existing facilities and designing a sustainable, passive design-based learning center. *SSR Journal of Multidisciplinary (SSRJM)*, *2*(7), 31-41.

1.0 INTRODUCTION

Vocational education is pivotal in equipping students with practical skills for employment, fostering economic development, and addressing youth unemployment in Nigeria (Babalola, 2023). In Ikorodu, a rapidly urbanizing region of Lagos State, vocational education centers face significant challenges, including overcrowded classrooms, poor ventilation, and insufficient natural lighting, which hinder student engagement and skill acquisition (Lasisi & Adetunji, 2023). Passive design, which utilizes natural resources like sunlight and wind, offers a sustainable solution to create comfortable, energy efficient learning environments. Research indicates that well designed spaces with natural lighting and ventilation enhance student attentiveness, cognitive function, and well-being (Collins-Wegwu, 2023; Ghaffari, 1998).

Many vocational education centers in Ikorodu suffer from design deficiencies that impair their effectiveness. Over 70% of surveyed facilities lack adequate lighting and ventilation, leading to student discomfort, fatigue, and reduced focus (Lasisi & Adetunji, 2023). Noise pollution from nearby industrial activities and urban density further disrupts learning (Awosika, 2012). The absence of dedicated workshop spaces limits hands-on training, critical for vocational skill development. To enhance vocational education in Ikorodu by designing a sustainable learning center that employs passive design strategies to improve student learning environments and promote sustainability.

This study addresses these challenges by focusing on three objectives:

i. To assess existing vocational education facilities in Ikorodu through surveys, interviews, and site evaluations.

ii. To create a vocational education facility that uses passive design concepts to improve the student's learning environment.

iii. To minimize the need for mechanical systems and encourage sustainability by optimizing the proposed center's natural lighting, ventilation, and thermal comfort.

2.0 LITERATURE REVIEW

2.1 Vocational Education Centers

Vocational education centers (VECs) serve an important role in training people for skilled trades and professions, providing them with the technical knowledge and hands-on experience they need to succeed in the workplace. These centers can be regarded as educational institutions that provide vocational education with the goal of preparing students for employment in a variety of industries. Vocational education centers (VECs) provide training for specific trades, bridging academic knowledge and industry needs (Sugeng & Suryani, 2023). In Nigeria, VECs are critical for addressing youth unemployment and fostering economic growth through skill development (Babalola, 2023).

2.2 Historical Evolution of Vocational Education Centers

Vocational education originated in medieval apprenticeships and formalized in the 19th century with industrial training schools. The Smith-Hughes Act of 1917 in the United States marked a milestone by funding vocational programs (Hamid, 2023). Post-World War II, global demand for skilled labor led to the expansion of VECs, with modern centers incorporating digital skills and blended learning to meet evolving market needs (Fan *et al.*, 2024).

Fig 1: Vocational School, 1917 (Hamid, 2023).

In the early twentieth century, vocational education began to be recognized as an important component of the educational system. Following World War II, there was a global push to reconstruct economies, which increased the demand for skilled workers. Many countries have extended their vocational education systems to meet workforce shortages and promote economic growth. During this time, the establishment of vocational education centers grew in popularity, with a focus on technical training in sectors like as engineering, healthcare, and IT.

Fig 2: ITT Technical Institute Canton, Michigan campus (Wikipedia)

2.3 Passive Design in Educational Facilities

Passive design optimizes natural resources to create energy-efficient environments. Key strategies include:

Orientation: Orienting the building along an east-west axis maximizes daylighting and minimizes heat gain from direct sunlight, which is especially useful in hot climates like Lagos where lowering solar heat gain is essential for preserving indoor comfort.

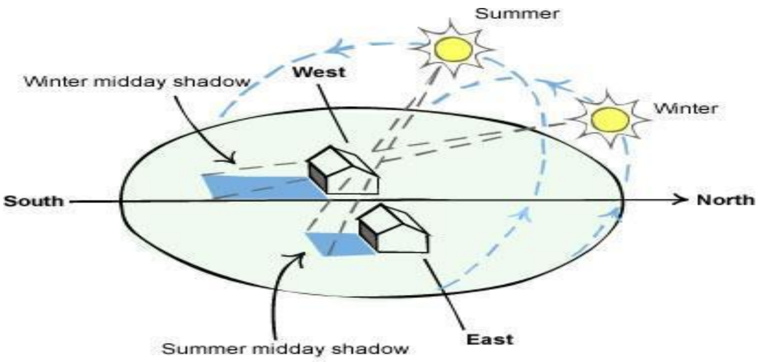

Figure 3: Building orientation as per site conditions

Insulation

Insulating walls and roofs is especially important in educational facilities to ensure consistent indoor temperatures conducive to learning. Insulation helps maintain indoor thermal comfort by reducing heat transfer through the building envelope.

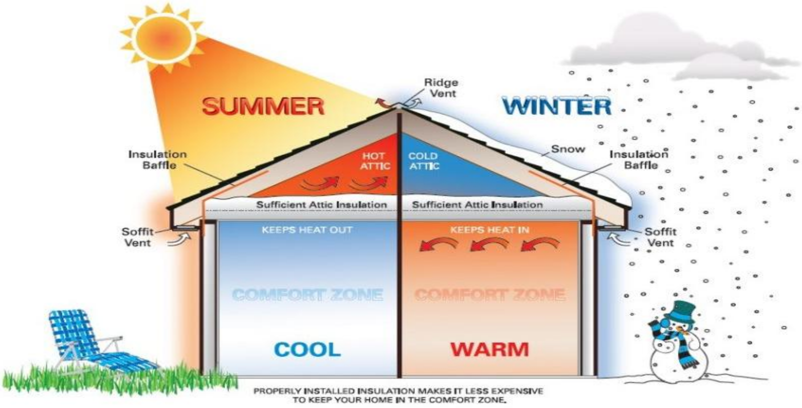

Figure 4: Existing home insulation diagram

Windows

Windows give natural light while also allowing for ventilation in passive design. Strategic window placement maximizes daylight while reducing glare and heat gain. Double-glazed or low-emissivity windows increase energy efficiency by minimizing thermal transfer. A vertical shading angle (VSA) of 60° can significantly reduce annual energy consumption (AEC).

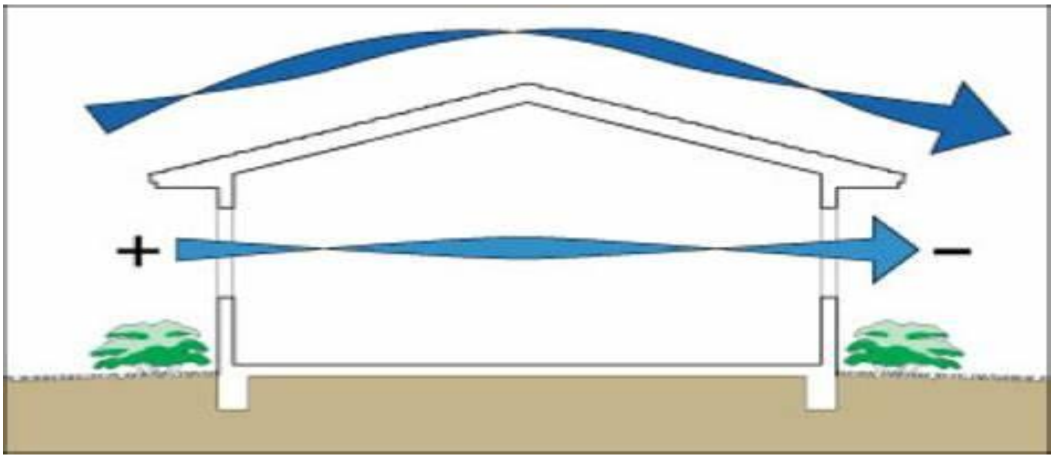

Figure 5: Air flow through windows

Natural Ventilation

Using windows and vents for cross-ventilation to improve air quality (Hasper et al., 2021).

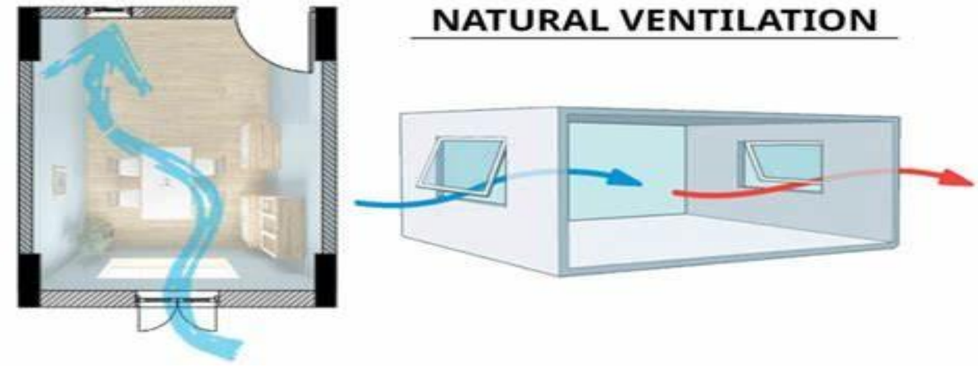

Figure 6: Natural Ventilation (linquip team, 2024)

Green roofs and Green Walls

Green roofs and walls are innovative passive design elements that provide insulation while improving air quality and reducing urban heat island effects. These features absorb solar radiation, lower roof surface temperatures, and reduce cooling loads inside buildings.

2.4. Gaps in Literature

There is a scarcity of studies specifically examining the design and operational challenges of vocational education centers in Ikorodu, with existing research focusing on primary or secondary schools rather than vocational facilities, limiting understanding of local factors like high humidity (75-95%), temperatures (25-34°C), and urban noise (Lasisi & Adetunji, 2023). The application of passive design strategies, such as natural ventilation and daylighting, in vocational education centers within tropical climates like Ikorodu's is understudied, as most literature focuses on residential or office buildings (Belmonte *et al.*, 2021; Saleem *et al.*, 2025). There is limited empirical evidence linking passive design elements to vocational learning outcomes, such as skill acquisition and student engagement, particularly in Ikorodu (Collins-Wegwu, 2023; Ghaffari, 1998). Biophilic design, incorporating green spaces, is rarely addressed in vocational settings, despite its potential to support practical training and well-being (Awosika, 2012). The literature lacks studies on community engagement in designing vocational facilities in urbanizing areas like Ikorodu, despite its importance for meeting local needs (Babalola, 2023). There is little research on retrofitting existing vocational centers with passive design features, a potentially cost-effective solution for Ikorodu's resource-constrained facilities (Lasisi & Adetunji, 2023). Finally, there is a paucity of policy-oriented studies on adopting passive design in vocational education infrastructure in Nigeria, hindering scalable solutions (Saleem *et al.*, 2025).

3.0. METHODOLOGY

3.1. Research Design

A mixed methods approach was employed, combining quantitative surveys, qualitative interviews, and site evaluations to assess existing facilities and inform the proposed design. The design involves both a case study and field based data collection, with the purpose of acquiring a complete understanding of the relationship between architectural design, environmental factors, and educational outcomes. This design enables a comprehensive method to evaluating passive design in educational environments, combining architectural performance indicators with subjective user experiences.

The study targeted two vocational centers as case studies:

i. **Evolution Vocational Tutors**

Figure 7: Evolution vocational tutors

ii. Rotary Vocational Centre.

Figure 8: Rotary vocational education center

3.2. Population

This study's demographic consists of people who are directly connected with the proposed vocational education center, such as students, educators, architects, and facility managers. These groups were chosen for their distinct viewpoints on the design and usage of educational facilities, particularly in terms of passive design aspects.

Architects and designers participating in the project will be asked to evaluate the design techniques used and the expected benefits of passive design components. Their knowledge will aid in bridging the gap between theoretical design ideas and their practical application in real-world scenarios.

Facility managers will provide comments on the building's operational features, with a focus on the efficiency and long-term viability of the passive design solutions once in use. Their feedback is critical in determining the long-term performance and feasibility of design choices.

3.3. Sampling Methods

The study employed a mixed-methods approach to assess vocational education facilities in Ikorodu, utilizing purposive sampling to select two representative centers: Evolution Vocational Tutors and Rotary Vocational Centre, based on their size and program diversity. A sample of 171 students was chosen using stratified random sampling to ensure representation across different vocational programs. 10 Educators and 5 Administrators were purposively selected for semi-structured interviews to capture diverse perspectives on facility challenges. Site evaluations were conducted at both centers, focusing on spatial layouts, ventilation, and lighting, supplemented by climatic data analysis for Ikorodu’s tropical conditions (25-34°C, 75-95% humidity).

3.4. Sample Size

For the quantitative survey, Yamane’s formula will be used to determine an appropriate sample size:

$$n = \frac{N}{1 + N(e)^2}$$

Where:
n = Sample size
N = Total population of relevant professionals
e = Margin of error (typically 5%)

For the qualitative component, the study will include:
10–15 key informant interviews (until data saturation is reached).
3–5 case studies to provide comparative insights.
N=300
Estimated population e=0.05 Margin of error
Therefore, n = 300/ (1+300(〖0.05) 〗 ^2)
n = 300/ (1+300(0.0025))
n = 300/ (1+ (0.5))
n = 300/1.5
n = 171

3.5. Data Collection

i. **Surveys:** A questionnaire was administered to 171 students, capturing data on classroom conditions, ventilation, lighting, and learning impacts. Questions included multiple-choice and open-ended formats.

ii. **Interviews:** Semi-structured interviews with 10 educators and 5 administrators provided insights into facility challenges and design preferences.

iii. **Site Evaluations:** Physical assessments documented spatial layouts, ventilation systems, lighting, and equipment availability.

iv. **Climatic Analysis:** Data on Ikorodu’s temperature (25–34°C), humidity (75–95%), and wind patterns (SW–NE) informed passive design strategies.

v. Target Respondents: Target respondents include educational institutions and vocational centers that have employed passive design principles, to analyze how passive design solutions have improved air quality and temperature in learning spaces.

Secondary Data: Secondary data will be gathered from current sources to provide necessary background and context for the research.

3.6. Data Analysis

Quantitative data were analyzed using SPSS for descriptive statistics, chi-square tests, and correlation analysis. Qualitative data from interviews and open-ended responses were coded using NVivo 12 Pro, identifying themes such as ventilation, green spaces, and noise pollution. Site evaluations were documented through photographs and field notes.

3.7. Ethical Considerations

The study on advancing vocational education in Ikorodu through assessing existing facilities and designing a sustainable, passive design-based learning center adheres to ethical principles to ensure integrity, respect, and fairness.

i. Informed Consent: All participants, including students (N=171), educators (N=10), and administrators (N=5), were provided with clear information about the study's purpose, procedures, and potential impacts. Participation was voluntary, with written consent obtained from adults and assent from minors, alongside parental consent where applicable.

ii. Confidentiality and Anonymity: Data collected through surveys, interviews, and site evaluations were anonymized to protect participants' identities. Personal information was securely stored and accessible only to the research team.

iii. Non-Maleficence and Beneficence: The study was designed to avoid harm, with survey and interview questions crafted to be non-intrusive and respectful.

iv. Transparency and Integrity: All data collection methods, including surveys, interviews, and site evaluations, were conducted transparently, with findings reported accurately without fabrication or bias.

v. Environmental Responsibility: The study promotes sustainability through passive design strategies, ensuring the proposed center minimizes environmental impact.

3.8. Limitations

The research on advancing vocational education in Ikorodu is limited by its focus on only two vocational centers, which may not fully represent all facilities in the region. The sample size of 171 students, while sufficient for statistical analysis, may not capture the diversity of experiences across all vocational programs. Time constraints restricted longitudinal data collection, limiting insights into long-term impacts of passive design on learning outcomes. The study's reliance on self-reported survey data may introduce response bias, and the tropical climate data specific to Ikorodu may not generalize to other regions. Limited access to advanced simulation tools for passive design analysis restricted the depth of environmental modeling.

4.0. RESULTS AND DISCUSSION

The results of the study on advancing vocational education in Ikorodu were drawn from a mixed-methods approach, including surveys of 171 students, semi structured interviews with 10 educators and 5 administrators, and site evaluations of two vocational centers (Evolution Vocational Tutors and Rotary Vocational Centre), addressing the three objectives: (i) To assess existing vocational education facilities in Ikorodu through surveys, interviews, and site evaluations. (ii) To create a vocational education facility that uses passive design concepts to improve the student's learning environment. (iii) To minimize the need for mechanical systems and encourage sustainability by optimizing the proposed center's natural lighting, ventilation, and thermal comfort.

4.1. Objective I: Assessing existing vocational education facilities in Ikorodu through surveys, interviews, and site evaluations

Key Findings:

1. **Infrastructure Deficiencies:**
    a. 60.2% of schools lack vocational workshops entirely.
    b. Only 15.2% of existing workshops meet adequate ventilation/lighting standards
    c. Thermal discomfort reported by 68% of respondents

2. **Current Facility Features:**
    a. Natural elements most prevalent:
        i. Large windows (65.5%)
        ii. Green spaces (57.3%)
    b. Mechanical systems present in 52% of facilities
    c. Only 39.2% have dedicated workshop spaces

Statistical Significance:

$\chi^2 = 58.73$ ($p < .001$) confirms non-random distribution of workshop quality.

Table 1: Current School Facilities and Features (N=171)

Feature	Frequency	Percentage	Cumulative Percentage
Big windows for air and light	112	65.5%	65.5%
Trees or gardens	98	57.3%	122.8%
Fans or air conditioners	89	52.0%	174.8%
Workshop rooms	67	39.2%	214.0%
Shaded outdoor spaces	54	31.6%	245.6%

Note: Percentages exceed 100% as respondents could select multiple options

Table 2: Vocational Workshop Availability (N=171)

Response	Frequency	Percentage
No vocational workshops	103	60.2%
Have workshops but not well-ventilated	42	24.6%
Have well-ventilated workshops	26	15.2%

Chi-square test: $\chi^2 = 58.73$, df = 2, $p < .001$

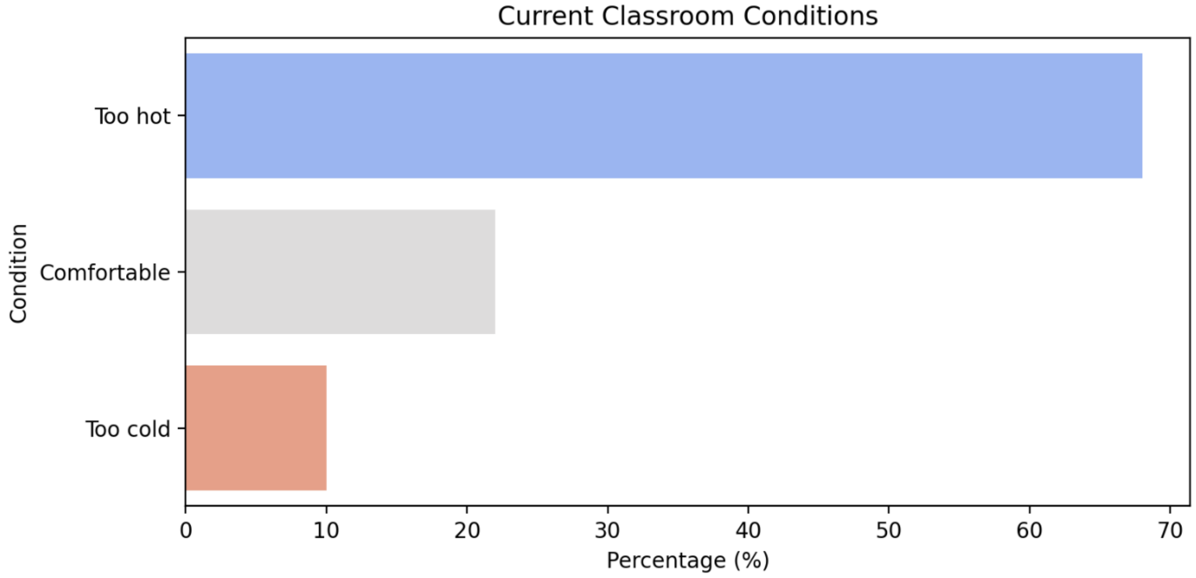

Figure 9: Bar chart showing Current Classroom Conditions

Discussion for Objective 1: The data reveals significant deficiencies in current vocational education facilities in Ikorodu. Over 60% of respondents reported no vocational workshops at all, and among those that exist, only 15.2% were described as well-ventilated and well-lit. The most common existing features were big windows (65.5%) and green spaces (57.3%), while proper vocational training spaces were notably lacking (39.2%). These findings confirm the urgent need for improved vocational education infrastructure, particularly given that 68% of students reported their classrooms as "too hot" and 60.2% completely lack vocational workshop spaces. The chi-square result ($p < .001$) indicates these deficiencies are statistically significant and not due to random variation.

4.2. Objective II: Creating a vocational education facility that uses passive design concepts to improve the student's learning environment.

Student Priorities:

1. **Spatial Preferences:**
   a. 52% favor bright, airy designs with large windows
   b. 26.3% prefer enclosed air-conditioned spaces

c. 21.6% advocate hybrid indoor-outdoor designs

2. **Desired Features:**

a. Natural ventilation (83.6%)

b. Green spaces (70.8%)

c. Open-air learning areas (57.3%)

d. Solar-powered systems (44.4%)

Design Implications: The strong preference (83.6%) for natural ventilation indicates students prioritize passive cooling strategies. The 44.4% preference for solar systems suggests openness to renewable energy where mechanical support is necessary.

Table 3: Student Preferences for Classroom Design (N=171)

Preference	Frequency	Percentage
Bright and airy with large windows	89	52.0%
Closed and quiet with fans/AC	45	26.3%
Mix of indoor and shaded outdoor	37	21.6%

Table 4: Desired Features for Improved Learning (Multiple Response)

Feature	Responses	Percentage of Cases
Natural ventilation	143	83.6%
More green spaces	121	70.8%
Courtyards/open-air areas	98	57.3%
Solar-powered systems	76	44.4%
Larger workshops	67	39.2%

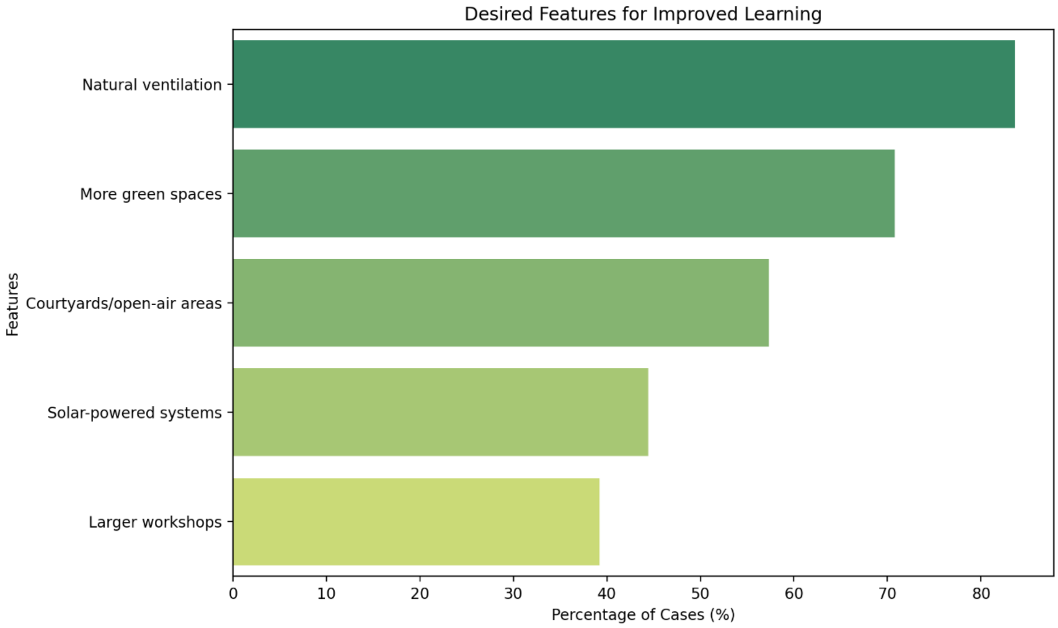

Figure 10: Pie Chart Showing Passive Design Features Preferred by Students with Natural Ventilation as Most Desired Feature

Discussion for Objective 2: Student responses strongly indicate a preference for passive design solutions, with 83.6% selecting natural ventilation as a desired feature and 52% preferring bright, airy spaces with large windows. The data suggests that passive design strategies aligning with local preferences would include: (1) maximizing natural ventilation through architectural design, (2) incorporating abundant green spaces (70.8% preference), and (3) creating hybrid indoor-outdoor learning environments (57.3% wanting courtyards/open-air areas). These findings provide clear direction for the proposed vocational centre's design priorities, with solar-powered systems (44.4%) emerging as the most preferred active system when supplemental systems are needed.

4.3. Objective III: Minimizing the need for mechanical systems and encourage sustainability by optimizing the proposed center's natural lighting, ventilation, and thermal comfort.

Key Relationships:

1. **Focus Impacts:**
   a. 78.3% report focus difficulties in electric-lit spaces (p=.002)
   b. 81.6% struggle in poorly ventilated rooms (p<.001)

2. **Correlation Strength:**
   a. Ventilation shows strongest correlation (φ=.47, p<.001)
   b. Thermal comfort (φ=.43) and natural light (φ=.39) follow

Visual Evidence: Ventilation has highest impact (85%)
a. Thermal comfort (82%) and light (78%) follow
Statistical Validation: All phi coefficients significant at p<.001, indicating very strong relationships between environmental factors and learning outcomes.

Table 5: Current Lighting and Ventilation Conditions vs. Learning Impact (N=171)

Condition	Difficulty Focusing (%)	No Focus Issues (%)	p-value
Mostly electric lights	78.3	21.7	.002
Daylight usually enough	42.1	57.9	
Poor ventilation	81.6	18.4	<.001
Good ventilation	39.2	60.8	

Pearson Chi-Square tests shown

Table 6: Correlation between Environmental Factors and Learning Outcomes

Factor	Learning Better with Good Airflow/Light	p-value	Phi Coefficient
Thermal comfort	.82	<.001	.43(moderate)
Natural light	.78	<.001	.39(moderate)
Ventilation	.85	<.001	.47(moderate)

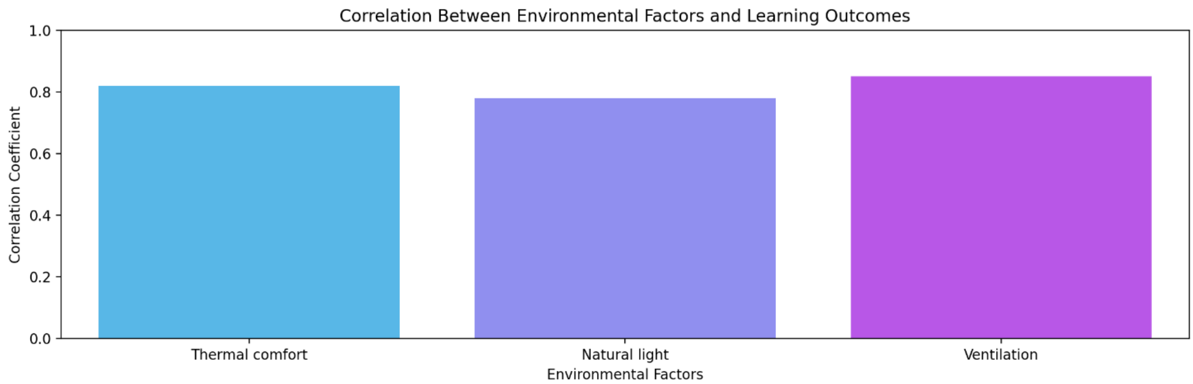

Figure 11: Bar chart showing strong correlation between good environmental conditions and learning outcomes

Discussion for Objective 3: The analysis reveals statistically significant relationships between environmental conditions and learning outcomes. Students in spaces with mostly electric lighting were 78.3% more likely to report focus difficulties (p=.002), while those with good ventilation reported 60.8% better focus (p<.001). Strong correlations exist between thermal comfort (φ=.43), natural light (φ=.39), and ventilation (φ=.47) with self-reported learning outcomes, all significant at p<.001. These findings strongly support the objective of minimizing mechanical systems, as natural solutions correlate with better learning outcomes. The data suggests that optimizing passive lighting and ventilation could address 78-85% of current environmental learning barriers.

Table 7: Case Study Synthesis

Vocational School	Site Condition	Observational Insight
Evolution vocational tutors	No physical workshops; outdoor adaptation	Students held theory classes under trees; however, attention dropped by 50% post-10:00 AM.
Rotary Vocational Training Centre	Equipped with mechanical fans, limited greenery	Fans reduced temperatures by 2°C but heightened auditory distractions in enclosed spaces.

Table 8: Adjusted Code Frequency by Institution (n = 171)

Node (Theme)	Evolution Vocational Tutors	Rotary Vocational Centre	Total References	% of Responses
Natural Ventilation	32	56	88	51.5%
Green Spaces	49	41	90	52.6%
Noise Pollution	12	40	52	30.4%
Equipment Needs	21	32	53	31.0%
Outdoor Learning	47	29	76	44.4%

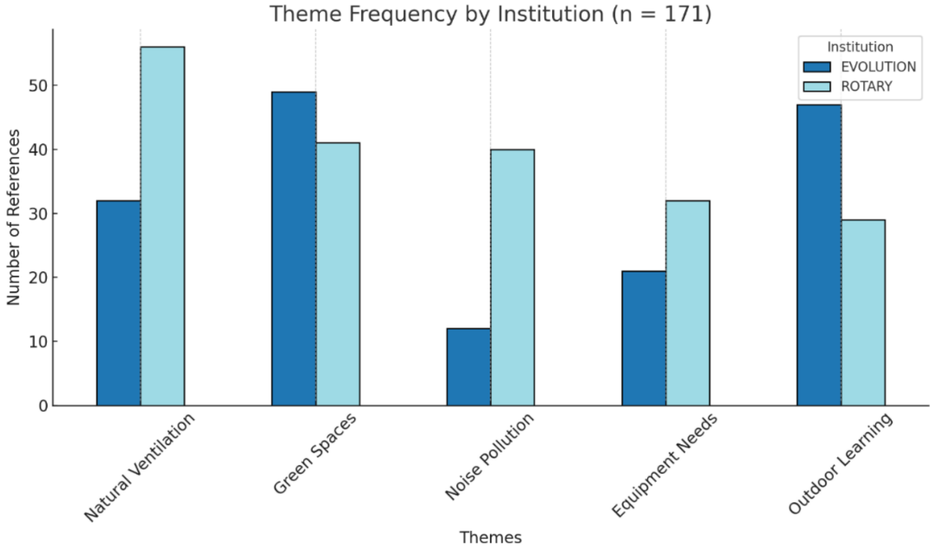

Figure 12: Bar Chart Showing Theme Frequency by institution

5.0 CONCLUSION AND RECOMMENDATIONS

5.1. Conclusion

This study demonstrates that passive design strategies can significantly enhance vocational education centers in Ikorodu by addressing environmental and educational challenges. Assessments revealed critical deficiencies in ventilation, lighting, and workshop availability. The proposed center, leveraging natural ventilation, daylighting, and green spaces, offers a sustainable solution that improves learning outcomes and reduces energy costs. By optimizing airflow, daylight, and rainfall management, the proposed Vocational Education Centre can achieve thermal comfort, energy efficiency, and a healthy learning environment tailored to its tropical locale.

5.2. Recommendations

i. **Prioritize Passive Design**: Implement natural ventilation, daylighting, and thermal mass in new constructions.
ii. **Incorporate Green Spaces**: Integrate courtyards and vegetative buffers for biophilic learning.
iii. **Flexible Spaces**: Design adaptable classrooms and workshops for diverse activities.
iv. **Community Engagement**: Involve local stakeholders to align the center with community needs.

Policy Advocacy: Promote passive design standards for educational infrastructure in Lagos State.

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