

Indoor Environmental Quality (IEQ) in Selected Nigerian University Entrepreneurship Incubation Centers: Effects on Mental Well-Being and Productivity

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Abstract

This study examines the impact of Indoor Environmental Quality (IEQ) on mental well-being and productivity in selected Nigerian university entrepreneurship incubation centers. Despite the critical role of these centers in fostering innovation and economic development, little attention has been paid to the indoor environmental conditions that influence their users. The study addresses this gap by evaluating IEQ factors (air quality, thermal comfort, lighting, acoustics, and ergonomics) and their effects on occupants' psychological and performance outcomes. A mixed-methods case study design was employed, focusing on 199 users from three Nigerian universities representing federal, state, and private institutions: the University of Ibadan, Gombe State University, and Covenant University. Data were collected via structured questionnaires administered to users of these centers and analyzed using descriptive and inferential statistics (Pearson correlation, regression analysis) in IBM SPSS. Key findings revealed that lighting (Mean=2.0) and air quality (Mean=2.1) were the highest-rated IEQ components, correlating strongly with mental well-being ($r=0.51$ and $r=0.45$, respectively) and productivity ($r=0.47$ and $r=0.38$). Regression analysis further identified lighting as the most significant predictor ($\beta=0.40$ for well-being, $\beta=0.35$ for productivity), explaining 58% of variance in well-being scores. Conversely, acoustics (Mean=2.4) and thermal comfort (Mean=2.3) scored neutrally, indicating areas needing intervention. Although the study is limited by its focus on only subjective user perceptions from three institutions, which can limit its generalization, it underscores the necessity of optimizing IEQ in incubation centers to enhance user experience and output. Recommendations include prioritizing natural lighting, improving ventilation, implementing acoustic zoning, and integrating ergonomic designs. These findings contribute to evidence-based strategies for designing healthier, more productive entrepreneurial spaces in Nigeria and similar contexts. Future research should incorporate objective IEQ measurements to validate perceptual data and explore cultural adaptations for tropical climates.

Keywords: Entrepreneurship Center, Indoor Environmental Quality (IEQ), Mental Well-Being, Productivity, Universities.

Introduction

The health, happiness, and productivity of occupants are greatly influenced by the quality of the indoor environment, especially in areas intended for entrepreneurship and innovation (Mewomo, Toyin, Iyiola & Aluko, 2023). Stress levels, mental health, and cognitive function have all been related to indoor environmental quality (IEQ), which includes elements like lighting, acoustics, thermal comfort, and air quality (Deng, Dong, Guo & Zhang, 2024). The effect of IEQ on productivity and mental health is still little understood in Nigerian university entrepreneurial incubation centers, where startups and students participate in rigorous creative and problem-solving exercises (Majid, 2024). Given the increased focus on entrepreneurship as a catalyst for economic growth, it is critical to comprehend how IEQ affects space occupants in order to create productive workplaces (Nurick & Thatcher, 2023).

Although more and more enterprise incubation centers are being established in Nigerian colleges, the indoor environmental conditions in these establishments have received little attention (Abubakar, Abubakar & Abdullahi, 2025; Adelowo & Oladimeji, 2024). Inadequate ventilation, high noise levels, poor lighting, and thermal discomfort are examples of poor IEQ, which can lead to decreased productivity, elevated stress levels, and weakened mental health in users (Deng, Dong, Guo & Zhang, 2024; Nyembwe, 2025).

While global studies have increasingly emphasized the role of Indoor Environmental Quality in enhancing mental health and productivity in workspaces, research remains disproportionately focused on corporate or Western contexts, with limited attention to university-based entrepreneurial settings in developing regions. In Nigeria, particularly, there is a notable scarcity of context-specific data that examines how IEQ variables interact with the unique pressures of student-led innovation and incubation. This lack of localized, empirical evidence creates a gap in adapting globally recognized environmental health strategies to African higher education systems. In grounding this study in Nigerian university incubation centers, the research not only addresses a national knowledge deficit but also contributes to the global discourse on inclusive and health-centered design for innovation-driven learning environments.

The aim of this study is to assess the effects of Indoor Environmental Quality (IEQ) on mental well-being and productivity in selected Nigerian university entrepreneurship incubation centers. The objectives are to:

- i. evaluate the current state of Indoor Environmental Quality (IEQ) in selected Institutional entrepreneurship incubation centers; and
- ii. assess its impact on user mental well-being and productivity.

This work is significant because it provides empirical evidence for how IEQ affects mental well-being and productivity in Nigerian business incubation centers, a critical but understudied context. The findings will help university administrators, architects, and policymakers make required modifications to these places for creativity and well-being.

Furthermore, the findings add to broader conversations about sustainable and health-conscious building designs in educational and business settings.

Literature Review

Conceptual Review

Indoor Environmental Quality (IEQ) refers to the conditions within a structure that affect residents' health, comfort, and productivity (Nimlyat, Salihu & Wang, 2024). IEQ's key components include air quality, thermal comfort, lighting, acoustics, and ergonomic design (Al-Jokhadar, Alnusairat, Abuhashem & Soudi, 2023). Poor IEQ has been linked to symptoms like headaches, weariness, and decreased cognitive function, whereas optimal IEQ improves concentration, creativity, and overall well-being (Franke & Nadler, 2021; Niza, de Souza, da Luz & Broday, 2024; Zhang, 2025). IEQ is especially important in entrepreneurial incubators, where innovation and long-term mental effort are required (Andersson & Müller, 2023). According to studies, well-ventilated areas, natural lighting, and noise management improve inhabitants' mental health and productivity (Aruta, Ascione, D'Urso, Iovane, Iuliano, Manniti & Nizetic, 2024).

Theoretical Review

Several ideas offer a framework for comprehending the link between IEQ, mental health, and productivity. According to the Stress Reduction Theory (SRT), well-designed settings lower psychological stress, which leads to improved cognitive performance (Zhang, 2025). Similarly, the Attention Restoration Theory (ART) indicates that environments with natural features and adequate illumination aid in the recovery of mental tiredness, improving focus and creativity (Yeh, Hung & Chang, 2022). Furthermore, the Adaptive Thermal Comfort Model emphasizes how people react to thermal circumstances, which influences their pleasure and job performance (Yao, Zhang, Du, Schweiker, Hodder, Olesen & Li, 2022). These theories all support the notion that enhancing IEQ in incubation centres might provide a more conducive atmosphere for entrepreneurial activities.

Empirical Review

Previous studies have looked at IEQ in a variety of settings, but research on university entrepreneurship incubation centers, particularly in poor nations like Nigeria, is sparse. Hamed, Hussain, Jani, Sabri & Rusli (2023) discovered that improving air quality and lighting dramatically increased productivity in workplace environments. Similarly, a study in educational settings (Jia, Han, Chen, Li, Lee & Fung, 2021) connected poor thermal comfort to lower academic performance. However, few research (Adelowo & Oladimeji, 2024) have specifically evaluated IEQ in Nigerian incubation centers. Existing gaps include a lack of localized data on how IEQ affects mental health and productivity at these facilities. Globally, research has consistently highlighted the positive correlation between optimized IEQ and enhanced workplace well-being and productivity; however, much of this evidence

is drawn from high-income countries with different climatic, cultural, and infrastructural realities. Studies from Western Europe and East Asia often assume the presence of advanced HVAC systems, acoustic insulation, and user-centered environmental controls, features that are limited or inconsistently implemented in many Nigerian institutions. Additionally, cultural expectations around personal space, heat tolerance, and work intensity differ significantly in the Nigerian context, which may influence how IEQ factors are perceived and experienced. Communal working norms and underinvestment in building maintenance may exacerbate the negative impacts of poor IEQ. Thus, while international findings provide useful benchmarks, context-specific research is essential to understanding how Nigerian users uniquely experience and respond to their indoor environments within entrepreneurship incubation centers. This study seeks to bridge that contextual gap by providing localized evidence to inform design and policy interventions that are both culturally relevant and environmentally responsive.

Methodology

This study employs a qualitative case study research design to conduct an in-depth examination of Indoor Environmental Quality (IEQ) in three selected university entrepreneurship centers in Nigeria. The study focused on one federal, one state, and one private university to ensure representation across Nigeria's higher education institutional types. The three cases were selected based on: institutional diversity, operational viability and accessibility. The selected case studies are the University of Ibadan, Gombe State University and Covenant University. A structured questionnaire was administered to users of the incubation centers. The questionnaire was designed to assess: IEQ conditions (air quality, thermal comfort, lighting, acoustics, and ergonomics) and their perceived effects on mental well-being and Productivity impacts.

Table 1: Distributed Sample Size

Institution	Targeted No. of Responses	Actual No. of Responses	Response Rate (%)
Covenant University	100	75	75.0%
University of Ibadan	100	75	75.0%
Gombe State University	100	49	49.0%
Total	384	279	72.7%

Source: Author (2025)

The collected data was analyzed using IBM SPSS. Descriptive statistics (mean, standard deviation, frequency distribution) were used to summarize IEQ conditions and user perceptions. Inferential statistics, including correlation and regression analysis, were employed to examine relationships between IEQ factors, mental well-being, and

productivity. Qualitative responses from open-ended questions were thematically analyzed to provide deeper insights. The study obtained ethical clearance from the Caleb University Lagos Research Ethics Committee (CULREC) before commencing data collection. Informed consent was obtained from all participants before their involvement in the study. The confidentiality and anonymity of participants were maintained throughout the research process.

Limitations of the study include; (i) its limitation to three universities, which may not fully represent IEQ conditions across all Nigerian incubation centers, (ii) responses based on subjective perceptions rather than objective IEQ measurements (e.g., CO₂ levels, lux measurements), (iii) the use of a smaller sample size which could affect the generalizability of findings, (iv) seasonal variations in temperature and humidity were not accounted for, potentially affecting thermal comfort responses. Despite these limitations, the study provides valuable insights into IEQ challenges in Nigerian university incubation centers and their implications for mental well-being and productivity.

Results and Discussion

Demography of Respondents

Table 2: Age and Gender Distribution of Respondents

Factor	Percent (%)	No. of Respondents
Age		
16–25 years	80	159
26–35 years	15	30
36–45 years	3	6
46+ years	2	4
Total	100	199
Gender		
Male	45	90
Female	55	109
Total	100	199

Source: Author (2025)

The majority of respondents were young adults aged 16–25 years, reflecting the student-dominated population of entrepreneurship incubation centers. 80% fell within this age group, followed by 26–35 years (15%), 36–45 years (3%), and 46+ years (2%). These percentages underscore the target demographic for such facilities. Gender distribution was balanced in both groups, with a slight predominance of female respondents. 55% identified as female and 45% as male. This near-equitable representation suggests broad inclusivity in entrepreneurship activities.

Analysis for Objective 1

Objective 1: evaluate the current state of Indoor Environmental Quality (IEQ) in selected Institutional entrepreneurship incubation centers.

Table 3: Mean Scores of IEQ Factors

IEQ Factor	Mean (SD)	Interpretation (Lower = Better)
Air Quality	2.1 (0.8)	Moderately Positive
Thermal Comfort	2.3 (0.9)	Neutral to Slightly Positive
Lighting	2.0 (0.7)	Moderately Positive
Acoustics	2.4 (1.0)	Neutral
Ergonomics/Spatial Design	2.2 (0.8)	Slightly Positive
Mental Well-being	2.5 (1.1)	Neutral
Productivity	2.3 (0.9)	Slightly Positive

Source: Author (2025)

The findings from Table 3 reveal that lighting (Mean=2.0) and air quality (Mean=2.1) emerged as the highest-rated IEQ factors among current users, indicating moderately positive perceptions, while acoustics (Mean=2.4) and mental well-being (Mean=2.5) scored closer to neutral, suggesting areas needing intervention. These results align with existing literature on workspace design. The prominence of lighting and air quality corroborates studies demonstrating their critical role in occupant satisfaction and cognitive performance (Jung, An & Hong, 2024; Kim & Lee, 2024; Zhang, 2025). Specifically, Kim & Lee (2024) found that natural lighting and ventilation were strongly associated with improved productivity in shared workspaces, which mirrors the users' preferences observed in this study.

The neutral ratings for acoustics resonate with research highlighting chronic noise disturbances in open-plan workspaces (Felipe, Aletta & Kang, 2023). Hutson & Hutson (2025) noted that inadequate soundproofing in collaborative environments often leads to distractions, reducing focus and well-being, a phenomenon reflected in the current study's lower acoustics scores. Similarly, the neutral assessment of mental well-being aligns with findings by Deng, Dong, Guo & Zhang (2024), who emphasized that IEQ factors like noise and poor ergonomics can cumulatively strain psychological health, even if individual elements (e.g., lighting) perform well. The slightly positive scores for ergonomics (Mean=2.2) and productivity (Mean=2.3) suggest that while current spatial designs are functional, there is scope for enhancement. This echoes recommendations by Elsamanoudy (2023) on integrating adjustable furniture and biophilic elements to bridge gaps between physical comfort and psychological outcomes.

Some of the findings may be better understood through the lens of Nigeria's unique cultural and infrastructural context. The moderately positive rating for lighting may reflect widespread reliance on natural daylight due to frequent electricity outages, which has

normalized user expectations around artificial lighting quality. Similarly, the relatively neutral perception of thermal comfort may be influenced by high heat tolerance among local users accustomed to warm climates and limited access to consistent air conditioning. The neutral scores for mental well-being could also be shaped by cultural stigmas surrounding discussions of psychological health, potentially leading to underreporting or a tendency to rate experiences as "neutral" rather than negative. Furthermore, the slightly positive rating for ergonomics might reflect a general adaptation to minimalist or non-ergonomic furniture, common in many institutional buildings in Nigeria, rather than an indication of optimal spatial design. These contextual factors suggest that user perceptions are shaped not only by physical IEQ features but also by socio-cultural norms, coping mechanisms, and infrastructural limitations, underscoring the importance of culturally grounded interpretations in environmental quality assessments.

Analysis for Objective 2

Objective 2: assess its impact on user mental well-being and productivity.

Table 4 shows the Pearson's r Results of each IEQ factor versus the outcomes (mental well-being and productivity)

Table 4: Correlation Analysis

IEQ Factor	Mental Well-being	Productivity
Air Quality	0.45**	0.38**
Thermal Comfort	0.32**	0.29*
Lighting	0.51**	0.47**
Acoustics	0.28*	0.25*
Ergonomics/Spatial Design	0.39**	0.42**
Significance: * $p < 0.05$, ** $p < 0.01$		

Source: Author (2025)

The correlation analysis in Table 4 reveals that lighting ($r=0.51$) and air quality ($r=0.45$) demonstrate the strongest positive relationships with mental well-being, while also showing significant associations with productivity (lighting $r=0.47$; air quality $r=0.38$). These findings align robustly with existing IEQ literature. A study by Schöllhorn, Deuring, Stefani, Strumberger, Rosburg, Lemoine & Cajochen (2023) and Erkan, Simsek, Avci & Akyol (2025) demonstrated that optimized lighting conditions could improve mood and task performance by up to 23% in workplace settings, directly supporting our observed strong correlation between lighting and both well-being and productivity outcomes. The substantial role of air quality mirrors findings by Wolkoff, Azuma & Carrer (2021), whose controlled experiments in office environments showed that improved ventilation rates could enhance cognitive performance scores by 15-20%. This physiological

mechanism - where better air quality increases oxygen flow to the brain - explains our moderate-to-strong correlations ($r=0.38-0.45$) between air quality and work outcomes. The weaker but still significant correlations for acoustics ($r=0.28$ for well-being) corroborate the "irrelevant sound effect" theory by Samper (2021) and Fan, Liang, Cao, Pang & Zhang (2022), which posits that even low-level background noise can cumulatively impair concentration and emotional states. Similarly, the moderate correlations for ergonomics ($r=0.39-0.42$) support Chen, Yang, Ma & Lu (2023) Demand-Control model, where adjustable workspaces reduce physical strain and thereby improve both psychological comfort and task efficiency.

Notably, the strength of these relationships follows the hierarchy predicted by the IEQ prioritization framework of Licina, Wargocki, Pyke & Altomonte (2021), where visual and atmospheric factors (lighting/air) typically outweigh other environmental parameters in their impact on knowledge workers. However, the slightly lower thermal comfort correlations ($r=0.29-0.32$) contrast with some tropical climate studies (e.g., Kolani, Wang, Zhou, Nouyep Tchitchui & Okolo, 2023), suggesting potential cultural or acclimatization factors in our Nigerian context that warrant further investigation.

Table 5 shows the multiple linear regression predicting mental well-being and productivity from IEQ factors.

Table 5: Regression Analysis

Predictor	Mental Well-being (β)	Productivity (β)
Air Quality	0.31**	0.27**
Lighting	0.40**	0.35**
Ergonomics/Spatial Design	0.25*	0.30**
Thermal Comfort	0.18*	0.15
Acoustics	0.12	0.10
R ² (Adjusted)	0.58	0.52

Source: Author (2025)

The regression analysis in Table 5 demonstrates that lighting emerges as the most robust predictor of both mental well-being ($\beta=0.40$, $p<0.01$) and productivity ($\beta=0.35$, $p<0.01$), accounting for 58% of the variance in well-being scores. This dominant role of lighting aligns with the "human-centric lighting" paradigm advocated by Jalali, Jones, Tural & Gibbons (2024), whose research established that spectral quality and intensity of light directly regulate circadian rhythms and serotonin production (neurophysiological mechanisms that explain our strong beta coefficients). The 58% explanatory power for well-being notably exceeds the 42-49% ranges reported in comparable studies (e.g., Boyce, 2022), suggesting lighting may have amplified importance in incubation center contexts where visual tasks dominate.

The secondary but still significant predictive role of air quality ($\beta=0.31$ for well-being) supports the neurocognitive model proposed by Ruaysap (2022), wherein CO₂ levels below 800ppm enhance decision-making performance by 50-100%, a finding that contextualizes our observed effect sizes. The moderate predictive power of ergonomic design ($\beta=0.25-0.30$) mirrors the "activity-based working" research of Mackey (2024), demonstrating how adjustable furniture enables posture variation that reduces fatigue accumulation. Notably, the minimal impact of acoustics ($\beta=0.10-0.12$, ns) contrasts with the "soundscape" literature (Samper, 2021) but may reflect the masking effect of background chatter common in entrepreneurial spaces. This discrepancy warrants acoustic zoning strategies tailored specifically for creative collaboration rather than traditional office quietness. The substantial R² values (0.52-0.58) surpass those in general workplace IEQ studies (typically 0.35-0.45; Hamed, et al., 2023), implying entrepreneurship environments may exhibit heightened sensitivity to environmental factors due to their cognitively demanding, innovation-driven nature.

The relatively lower predictive value of thermal comfort and acoustics in this study, despite their documented significance in global IEQ literature, may be partly explained by contextual and cultural factors unique to Nigerian university environments. Students and entrepreneurs in Nigeria often develop a higher tolerance for thermal discomfort due to chronic exposure to unreliable power supply and the normalization of high ambient temperatures. This habituation may reduce their sensitivity to thermal variations, thereby weakening its perceived impact on productivity and well-being. Similarly, the low beta values for acoustics may reflect a cultural adaptation to ambient noise, as shared spaces in Nigerian institutions are frequently characterized by communal activity and informal communication. In such settings, noise may be interpreted more as a sign of liveliness than as a distraction. Moreover, the strong emphasis on lighting, especially natural lighting, could be amplified by the scarcity of consistent artificial lighting in many public institutions, which makes daylight a critical and deeply appreciated resource. These contextual dynamics suggest that environmental tolerances and preferences in Nigerian incubation centers are shaped not only by physiological responses but also by socio-economic infrastructure and cultural norms, necessitating localized design and policy strategies that move beyond Western-centric IEQ models.

Further Discussion

The findings of this study reaffirm many conclusions in global literature, particularly the strong influence of lighting and air quality on both mental well-being and productivity. However, several contextual nuances emerge when these results are compared to studies in high-income countries. While global research often treats thermal comfort and acoustics as high-priority factors in workspace design (e.g., Boyce, 2022; Samper, 2021), these elements showed weaker correlations in the Nigerian case. This suggests a distinct IEQ hierarchy shaped by local environmental realities and user adaptation. In many Nigerian

settings, tolerance for thermal fluctuations and background noise is higher due to frequent power instability, limited HVAC infrastructure, and socially vibrant work cultures. Consequently, users may prioritize lighting and air quality, conditions they perceive as both scarce and essential, over other factors more readily controlled in Western workspaces.

Another point of divergence lies in the nature of the work conducted in entrepreneurship incubation centers compared to traditional academic environments. While both require concentration and cognitive stamina, entrepreneurship centers emphasize rapid ideation, prototyping, and teamwork. These activities demand greater flexibility, visual acuity, and resilience to environmental distractions, possibly explaining why lighting and air quality carry amplified importance in the present study. This aligns with Jalali et al. (2024) and Mackey (2024), who advocate for adaptive, human-centric workspaces specifically tailored to innovation-driven tasks rather than solitary academic work.

Nevertheless, several limitations temper the generalizability of this study. The cross-sectional design, conducted during a single climatic season, limits understanding of how thermal comfort and ventilation perceptions may vary year-round, especially given Nigeria's pronounced dry and rainy seasons. The reliance on self-reported measures also introduces subjectivity, potentially influenced by cultural hesitations to express dissatisfaction, particularly on mental well-being. Furthermore, the absence of objective IEQ measurements (e.g., CO₂ levels, decibel readings, lux meter data) means that perceptions could not be validated against environmental benchmarks. A relatively modest sample size and focus on a limited number of institutions also restricts the scope for broad national extrapolation.

From a policy and implementation standpoint, the results underscore the need for more nuanced IEQ standards tailored to entrepreneurship spaces in low-resource settings. While international guidelines such as WELL and LEED offer robust frameworks, their application in Nigerian contexts must account for infrastructural limitations, fluctuating energy availability, and cultural perceptions of comfort. Additionally, practical interventions, such as maximizing access to daylight, improving cross-ventilation through passive design, and using low-cost acoustic zoning techniques, are more viable than high-tech solutions in many institutional settings. However, implementation challenges include budget constraints, maintenance culture, and administrative inertia. Addressing these will require cross-sector collaboration between university leadership, architects, and policymakers, supported by evidence-based advocacy rooted in localized research such as this study.

Conclusion and Recommendations

This study evaluated IEQ conditions in Nigerian university entrepreneurship incubation centers and their effects on mental well-being and productivity. Findings indicate that while lighting and air quality are well-perceived and strongly linked to positive outcomes, acoustics and thermal comfort remain suboptimal, negatively impacting users.

The regression models highlight lighting as the most critical factor, explaining a substantial portion of variance in well-being and productivity. These results underscore the need for targeted IEQ improvements in incubation centers to support Nigeria's growing entrepreneurial ecosystem. Following these findings, the following recommendations are made;

- i. Optimize Lighting Systems: Prioritize natural lighting where possible and install adjustable LED panels to reduce glare and eye strain.
- ii. Enhance Air Quality: Improve ventilation systems, incorporate air-purifying plants, and monitor CO₂ levels to maintain healthy indoor air.
- iii. Acoustic Modifications: Introduce sound-absorbing panels, zoning for quiet vs. collaborative areas, and white noise systems to mitigate distractions.
- iv. Ergonomic Upgrades: Provide adjustable furniture, standing desks, and biophilic design elements to reduce physical strain and boost comfort.
- v. Policy and Awareness: Universities should adopt IEQ guidelines for incubation centers and conduct regular user feedback surveys to monitor environmental conditions.

While this study provides important perceptual insights into IEQ and its impact on user outcomes, future research must prioritize the integration of objective environmental measurements (such as lux levels, temperature, humidity, CO₂ concentration, and decibel readings) to validate and deepen understanding of the observed correlations. The inclusion of such quantitative data will not only enhance the reliability of findings but also enable the development of localized IEQ benchmarks suited to the Nigerian context. More critically, improving IEQ in incubation centers is not merely a technical concern, it holds strategic importance for the success of Nigeria's broader innovation and entrepreneurship ecosystem. As universities continue to serve as incubators for economic transformation and youth-led enterprise, creating healthy, productive, and supportive physical environments will be essential to nurturing the next generation of innovators and problem-solvers.

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