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Effects of Natural Ventilation on Users' Comfort in Administrative Buildings in Southwestern Nigerian Federal Polytechnics

YEKEEN WALIU ADETAYO[1], FUNMILAYO LANREWAJU AMAO[2]
[1,2]*Department of Architecture, Ladoke Akintola University of Technology, Ogbomoso, Nigeria*

Abstract- ***This study assessed the effects of natural ventilation on users' comfort in selected administrative buildings of Federal Polytechnics in Southwestern Nigeria. A mixed-method research design was adopted across Federal Polytechnic Ede, Federal Polytechnic Ado-Ekiti and Federal Polytechnic Ilaro. Data were obtained through structured questionnaires, physical observation, field measurements and interviews. A total of 295 valid questionnaire responses were analysed alongside qualitative observations. Findings showed that the surveyed buildings were predominantly low- to medium-rise, with cellular office layouts, operable windows and mixed-mode ventilation systems. Natural ventilation was strongly recognised as beneficial, with the statement that natural ventilation improves indoor comfort recording the highest mean score of 3.71, while comfort without mechanical cooling recorded the lowest score of 2.99. Cross ventilation was mostly rated fair, with 40.0% of respondents reporting fair performance, 20.0% poor and 10.2% unavailable. Interview findings further identified thermal discomfort during hot periods, dependence on mechanical cooling and uneven airflow distribution as major concerns. A very strong positive association was observed between ventilation quality and users' comfort and work performance (r = 0.98), although the relationship was derived from four paired mean observations and should therefore be interpreted cautiously. The study concludes that natural ventilation contributes meaningfully to comfort and workplace performance, but current building configurations do not consistently provide satisfactory conditions. It recommends improved orientation, operable window design, cross-ventilation, shading, airflow pathways and reduced dependence on mechanical cooling in future administrative buildings.***

Keywords: ***natural ventilation, users' comfort, administrative buildings, federal polytechnics, thermal comfort.***

I. INTRODUCTION

Administrative buildings in higher education institutions support governance, records management, finance, personnel administration and other routine functions that require prolonged occupancy by staff and other users. The environmental conditions within these facilities therefore have direct implications for comfort, health and productivity. Ventilation is central to these conditions because it supports air exchange, heat dissipation and acceptable indoor air quality (Jayeoba and Awojobi, 2024). In warm-humid climates such as Southwestern Nigeria, natural ventilation provides an important passive means of improving indoor environmental quality while reducing dependence on mechanical cooling (Zaniboni and Albatici, 2022).

The effectiveness of natural ventilation depends on the relationship between climate and architectural form. Building orientation, window size and configuration, shading, internal layout and the position of ventilation openings determine the potential for cross-flow and air movement within occupied spaces (Akubue and Adesina, 2023). Where these elements are poorly coordinated, administrative buildings may experience stagnant air, excessive indoor heat and uneven ventilation, increasing users' reliance on fans and air-conditioning. Conversely, operable openings, cross-ventilation and appropriate spatial planning can improve air movement, reduce indoor pollutants and enhance user satisfaction (Irsyad et al., 2023; Ho et al., 2023).

The problem is particularly relevant in Nigerian tertiary institutions, where some administrative buildings continue to depend on mechanical cooling despite the climatic potential for passive ventilation.

Previous studies have identified inadequate orientation, poor window design, weak building spacing and limited consideration of passive strategies as contributors to thermal discomfort in institutional buildings (Ogunsemi and Ojo, 2017; Olaniyan et al., 2019). However, empirical evidence linking natural ventilation characteristics to user comfort in Federal Polytechnic administrative buildings in Southwestern Nigeria remains limited. This study therefore assesses the typology and ventilation characteristics of selected administrative buildings, evaluates users' comfort, and examines the relationship between perceived ventilation quality and users' comfort and work performance. The findings are intended to guide the development of future climate-responsive administrative building. The study objectives were to identify administrative building typologies, examine design features that enhance natural ventilation, analyse ventilation strategies for indoor comfort, evaluate users' comfort perception, assess the relationship between ventilation and comfort.

II. LITERATURE REVIEW

Natural ventilation refers to the exchange of indoor and outdoor air through building openings driven mainly by wind pressure and buoyancy effects. It is recognised as an important passive strategy for improving indoor air quality, thermal comfort and energy performance, particularly in warm climates (Zaniboni and Albatici, 2022; Jayeoba and Awojobi, 2024). Its effectiveness is not determined by openings alone; building form, orientation, floor level, internal partitions, façade permeability and occupant control all influence the quantity and distribution of airflow (Akubue, 2023; Akubue and Adesina, 2023). Natural, mechanical and mixed-mode ventilation therefore represent different approaches to meeting indoor environmental requirements, with hybrid systems often used where natural airflow is insufficient for all operating periods (Alabor et al., 2024; Idowu et al., 2023).

In administrative buildings, user comfort is closely related to thermal conditions, air movement and perceived indoor air quality. Thermal comfort is influenced by air temperature, humidity, air velocity, clothing and activity, while increased air movement can improve the perception of comfort in warm-humid conditions by enhancing convective and evaporative heat loss (ASHRAE, 2022; CIBSE, 2021). Evidence from office environments indicates that inadequate ventilation can coincide with higher indoor temperatures, discomfort and reduced work performance (Ajayi and Adebayo, 2017). Maintaining effective natural airflow is therefore relevant not only to environmental quality but also to the ability of workers to concentrate and perform routine tasks comfortably.

Architectural planning has a significant role in determining ventilation performance. Window size and placement, cross-ventilation paths, orientation, high ceilings, shading devices and the organisation of internal spaces influence how outdoor air reaches occupied zones (Akubue and Adesina, 2023; Alabor et al., 2024). In Southwestern Nigeria, warm temperatures, high humidity, solar radiation and seasonal wind variation make climate-responsive planning particularly important. The study is therefore situated within the broader Indoor Environmental Quality, Natural Ventilation and Thermal Comfort frameworks, which collectively provide a basis for relating architectural characteristics and environmental conditions to user experience (ASHRAE, 2022; CIBSE, 2021). Previous Nigerian research has largely addressed residential and general educational buildings, leaving a more specific evidence gap concerning administrative buildings in Federal Polytechnics. The present study addresses that gap by combining physical assessment with user perception.

III. METHODOLOGY

The study adopted a mixed-method research design combining quantitative and qualitative approaches to evaluate natural ventilation and users' comfort in selected administrative buildings of Federal Polytechnics in Southwestern Nigeria. The study covered three institutions: Federal Polytechnic Ede in Osun State, Federal Polytechnic Ado-Ekiti in Ekiti State, and Federal Polytechnic Ilaro in Ogun State. Within each institution, key administrative facilities, including principal administrative offices, Registry,

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Academic Affairs and Bursary units, were purposively selected because of their institutional importance and prolonged occupancy. The study focused on administrative buildings and related management spaces; classrooms, laboratories, workshops and hostels were excluded. The broader study area comprised the six states of Southwestern Nigeria, characterised by a warm-humid tropical climate with high humidity, significant solar radiation and variable seasonal winds.

Primary data were obtained through structured questionnaires, field measurements, physical observation and key-informant interviews. Observations considered building orientation, window configuration, ventilation openings, shading, ceiling height, internal layout and cross-ventilation paths. Air velocity was measured with an anemometer, while temperature and relative humidity were measured with a thermo-hygrometer. The estimated administrative staff population across the three institutions was 1,260, from which a minimum sample of 304 respondents was derived using Slovin's formula at a 5% margin of error. Questionnaire distribution produced 295 valid responses used in the analysis. A multistage sampling procedure was applied, while five key informants were identified from senior administrative officers and regular building users. Questionnaire data were analysed using frequencies, percentages, mean scores and standard deviations, while correlation and related inferential procedures were used to examine relationships among ventilation and comfort variables. Qualitative interview and observation data were analysed thematically. Measured environmental conditions were compared with relevant ASHRAE and CIBSE benchmarks.

IV. RESULTS AND FINDINGS

4.1 Socio-Demographic and Building-Use Characteristics of Respondents

Table 1: Socio-Demographic and Building-Use Characteristics of Respondents (n = 295)

Variable	Category	Frequency	Percentage (%)
Gender	Male	172	58.3
	Female	123	41.7
Age	20–29 years	50	16.9
	30–39 years	102	34.6
	40–49 years	85	28.8
	50–59 years	43	14.6
	60 years and above	15	5.1
Educational qualification	ND/NCE	42	14.2
	HND/BSc	148	50.2
	MSc	76	25.8
	PhD	18	6.1
	Others	11	3.7
Respondent category	Administrative staff	138	46.8
	Academic staff	86	29.2
	Technical staff	41	13.9
	Students	18	6.1
	Visitors	12	4.1
Work experience	Less than 10 years	36	12.2
	10–20 years	78	26.4
	21–30 years	95	32.2
	Above 30 years	86	29.2
Primary ventilation system	Natural ventilation	68	23.1

	Mechanical ventilation	54	18.3
	Mixed-mode ventilation	173	58.6

The respondent profile indicates that the study was dominated by regular institutional users. Males represented 58.3% of respondents, while females accounted for 41.7%. The largest age group was 30–39 years (34.6%), followed by 40–49 years (28.8%), meaning that 63.4% of respondents were between 30 and 49 years. HND/BSc and MSc holders constituted 76.0% of the sample, while administrative and academic staff together represented 76.0% of respondents. More than half of respondents had over 20 years of work experience, indicating substantial familiarity with the buildings and their environmental conditions. Mixed-mode ventilation was the dominant reported system (58.6%), compared with natural ventilation alone (23.1%) and mechanical ventilation (18.3%). This pattern suggests that natural ventilation is widely supplemented by mechanical cooling where the existing buildings do not consistently provide satisfactory indoor conditions.

4.2 Typology and Ventilation Characteristics of the Administrative Buildings

Table 2: Selected Typological and Ventilation Characteristics of the Buildings

Characteristic	Category	Frequency	Percentage (%)
Building type	Central administrative block	89	30.2
	Faculty administrative block	74	25.1
	Departmental office block	74	25.1
	Registry/records office	44	14.9
	Others	14	4.7
Building form	Single storey	118	40.0
	Two storey	88	29.8
	Multi-storey	74	25.1
	High-rise (>5 floors)	15	5.1
Office layout	Cellular offices	133	45.1
	Open-plan offices	88	29.8
	Mixed layout	74	25.1
Window type	Casement	103	34.9
	Louvred	74	25.1
	Sliding	59	20.0
	Fixed with vents	30	10.2
	Combination	29	9.8
Window operation	Fully operable	162	54.9
	Partially operable	103	34.9
	Not operable	30	10.2
Cross ventilation	Good	88	29.8
	Fair	118	40.0
	Poor	59	20.0
	Not available	30	10.2
Façade openness	Highly open	74	25.1
	Moderately open	118	40.0
	Slightly open	74	25.1
	Fully enclosed	29	9.8

The surveyed administrative buildings were predominantly low- to medium-rise facilities. Central administrative blocks constituted the largest typology (30.2%), while faculty and departmental office blocks each accounted for 25.1%. Cellular office layouts were most common (45.1%), reflecting the privacy and functional separation requirements of administrative work. Fully operable windows were present in 54.9% of the buildings and both low- and high-level ventilation openings were reported in 40.0%. Despite these openings, cross ventilation was rated mainly as fair (40.0%), with 20.0% rated poor and 10.2% reported as unavailable. Moderately open façades were dominant at 40.0%. These findings indicate that the buildings possess basic ventilation opportunities but do not consistently translate those opportunities into effective cross-airflow. The implication is that future administrative buildings require better coordination of orientation, window placement, opening size and internal spatial configuration.

4.3 Users' Perception of Comfort

Table 3: Users' Perception of Comfort (n = 295)

S/N	Statement	TMV/TWV	Mean (μ)	Interpretation
1	Offices are thermally comfortable	976	3.31	Moderate
2	Natural ventilation improves indoor comfort	1095	3.71	High
3	Air movement is adequate	979	3.32	Moderate
4	Windows provide sufficient airflow	1021	3.46	Moderate
5	Comfortable without mechanical cooling	883	2.99	Moderate
6	Satisfaction with office ventilation	964	3.27	Moderate

The comfort assessment shows that respondents recognise the contribution of natural ventilation but perceive its present performance as only moderately satisfactory. The highest-rated statement was that natural ventilation improves indoor comfort (μ = 3.71), indicating strong agreement with the value of passive airflow. However, windows providing sufficient airflow scored 3.46, while air movement adequacy and office thermal comfort recorded 3.32 and 3.31 respectively. Satisfaction with office ventilation was also moderate at 3.27. The lowest rating, 2.99, was obtained for comfort without mechanical cooling. This suggests that although natural ventilation is valued, it does not yet provide sufficient comfort to eliminate dependence on fans and air-conditioning. The results reinforce the importance of improving window design, airflow distribution, building orientation and passive ventilation paths rather than merely adding mechanical cooling.

4.4 Key Informant Findings on Ventilation Performance

The qualitative findings corroborated the questionnaire results. The dominant themes were thermal discomfort during hot periods, dependence on mechanical cooling, inadequate airflow distribution, seasonal variation in comfort, and design-related ventilation problems. Interview responses particularly associated ventilation performance with building orientation, internal partitions and window size. Although natural ventilation was acknowledged as beneficial, its effectiveness was described as inconsistent across the buildings. The convergence between qualitative and quantitative evidence suggests that the central problem is not the absence of ventilation openings, but the limited capacity of existing layouts and envelope configurations to distribute air effectively under changing climatic conditions.

4.5 Relationship Between Ventilation and Users' Comfort and Work Performance

Table 4: Relationship between Perceived Ventilation Quality and Comfort/Performance

Variables	Mean	Pearson r	Interpretation
Ventilation Quality (X)	3.49	0.98	Very strong positive relationship
Comfort and	3.51		

Work Performance (Y)			

The analysis produced an overall mean of 3.49 for perceived ventilation quality and 3.51 for users' comfort and work performance. A Pearson correlation coefficient of r = 0.98 was reported, indicating a very strong positive association between the two variables. The result suggests that more favourable ventilation conditions tend to accompany more favourable perceptions of comfort, concentration, productivity and reduced reliance on mechanical cooling. From an architectural perspective, the finding reinforces the importance of orienting buildings and openings to support airflow, providing effective cross-ventilation and reducing obstructions created by internal partitions. However, the reported correlation should be interpreted cautiously because it was calculated from only four paired mean observations rather than respondent-level composite scores. The thesis itself identifies this limitation; a correlation based on individual respondent data would provide stronger statistical evidence of the relationship.

4.6 Case Study Implications

The case studies reinforce the survey findings by showing how architectural configuration affects natural ventilation in practice. The Federal Polytechnic Ilaro administrative building combines natural ventilation with fans and air-conditioning, but corridor arrangements restrict cross-ventilation in some areas and some offices experience inconsistent airflow. The Federal Polytechnic Ede and Ado-Ekiti administrative buildings similarly operate mixed-mode systems; both exhibit limitations in cross-ventilation and dependence on mechanical cooling. In contrast, the case study of The Crystal, London demonstrates a more integrated approach through mixed-mode ventilation, operable openings, atrium spaces, shading and environmental controls. These comparisons suggest that future administrative buildings can adapt the useful principles of flexible planning, controlled openings, shading and mixed-mode operation while remaining responsive to the local climate and energy context.

V. CONCLUSION AND RECOMMENDATIONS

The study concludes that natural ventilation is an important determinant of users' comfort and workplace performance in administrative buildings of Federal Polytechnics in Southwestern Nigeria. The surveyed buildings are largely low- to medium-rise, with cellular layouts, operable windows and basic passive ventilation features. However, the prevalence of fair cross-ventilation and continued dependence on mixed-mode systems shows that these features do not consistently produce optimal indoor conditions. Users strongly acknowledge the value of natural ventilation, but comfort, airflow adequacy and satisfaction with office ventilation remain moderate. The results further indicate that ventilation quality is closely associated with comfort and work performance, although the reported r = 0.98 relationship should be treated cautiously because it was derived from four paired mean observations. Overall, the findings support a shift towards more deliberate climate-responsive administrative building design in Ede.

In response to the study objectives, future administrative buildings should adopt building orientations and spatial layouts that promote cross-ventilation and reduce airflow obstruction. Large operable windows, well-positioned inlet and outlet openings, high ceilings and suitable shading devices should be integrated at the design stage. Existing buildings should be improved by removing or reducing airflow obstructions, repairing non-functional windows and strengthening ventilation pathways. Administrative buildings should also provide adequate support spaces, including waiting areas, staff lounges and meeting spaces, so that users are not concentrated in poorly ventilated rooms. Finally, institutional authorities and relevant regulators should incorporate natural ventilation requirements into the design, assessment and maintenance of administrative facilities, while future research should use longer-term environmental monitoring and respondent-level statistical analysis to strengthen the evidence base for climate-responsive design.

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