Investigation of the Influence of lecture halls IEQ on the Lecturers' performance in Federal Polytechnic, Ilaro Ogun State

Olugbenga Adetona. ADETONA

Abstract

Studies on Indoor Environmental Quality (IEQ) at academic institutions primarily focus on students, with little attention paid to lecturers in higher education institutions such as universities, and polytechnics. IEQ represents a space that has different environmental conditions that affect people's lives in a building such as "Indoor air quality (IAQ), lighting, thermal comfort, acoustics, ergonomics" IEQ assesses the extent to which lecture Hall settings provide the expected comfort that lecturers require to contribute to the completion of specific academic tasks. The data for this study were gathered from 206 lecturers at Federal Polytechnic Ilaro that responded to the google suvery out of the academic staff of the Polytechnic. SPSS was used to examine the data, and the findings from various variables and parameters reveal that the correlation and regression values are 0.05. Some lecture halls identified by respondents as failing to fulfil IEQ criteria were recommended to be retrofitted.

Keywords: *Indoor Environmental Quality (IEQ), Ergonomics, Academic Institution*

Introduction

Indoor environmental quality (IEQ) is the state that exists within a building whereby related qualities such as types of construction components, users' individualities, furniture, mechanical and electrical equipment. (Frontczak et al., 2012) it was designated as an indoor environment which includes "air quality, accessibility to daylight and views, pleasant acoustic conditions and occupant control over light and warm comfort." Containing practical characteristics of the site, such as a layout that allows for flexibility for tools and people, when necessary, as well as ample room for inhabitants. (JIMOH, 2017)The core objective of (IEQ) is that superior interior standard are to best act in the interests of residents during the design, construction, and performance levels of manufactured materials. Balancing employee working environment and (IEQ) has become a priority in building construction and design for high-profile firms. Because of the acknowledgement of the influence of IEQ on the population, higher education institutions began to take keen attention to monitoring their building performance. Studies on (IEQ) at academic institutions mostly focus on undergraduates, with little thought paid to the workforce in higher education establishments such as universities, polytechnics, and so on, particularly in poor and undeveloped countries. (Burdova et al., 2016; El Asmar et al., 2014) Academic institutions must learn to create stimulating internal environments compatible with work opportunities that support learning, teaching, and research styles (Okolie, 2011) The function of lecturers in such facilities is frequently determined by the quality of the interior, which is predisposed to user preferences and the environment of the structure. (Frontczak et al., 2012) A building structure can be anything made with a roof and walls, such as a house or a factory, constructed and permanently located on a plot, as defined by Rogers. (Frontczak et al., 2012) It is also defined as the image of whether a covered wall structure should be erected for proper use, according to the nature of accommodation for people and storage of products (Taleghani et al., 2013). JIMOH, (2017) definition of home technology as an application of technology in building design. High-level employees such as instructors in various offices and training rooms use strategies that can affect their satisfaction and performance in IEQ.

The state of the workplace environment now has significant effects on educators' health, stress levels, performance, and overall well-being (Dessouky & Bayer, 2002). Almeida et al., (2015) stated that (IEQ) represents a space that has different environmental conditions that affect people's lives in a home and a place of work such as "Indoor air quality (IAQ), lighting, thermal comfort, acoustics, ergonomics" and many other aspects go into this category. One of the main aspects determining the quality of the interior environment is indoor air quality (IAQ), which is dependent on atmospheric contaminants. One of the most essential duties of a building is to provide acceptable air quality for its occupants. Among the health consequences of low IAQ include lung cancer, Legionnaires' disease, carbon monoxide poisoning, allergies, and asthma. (Burdova et al., 2016; El Asmar et al., 2014). "Sickness" may result from inadequate levels of IAQ ominously affecting the healthiness and efficiency of instructors. (Burdova et al., 2016)

There are two primary approaches to addressing IAQ concerns in buildings: increasing the ventilation of external air in the building and reducing or controlling the sources of air pollution within and outside the structure. (Justo Alonso et al., 2022; Mikola et al., 2022) The main source of electricity in buildings are natural light (daylight) and artificial light.

Existing research indicates that high-quality ambient lighting in workplaces, schools, and studios improves performance, satisfaction, and user comfort. (Nicol et al., 2006; Vasquez et al., 2022) Population behaviour shows a significant but complex role in quality electrical environments. Nicol et al. (2006) as cited by (Okanya et al., 2021) investigated how illumination conditions affect occupant happiness while controlling for daylight and blinds. They discovered that residents did not considerably modify their light levels in response to exterior circumstances and that people who had access to daylight were more satisfied than those who did not. Residents prefer light environments with 100-foot candles, according to Nicol et al. (2006) as cited by (Okanya et al., 2021). Subjects behaved better in another experiment when they had more control over the lighting settings. (Frontczak et al., 2012; Jimoh, 2017; Joanna, 2012; Vasquez et al., 2022) Other research implies that enhancing building thermal comfort can similarly increase IEQ. (El Asmar et al., 2014) Thermal comfort is a state that is influenced by a variety of environmental and human variables. (Gentner & Favart, 2019) According to the Health and Safety Executive (HSE), the environmental and human factors are “air temperature, wind speed, humidity, radiant temperature, and relative humidity, while the main human factors are clothing and heat, physical health, mental state, availability of food and drink, and environment” (Taleghani et al., 2013) Building acoustics is the science of managing the sound quality within a structure. It is the sound transmission within the building, room, and between rooms (respectively through walls, doors, and floors). (Burdova et al., 2016; El Asmar et al., 2014) Also, keep in mind that room acoustics is primarily concerned with sound quality (e.g., simple communication and high levels of intelligibility in office environments) and lowering/minimizing "unwanted sound" (e.g., noise in one room should not be a nuisance to other rooms) Acoustic comfort in the house has a tremendous influence on health, well-being, communication, and creativity. Acoustic comfort may be influenced by elements such as a room's shape and volume, the creation of sound inside or outside the area, the transmission of wind noise and impact noise, and the space's acoustic properties (absorption, transmission, and reflection of sound(Alsanusi, 2019; Azar et al., 2020; Nowicka, 2020; Urbán et al., 2016) Ergonomics “is concerned with the design of objects, systems, and environments, respectively to guarantee human comfort” (Oron-Gilad & Hancock, 2017) In reality, ergonomics embraces all aspects of IEQ because the primary goal of IEQ is human health and comfort. It includes a variety of topics such as “anatomy, physiology, psychology, and design” Tasks, tools, equipment, environment and space, environment, and organizational structure are all elements that impact workplace ergonomics, according to Edmonds, (2016). An interior ergonomist must be knowledgeable about the interaction of the human mind and body with many components of the house, including building style, internal design, building services, structure, materials, and microclimate. (Ushada et al., 2017)

In general, environmental ergonomics is concerned with the dealings of individuals and their surroundings, with a focus on warmth, light, and noise. Ergonomics in the home, as well as ergonomics in offices and the workplace, is a scientific field and study topic. (Khalid et al., 2019) Educator performance is the ability of educators to perform and perform their roles. it was also the extent to which educators perform their work task (Ayodele, n.d.; Buchari & Matondang, 2017; Khalid et al., 2019; Tong et al., 2017) Investigation in various research have recognized positive correlations between IEQ and user comfort levels for improving efficiency being, health, safety and work. (JIMOH, 2017; Okanya et al., 2021; WBDG, 2020) A high IEQ workplace increases employees' health and morale, enhancing their performance. Decent interior environmental quality, such as visual access, pleasant warmth, calm lighting, effective sound quality, and ergonomic design, among other things, supports instructors' capacity to perform optimally. (El Asmar et al., 2014; Okanya et al., 2021) On the other side, a low IEQ affects one's capacity to work. After all, keeping academics staffs happy, healthy, and productive makes good financial sense. As a result, there is a more sophisticated means of teaching and learning at academic establishments. Consequently, IEQ should be given special consideration during the design of new structures as well as building rehabilitation plans. Improving the quality of the internal environment may improve occupants' quality of life as well as the building's occupancy rate and resale value.

The quality of IEQ in many universities/polytechnics is not good (Iwaro & Mwasha, 2013; Okanya et al., 2021) Studies have shown that many higher institutions have dilapidated facilities, uninhibited projects, par-maintained offices, lecture halls, studios, and workshops. (Kolokotsa & Santamouris, 2015; Okanya et al., 2021) IEQ materials are not included in the building plan and construction phases of many building projects in many institutions. And many of these higher institutions that have limited IEQ amenities lose them due to neglect and poor maintenance

practices. (Iwaro & Mwasha, 2013; Kolokotsa & Santamouris, 2015; Persily & Emmerich, 2012) The quality of IEQ in many institutions is not good due to the lack of adequate funds to maintain and improve the infrastructure. In addition, the indifference of many employees when using offices, laboratories, lecture halls, and workshops contributes to the insecurity of IEQ facilities in many institutions, a summary of many issues that must be fully integrated for residents in physical, occupational, and psychological health. (Okanya et al., 2021) In Iwaro's (2013) research, academic staff and students suffered symptoms such as coughing, throat irritation, weariness, headache, and shortness of breath when listening to lectures in institutions and seminars with sick building syndrome (SBS). Sick Building Syndrome refers to the poor quality of the indoor environment of lecture halls, laboratories, workshops, and offices for lecturers and other institution employees, which can cause health problems or even lawsuits due to poor indoor air quality, insufficient lighting, thermal discomfort, and ergonomic accidents at work (SBS). Lecturer office buildings are an important component of the infrastructure required for teaching and research. According to Jimoh (2017), Nigeria has an Environmental Protection Agency (EPA), however, the operations planned are focused on the exterior environment of buildings rather than the inside environment. Maintaining faculty offices for occupational comfort, contentment, good health, and performance is an issue that Nigerian university maintenance and facilities management must handle. As a result, there is a need to find measures to assure or improve the IEQ of buildings in Nigerian institutions to increase the efficacy of teachers' work. There is also a need to research IEQ installation issues and potential solutions.

Materials

Study area: The Federal Polytechnic, Ilaro

On July 25, 1979, the institution was formally constituted, and on November 15, 1979, it opened its doors to the public. Since then, the Polytechnic has established itself as a traditional institution, educating and developing students throughout five schools or colleges. Engineering, Environmental Studies, Communication and Information Technology, Management Studies, and Pure and Applied Sciences are among them, with 460 (four hundred and sixty) academic staff members.

Sample Size

The sample size is the issue of obtaining a sample of the population. If you asked just one individual in the population if they were vegetarian, their response would not be indicative of the entire community, a formula is then needed to calculate a large enough sample size. (Stephanie Glen, n.d.) Slovin developed the formula (also known as Sloven's formula) in 1960.

The Slovin formula is given as

$$n = N \div (1 + Ne^2)$$

Where n = sample size

N = Population size

e = error tolerance = (1 - confidence level) for this study the confidence level is 95% (0.95)

e = 1- 0.95 = 0.05

The population size (N) of lecturers at Federal Polytechnic, Ilaro is 460

Therefore, the sample size $n = 460 / (1+ 460*0.05^2)$

$$n = 460/2.15 = 214$$

Data Collection

This research was done with the use of primary data which was gathered through the instrumentality of a structured closed-ended questionnaire to obtain responses from speakers who have utilized the various lecture rooms at the Polytechnic, Ilaro. The questionnaire was created following (Barrett et al., 2013) types, which included multiple-choice, closed-ended, and Likert-type questions. It was separated into sections ranging from background information to the four factors of comfort identified by (Almeida et al., 2015) as having the greatest influence on users. Thermal

comfort, acoustic (sound), lighting, and indoor air quality are among them. Two hundred and sixty polytechnic instructors who were interested in the research completed a questionnaire on the indoor environmental quality of the lecture halls.

Results and discussions

Table 1: Sex of respondent

		Frequency	Per cent	Valid Percent	Cumulative Percent
Valid	Male	162	78.6	78.6	78.6
	Female	44	21.4	21.4	100.0
	Total	206	100.0	100.0	

Source: Author 2022

Table 2: School/Faculty

		Frequency	Per cent	Valid Percent	Cumulative Percent
	School of Environmental Studies	56	27.2	27.2	27.2
	School Pure and Applied Science	25	12.1	12.1	39.3
	School Communications and Information Technology	21	10.2	10.2	49.5
	School of Engineering	41	19.9	19.9	69.4
	School of Management Studies	63	30.6	30.6	100.0
	Total	206	100.0	100.0	

Source: Author 2022

Table 3: Age of respondent

		Frequency	Per cent	Valid Percent	Cumulative Percent
	26 - 35 years	9	4.4	4.4	4.4
	36 – 45 years	87	42.2	42.2	46.6
	46 – 55 years	85	41.3	41.3	87.9
	56 – 65 years	25	12.1	12.1	100.0
	Total	206	100.0	100.0	

Source: Author 2022

Tables 1,2 & 3 show the descriptive statistics analysis of respondents in terms of Sex, School/Faculty and Age respectively, this analysis is just to show how the respondents were distributed in terms of Sex, School/Faculty and Age respectively. Table 4 shows a Likert-scale type question, that asked respondents to rate their lecture halls in terms of visual comfort, the Likert scale was rated 1 – 10 with 1 and 10 representing very poor and excellent respectively. Over 84% of the respondents agreed that the visual comfort of the lecture halls ranges from Good to Excellent.

Table 4: Rating the lecture halls in terms of visual comfort

		Frequency	Per cent	Valid Percent	Cumulative Percent
Valid	3	6	2.9	2.9	2.9
	4	5	2.4	2.4	5.3
	5	21	10.2	10.2	15.5
	6	21	10.2	10.2	25.7
	7	15	7.3	7.3	33.0
	8	55	26.7	26.7	59.7
	9	40	19.4	19.4	79.1
	10	43	20.9	20.9	100.0
	Total	206	100.0	100.0	

Source: Author 2022

Table 5&6 shows the regression analysis model and coefficient when the variables "rate your lecture halls in terms of visual comfort on a scale of 1 – 10" and "how well do you see in the lecture halls" as dependent and independent variables, respectively. The R square value from Table 5 is 0.381that is 38.1% agreeing that the visual comfort is good, and Table 6 shows the significant level is 0.000 which shows that the two variables are incredibly significant for this study. The significant level is further confirmed with the Chi-square values in Table 7.

Table 5: Regression Analysis Model Summary for visual comfort

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.617	.381	.378	1.479

Source: Author 2022

Table 6: Regression Analysis Coefficients for visual comfort

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.870	.626		1.389	.166
	11. How well can you see the various part of the lecture halls?	1.665	.149	.617	11.200	.000

Source: Author 2022

Table 7: Chi-Square Test Statistics for visual comfort

	8. Do you need artificial light to write in lecture halls?	11. How well can you see the various part of the lecture halls?	12. On a scale of 1-10, rate the lecture hall in terms of visual comfort.
Chi-Square	191.660	31.728	90.777
df	2	2	7
Asymp. Sig.	.000	.000	.000

Source: Author 2022

Table 8 shows a Likert-scale type question, that asked respondents to rate how audible the sound from the stage, the Likert scale was rated 1 – 10 with 1 and 10 representing very poor and excellent respectively. Over 68% of the respondents agreed that the acoustic comfort of the lecture halls ranges from Good to Excellent.

Table 8: Rating how audible the sound from the stage

		Frequency	Per cent	Valid Percent	Cumulative Percent
Valid	1	6	2.9	2.9	2.9
	3	22	10.7	10.7	13.6
	4	21	10.2	10.2	23.8
	5	15	7.3	7.3	31.1
	6	20	9.7	9.7	40.8
	7	45	21.8	21.8	62.6
	8	29	14.1	14.1	76.7
	9	15	7.3	7.3	84.0
	10	33	16.0	16.0	100.0
	Total	206	100.0	100.0	

Source: Author 2022

Table 9&10 shows the regression analysis model and the coefficient for acoustic comfort when the variables "rate your lecture halls in terms of acoustic comfort on a scale of 1 – 10" and "is there any form of echo in the lecture halls" as dependent and independent variables, respectively. The R square value from Table 9 is 0.51 which is 51.0% agreed that the acoustic comfort is good, and Table 10 shows the significant level is 0.001< 0.05 which shows that the two variables are incredibly significant for this study. The significant level is further confirmed by the Chi-square values in Table 11.

Table 9: Regression Analysis Model Summary for acoustic comfort

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.227	.051	.047	2.355

Source: Author 2022

Table 10: Regression Analysis Coefficients for acoustic comfort

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	9.438	.864		10.926	.000
	14. Do you experience echo in the lecture halls?	-1.407	.423	-.227	-3.327	.001

Source: Author 2022

Table 11: Chi-Square Test Statistics for acoustic comfort

	17. On a scale of 1-10, how audible is the sound from the stage?	15. During lectures, do you get distracted by any of these types of noises? (Tick as appropriate)	14. Do you experience echo in the lecture halls?
Chi-Square	45.913	30.488	247.000
df	8	1	2
Asymp. Sig.	.000	.000	.000

Source: Author 2022

Table 12 shows a Likert-scale type question, which asked respondents to rate how audible the sound from the stage, the Likert scale was rated 1 – 10 with 1 and 10 representing very poor and excellent respectively. Over 67% of the respondents agreed that the quality of light in the lecture halls ranges from Good to Excellent.

Table 12: Rating the quality of lighting

		Frequency	Per cent	Valid Percent	Cumulative Percent
Valid	2	5	2.4	2.4	2.4
	3	22	10.7	10.7	13.1
	5	26	12.6	12.6	25.7
	6	15	7.3	7.3	33.0
	7	26	12.6	12.6	45.6
	8	44	21.4	21.4	67.0
	9	35	17.0	17.0	84.0
	10	33	16.0	16.0	100.0
	Total	206	100.0	100.0	

Source: Author 2022

Table 13&14 shows the regression analysis model and the coefficient for acoustic comfort when the variables "rate your lecture halls in terms of quality of light on a scale of 1 – 10" and "Does the number of windows allow for

natural lighting" as dependent and independent variables, respectively. The R square value from Table 13 is 0.64 which is 64% agreed that the quality of light is good, and Table 14 shows the significant level is 0.000< 0.05 which shows that the two variables are incredibly significant for this study. The significant level is further confirmed by the Chi-square values in Table 15.

Table 13: Regression Analysis Model Summary for quality of light

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.254	.064	.060	2.014

Source: Author 2022

Table 14 Regression Analysis Coefficients for quality of light

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	9.379	.596		15.736	.000
	26. Does the number of windows allow for natural lighting?	-2.023	.540	-.254	-3.746	.000

Source: Author 2022

Table 15: Chi-Square Test Statistics for quality of light

	21. On a scale of 1-10, how will you rate the quality of lighting?	20. Which of the lighting system of the lecture halls gives the best illumination?	19. What type of lighting is prevailing in the lecture halls during lecture hours?
Chi-Square	40.058	45.476	63.621
df	7	2	2
Asymp. Sig.	.000	.000	.000

Source: Author 2022

Table 16: Regression Analysis Coefficients

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	1.181	.242		4.886	.000
35. How will you rate the quality of the indoor air in the lecture halls?	.365	.076	.363	4.778	.000
37. Is the indoor environment of the lecture halls good for learning delivery?	-.201	.060	-.254	-3.345	.001

Source: Author 2022

Table 16 shows the multivariant regression analysis coefficients where the variable "Does the condition of these lecture halls affect your performance?" as a dependent variable where the independent variables are "How will you

rate the quality of indoor air and Is the indoor environment of the lecture halls good for learning delivery" for this analysis the significance values both the independent variables are 0.000 and 0.001 respectively and both values are <0.05. The Chi-Square table further confirms the above significant value values from Table 17. The Correlation from Table 18 also confirms the aforementioned significant value with a significant value of 0.01.

Table 17: Chi-Square Test Statistics

	40. Does the condition of these lecture halls affect your performance?	37. Is the indoor environment of lecture hall 4 for learning delivery?	35. How will you rate the quality of the indoor air in the lecture halls?
Chi-Square	32.223	100.369	123.243
df	2	3	3
Asymp. Sig.	.000	.000	.000

Source: Author 2022

Table 18: Correlations

		40. Does the condition of these lecture halls affect your performance?	35. How will you rate the quality of the indoor air in the lecture halls?
40. Does the condition of these lecture halls affect your performance?	Pearson Correlation	1	.239**
	Sig. (2-tailed)		.001
	N	206	206
35. How will you rate the quality of the indoor air in the lecture halls?	Pearson Correlation	.239**	1
	Sig. (2-tailed)	.001	
	N	206	206

**. Correlation is significant at the 0.01 level (2-tailed).

Source: Author 2022

Conclusion and recommendation

Studies have shown that there is a correlation between academic performance and Indoor Environmental Quality (IEQ), this study has further shown that the performance of lecturers is also determined by IEQ. Indoor environmental quality measures the extent to which lecture Hall settings deliver the expected comfort that educators contribute to the completion of specific jobs (IEQ). The survey data may be used to evaluate the environmental design and performance of lecture halls in Nigerian academic institutions. From the survey the respondents identified that the following lecture hall's indoor environment quality is not comfortable are as follows: AG 1&2, AG 3&4, AH 1&2, AH 3, AH 4&5, AUD 1, AUD 2, and ADU 3, it is hereby recommended to the management of The Federal Polytechnic, Ilaro to retrospectively makes the above-named lecture halls more comfortable for both lecturers and student to optimize performance.

Reference

Almeida, R. M. S. F., de Freitas, V. P., & Delgado, J. M. P. Q. (2015). School Buildings Rehabilitation. *SpringerLink*. https://doi.org/10.1007/978-3-319-15359-9

Alsanusi, S. S. (2019). Effect of various plan types on acoustical characteristics of restaurants. *A thesis submitted to*

the graduate school of natural and applied sciences of Çankaya University, *2*, 1–13.

Ayodele, A. E. (n.d.). *The extent of Noise pollution and its implication on secondary school students in Agege area of Lagos State*. Retrieved August 23, 2022, from https://www.academia.edu/10080562/The_extent_of_Noise_pollution_and_its_implication_on_secondary_school_students_in_Agege_area_of_Laghos_State

Azar, E., O'Brien, W., Carlucci, S., Hong, T., Sonta, A., Kim, J., Andargie, M. S., Abuimara, T., El Asmar, M., Jain, R. K., Ouf, M. M., Tahmasebi, F., & Zhou, J. (2020). Simulation-aided occupant-centric building design: A critical review of tools, methods, and applications. *Energy and Buildings*, *224*, 110292. https://doi.org/10.1016/J.ENBUILD.2020.110292

Barrett, P., Zhang, Y., Moffat, J., & Kobbacy, K. (2013). A holistic, multi-level analysis identifying the impact of classroom design on pupils' learning. *Building and Environment*, *59*, 678–689. https://doi.org/10.1016/j.buildenv.2012.09.016

Buchari, & Matondang, N. (2017). The impact of noise level on students' learning performance at state elementary school in Medan. *AIP Conference Proceedings*, *1855*(June 2017). https://doi.org/10.1063/1.4985498

Burdova, E. K., Vilcekova, S., & Meciarova, L. (2016). Investigation of Particulate Matters of the University Classroom in Slovakia. *Energy Procedia*, *96*, 620–627. https://doi.org/10.1016/J.EGYPRO.2016.09.111

Dessouky, Y. M., & Bayer, A. (2002). A simulation and design of experiments modeling approach to minimize building maintenance costs. *Computers and Industrial Engineering*, *43*(3), 423–436. https://doi.org/10.1016/S0360-8352(02)00056-6

Edmonds, J. (2016). What is human factors? *Human Factors in the Chemical and Process Industries: Making It Work in Practice*, 3–11. https://doi.org/10.1016/B978-0-12-803806-2.00001-7

El Asmar, M., Chokor, A., & Srour, I. (2014). Are building occupants satisfied with indoor environmental quality of higher education facilities? *Energy Procedia*, *50*(480), 751–760. https://doi.org/10.1016/j.egypro.2014.06.093

Frontczak, M., Schiavon, S., Goins, J., Arens, E., Zhang, H., & Wargocki, P. (2012). Quantitative relationships between occupant satisfaction and satisfaction aspects of indoor environmental quality and building design. *Indoor Air*, *22*(2), 119–131. https://doi.org/10.1111/J.1600-0668.2011.00745.X/ABSTRACT

Gentner, A., & Favart, C. (2019). (Thermal) Comfort and its Specific Influencing Factors. *Aachen Colloquium Automobile and Engine Technology*, *477*(1970), 477–478.

Iwaro, J., & Mwasha, A. (2013). The impact of sustainable building envelope design on building sustainability using Integrated Performance Model. *International Journal of Sustainable Built Environment*, *2*(2), 153–171. https://doi.org/10.1016/J.IJSBE.2014.03.002

JIMOH, I. A. (2017). WORKSPACE UTILISATION, MAINTENANCE PRACTICE AND LECTURERS' SATISFACTION WITH INDOOR ENVIRONMENTAL QUALITY IN SELECTED NIGERIAN UNIVERSITIES. *PhD Thesis*, *1*, 43. https://doi.org/10.1017/CBO9781107415324.004

Joanna, M. (2012). Human comfort and self-estimated performance in relation to indoor environmental parameters and building features. *PhD Thesis Department of Civil Engineering 2012*. www.byg.dtu.dk

Justo Alonso, M., Wolf, S., Jørgensen, R. B., Madsen, H., & Mathisen, H. M. (2022). A methodology for the selection of pollutants for ensuring good indoor air quality using the de-trended cross-correlation function. *Building and Environment*, *209*. https://doi.org/10.1016/j.buildenv.2021.108668

Khalid, H., Kogi, K., & Helander, M. (2019). Ergonomics Intervention of Workplaces Using SEANES Ergonomic Checkpoints. *Advances in Intelligent Systems and Computing*, *824*, 1125–1134. https://doi.org/10.1007/978-3-319-96071-5_113/COVER

Kolokotsa, D., & Santamouris, M. (2015). Review of the indoor environmental quality and energy consumption

studies for low income households in Europe. *Science of The Total Environment*, *536*, 316–330. https://doi.org/10.1016/J.SCITOTENV.2015.07.073

Mikola, A., Hamburg, A., Kuusk, K., Kalamees, T., Voll, H., & Kurnitski, J. (2022). The impact of the technical requirements of the renovation grant on the ventilation and indoor air quality in apartment buildings. *Building and Environment*, *210*. https://doi.org/10.1016/j.buildenv.2021.108698

Nicol, F., Wilson, M., & Chiancarella, C. (2006). Using field measurements of desktop illuminance in European offices to investigate its dependence on outdoor conditions and its effect on occupant satisfaction, and the use of lights and blinds. *Energy and Buildings*, *38*(7), 802–813. https://doi.org/10.1016/J.ENBUILD.2006.03.014

Nowicka, E. (2020). The acoustical assessment of the commercial spaces and buildings. *Applied Acoustics*, *169*, 107491. https://doi.org/10.1016/J.APACOUST.2020.107491

Okanya, A., Asogwa, J., & Onyedikachi, I. (2021). Indoor Environmental Quality (IEQ) in Nigerian Tertiary Institutions: The Effect on Performance of Building Technology Lecturers. *Middle Eastern Journal of Research in Education and Social Sciences*, *2*(1), 172–186. https://doi.org/10.47631/mejress.v2i1.143

Okolie, K. C. (2011). Performance Evaluation of Buildings in Educational Institutions: A Case of Universities in South-East Nigeria. *A Thesis Submitted in Partial Fulfilment of the Requirements for the Award of the Degree of Philosophiae Doctor in Construction Management in the Department of Construction Management, School of the Built Environment, Faculty of Engineering, the Built Env*, *July*.

Oron-Gilad, T., & Hancock, P. A. (2017). From Ergonomics to Hedonomics: Trends in Human Factors and Technology—The Role of Hedonomics Revisited. *Emotions and Affect in Human Factors and Human-Computer Interaction*, 185–194. https://doi.org/10.1016/B978-0-12-801851-4.00007-0

Persily, A. K., & Emmerich, S. J. (2012). Indoor air quality in sustainable, energy efficient buildings. *HVAC and R Research*, *18*(1–2), 4–20. https://doi.org/10.1080/10789669.2011.592106

Stephanie Glen. (n.d.). *Slovin's Formula: What is it and When do I use it?* Statistics How To. Retrieved August 28, 2022, from https://www.statisticshowto.com/probability-and-statistics/how-to-use-slovins-formula/

Taleghani, M., Tenpierik, M., Kurvers, S., & Van Den Dobbelsteen, A. (2013). A review into thermal comfort in buildings. *Renewable and Sustainable Energy Reviews*, *26*, 201–215. https://doi.org/10.1016/J.RSER.2013.05.050

Tong, Y. G., Abu Bakar, H., Mohd Sari, K. A., Ewon, U., Labeni, M. N., & Fauzan, N. F. A. (2017). Effect of urban noise to the acoustical performance of the secondary school's learning spaces-A case study in Batu Pahat. *IOP Conference Series: Materials Science and Engineering*, *271*(1). https://doi.org/10.1088/1757-899X/271/1/012029

Urbán, D., Zrneková, J., Zaťko, P., Maywald, C., & Rychtáriková, M. (2016). Acoustic Comfort in Atria Covered by Novel Structural Skins. *Procedia Engineering*, *155*, 361–368. https://doi.org/10.1016/j.proeng.2016.08.039

Ushada, M., Suyantohadi, A., Khuriyati, N., & Okayama, T. (2017). Identification of environmental ergonomics control system for Indonesian SMEs. *2017 3rd International Conference on Control, Automation and Robotics, ICCAR 2017*, 453–456. https://doi.org/10.1109/ICCAR.2017.7942737

Vasquez, N. G., Rupp, R. F., Andersen, R. K., & Toftum, J. (2022). Occupants' responses to window views, daylighting and lighting in buildings: A critical review. *Building and Environment*, *219*, 109172. https://doi.org/10.1016/j.buildenv.2022.109172

WBDG. (2020). *Enhance Indoor Environmental Quality (IEQ)*. Whole Building Design Guide. https://www.wbdg.org/design-objectives/sustainable/enhance-indoor-environmental-quality