# Post Occupancy Evaluation of Building Services Provisions in Higher Institution Libraries in Niger State

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Library is perceived as the heart of every educational institution but has continually being poised with a poor and neglected design approach and maintenance regardless of its relevance in the educational institutions. This paper reports on the post occupancy evaluation (POE) of the buildings services engineering provisions in three selected higher institutions libraries in Niger State within the months of July and December, 2014. The study adopted a bespoke POE approach in carrying out the objective measurement. The data reveal temperature to be within the ranges of 25.0 ºC to 32.6 ºC, the relative humidity between 52.1 to 83.2 % with most value above 70%, the noise rating recorded was within 27.0 to 86.8 dBA and lighting was within 15.2 to 286.5 lux. The results from the technical indices obtained suggested that most parameters within the indoor space did not conform with the standard provided in CIBSE Guide A (2006). It was recommended that as designers go about their planning and execution of habitable structures, great consideration should be given to the comfort and wellness (physiological and Psychological wellbeing) of the occupants of such spaces with a strong emphasis on the guide provided in Integrated School Design by Chattered Institute of Building Services Engineers [CIBSE] TM57 (2015). Also, a proactive maintenance should be adhered to with a mandate from a periodical POE survey on comfort.

**Keywords**: Building Services Engineering, Institution Library, Occupant Satisfaction, Post Occupancy Evaluation (POE), Psychrometer.

## Introduction

Sustainable development of Building projects in Nigeria should be approached through the Concept of "Fit Building" – fit for the people that use it, fit for its purpose, and fit for the planet. School buildings more than many other buildings, do have more challenging environmental requirements that are more demanding and complex (*CIBSE TM57 (2015)*. Cognitive psychologists have identified the physical environment as having a significant impact on safety and human performance. Reiling *et al*. (2008) established that understanding the interrelationships between humans, the tools they use and the environment in which they live and work is basic to any design of building for humans' use. Hence, various researchers over the years have been able to apply the idea of building services in the library to discover the performance of libraries designed for academic purposes. Geoffrey (2005) in an effort to picture a library as an inspirational environment were able to discover the library in an academic setting as the only symbolical and physical representation of the academic heart of an institution. Mumovic (2005) stated that School buildings possess environmental requirements that are more complex and demanding and should thus; offer a safe, comfortable and stimulating environment for learning and social interactions.

The physical facility of any academic library should inspire and elevate those who enter it. Researchers (Geofrey, 2005; Vashishta, 2007; Morenikeji, 2007; Nwabueze *et al*., 2010) have established that educational institutions contribute a major share in the overall human development by providing people with the necessary tools and knowledge needed for social and economic development of a nation by producing graduates with new and innovative ideas so as to achieve this goal, whereby these higher educational institution libraries become the knowledge centre to users. Vashishta (2007) noted that the libraries must therefore be comfortable, convenient and safe for these goals to become a success.

Saddled with the responsibility of providing such an enabling environment, a team of engineers in the early 1990s backed by the CIBSE organization established a group called Post Occupancy Review of Building Engineering (PROBE) in the UK with an aim to improve building performance through a systematic and detailed inspection and carried out on occupied buildings (Cervi, 2012). Tanyer and Pembegul (2010) both provided us with proven facts of POE providing credible evidence about positive and negative aspects of a building from the user's point of view. Taylor *et al.* (2011) are of the believe that POE originates from an interest in learning how a school building performs once it is built, including if and how well it has met expectations and how satisfied building users are with the environment that has been created. This has encouraged the use of PROBE to identify the flaws in school buildings so as to proffer remedial actions that would further enhance a comfortable, convenient and safe learning environment for student development and discourage bad practices.

As was advocated by Prescott (2001), several researches in the past have suggested that school children are susceptible to various factors affecting their performance such as heat stress, acclimatization, glare, noise and other factors etc. Design errors hampers students' performance and productivity and as this was clearly identified by Scottish Executive (2004) that these errors impose a direct impact on the users through some indices supported by certain building issues such as acoustics, visual, thermal conditions, sanitations, ergonomics and lots more. Technical index underpins the solutions developed in response to comfort demand.

POE can be carried out on the selected buildings either for a short term, medium term and long term bases (Meir *et al*., 2009). This paper presents the report of POE conducted on library buildings of three Schools employing the use of some potable environmental devices in measuring physical parameters put in place for an optimum performance of these indices. Information retrieved was compared with the available standards of PROBE benchmark for library comfort design extracted from (CIBSE, 2006) and as directed *CIBSE, 2015)*. Library is an integral part of any educational institution but most library buildings in the institutions have continually been wrongly designed and neglected. These poor practices are traced to the assertion that 'No school building is perfect, not even a completely new one'. This has encouraged an enormous need for an evaluation of the users' comfort and performance. Tanyer and Permbegul (2010) noted that it is a good practice to always investigate if the essence for which the building was designed is actually met.

**Brief Review of Methods Used for Buildings Energy Performance Modelling**

There are a lot of studies trying to group building performance evaluation methodologies. This section presents a brief overview of currently used methodologies, type of models as well as the input parameters used for modelling buildings energy performance. Some studies have categorized building performance evaluation methodologies through black, grey or white box methodologies and detailed model calibration, as follows:

- Black box models are purely statistical, with little information required for each building. This refers to the use of simple mathematical or statistical models which relate a set of influential input parameters. Statistical or machine learning formulations called ''black box'' approaches are mainly used with the aim to deduce a prediction model from a relevant database,
- White box models, often described as engineering approach, are based on building

physics, and are highly dependent on user inputs. For example, the white box scheme allows one to evaluate the indoor temperature in a building for different time and spatial scales,

- Grey box models, also called hybrid approach, differ from black-box approaches in a way that they use certain key system parameters identified from a physical system model. Grey box models mix limited building physics with statistical methodologies and
- Detailed model calibration approach uses a fully descriptive law-driven model of a building system and tunes the various inputs to match the measured data. This approach provides the most detailed prediction of building performance, given the availability of high-quality input data.

Each of the mentioned model categories consists of specific advantages yet extracting outputs from complex engineering models may be exhaustive and time consuming. Therefore, the detailed model calibration approach was used in this study because of its obvious advantages over other methods as mentioned above.

## Research Methodology

The study conducted a POE of two Universities in Niger State but one of the universities had two Libraries with focus on the technical performance of the library building. The selection was based on the model design and facilities put in place to achieve a standard design from these three libraries. Two of which are less than ten years of occupancy and the other more than ten years but recently underwent a performance upgrade. These buildings have a little more of sustainable design principle employed in the design which was not fully considered in other nearby academic libraries. These include having a proper fenestration design with stack system, providing mechanical cooling and ventilating system, depth and space consideration, shading and orientation principles. As at the time of conducting this research, these library buildings were the only university libraries in the state and were also considered the most recently constructed higher institutional libraries built with a more advanced technological concept.

Considering the set objectives as comfort, convenience and safety expected within the library indoor space, measurements of the building services engineering provisions and determination of the comfort criteria under the processes of POE were conducted using potable handheld environmental sensing measuring devices, such as Lux for light intensity; sound meter for sound level; psychrometer for thermal comfort; checklist for water consumption and fire safety and security (see Table 1).

Table 1: Brief on the Potable Instruments Used in Measurements

| S/No | Instruments | Model Number | Manufacturer | Capacity | Units |
|---|---|---|---|---|---|
| 1. | Light Lux Meter | E75CC | Precision Gold | 0-50,000 | Lux, ft/cd |
| 2. | Digital Sound Meter | NO5CC, IEC 401 type 2 | Precision Gold | Lo; 0-100 Hi; 80-130 | dBA |
| 3. | Digital Psychrometer | EX 330 | Extech | Internal & External | $^{o}$C & % |

The study adopted a quantitative research method while using a bespoke POE approach to ensure that a more focused and accurate empirical analysis was established. With regards to the principle that environments vary from place to place, Mastor and Ibrahim (2011) initiated that it is best adopting a bespoke POE approach which is more flexible and precise since the study conducted overseas on POE were more intense and relied on the tools developed to suit their foreign experiences. A pilot study was conducted to compare and analyse the prevailing indoor physical comfort parameters with the standard design conditions. While using the bespoke approach which involved technical combination of two approaches i.e. De

Montfort method (Walkthrough building) and PROBE (Measurements using tools) to achieve a better performance process. Checklist template was developed from various templates as retrieved from literature (The International Library Association and Institutions [IFLA]), 2006; BS 6465 - 1 (2006); Her Majesty Government - HMG, 2006; Barlex, *et al*., 2007).

In using the potable instruments, the measurement was conducted within three (3) months and in nine (9) different days from July to September, 2014 of which the weather was neither too cold nor too hot in this time of the year due to rainfall (considered as the best weather of the year) with each library measured thrice (3)/day. Several points were established for sampling depending on the room size and occupants space (Shaharon and Jalaludin, 2012). An average sitting height of 1.3m for all sedentary occupants within the library was established as a beacon for measurements of thermal, sound as well as visual where no working plane exists. To avoid errors, the readings were taking after 30 seconds to allow for settlements of each instrument as they are sensitive to vibrations. All readings within the space were conducted within 30minutes and an average value was calculated from each space for the sample study to be analysed and data presented in tables, charts and graphs. Also, checklist was used during the walkthrough survey process to assess the convenience and safety indices. The data were analysed by comparison with a standard benchmark for indoor design criteria from (Chartered Institution of Building Services Engineers [CIBSE], 2006) and backed by CIBSE TM57 (2015).

The research involves the measuring of the indoor comfort variables and verifying them with the existing theories of PROBE Benchmark. This approach was adopted for the pilot study conducted in order to compare and analyze the prevailing indoor physical comfort conditions with the design conditions.

## Results

The results of the observations and measurements taken are as presented in the following subsections:

Walkthrough and Observations

These include the utility conditions of the environmental indicators that contribute to convenience and safety of the users. It covers water consumption and internal sanitation, fire safety and security. Presented in this study are data gathered through walkthrough process and observations within the premises using a checklist drawn from (IFLA, 2006).

Table 2 shows that the water provided within these spaces were from the borehole. There is steady water supply for use due to the provided storage system. Except for University A Library 1 (SA) library which had toilets provided for all users, University A Library 2 (SB) and University B Library (SC) library both in same Institution provided toilets for only staff but none for students and visitors. None of the schools provided toilet accessories.

Table 3 further show the safety indicators of the Library units

Observations from the study revealed the possible sources of ignition as electricity sparks and sources of fire fuel are books, furniture, curtains electronic devices and PVC materials. Cooling units and atmospheric air are the sources of oxygen while the people at risk are the students, staff members and visitors. The checklist result in Table 3 showed that only the SC has a smoke detector properly positioned and a well-organized fire alarm system for notification in a case of fire outbreak. The three libraries have adequate escape exit route provided but only the School C library has an emergency lighting system and escape exit that is clearly visible for direction in an event of fire. There is no proper care for the fire extinguisher, not adequate enough and no fire hose reel provided for the School B. There is a local fire brigade facility very close to the premise of School C. School A Library has no security cameras provided within the space.

**Table 2: Checklist for Convenient Indicators (Water consumption and Sanitation)**

| Description | SA | SB | SC |
|---|---|---|---|
| **Water Consumption** | | | |
| Is there any supply of water? | | | |
| What is the water source? | Borehole | Borehole | Borehole |
| Is there any Staff accessibility to water | | | |
| Student /other users accessibility to water | | | |
| Is there a Steady Availability of water | | | |
| Method of storage | Surface tank | Elevated | Surface tank |
| **Internal Sanitation** | | | |
| Are there enough toilets? | | staffs alone | staffs alone |
| Accessibility of toilets by students | | | |
| Accessibility of toilets by staffs | | | |
| Properly located | | | |
| Enough adapted toilets for disabled | | | |
| Is there vandalism by users? | | | |
| Are toilets properly equipped (soap dispenser, hand dryers, changing mats, hygienic paper, hangers in the toilets) | | | |
| Do they often break down | | Not often | Not often |
| Availability of cleaning facilities | | | |

Keys
Signifies Yes
Signifies No
None

Table 3: Checklist on Safety Indicators (Fire Safety and Security)

| **Fire Safety and Security**<br>**Description** | **SA** | **SB** | **SC** |
|---|---|---|---|
| Is there any passive system in the design? | | | |
| Does the library have an alarm system? | | | |
| Is it connected to the local fire brigade? | | | |
| Is fire security above national standard? | | | |
| What fire extinguishing systems are in use? | Hose reel, Extinguisher | Extinguisher ($CO_2$, Powder) | Hose reel, Extinguisher |
| Have there been any false alarms? | | | |
| Are fire drills and evacuation practices carried out regularly? | | | |
| Is there an anti-intrusion alarm system in the building? | | | |
| Does the library work with one access control at the entrance? | | | |
| Are there security measures in place for the collections? | | | |
| Which anti-theft control does the document collection have | Key lock | Tags | Tags |
| Are lockers available for bags and clothes? | | | |
| Do they need video surveillance? | | | |
| Has there been any safety problem with the library? | | | |
| Is there a problem with vandalism? | | | |
| Does the library employ security staff? | | | |
| Does the library provide safety instruction and devices in case of fire or other hazards | | | |
| Are emergency exits to escape the building in case of fire and other dangers clearly visible? | | | |
| Do emergency exits have an acoustics visual alarm to avoid robbery? | | | |
| How are these alarms connected to staff work places to enable them to take appropriate control and if necessary action? | | | Cabling |

## Lighting Index

The illuminance for the library spaces were measured using the light lux meter. This lux was measured for both with and without the lighting switches on and with the external lux from natural lighting at the instance of measurement. Figure 1 present the lux readings.

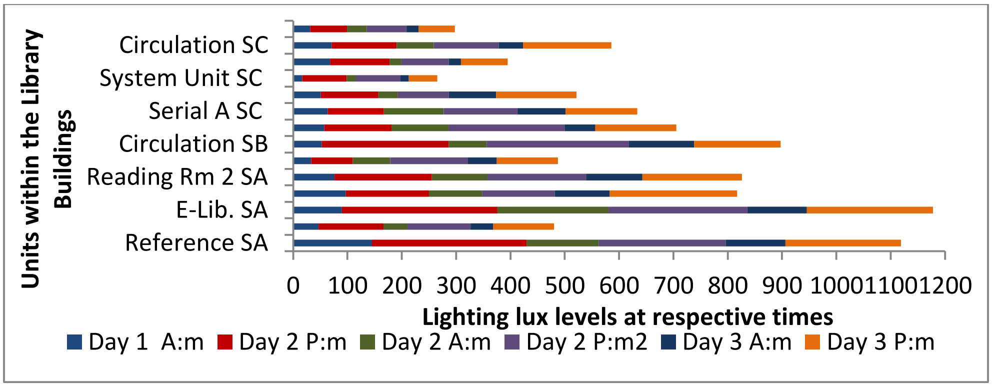


Figure 1: Collected lighting lux level of the three library buildings

The lighting result data collected in Figure 1 revealed that the spaces within the libraries had no adequate illuminance. No uniformity of light is experienced within the indoor spaces despite subjecting the buildings to its best lighting condition by allowing the natural daylight into the space. The system unit in School C library recorded the lowest light intensity at 15.2 lux with the conditions believed to be the presence of curtain which is allowed to be able to correct reflective glare that might come from the natural daylight and reflected by the monitor screen. The E-library Unit of the School A library recorded the highest average light intensity with 286.5 lux. The three libraries recorded an average daylight factor within 1.5 to 3.9 as shown in Table 4.

**Acoustic Index**

The readings of the sound level for each library space are shown below with decibel recorded for in A-weighting network as presented in Figure 2. The result showed that the library space recorded on day 1 had a sound pressure level (dBA) within the ranges of 27.0 to 52.0 dBA and since the students were not in session the spaces were unoccupied, while for day 2 to day 3 a sound pressure level between the ranges of 44.5 to 83.5 dBA were recorded with the spaces being occupied. This could have significant effect as the background noise could be caused by the users or the cooling facilities or general surrounding noise.

**Table 4: Daylighting factors of the indoor spaces**

| Location | Space Description | Daylight factor |
|---|---|---|
| **School A** | Reference Unit | 2.6 |
| | Serial Unit | 3.9 |
| | E-Library | 1.8 |
| | Reading Room 1 | 3.5 |
| | Reading Room 2 | 3.4 |
| **School B** | System Unit | 1.5 |
| | Circulation Unit | 1.6 |
| | Reference Unit | 1.8 |
| **School C** | Serial Unit A | 2.3 |
| | Serial Unit B | 1.8 |
| | System Unit | 2.6 |
| | PG Unit | 2.1 |
| | Circulation Unit | 2.3 |
| | Reference Unit | 2.1 |

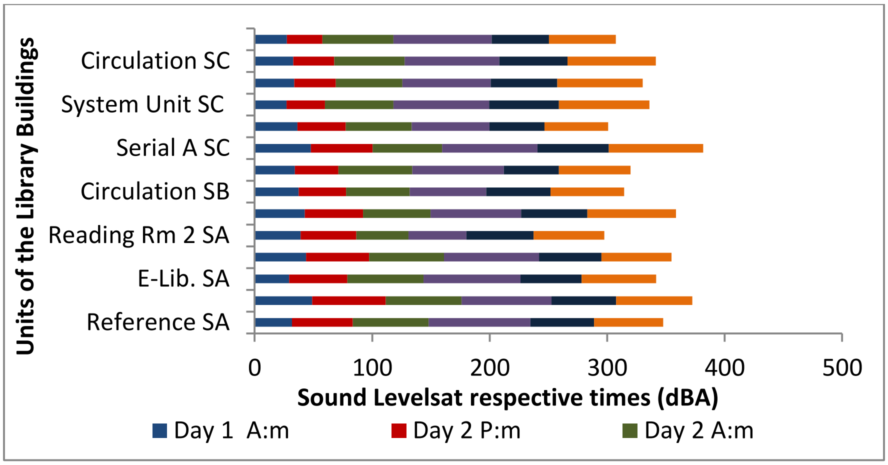


Figure 2: Measured A- weighting (Normal Sound) for the library space, dBA

**Thermal Indices**

Readings for Thermal indices comprising of relative humidity and dry bulb temperature were recorded for the internal spaces. This was also carried out using the psychometric device at same points established within each space for measurements. The readings are as indicated in Figure 3.

From Figure 3 Reference unit of the SC recorded a very high relative humidity (RH) present in the indoor atmosphere with an RH of between 79.5 % to as much as 83.2 % during the survey. This could be due to the fact that the location is on the ground floor within a green area with the cooling units present. The PG and System units of SC and the day 1 and 2 of the Reading rooms 2 of SA recorded lower RH value within the range of 52.1 to 69.3 % while all other units recorded high RH of 70.3 to 81.8 % as present in the atmosphere. Humidity is however of little effect on feelings of warmth unless the skin is damp with sweat.

Figure 4 presents the Dry bulb temperature reading as recorded for the Library buildings. Among all the thermal comfort indicators, temperature is usually the most important environmental variable affecting thermal comfort. A temperature change of about 1 ºC will change the response scale of subjective warmth. It is seen also in Figure 4 that only the PG unit recorded once an average temperature of 25.0 ºC at the morning hours of the day 2 and this is an attribute to a fully conditioned space. All other temperature for all the days showed that the temperature ranged from 25.5 to 32.6 ºC causing the environment to be slightly hot, but most of the cooling systems in School A Library were not in good order and the control system is beyond authorization of the students.

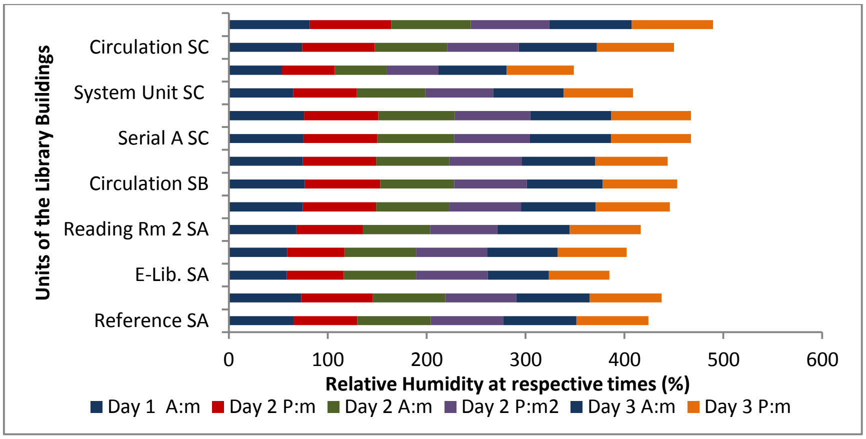


Figure 3: Readings for Relative humidity within each Library spaces

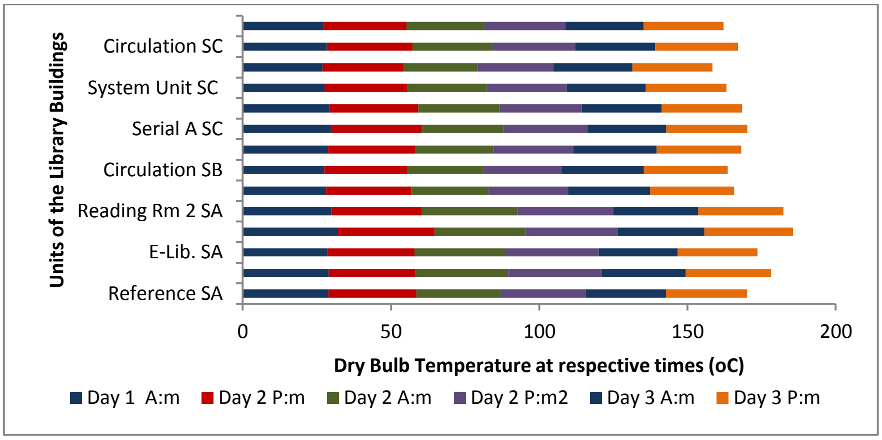


Figure 4: Readings for Dry bulb temperature within each Library spaces

Only the System unit and the Reference unit in School B had a cooling system but the cooling units were not effective. Although, most of the cooling systems in School A Library were not in good order and the control system is beyond authorization of the students. Only the E-library and the Reference unit had a cooling system but the cooling units were not fully in good conditions. From the School C Library, the cooling systems were all in good order and working but were not enough to provide a uniform cooling to the spaces provided.

**Psychrometric chart indicating the Comfort Zone for thermal comfort**

Figure 5 presents the psychrometric chart which shows only one unit in one of the days fell on the boundary of the comfort zone while some had good relative humidity but poor temperature shown indicate that it wasn't meeting the comfort state.

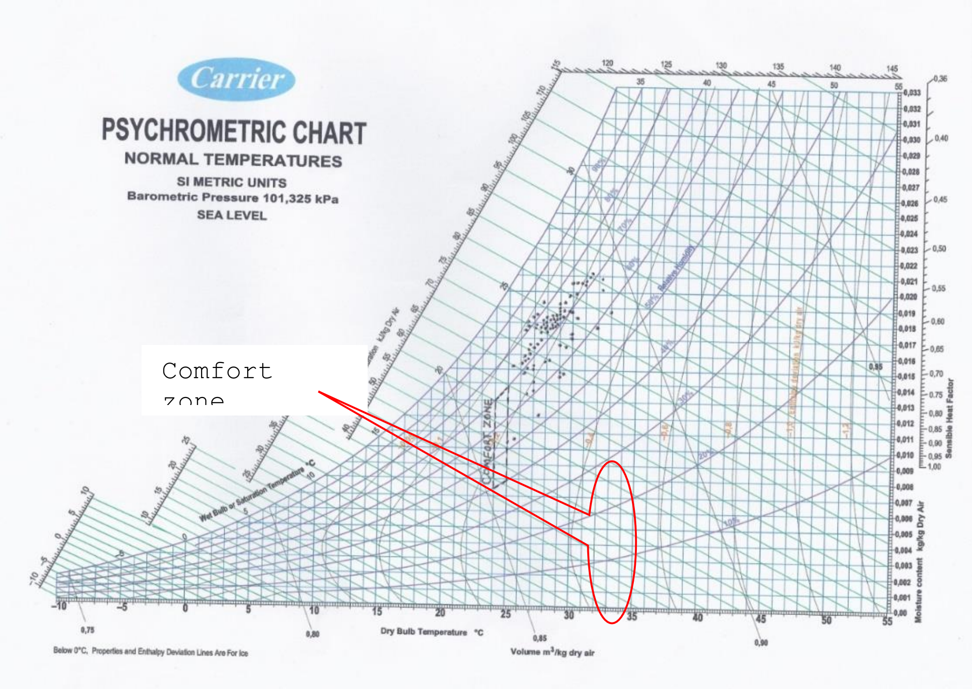


Figure 5: Psychrometric chart indicating the comfort zone
Source: Carrier Psychrometric (Chart 2015), retrieved from https://fenix.technico.ulisboa.pt

## Discussion

The result presented was analysed using the widely acceptable international standard for comfort satisfaction on an objective perception known as PROBE benchmark and represented in Figure 6. This benchmark was provided from the CIBSE Guide A *(2006)*. Although, the physical environmental comfort indices was influenced by climatic conditions, season and time of the day. Figure 6 shows the light intensity of the three libraries indoor space not corresponding with the required standard of 500 lux reaching the study tables or carrels. It was noted that during the point to point measurement, points closer to windows recorded large lux values even more than the standard as this could be attributed to daylight compliments experienced at the rise of sun and its setting time. Only the reference unit and the E-library unit of the School A Library had a lux value recording above 200 lux and at afternoon hours because of the position of its windows and the smaller width of the room.

Although some of the lamps are not functioning. The three libraries recorded a daylight factor of between 1.5 to 3.9 DF which is not up to the Average of 5 DF standard for such space but Reading room 1, Reading room 2 and Serial unit of School A Library had an average daylight factor 3.4, 3.5 and 3.9 respectively but would still need an artificial source to complement as directed (*CIBSE 2015)*.

The benchmark on acoustic as compared with measured noise level is presented in Figure 7.

Though, the relationship between noise rating (NR) and dBA is not constant because it all depends upon the spectral characteristics of the Noise. However, ordinary noise found in buildings has a dBA greater than the corresponding NR with an average of 6. Figure 7 reveals that the benchmark of noise rating lies within 30 - 35 NR which on conversion to dBA becomes 36 - 41 dBA by adding 6 dBA to each. While this conversion was done it was seen that only the Circulation Unit of SB and Serial Unit B of SC had its noise rating for the first day meeting with the standard noise acceptability and acceptability due to the absence of students.

As seen in Figure 8 there seems to be a general fall in the amount of water vapour present in the atmosphere at noon time from that noticed at morning hours. This can be due to presence of staff members, computers and books present in the System PG units of the SC, when the readings were taken. All the cooling systems were constantly functioning and only these two units proved to have their RH value complying with the standard state of 40 to & 70 %. Except for the Reference unit, E-library unit, and the two reading room units of the School A library which had some of the days with a good RH condition, all other units recorded RH values higher than the limit above 70 %.

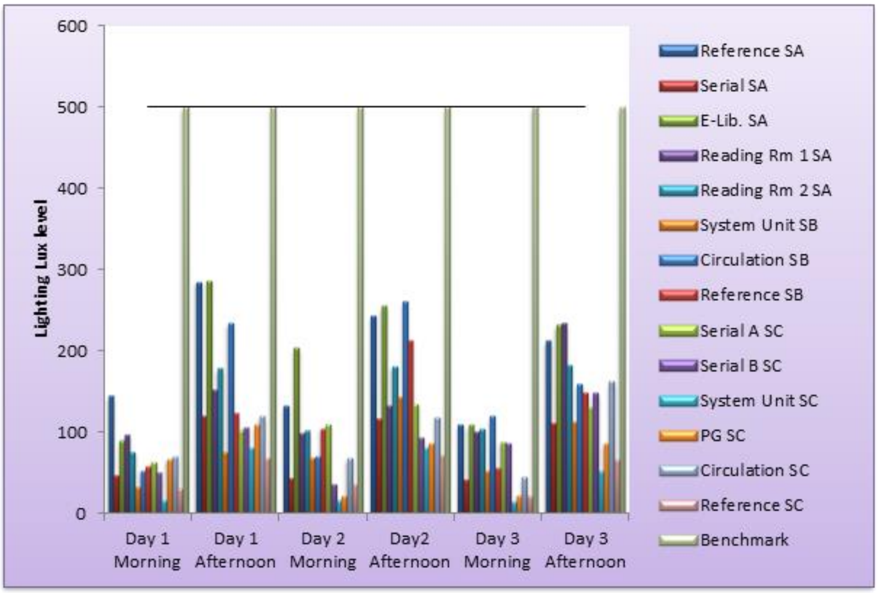


Figure 6: Lighting benchmark standard compared with the existing light lux level

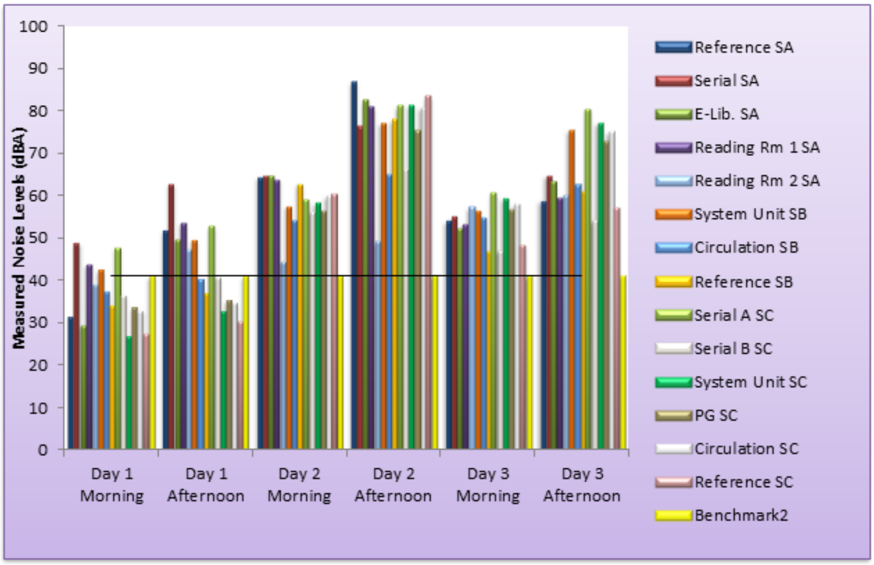


Figure 7: Benchmark on Acoustics compared with the measured noise level

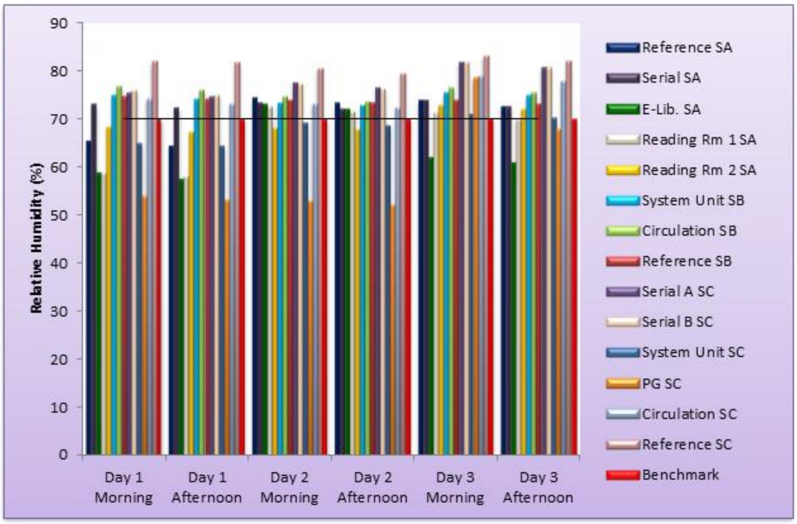


Figure 8: Relative humidity benchmark compared with the measured RH Value

The metabolic rate (Met) and clothing insulation (Clo) was estimated in accordance with *CIBSE TM57 (2015)*. Since its setting was regarded as sedentary activities for the library, the study selected a Met at 1.1 and Clo value of 1.0 as specified in CIBSE Guide A (2006). Temperature is the most vital component of the thermal comfort affecting human. The spaces were benchmarked in Figure 9 to a standard of 23 to 25 °C and only the PG unit recorded a 25 °C on Day 2 morning and the rest space in all the days recorded between 25.7 to 32.6 °C. None of the building spaces fell within the acceptable limit.

Finally, the quality of water provided is of an acceptable state with enough quantity available except the toilets in SB and SC which are not of satisfactory quantity since the students and visitors were not considered. While the fire safety and security measures are in place for SC, SB only enjoys good security measures and SA had only the fire safety put into consideration.

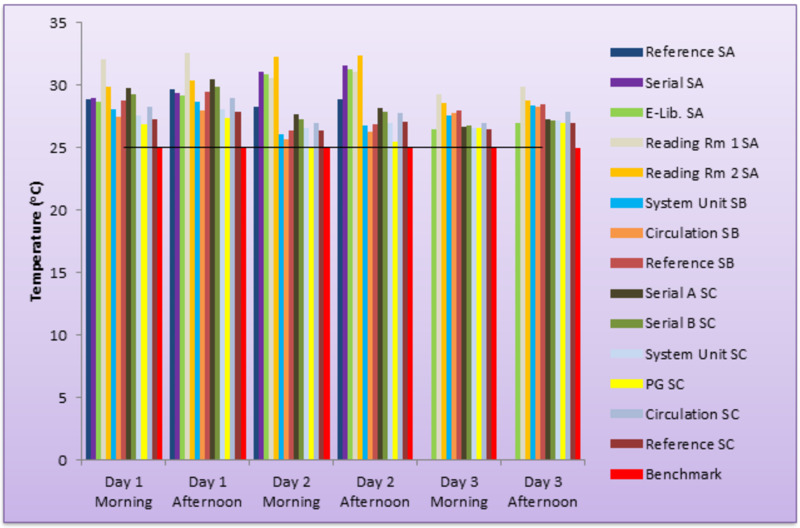


Figure 9: Temperature benchmark in comparison with the measured temperature

## Conclusion

The myriad of technical problems now confronting man within the indoor space is becoming a source of concern and a challenge to all building services engineers and facility managers with a search for how these issues can be resolved. This study used POE to investigate the building services engineering provisions of three (3) selected higher institution libraries in Niger State and the readings obtained compared with set out standards for benchmarking. The results from the technical indices suggested that these parameters did not conform with the standard CIBSE Guide A (2006) which was set in PROBE as benchmark stipulating that study tables and carrels requires 500 lux or a 300 lux for general library use; an accepted sound level of between 30 - 35 NR; a relative humidity ≥ 40 % ≤ 70 %; temperature between 24 – 25 ºC. The inferences from the study are presented under the following headings.

### Lighting

At 500 lux benchmark, no space on average was able to meet this standard at the carrels. Although, carrel points, which are close to the windows, due to compliment of daylight recorded lux intensity above the benchmark. This indicates there was no uniformity of lighting intensity causing some shadows at most carrels positioned at an in-depth space far away from the window. As a result of poor illumination users are likely going to experience discomfort glare which would also alter their circadian rhythm. While CIBSE Guide A (2006) posits that users of poor lighting condition are likely to experience eyestrain if associated with prolonged experience of discomfort leading to headache, irritation of eye, inflammation of eyelids, breakdown of vision and possibly indigestion and giddiness, discouragement to study could also set in as a result of this. Although, because there are enough and wider windows in most of the space, the daylight factor by calculation fell within the appropriate limit with 1.6 - 3.5 as against 3.5 - 5.0 benchmark, the carrel design would not allow for appropriate illumination on the study table causing shadows around horizontal surface. This would require more focus on artificial light as expected in the design criteria as with a DF < 2 the interior will not be perceived as well daylit and an additional artificial lighting may need to be in constant use while if it exceeds 5 on horizontal plane, an interior will look cheerfully daylit. Edwards and Torcellini (2002) postulates that students in a daylit room recorded higher test scores while legislation according to Edwards and Torcellini (2002) requires lighting to be of natural daylight as much as practicable.

### Acoustics

A standard noise rating of 30 – 35 NR was given as the acceptable sound level expected within this space. While the measured sound level was gathered and compared against the stated benchmark, just very few spaces met with this guide after the conversion from NR to dBA by adding 6 dBA to the standard. The result revealed that only two units fell within this guide and was recorded on the first survey with reason being that students were not in Session. This implies that the noise from the mechanical devices such as standing fans, air conditions, lamps etc. were enough to shift the background sound level out of the acceptable limits. As the spaces were occupied, the background sound level increased as a result of occupiers' speech, noise from footsteps as the ground is hard with other activities like book flapping, making the indoor space unacceptable for its sound level. The wall surface materials are perceived to be hard, making the sound reaching the surface to reflect. This may cause increase in noise level, although human body absorbs certain amount of sound reaching the body (Asdrubali *et al.,* 2015).

### Thermal comfort

In the case of thermal comfort, practically almost all units proved not to comply with the benchmark standard set for both relative humidity and temperature (RH ≥ 40 % ≤ 70 %; Temperature 24 to 25 ºC). The result from the psychrometric chart showed only two units fell within RH benchmarking limit and a unit once recorded 25.0 ºC for temperature. CIBSE Guide A (2006) postulates that on health grounds prolonged high air humidity (RH ≥ 70) in building may likely bring about airborne fungi and house dust mite. This with an experience of long time low humidity complaints of dryness, perception to smell increases make it more objectionable. Irritation of the mucus but a low humidity for short period of time is acceptable. At no time was the RH of any space less than 40 % rather most times at morning hours the RH was more than 70 % than at afternoon hours. Practically all units are fitted with an air conditioning system except in a case where there is power outage. Hence, the Guide addressed that for an air conditioning system, a maximum of 60 % is recommended. Temperature is perceived as the most critical aspect in the study of thermal comfort. The measured spaces recorded a temperature distribution from 25.0 – 29.0 ºC as against the 24 – 25 ºC acceptable standards for such spaces thereby making them unacceptable with a difference of 0.5 to 4.0 ºC.

**Sanitation, Fire safety and Security:**
Although all sufficient and recommended water was made available for use as well as sanitary facilities provided are within the proxy of 100 m, only school A considered the need to make sanitary facilities available for all users while the other two Schools couldn't meet with the BS 6465-1 (2006). Also, School C alone had a complete fire and security system fully put in place for emergency purpose while School A and B are yet to give this the requisite consideration.

## Recommendations

In building design, emphasis is stressed more on construction and maintenance cost but since real people would be making use of these buildings consideration should be given to their physiological and psychological wellbeing. The following recommendations were drawn since the expectation of users have increased as status of deemed Institutions have been elevated; much is required of the bodies saddled with the responsibility of making these facilities conducive and comfortable.

An improved daylighting should be encouraged on further design of libraries considering the psychological and physiological wellness of students as students perform better with natural light.

Sound absorbent materials (rubber, plastics, wood, and wool) should be considered in places such as the base of chairs and tables, the foot path, internal wall surfaces. While considering locations away from very busy areas, barriers for noise attenuation from surrounding area should be provided externally such as vegetation and tree plantings, reflective external surface and short fence.

The indoor temperature has to be decreased to achieve comfortability. Mechanical cooling system should be well calculated and all factors considered during the design stage. With large indoor space depth of above 6 m, mechanical ventilation should be encouraged to improve the air quality and maintained within a flow of 8 to 10 litres/ person as recommended by CIBSE Guide A (2006).

All design criteria regarding fire safety and security in the Fire safety engineering should be adhered to and enforced by the concerned authority.
Irrespective of whether staff members, students and visitors or physically challenged, such a premise should provide an adequate, neat and functional convenience room for users while maintaining WHO standard on water consumption.

A periodical survey -POE on the functionality of these facilities that address issues of comfort, convenience, safety which could have adverse effect on the wellbeing and performance of the users should be practiced and encouraged to ensure adequate compliance.

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