

Post Occupancy Evaluation an Actuate for Sustainable Architectural Design of Housing Estate

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Abstract— *The lack of adequate performance of buildings after completion of the construction phase has led to total dissatisfaction to the building users and occupants and the replication of similar design mistakes in subsequent design and construction. The Study conducted a post occupancy evaluation of residential buildings in Democracy Housing Estate Abakaliki, Ebonyi State with a view to establish criterias that will enhance sustainable design in subsequent housing design. A total of 100 questionnaires were administered with 82 returned adequately filled. The data collected were analyzed using a computer based software Statistical Package for Social Sciences (SPSS) and the result of the analysis were present using simple percentages and Relative Importance Index (RII). The result revealed among others that; from the 9 Performance Criteria assessed, occupants attested to a high level of satisfaction of the following Seven (7) criteria in their order of severity: artificial lighting (0.84), space allocation (0.83), sound insulation (0.82), safety and security (0.82), accessibility (0.81), health (0.80), plumbing and electrical services (0.78).the respondents expressed the highest level of dissatisfaction is the 'Cost of Maintenance (RII=0.66) an indication that building are constructed with little on attention paid to the maintainability of the building. Conclusion was reached that Most of the residential building have relatively high cost of maintenance and are quite difficult to maintain. Thus from the ongoing it is recommended that: subsequent design should give adequate attention to the maintainability and serviceability of the building as a key to a more sustainable design.*

Keywords— *Post Occupancy Evaluation, Sustainable Architectural Design.*

I. INTRODUCTION

The non-compliance of building owners and occupants in introducing lacking feature/characteristics, has resulted in the failing of residential housing projects (both private and public owned) in Nigeria; Often, the design of a new residential development has been patterned along designers' idea and perception (Jiboye, 2011). Post Occupancy Evaluation (POE) is a general term for a broad range of activities aimed at understanding how buildings perform once they are built, and how satisfied building users are with the environment that was created (Hewitt, 2005). It is of utmost importance for building developers or owners to know the level of performance satisfaction of their buildings to the users.

POE would provide useful information in future design for housing projects, so as to incorporate qualitative/quantitative features lacking in previous housing projects. Due to the

complexity of building, evaluation of its performance could help to tackle technical, social, functional, and aesthetic issues. A completed residential building should be able to function in such a way that it satisfies the needs of the occupants need; once the building has been completed and occupied, maintenance commences to ensure that the elements or facilities in the building function to their maximum capacity; occupants of the building will then evaluate the facility to determine whether the building is functioning in accordance with its intended purpose (Chinemerem, 2014).

The occupants' wellbeing and performance are affected by various factors associated with the building, such as indoor air quality, temperature, daytime lighting and ergonomics. All these factors have an impact on human health, and could result in low morale of the occupants (Eze, 2014). Quality of work and productivity maybe compromised if all these factors are not addressed appropriately. Air pollutants, ergonomics, lighting and temperature may cause a deterioration of health of the occupants of the building (Kooymans, & Haylock, 2010).

To measure a building's operations and performance, a post-occupancy evaluation (POE) is typically utilised to determine whether decisions made by the design, construction and facilities management (FM) professionals have met the envisaged requirements of end-users and the development's commissioners (Adeyeye et al., 2013; Skills Funding Agency, 2014).

POE will as access to the response of the occupants with regard to the satisfaction derived from the building they live in everyday. The relationship between the building and its occupants must be understood by designers prior to designing the building in order to understand the impact that the building will have on the occupants with regards to workplace setup, health and safety, etc. (Eze, 2014).

Abakaliki, is one of the fast developing areas in the south east Nigeria located in Ebonyi State. Unlike the older cities that appears to be fully built there is still vast land and estate springing out in it primary stages. Thus, unlike the built areas where sustainability was not a drive in its establishment, it is possible to achieve sustainable environment in the upcoming estates via excellent architectural design and construction methodology. A good design can often resolve the apparent conflicts between the need for development and the desire to

conserve the best aspects of the natural and built environment. This spurred the interest for a Post Occupancy evaluation of the first housing estate (Democracy estate) so that it serve as an actuate for subsequent design within the study area. Democracy Estate is locate in Aguogboriga, Abakaliki, Ebonyi state. Behind Agon place, Abakaliki-Enugu Express way. It is one of the fastest developing areas in Abakaliki town characterised by numerous giant residential buildings. It's close to Ebonyi State University, Presco campus. Considering the influx of occupants in the area, it promises to give a good evaluation of the occupants satisfaction level and consequently Triger and inform designers and building on the peculiarity of the area for a sustainable environment.

The study only considered residential buildings within Democracy Estate in Abakaliki only. Due to the complexity of building projects, only residential buildings within the Democracy estate in Abakaliki was considered were assessed and evaluated as it models a typical/formal building with an actual architectural design before construction. The occupants with the estate were randomly selected cutting across all level of income earners (low, medium and high-income earners) within the estate. Similarly, the study only evaluated occupants Satisfaction in relation to only the nine (9) performance criteria developed classified under the Functional Performance, Technical and environmental Performance and Economical performance they include:

- i. Functional performance: involving functional space in and around the building; space allocation and accessibility; operational aspects (cleaning and maintenance).
- ii. Technical and environmental performance: these include health, security and safety; building services (lighting, sound insulation, plumbing and electrical services).
- iii. Economic performance: concurrent costs associated with the building occupancy and operation (maintenance cost).

II. LITERATURE REVIEW

Methods for Post Occupancy Evaluation

The study of Post Occupancy Evaluation (POE) methodology has tended to focus on commercial and institutional buildings, while the performance of residential buildings has received less attention. According to Turpin, Brooks & Vicars (2006), POE is used to consider the extent to which a building meets the needs of its end-users while also recognizing ways in which design, performance and fitness for purpose can be enhanced. The idea of POE was established in relation the problems arising from the building industry, more especially in the care facilities such as the mental hospital, nursing homes, school residence and correctional services (Mouton, 2008).

POE was adopted in the built environment as a result of the fast housing creation during Second World War. Many residences created in North America have been obliged to fit the needs of the tenants' lifestyles as a result of urban redevelopment programmes (Mouton, 2008).

Benefit which can potentially be derived from POE offers an incentive which drives its deployment for many building owners. Presser (2003) views post occupancy as a system which

allows facility managers to identify and evaluate critical aspects of building performance systematically. This system was also applied to identify problem areas in existing buildings, to test new prototypes and to develop guidance and criteria for future facilities. It is also used as an umbrella that includes a review of the process of developing the projects as well as the technical and functional performance of the building during occupation (HEFCE, 2006).

The process of POE review evaluates and identifies any remedial work required, provides information to support continuous improvement for future projects and can be an important part of the communication process change management (Queensland, 2007). Also, it focuses on the occupants needs and measures the extent to which building outcome meets the occupants expectations in relation to the safety qualities and importance of the residential environment and the functionality of the design; and effectiveness of the design, construction, communication and occupancy process. This process of measuring building outcome and occupants needs have conducted for many years, dating back to the post world war II period, and it has shown tremendous improvement with time (Eze, 2014). The conducting of POE is sending a message to the occupants that building owners care about how they feel about their accommodation. The barriers to the use of POE include:

Corporate managers acting on behalf of the organization will from time to time use POE as the guidance tool when one wants to design the future projects (Eze, 2015). The interaction of facility managers with the occupants may enhance communication within the building by applying POE (O'Neill and Davis, 2005). With occupants raising concerns to facility managers in the residence, these would help the facility managers to do their work at ease (Eze, 2014). POE is a tool that is used to evaluate the outcome of a specific project, identify any remedial work required, provide information to support continuous improvement for future projects and can be an important part of communication process for change management (Queensland, 2007).

Sustainable Design and Context

Design as a creative activity largely rest on the intelligence, taste and fantasy of the designer exploring the tendency of generating something entirely new. Architects are known to play with forms masses, functions, and structures in order to find better solutions (Farivarsadri & Alsac, 2006). A Sustainable building design is expected to establish a relationship between building and life, reducing impacts in human health within the context of the architects fantasy. It is expecting that it imbibed an ecological integration between human life and other species' lives.

Sustainable design is frequently viewed as a vital tool for attaining sustainability; it emphasises the importance of establishing sustainability targets, indicators, and benchmarks at an early stage to avoid potential disputes amongst important actors that stymie progress toward sustainability. Sustainable design (also known as "green design," "eco-design," or "design for the environment") is a method of reducing or eliminating these effects while maintaining quality of life by employing

Careful analysis and clever design to replace conventional products and processes with less harmful alternatives. Buildings can offer opportunities to increase habitats for greening to improve the micro-climate and visual amenity of an area (Edwards, 2001).

III. METHODOLOGY

The field work of this study was conducted using various research instruments, each adopted to meet a particular research need. The various instruments and its application are as explained:

Sample Size and Sampling Techniques

With regards to the sampling size in the distribution of the questionnaire, the sampling size was determined based on the formula below considering the fact that the targeted population is unknown

$$n = (z^2pq)/d^2 \tag{3.1}$$

Where;

n = the desired sample size

z = the ordinate on the Normal curve corresponding to α or the standard normal deviate, usually any of the following determined based on the 'margin error formula'

- i. A 90% level of confidence has $\alpha = 0.10$ and critical value of $z_{\alpha/2} = 1.64$.

P = the proportion in the target population estimated to have particular characteristic (normal between the range of 0.1 - 0.5)

q = 1.0-p

d = degree of accuracy corresponding to the confidence level and Z selected.

For the purpose of this study, a confidence level of 90% was adopted owing to the fact that the questionnaire was geared towards evaluating post occupancy assessment.

Consequently, the sample size is determined as thus,

$$z = 1.64, d = 0.1 \text{ where } p = 0.5, q = 0.5$$

$$N = (1.64^2 \times 0.5 \times 0.5) / (0.1)^2 = 67$$

Therefore a total of hundred occupants (respondents) were sampled in the area using random sampling technique.

Tools for Data Collection

Other data gathering instruments, such as a well-structured questionnaire, were used in addition to the literature review. The following are the details of the sample size and sampling method used in the field survey:

Questionnaire

Research Instrument: a well structured questionnaire was be employed and administered to various residential building occupants within the research area of study to determine their perception on the Nine(9) Post occupancy criteria identified. The questionnaire was structured to be consistent with taking into cognizance existing literatures on Post Occupancy evaluation.

The questionnaires were administered to occupants in the residential building within Democracy estate Abakaliki, cutting across buildings that suits all levels of income randomly selected. The personal profile of the respondents

- i. Details of occupants profile as well as how long they have lived in such building for a reliable Post occupancy evaluation
- ii. An Evaluation of the Functional and Economic Performance
- iii. An evaluation of the Post Occupancy Criteria in their order of severity

Data Analysis

The data collected will be analysed using the computer based software "Statistical Package of Social Sciences" (SPSS). The results of the analysis will be presented in the forms of table for the purpose of easy comparism and clear expression of the findings. During Project Monitoring, relative importance indices (RII) were also employed to rank Areas of Emphasis. Memon et al, (2006) and Othman et al, (2007) suggested that the Relative Importance Index (RII) be calculated for each document based on its frequency of use (2005).

$$\text{Relative Importance Index (RII)} = \frac{\sum fx}{\sum f} \times \frac{1}{k} \tag{3.2}$$

Where,

$\sum fx$ = is the total weight given to each attributes by the respondents.

$\sum f$ = is the total number or respondents in the sample.

K = is the highest weight on the likert scale.

Results are classified into three categories as follows (Othman et al, 2005) when;

RII < 0.60 -it indicates low frequency in use

0.60 ≤ RII < 0.80 -it indicates high frequency in use.

RII ≥ 0.80 -it indicates very high frequency in use.

Using the computer-based software "Statistical Package of Social Sciences," the data acquired for this study was subjected to various statistical analyses (SPSS). The analysis' results are supplied in the form of tables for simple comparison and clear description of the findings.

IV. DATA PRESENTATION AND ANALYSIS

Percentage response

One hundred (100) copies of the questionnaire were administered to the respondents during the study. Eighty two (82) copies of the questionnaire were retrieved after completion. This gave a response rate of 82%.

TABLE 1: percentage response rate

Responses	Frequency	Percentage (%)
Questionnaires retrieved	82	82
Questionnaires not retrieved	18	18
Total	100	100

Source: Survey, 2021

Demographic Information of the Respondents

This section presents the respondents profile, comprising of the gender and age group of the respondents, Status and the Duration of stay in the houses assessed.

From Table 2, it can be deduced a larger percentage of the respondent were male 71.95% with only a few percentage of female that responded to the questionnaire. Also, with regards to the age Bracket of the respondents, it can be deduced that a larger percentage of the respondent were within the age bracket of 26- 35yrs (40.24%). This was followed closely by those

within the age bracket of 16-25yrs (25.61%), while the lease age bracket is 56yrs and Above (2.44%).

TABLE 2: Respondent Profile

S/N	Profile	Option	Frequency (No)	Percentage (%)
1	Gender	a) Male	59	71.95
		b) Female	23	28.05
		Total	82	100
2	Age of Respondents	a) 16-25yrs	21	25.61
		b) 26- 35yrs	33	40.24
		c) 36-45yrs	18	21.95
		d) 46-55yrs	6	7.76
		e) 56yrs and above	4	2.44
		Total	82	100
3	Category of respondent	a) Student	34	41.46
		b) Working Class	48	58.54
		Total	82	100
4	Duration of stay of the respondents in the building.	a) 0-5yrs	3	5.0
		b) 0-2yrs	8	9.76
		c) 3yrs-5yrs	18	21.95
		d) 5yrs and above	56	68.29
		Total	82	100

Source: Field Survey, (2021)

Still on the demographics of the respondent, the study also sort information regarding the status of the respondents. From the result of the analysis, it was deduced that 41.46% of the respondents are student while 58.54% of the respondents are worker ranging from farming, public services and craftsmen.

To authenticate the knowledge of respondents on the nature of the buildings accessed, the study sort for information regarding the duration of stay of the respondents in the building.

The result of the analysis showed that a larger percentage of the respondent had lived in the buildings for more than a year (68.29%) a reasonable duration for a Post occupancy Assessment.

Assessment of the General Level of Satisfaction and Ranking

This section presents the General level of Satisfaction and the Ranking of the Post Occupancy Assessment criteria. Relative Importance Index (RII) was adopted to measure the degree of severity of the criteria.

Based on the respondents satisfaction level, the various building characteristics/features was transformed into a relative importance index (RII). With this, each item was ranked and it shows how important each item is to the building user. This is illustrated in the table below;

From the result of the analysis above, it can be deduced that the performance criteria the building users perceived to be much satisfied with is the Artificial lighting of the building (RII= 0.83). this was followed closely by the Sound insulation nature of the building (RII=0.82); Safety and Security of the Area. However based on the ranking of the criteria, too, it can be deduced that the criteria that the respondents expressed the highest level of dissatisfaction is the 'Cost of Maintenance (RII=0.66) an indication that building are constructed with little on attention paid to the maintainability of the building. Similarly it can be deduced that the respondents also expressed a high level of dissatisfaction the ease of maintenance of the buildings (RII=0.68). And as such the maintenance can be established as the major problem of the building in the study area. Details of the respondents ranking of other criteria are as presented in Table 3

TABLE 3: Level of Satisfaction Derived By Building Users

S/N	Performance Criteria	1	2	3	4	5	ΣF	ΣFX	MEAN	RII	RANK
1	Space allocation	0	5	0	58	19	82	337	4.11	0.82	2 nd
2	Accessibility	0	8	7	41	26	82	331	4.04	0.81	4 th
3	Maintenance ease	0	21	20	28	13	82	279	3.40	0.68	8 th
4	Cost of maintenance	13	2	30	20	17	82	272	3.31	0.66	9 th
5	Health	0	7	15	35	25	82	324	3.95	0.79	7 th
6	Safety/security	0	8	5	43	26	82	333	4.06	0.81	4 th
7	Artificial lighting	0	3	15	30	34	82	341	4.16	0.83	1 st
8	Sound insulation	0	1	15	40	26	82	337	4.11	0.82	2 nd
9	Plumbing/electrical services	2	3	18	38	21	82	319	3.89	0.78	6 th

Source: Field Survey, (2021)

Where; 1= Very dissatisfied, 2= Dissatisfied, 3= Neutral, 4= Satisfied, 5= Very satisfied

V. SUMMARY OF FINDINGS

The outcome of the analysis has shown that respondents are satisfied with seven of the nine performance criteria of which they were assessed of. The respondents are satisfied with the following assessed performance criteria: space allocation; accessibility; maintenance ease; health; safety/security; artificial lighting; sound insulation and plumbing/electrical services. Whereas their perception to the remaining maintenance cost and ease of maintenance was neutral.

VI. CONCLUSION

The information gotten from the questionnaires based on the respondents' perception was presented and analyzed relating it

to the research questions. The outcome of the analysis was able to address the research questions. The information obtained through the use of questionnaires was analyzed using clear descriptive statistical tools, percentages and relative importance (R.I.I). Recommendation was drawn from the analysis. The study has shown areas that needs improvement. Most of the building features/characteristics are performing as intended. The occupants of the residential buildings assessed are generally satisfied with seven of the building performance criteria of which they were assessed of while two of the criteria need improvement. The ease and cost of maintenance of the residential buildings are neutral to the occupants and needs improvement. The occupants are satisfied with space allocation; accessibility; maintenance ease; health;

safety/security; artificial lighting; sound insulation and plumbing/electrical services. These also need improvement so as to increase the satisfaction derived by the occupants.

VII. RECOMMENDATIONS

This study has shown that it is important to conduct post occupancy evaluation on any building. The evaluation of how buildings perform is an important aspect of post occupancy evaluation for building sustenance. To realize this, it will be of great need to understand how satisfied building occupants are with the created environment. Information coined out from an in-depth literature review and the survey result, the following recommendations are made:

- i. It is strongly recommended that building owners perform post occupancy evaluation at intervals so as to ascertain if the building still performs as intended. This sends a message to the building occupants that their satisfaction is of priority to the building owners.
- ii. Another recommendation is for building developers to conduct post occupancy on already built and occupied buildings. This will enable the developer to identify areas that require improvement and the improvement subsequently introduced in new projects. This enables the developer to have an understanding on how the occupants desire has changed over time.
- iii. It is important that building owners and developers attend workshops so that they have a better understanding on conducting post occupancy evaluation.

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