Post Occupancy Evaluation Framework to determine the user satisfaction on the institutional Assets and Facilities in Abubakar Tatari Ali Polytechnic Bauchi Nigeria.

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Abstract

The practice of evaluating a building's performance for its users and intended usage while occupied is known as post-occupancy evaluation (POE). User happiness affects how well educational settings operate as well as the users who use them: teachers, staff, and students. Teams that invest a lot of time and money in a building's long-term sustenance also manage and maintain it. The Polytechnic planning departments are better equipped to grasp the inputs for programming and future project planning by examining the feedback from users of higher education facilities. The aim of this study is to examine and identify the prevailing factors required and further propose Higher education POE framework in Abubakar Tatari Ali Polytechnic Bauchi, Nigeria. A structured questionnaire was distributed to 357 higher education facility users, in ATAP Bauchi, to capture their perceptions and experience on the factors of POE requirements. Further, exploratory factor analysis EFA was employed for data analysis. Results pointed out similarity in perceptions of Users (staffs and students) for the prevailing factors and their strength across five groups of factors, namely, structural and mechanical features, plant and building maintainability, building safety and security, educational sufficiency and institutional learning environment.

Keywords *Post Occupancy Evaluation, Higher Education, Building Performance.*

1.Introduction

All academic institutions have their own internally agreed-upon design standards that direct all development on campus, in addition to any applicable zoning or building requirements (Al horr *et al*., 2016). When polytechnics want to build a new structure, an architect will create the design, and builders are expected to follow these criteria. These criteria are typically documented in a manual that has been around for a very long time and is continually revised at the polytechnic (Al horr *et al*., 2016). The goal of this handbook is to construct appropriate and useful buildings for that particular institutional purpose or goal which is teaching and learning. Despite such architectural rules, there are several instances where a building does not perform as planned (Alborz, & Berardi, 2015; Al horr *et al*., 2016). According to conversations with senior individuals on campus, polytechnics have experienced problems with the subpar performance of recently built facilities that cost millions of naira.

What exactly is the issue, then? How is it possible to construct a structure in accordance with codes and design specifications and have it nonetheless operate below par? What is the most effective method for spotting these mistakes, and what are the fixes? The answers to these queries make up the research's hypothesis. The goal of this study is to demonstrate that polytechnics require an evidence-based framework to address their problems over the long term in the form of updated design standards and non-oversight procedures. Polytechnics can benefit from their

past to enhance the usefulness and effectiveness of their structures in the future. POE is one of the most effective and practical approaches to identifying and correcting problems (Alborz, & Berardi, 2015; Al horr *et al*., 2016). Facility managers can use POE to recognize and assess a building's behavior. POE can then provide guidance on future facility design (Alborz, & Berardi, 2015; Al horr *et al*., 2016). With the help of POE, facilities can make greater use of their available space while spending less on operations and maintenance (Al horr *et al*., 2016). Finding out whether Facilities Management (FM) is succeeding in creating and maintaining structures and areas that support the polytechnics' educational objectives is one of the goals of POE in higher education (Baird, 2010; Cohen *et al.*, 2001). In order to identify the major occupant and building performance issues, POE is the gathering and analysis of occupant satisfaction, space usage, and resource consumption of a finished, constructed facility after occupation. POE can also be used to analyze patterns over time and find improvements to current procedures and results. Implementing the POE procedure improves facility managers' accountability and harmonizes best practices (Baird, 2010; Cohen *et al.*, 2001).

Post-Occupancy Assessment of Buildings are constructed primarily to shield occupants from the elements, including wind, water, and our surroundings. Today, however, people have higher expectations for their buildings; they want more features, or they want them to be more efficient or suitable for their users. They desire structures that are safe, comfortable, capable of accommodating new usage, and useful for certain purposes. The concepts of sustainability, green construction, and energy efficiency have made building owners and the construction industry more conscientious about how their structures operate (Tookaloo, & Smith, 2015; Meir *et al.*, 2009). The degree to which a building can fulfill any one of these requirements, or all of them, is referred to as building performance. There are hundreds of theories and tools that have been developed to evaluate a building from environmental compliance to energy performance (Tookaloo, & Smith, 2015; Hawkins, & Lilley, 1998; Meir *et al.*, 2009). One of these strategies that is already in use is post-occupancy evaluation. A team of experts got together in 1990 to figure out how to monitor and gauge the whole facility's performance in order to address the questions of "What is an effective building?" and "How can we measure its effectiveness?" They named it the "Post Occupancy Evaluation" method (Tookaloo, & Smith, 2015; Hawkins, & Lilley, 1998; Meir *et al.*, 2009). In other words, POE is the process of rigorously and methodically analyzing a structure after it has been occupied (Tookaloo, & Smith, 2015; Hawkins, & Lilley, 1998). Lushington and Kusak claim that POE establishes accountability in the difficult and expensive process of establishing a new structure by depending on a formal report and survey, which will be useful to this article. Like any method of evaluation, POE has benefits and drawbacks of its own. Advantages of POE include ongoing development, improved occupant-building fit, increased user comfort, and a decrease in energy use (Hawkins, & Lilley, 1998; Meir *et al.*, 2009). Obstacles to POE include disputed and trustworthy indicators, the owner's potential liability, exclusion from current delivery expectations, and segregation from professional courses. POE studies can also be impacted by subjective variables like disagreements or personal emotions during surveys (Tookaloo, & Smith, 2015; Meir *et al.*, 2009). Therefore, it is beneficial to restrict, regulate, and otherwise take into account these variables in any POE study.

2. Literature Review

There has been a history of almost fifty years of post-occupancy evaluation of educational environments and school buildings. In the late 1960s, the University of Strathclyde's Building Performance Research Unit (BPRU) evaluated more than fifty comprehensive schools in Scotland (Hawkins, & Lilley, 1998; Meir *et al.*, 2009). One of the key instances of the post-occupancy evaluation of school buildings was offered by this study. There were established methods for relating space and its structure to people's reactions to the building, space utilization, costs, services, and movement (Meir *et al.*, 2009)**.** Together, these regions demonstrate how diverse POE can be. However, whether qualitative or quantitative, all of these fields of research apply the same strategies. The Council of Educational Facility Planners International (CEFPI) made an attempt to control the evaluation of educational buildings for the first time in 1986 (Tookaloo, & Smith, 2015; Hawkins, & Lilley, 1998; Meir *et al.*, 2009). These laws were introduced in response to serious issues with building performance, with a focus on the viewpoint of the building occupants, twenty years after the initial POE attempt (Tookaloo, & Smith, 2015; Hawkins, & Lilley, 1998).

Preiser, (2001) for school administrators and community leaders to assess a school's quality for everyday use and suitability for learning, CEFPI offers evaluation standards, in the following areas: school site structural and mechanical features, plant maintainability, school building safety and security, educational sufficiency and learning environment, Preiser claims that over 125 factors have an impact on how well school buildings perform (Tookaloo,

& Smith, 2015; Olatunji, 2013; Hawkins, & Lilley, 1998; Meir *et al.,* 2009). According to his research, an assessment instruments (elementary, middle, and secondary school) were developed using non-technical language for educators and community leaders in addition to technical professionals to undertake evaluations (Preiser, 2001). These evaluations had the following stated objectives: to conduct a post-occupancy evaluation, to create a permanent record to monitor deterioration, to highlight particular assessment needs, to look at the existing or new facilities and evaluate the need for renovation, as well as to serve as an instructional tool (Meir *et al.,* 2009; Tookaloo, & Smith, 2015; Olatunji, 2013;).

By measuring the educational capacity of the physical environment, post-occupancy evaluation in the context of school assets and facilities is primarily focused on how well the facility supports the objectives of the educational process. The effectiveness with which a school's facilities support educational objectives and activities is referred to as educational adequacy (Olatunji, 2013; Tookaloo, & Smith, 2015; Hawkins, & Lilley, 1998; Meir *et al.,* 2009). Because it places a strong emphasis on user needs, experience, and value, this type of assessment is quite similar to conventional post-occupancy evaluation techniques. The ongoing development of POE methodologies has always been heavily influenced by research into and evaluation of educational settings in academic institutions. Tertiary institutions have consistently played a significant role in POE exercises since the 1960s, collaborating with design practitioners. The University of Wisconsin-Milwaukee, The University of Cincinnati, The University of Washington's Centre for Architecture and Education, The University of North Carolina-Charlotte, The North Carolina State University, The Georgia Institute of Technology, and The University of Minnesota are a few examples from the United States (Tookaloo, & Smith, 2015; Olatunji, 2013; Hawkins, & Lilley, 1998; Meir *et al.,* 2009).

There are numerous instances of post-occupancy evaluations conducted in conjunction with academic scholars in the schools of architecture and engineering. It is commonly believed that the POE is "widely acknowledged but rarely practiced," despite the appearance of activity from numerous academic centers around the west Africa and the world performing POEs (Alborz, & Berardi, 2015; Al horr *et al*., 2016). It is evident by looking at the documents and data from the aforementioned case studies and other prior studies in this field that everyone has concentrated their research on particular projects (Baird, 2010; Cohen *et al.*, 2001). Unfortunately, there hasn't been any research done to compare and connect them. There isn't a common design standard for all of higher education, despite the fact that there are design standard documents for each educational institution or university, as well as climate standards and numerous other publications in the construction business. This paper's objective is to pose the question and then, using data from earlier case studies, derive an answer. Second, use an ongoing POE case study at the Abubakar Tatari Ali Polytechnic to support a logical case for the critical role POE plays in higher education.

2.1 Determinants of POE in Higher Education

Several studies throughout the globe, in varied higher education institutions such as universities, polytechnics and collages, testified diverse POE variables significantly influencing different degrees and types of educational adequacy (Olatunji, 2013; Tookaloo, & Smith, 2015; Hawkins, & Lilley, 1998; Meir *et al.,* 2009). These consist of Structural and Mechanical Features, General Circulation routes, Visual Ease, Accessibility to facilities, General Security System, Land Scaping, Physical Tangibility, Use of Space, Energy Consumption, Fixtures and Fittings (Olatunji, 2013; Tookaloo, & Smith, 2015; Hawkins, & Lilley, 1998; Meir *et al.,* 2009). Of plant and building maintainability factors, the dimensions were found to significantly influence educational adequacy, these include**,** Maintenance Strategy**,** Quality of Building Materials used**,** Cost of Maintenance**,** Provisions for Maintenance**,** Frequency of Maintenance, building materials, service level agreement (Olatunji, 2013; Tookaloo, & Smith, 2015; Hawkins, & Lilley, 1998; Meir *et al.,* 2009). While of the building safety and security dimensions, these factors were found to significantly influence educational adequacy they consist of Conveniences, Level of cleanliness, Security level , Car parking, Noise level in the building, Fixtures and fittings components, Risk Management Plan, Use of safety Regulations, Use of safety appliances, Thermal Control (Olatunji, 2013; Tookaloo, & Smith, 2015; Hawkins, & Lilley, 1998; Meir *et al.,* 2009). POE survey also includes factors such as class room size, class room number, lecture theater size and comfort, offices space, library space, workshop space, laboratories space, book selves, health and accommodation facilities and institutional learning environment such as thermal comfort, ventilation, visual comfort, physiological and psychological comfort, social interactions, natural and artificial classroom lighting, air quality, cooling system, fanning and furniture comfort, library and ict internet facilities, power plant, electricity supply and water supply. (Olatunji, 2013; Tookaloo, & Smith, 2015; Hawkins, & Lilley,

1998; Meir *et al.*, 2009). Consequently, these groups of factors were extracted from the analysis of the extant literature on POE in higher education, from which the higher education POE framework in ATA Polytechnic was proposed.

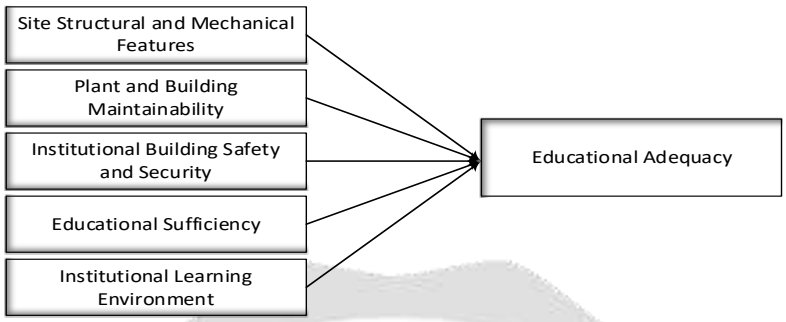

Fig 1: POE Framework

Before drawing any conclusions from earlier occurrences, this research will describe the ongoing POE study at the Abubakar Tatari Ali Polytechnic. These are the methodologies used.

3. Research methods

This research study used a survey to ask its questions in order to gather information from the educational group. Surveys can be readily designed and administered, and they are less expensive than many other methods of acquiring data. A survey can also be used to gather data on many different topics, such as aesthetics, indoor air quality, acoustics, lighting, etc. However, it has drawbacks of its own, including the possibility of the study being undermined by poorly designed and administered surveys. Additionally, the response options on a survey could not fully reflect how the respondents genuinely feel. Increasing the likelihood of accuracy requires providing answers that assess the level of agreement among contributors.

Using a cross sectional survey method, data were gathered from educational facilities users such as class rooms, lecture halls, laboratories, library and offices, these include students, academic and non-academic staffs in Abubakar Tatari Ali Polytechnic Bauchi, by distributing a structured questionnaire instrument. Purposive sampling techniques was employed to select the sample for the study. In whole, 357 users were approached for the data collection. Totally, 318 responses from the users were retrieved, thus, returning a response rate of about 89%. Nevertheless, of the 318 responses, only 294 were regarded appropriate for the data analysis. Exploratory Factor Analysis EFA was used for the data analysis to be able to respond to the research questions of the study. In an entirety, 41 items signifying Post Occupancy Evaluation dimensions were subjected to principal component analysis using varimax rotation in order to find out the factor structure. In this, the factors with factor loadings greater than or equal to 0.5 were recollected and reserved (Kaiser, 1974). The outcomes were also used to identify the sampling adequacy Kaiser-Meyer-Olkin (KMO).

4. Results and Discussions

The outcomes of data analysis using exploratory factor analysis are presented as follows:

4.1 Data Screening and Preparation

Data screening is a significant task mainly in exploratory factor analysis. In this research, data was screened and no mislaid data was found. Multivariate outliers were also checked using Mahalanobis test. In this instance, 10 cases were identified to be directly above the Mahalanobis Value, these cases were discarded as outliers and were not part of the analysis.

4.2 Data Analysis: Exploratory factor analysis (EFA)

Exploratory factor analysis EFA was used in this study, as a dimension reduction tool, to find out, among others, the prevailing and relevant factors of post occupancy evaluation in the study area. To achieve this, the result of the sampling adequacy test revealed:

Table I below displays Kaiser-Meyer-Olkin (KMO) together with the Bartlett's test of sphericity values. The KMO result show that (0.836) is significant at 1% level of significance and above the required threshold of 0.6. This had further complied with the sampling adequacy for exploratory factor analysis (Kline, 2014).

Table 1: KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.836
Bartlett's Test of Sphericity	Approx. Chi-Square	4073.936
	df	465
	Sig.	.000

Table 2 describes the components containing the latent factor structure and Cronbach's alpha reliability values of every construct or scale. The EFA analysis revealed five components factors with eigenvalues higher than one (>1), which also denoted 58 % of the over-all variance. Subject to the high extraction of communalities amongst the variable components, five key constructs were acknowledged from the analysis.

These constructs were identified as components 1 to 5 each representing a particular component or construct with a various factor loading of items or predictors. The value of a factor loading reveals the strength of an item and to what extent that exact item correlates with or describes the key construct. For example, in component 2 of table 2, PMB1 is the item or factor that has the uppermost factor loading at 0.889, which signifies that is the item that best predict and explains the main construct. Nevertheless, the least tolerable limit of a factor loading is 0.5. Henceforth, any item with less than 0.5 factor loading is a weak predictor in the complete construct. However, the outcomes revealed that some of the items would be removed subject to their low factor loadings (<0.4).

Table 2: Rotated Component Matrix

Item Codes	Components				
	1	2	3	4	5
SMF7	.732				
SMF4	.700				
SMF6	.692				
SMF2	.683				
SMF3	.571				
SMF1	.543				
SMF9	.481 Deleted				
SMF10	.464 Deleted				
SMF8	.388 Deleted				
SMF11	.233 Deleted				
PBM1		.889			
PBM3		.859			
PBM5		.743			
PBM2		.722			
PBM4		.456 Deleted			
PBM6		.388 Deleted			
PBM7		.334 Deleted			
BSS1			.911		
BSS2			.867		
BSS3			.876		
BSS4			.834		
BSS5			.732		
BSS6			.710		
BSS10			.480 Deleted		
BSS7			.476 Deleted		
BSS9			.355 Deleted		
ES5				.899	
ES6				.871	
ES4				.726	
ES3				.666	
ES2				.643	
ES1				.562	

ES8				.543	
ES7				.472 Deleted	
ES12				.441 Deleted	
ES9				.354 Deleted	
ES10				.271 Deleted	
ILE1					.923
ILE2					.881
ILE3					.873
ILE5					.776
ILE4					.753
ILE7					.681
ILE10					.511
ILE9					.472 Deleted
ILE12					.441 Deleted
Reliability Test	**0.811**	**0.724**	**0.843**	**0.857**	**0.833**

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
a. Rotation converged in 6 iterations.
b. ILE= Institutional Learning Environment, ES= Educational Sufficiency, BSS= Building Safety and Security, PBM= Plant and Building Maintainability, SMF= Structural and Mechanical Features

4.3 Prevailing Factors of POE in ATA Polytechnic Bauchi Metropolis

Table 3 exhibits only the leading or prevailing factors of POE, item descriptions and their consistent factor loadings. In this, all the items were condensed to more strong and reliable predictors. This revealed 30 resilient predictors across the entire research constructs. Of the 30 predictors, six loaded to the first component and were labelled as Structural and Mechanical Features construct. These include General Circulation routes, Visual Ease, Accessibility to facilities, General Security System, Land Scaping, Physical Tangibility e.t.c. these are said to be the factors that best explains Structural and Mechanical Features of educational institution. Four items that loaded under the second component were termed as Plant and Building Maintainability, they include Maintenance Strategy, Maintenance Frequency, Cost of Maintenance and Maintenance Provisions, these items are termed as the strongest predictors of Plant and Building Maintainability. While six items loaded to the third component, these were called Building Safety and Security, they consist of Conveniences, Cleanliness Level, Security level, Safety Regulations, Risk Management and Safety appliances, these are the more appropriate predictors that explains the building safety and security.

Table 3: Prevailing Factors of POE in ATA P Bauchi, Factor Loadings and Reliability

Item Codes	**Components**				
	Structural and Mech. Features	**Plant and Building Maintainability**	**Building Safety and Security**	**Educational Sufficiency**	**Institutional Learning Environment**
General Circulation routes	.732				
Visual Ease	.700				
Accessibility to facilities	.692				
General Security System	.683				
Land Scaping	.571				
Physical Tangibility	.543				
Maintenance Strategy		.889			
Maintenance Frequency		.859			
Cost of Maintenance		.743			
Maintenance Provisions		.722			
Conveniences			.911		
Cleanliness Level			.867		
Security level			.876		
Safety Regulations			.834		
Risk Management			.732		

Safety appliances			.710		
Noise Level				.899	
Class size sufficiency				.871	
Class number sufficiency				.726	
Lecture theater size				.666	
Hostel Facilities				.643	
Library space				.562	
workshop space				.543	
Ventilation					.923
Visual Comfort;					.881
Occupants' Satisfaction					.873
Psychological Comfort					.776
Social Interactions					.753
Natural Lighting					.681
Artificial Lighting					.511
Reliability Test	**0.811**	**0.724**	**0.843**	**0.857**	**0.833**

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
a. Rotation converged in 6 iterations.
b. ILE= Institutional Learning Environment, ES= Educational Sufficiency, BSS= Building Safety and Security, PBM= Plant and Building Maintainability, SMF= Structural and Mechanical Features

Similarly, table 3also revealed that seven items loaded to the fourth component and were called Educational Sufficiency, they are composed of Noise Level, Class size sufficiency, Class number sufficiency, Lecture theater size, Hostel Facilities, Library space and workshop space, these emerged as the strongest predictors of Educational Sufficiency. Lastly, seven items loaded to the fifth component and were called Institutional Learning Environment, these were known as Ventilation, Visual Comfort, Occupants' Satisfaction, Psychological Comfort, Social Interactions, Natural Lighting, Artificial Lighting, these items are the actual predictors of Institutional Learning Environment based on the responses of respondents.

6. Discussion and implications

This study focused on the deficiency of POE system to deliver adequate building performance in educational institutions, with particular reference to Abubakar Tatari Ali Polytechnic Bauchi. This is due to the existing gap in the lack of POE framework for the assessment of educational building performance abilities usually referred to as Educational Adequacy. Hence the study examines the prevailing factors of POE of educational building performance and thereafter, proposed POE framework in the study area. The findings of the study revealed that, of the overall 46 items or factors of POE, 30 prevailed and emerged as the strongest and reliable predictors of the various POE constructs in A T A Polytechnic Bauchi Nigeria. Consistent with this finding are the outcomes of the various researches such as (Olatunji, 2013)also argued that Building Adequacy is significantly influenced by various POE factors.

To this end, five main constructs were detected from the result of the exploratory factor analysis EFA. These include Structural and Mechanical Features, Plant and Building Maintainability, Building Safety and Security, Educational Sufficiency and Institutional Learning Environment. Further, 30 measurement items loaded across the aforementioned constructs each with an acceptable factor loading of 0.5 and above. This means that 16 items with factor loading below 0.5 are not relevant to the 5 identified constructs or POE factors based on the responses of the respondents and were therefore deleted. Of the 16 deleted items, 4 are from Structural and Mechanical Features construct. These include Use of Space, Energy Consumption and Fixtures and Fittings. This could be ascribed to the fact that those variables are not the most instant ways of assessing POE satisfaction to the respondents. Also from the deleted items, three belonged to Plant and Building Maintainability construct, which involved Building Materials Quality and Service Level Agreement. The weakness of these items in this research, might only be linked to the fact that those factors could be more applicable to general awareness rather than personal awareness of an individual. Likewise, 3 items were uninvolved from Building Safety and Security construct, these are Thermal Control and Air Movement. These also might be related to the fact that the items are more relevant to other social setting rather than the respondents case area.

In the Educational Sufficiency construct, 4 items appeared not related to the main construct, these are drainage provision requirement, social amenity requirements, parking space requirements etc. These also are associated to the reason that that these factors are not part of the factors used to assess POE in the study area as suggested by (Olatunji, 2013; Tookaloo, & Smith, 2015; Hawkins, & Lilley, 1998; Meir *et al.*, 2009)

Conclusion

This study uses quantitative research techniques to support its hypothesis on the use of POE in higher education. This case study serves as an illustration of the need for POE at the collegiate level. Additionally, by using examples, it demonstrates how POE raises design standards in higher education in order to have better, healthier environments and more efficient buildings because they all have an impact on learning and productivity. Using POE in higher education benefits a wide range of individuals. Above all, by identifying the strengths and shortcomings of the current situation, this study will directly and indirectly assist policy makers and higher education. By being prepared for issues and preventing mistakes from occurring in the first place, they can save money in this manner. Students, faculty, staff, FM, custodians, and other higher education users are among the second category of people who might find value in this study. They are the ones who use these structures on a daily basis. The POE procedure can be extensive and involve many different steps. The scope of this study is narrowly focused on a single higher education institution (A T A Polytechnic Bauchi) due to a constrained schedule. To ascertain the significance of the function of POE in higher education and its effects on design standards, this study and its critical examination of prior POE case studies have been conducted. The realm of POE is infinite, and this research is only beginning to explore it. For instance, one of the key focuses of this research is to examine the POE factors and use it to propose POE framework in the study area. Finally, one approach to assessing this assumption is through the evidence gathered during the POE exercise described in this work. The tools presented in this work are a useful way to do that.

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