POST OCCUPANCY EVALUATION OF THE FACULTY OF ENGINEERING AND TECHNOLOGY BUILDING IN THE UNIVERSITY OF BOTSWANA

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Abstract

The objective of the study was to analyse the performance of the Faculty of Engineering and Technology (FET) building and to find out if the users of the building are satisfied with the services provided by the building. Post occupancy evaluation (POE) was used to analyse the performance of FET building. A quantitative research approach was chosen for this study. Primary and secondary data sources were used for data collection. Primary data was collected using a questionnaire and an interview guide. Questionnaires were administered to students, lecturers, cleaners and security guards who regularly utilise FET building. Interviews were held with facility managers who are responsible for maintenance of FET building. A simple random sample from a population of 1453 users was used to sample the study. A sample of 96 respondents was selected, comprising 76 students, 12 Lecturers, 1 facilities manager, 5 security guards and 3 members of cleaning staff. Microsoft Excel was used to analyse and present the data. The findings reveal that the building occupants are moderately satisfied with FET building. Many complaints are reported in the FET building on few defects such as broken elevators, leaking pipes, and faulty air conditioners, leaking water closets and burnt bulbs etc. to the Faculty's Facility Manager every year. These building defects results in students and lecturers not being satisfied with the building as they have a negative impact on learning and teaching. It was also revealed that climate affects the performance of FET building. The study recommends that there should be proper maintenance requests or reports on building defects should be fixed timeously. This will encourage users to report any defects that need to be addressed in the future to facility

managers. This study has created a context in which a building performance evaluation can be conducted and used to improve building satisfaction among occupants. It is also of utmost importance to facility managers, architects, contractors and other who professionals will be involved in future college projects. Professionals and stakeholders are among those who will benefit from this study as it adds to the body of knowledge in Botswana.

Keywords: Post-occupancy evaluation (POE); Building performance evaluation (BPE); Faculty of Engineering and Technology (FET)

1.0. Introduction and Background of The Study

Buildings represent a significant portion of assets, operating costs and user needs of most educational institutions(Okolie, 2011). The performance level of buildings is therefore critical to the academic success of each and every student. In addition, optimal performance of buildings facilitates effective teaching and learning. Even though buildings of higher learning are a crucial resource in academic achievement and learning, evaluation of building performance is not conducted by facility managers in higher learning institutions (Ilesamni, 2010). Management and maintenance are very important to a building and its facilities. Building conditions such as its age, heating and cooling systems, lighting, air ventilation, choice of wall colours, type of furnishing and room layout and many more, have all been associated with significant, measurable changes in student attainment and performance (Anon., n.d.). Users of a building expect better performances from buildings they procure and occupy. Therefore educational building facilities are a major investment to any learning institution such as the University of Botswana. There are many instances where a building does not perform as expected despite following the stipulated building codes and design guidelines.

The University of Botswana is faced problems related to poor performance of recently constructed buildings, one of which is the FET building. This building has incurred exorbitant repair costs. The question is what is the problem? How is it possible to build a building based on regulations and design requirements and still not perform as expected? What is the best course of action to find these errors and what are the solutions? Since many buildings sometimes do not function as planned and can affect the building's operating costs, employee and student satisfaction and performance, health, safety and comfort, an analysis

was conducted using the POE method. This was done to obtain feedback from users of the FET building on its performance. Post occupancy evaluation is a tool for facility managers to identify and evaluate the behaviour of a building (Steinke, et al., 2010). POE can then provide planning and design guidance for future facilities (Tookaloo & Smith, 2015). One of the purposes of POE in higher education is to ascertain whether facilities management is meeting its primary objective of maintenance and space management of buildings to achieve the educational visions of learning institution.

“Post-occupancy evaluation is a process of consistently evaluating the performance of buildings after they have been constructed and used for some time (Hadjiri & Crozier, 2009).”POE integrates stakeholders, construction disciplines, research traditions and the building life cycle in a variety of ways. In particular, assessment of a building's lifecycle will regularly require POE more so that we are trying to move towards a sustainable built environment. An occupancy evaluation assesses how well buildings are meeting user needs, and identifies opportunities to improve the building's design, performance and usability. This evaluation method has helped organizations involved in the provision of new buildings to become aware of the needs of users and also to participate in the feedback mechanisms which result in a cyclical construction process (Ilesamni, 2010). The performance of building occupants or users in any organization or institution depends on the condition of the building itself and the facilities available in the building. Failure to address user needs can result in poor building utilisation and loss of productivity, contributing to the demise of many organisations. This is why (Gabr & Al-Sallal, 2003) suggest that POE should address only those items that an organisation is willing and able to correct on-site or as part of downstream projects.

Frameworks or checklists have over the years been advanced in order to allow educational facilities to be evaluated in terms of the level in which they successfully enable learning and teaching (Anon., n.d.). Post-occupancy evaluations enhance design checklists by helping to evaluate schools once they are utilised. According to (Anon., n.d.), they must describe the performance of a building, in this case preferably a school building. Most of the evaluative efforts are caught up in quantitative measures of performance for the indoor and outdoor environments. Consequently, most efforts are subjected to this measure and only evaluate the quality of the place, for example, the degree of adequacy of lighting, air ventilation, thermal comfort and so on (Ornstein & Ono, 2010).

POEs are inherently non-experimental and most post occupancy evaluations are single data collection (Pati & Pati, 2013). The duo continue to state that the data collection could be

quantitative or qualitative. Since none of the necessary characteristics of the experiments (comparison groups, random assignments) are taken into account, no knowledge of the cause-effect relationships should be expected. At most a researcher can only expect patterns (hypotheses) as the derived data from POE on the potential existence of some cause-effect relationships.

Several studies have been conducted regarding POE in buildings. (Adewunmi, et al., 2011) conducted a research on the post occupancy evaluation of graduate dormitory facilities at the University of Lagos. The authors noted that building occupants are generally satisfied with the cleanliness, lighting, building temperature, comfort, natural ventilation, space, air quality, fire protection and parking spaces in the university. (Gabr & Al-Sallal, 2003) rated the performance of college educational buildings in the United Arab Emirates (UAE). From the previous researches that were carried out using POE to analyse the performance of the buildings, scholars did not assess the impact of climate on the performance of the building for its intended use therefore that is the knowledge gap for this research.

The FET building is in the University of Botswana. It is in between Block 247 and Block 252, in front of the Business Block (245) and next to the Student Centre. The building has been operating for more than 6 years now and many defects have been reported since it started operating. The building was built using burgundy face bricks externally, plastered and painted walls internally. The building is furnished with ceramic floor tiles in toilets, has natural lighting, ramps that can be used by the disabled and has four elevators and stairways in case of any emergencies. The building according to the school site is approximately 16, 000 sq.m and each block within FET (i.e. Blocks 248, 249, 250 and 251) has 3 floors. The FET building construction began in September 2008 and was anticipated to finish in October 2012 by Italtswana Construction Company. The building is relatively new, it has been operating for at least more than 6 years. Within in its period of operation, the building experienced many faults such as water leakages in the rest-rooms, broken down projectors, water leakages from air-conditioning systems through the ceiling in lecture rooms, faulty elevators and many more. The FET building was chosen in order to figure out the root problem of all these faults rather than treating symptoms. The conclusion drawn from analysing the performance of the FET building would be used to help future projects as well to try and reduce or avoid possible defects on the new buildings.

The FET building was recently built with sophisticated facilities such as elevators, projectors, air conditioners and equipment used by Architecture, Planning, Geomatics students and

other FET students. These facilities are wisely utilised to benefit the students and other users of the building. Many building defects are reported in the FET building such as broken elevators, leaking pipes, faulty air conditioners, leaking water closets, burnt bulbs etc. to the faculty's facility manager every year. These defects can be frustrating to staff and the students and may delay academic progress if the broken or faulty building element is needed to carry out any course work. Not only is it frustrating to the students and staff but also tempers with the school budget especially when fixing of such defects on building elements was not budgeted for at that particular time and only accounted for in the cyclic maintenance budget which takes place after a certain period of time. POE can be seen as multi-faceted tool for solving building problems of the FET building, as it systematically evaluates the performance of buildings and facilities. POE refers to the integration of the needs of people and their workplace. Therefore, POE is the best technique to use. Now a question can also be asked if some of these defects and faults are caused by the country's climate or weather conditions (semi-arid climate). POE strategy should be applied when evaluating the performance of the FET building in the University of Botswana.

The above problem led to the formulation of the research goals and objectives. The general objective of this research was to use POE method to evaluate the performance of the FET building. The objectives are as follows:

1. To determine the satisfied level of the building occupants in terms of building elements, services and the environment.
2. To establish the effect of climate on the performance of the FET building.

This paper's exertion was to illustrate that the University of Botswana particularly the FET building, needs evidence-based plans to permanently address its building issues in the form of revised design standards and monitoring processes. Carrying out POE process will increase accountability for facilities managers; it will standardize best practices and also help the University identify things that need to be carried out on future projects. In addition, POE would ensure that all individuals are ultimately satisfied with the buildings and most importantly cost reduction for unplanned maintenance activities. To achieve the above objectives, the study adopted a quantitative research method by administering a questionnaire to the occupants of the building and interview guide for the Facilities Manager. The recommendations of the study can therefore influence the university management to include POE strategy to achieve the strategic objectives of the institution.

2.0. Literature Review

The review of related literature is arranged into two themes. Theme one discusses the general principles of POE while the second theme discusses how climate change can affect the performance of a building.

2.1 The performance concept of a building

“The 'performance concept' suggests that post occupancy evaluations integrated early into the planning and design programs of agencies as an important part of the construction process (Preiser, 1995).” Preiser further states that the performance concept is based on the assumption that a building is designed and constructed to support, and enhance, the activities and objectives of its users. Performance evaluation and feedback connects customer objectives and performance criteria to the actual measurable building performance. The term 'evaluation' according to Preiser (1995) contains the word 'value' which is essential in the context of post occupancy evaluation. This is because an evaluation must explicitly indicate which and what values are used in determining valuation criteria. For an evaluation to be meaningful, values need to be identified that determine the goals and objectives of those who want their buildings to be evaluated (Khalil & Nawawi, 2008).

2.2 General principles of post occupancy evaluation

This theme entails a discussion on post occupancy concept, purpose of carrying out POE in buildings, POE evaluation methods and barriers to effective POE.

2.2.1 Understanding what post-occupancy evaluation is all about

POE according to Preiser & Schramm (2002) is different from other evaluation techniques and methods as it focuses on the users' needs e.g. comfort, health and safety, security, functionality and efficiency as well as aesthetic quality. POE describes building performance settings rather than manipulating them.

The information used for POE has traditionally comes from three sources, namely occupant comments, bills and metrics and measurements and readings (Cooper, 2001). Post-occupancy helps identify the measurable relationship between building quality and educational outcomes. It provides an extension to other technical evaluations such as operational and maintenance reviews, safety inspections (Khalil & Nawawi, 2008). POE main

motivation is user satisfaction. Post-occupancy evaluation is highly rated in the real estate industry as a necessity to improve the design, construction and maintenance of sanitary and educational facilities (Hadjiri & Crozier, 2009).

Current views on POE suggest that technical performance, financial performance and the impact of the built environment on the working conditions should also be considered. POE provides a mechanism to understand the relationship between buildings and user needs. It consequently, enables formulation of strategies and solutions of improving the environment and making it conducive to accommodate user needs (Khalil & Nawawi, 2008). To construct and operate buildings at a lower cost, there is need to understand how buildings differ in use from what is expected of their design, and this can be only be done through post occupancy evaluation.

Implementing POE has the potential to uncover issues that stakeholders are unaware of, making POE important in the construction industry especially residential, learning, commercial and healthcare buildings, where poor performance of the building affects operating costs, wellbeing of users' and business productivity. However, POE has the limitation that it is less responsive and may not be generic enough. POEs are by nature non-experimental. Most POEs involve one-shot data collection (Pati & Pati, 2013). This could be qualitative or quantitative data. However since none of the necessary characteristics of experiments (comparison groups, random assignments) are implemented – POEs should not be generally be to provide insight on cause-effect relationships (Pati & Pati, 2013). The most one can expect to derive out of POE data is patterns (hypotheses) on the potential existence of some cause-effect relationships (Pati & Pati, 2013).

2.2.2 Purpose of carrying out POE

The main purpose of carrying out POE is to verify that a building is operating as expected. This would lead to an important addition to an improved design process. The result of carrying out POE can only be positive and the true successes can be recognized and repeated in the future. If some aspects of a building do not meet required expectations or if innovations are missing their targets, these will be disclosed (Cooper, 2001). Facility managers and construction industry professionals carry out post-occupancy evaluations to manage existing facilities and aim at improving future designs. Post-occupancy evaluation collects insights that will be helpful in making better use of a building and improve on worker productivity (Khalil & Husin, 2009). Post occupancy evaluation is important for long-term reviews e.g. 3-5 years of occupation for example, to assess how buildings are likely to meet future needs and whether

they have been able to respond to changing need so far (Hadjiri & Crozier, 2009). Reviews can also be used to re-evaluate the brief's functional and technical performance requirements of the building types. The findings will inform and feed forward into the future estates strategy (Gabr & Al-Sallal, 2003).

2.2.3 An analysis of post-occupancy evaluation

"Post occupancy evaluations are done by people and companies who are familiar with human behaviour and building design. Ideal candidates have experience in both design and environmental psychology or environmental design (Khalil & Husin, 2009)." Krawczyk (2015) further added on that "while many design firms include evaluations into their design packages, few of these evaluations go beyond measuring how well the design goals were met." It is important that the changing needs of the users are met. Needs must be properly determined at the time of design programming otherwise the design will not serve its users well. The user's needs often change from initial design goals so even if the design considerations were well researched, the building will still not fully satisfy the users. "POE can be performed across all sectors within the business, including facilities management staff, to gauge feeling and satisfied with their own working environment (Shah, 2007)." According to Khalil & Husin (2009) there are three phases and steps involved in conducting POE namely:

1. Planning
2. Conducting and
3. Applying

A. Planning: When the researcher is planning their work, all preliminary agents such as objectives of conducting the post occupancy evaluation are defined. This phase also assesses the building's feasibility study and analyses its functionability. There should be definition of strength and weaknesses of the building in this phase. Researcher should identify the number of users or occupants of the building. This is important in developing a research plan before evaluation starts (Khalil & Husin, 2009).

B. Conducting: Key task in conducting post occupancy evaluation is 'data collection'. At this phase, the occupants of the building are identified in order to develop data collection strategy, whether based on interviews or questionnaires. Evaluation takes place in this phase and it is important to ensure that all data collection procedures are monitored and managed. "After the evaluation is conducted, the data is analysed. This involved the finding and making sense of the data in terms of the questions asked in the beginning of research." (Khalil &

Husin, 2009).

C. Applying: "The application of POE includes reporting on the results, recommending and planning measures. The outcome of the report finding depends on the purpose of the implementation. The purpose could identify problems and failed performance in the facilities. Results of the reports are implemented, measured are taken and the effects of the measures are measured (Khalil & Husin, 2009)."

2.2.3.1 Methods that can be used in data collection when conducting post occupancy evaluation

In the data collection phase, various data collection methods can be used when conducting a recruitment evaluation.

Examples of the methods that can be used in data collection:

1. Questionnaires: closed-ended and open-ended questionnaires can be used or a combination of both can be used. For open questions, respondents use their own words to respond to questions whereas in closed questions responses are given for respondents to answer.

2. Structured interviews: a questionnaire constructed. This list is used to ask residents questions in the same order and format to each one of them (Dawson, 2009).

3. Structured observations and walk through: looking at the building and observing how space is utilized. Discussing with users what can be done to improve the performance of the building.

4. Literature search: Reading published literature so as to identify good references regarding a specific topic (Liverpool Hope University, 2012).

5. Focus groups: a group of individuals are required to come together and discuss the topic at hand for the purpose of the study (Dawson, 2009).

2.2.4 Post occupancy evaluation methods

Barrett and Finch (2014) discussed three examples that explains the various techniques and use of POE. They believe that these examples will provide the facilities managers with adequate information to enable them to conduct their own POEs. These are:

Partial user participation –this model was developed by (Preiser, et al., 1998). Users are only partially involved in the evaluation process. Evaluators with adequate experience lead the process and users only participate at the request of those evaluators. This model proposes three levels of effort:

1. **Level 1: Indicative POE** – This POE provides an indication of the success and failure of the overall performance of a building's (Barrett & Finch, 2014). It is usually carried out by experienced evaluators who are familiar with the type of building to be evaluated.

2. **Level 2**: **Investigative POE –** Barrett & Finch (2014) say that this technique is often initiated as a result of a problem identified during an indicative POE. Annotated drawings and photographs may be required as this complex data collection methods to obtain results.

3. **Level 3**: **Diagnostic POE –** This technique aims not only to improve the respective facility to be evaluated, but also to influence the future design of similar facilities (Barrett & Finch, 2014). An in-depth evaluation will require a lot of time and budget to produce reliable results. Multiple methods such as questionnaires, interviews, observations and physical measurements.

Full user participation – Users are fully involved throughout the evaluation. Experienced people in the process of evaluation are still involved, but their function is purely to guide the participants through the process rather than to make judgments (Barrett & Finch, 2014). Every evaluation will include the same three core events which are: introductory meeting; touring interview; review meeting (Barrett & Finch, 2014).

POE as a management aid – POEs not only serve to improve physical conditions but can also act as an aid to management. In POE, the process of consultation can be as important as information collected judgments (Barrett & Finch, 2014).

2.2.5 Barriers to POE

Hadjiri and Crozier (2009) suggests that, the fact that this evaluation method is widely discussed shows a growing frustration with the POE lack of progress toward the core business. Hadjiri and Crozier (2009) also identifies the barriers to widespread adoption of POE as costly, protects professional integrity, time and skills. A number of significant barriers to the widespread adoption of POE include fragmented incentives and benefits within the procurement and operation process, lack of agreed and reliable indicators, potential liability for owners, exclusion from the current delivery expectations and exclusion from professional

curricula (Zimmerman & Martin , 2010). POE is not regarded as part of an architect's normal services to their client, thus, client organizations are unlikely to pay for POE unless the benefits of such evaluations are both evident and substantial in value (Zimmerman & Martin , 2010).

2.3 Effects of climate on the built environment

The world's climate is changing. The 1990s were the hottest decade since the 1860s, and the 1900s the warmest century of the millennium (Camilleri, et al., 2010)." The implicit assumption that climate is static, bounded by known extremes and that it changes only slowly with time, is no longer tenable (Camilleri, et al., 2010). Argument still persists about whether recent changes in climate have been influenced by anthropogenic greenhouse gas emissions, but this cannot alter the fact that the climate has changed significantly over years, and the best predictions suggest that more changes are on the way. Therefore the risks of future climate change to buildings should be managed.

Adequate planning and preparation can make brick construction possible in virtually all weathers. Cold and hot weather can negatively affect masonry materials and the quality of constructed masonry (Brick Industry Association, 2006). This is to say that weather conditions affect the design, construction, and performance of buildings. A detailed discussion below explains how changing weather conditions affect building materials in a building.

2.3.1 Impact of weather on buildings

Weather affects every aspect of a building and what is used to construct a building. The following are:

- **Concrete:** Dry weather can cause the water in concrete and masonry to evaporate too quickly. This will cause a production of concrete with lower compressive strength and a finished concrete that tend to curl upward and to spall (Crissinger, 2005). Cold weather can cause ice crystals to form and retain moisture. Cool temperatures can also slow the curing, which may affect concrete strength, promote spalling, and can ruin the finish.
- **Masonry mortar:** Hot and dry weathers similarly to concrete causes the moisture from the masonry and mortar to rapidly evaporate causing the mortar to set prematurely. This means that the mortar will set prematurely and there may be insufficient moisture to ensure that brick absorbs mortar paste properly (Crissinger, 2005).
- **Brick:** if not damped prior to laying, they become dry and when laid, they absorb the

water from the mortar too quick that the paste creating the bond between the brick units is not absorbed. Brick is a reservoir for moisture. When damp brick heats up from the sun, the warmth causes the moisture to move toward the cooler interior. "Unless the building is designed and constructed with an interior rain screen and through-wall flashing, the moisture will continue to migrate inward and condense on the cooler interior wall (Crissinger, 2005)." When the brick absorbs moisture it expands and as it expands it can break adjacent bricks and open mortar when fog or mist are present (Crissinger, 2005).

- **Foundations**: In cold climate, founding bases must be set below the frost air to prevent heaving. The colder the climate, the deeper the frost parentage, and consequently, the deeper the foundation. If the foundation is above the frost line, freeze -thaw cycles can cause excessive structural movement (Crissinger, 2005).
- **Paint:** Weather can affect both paint work and performance. During application, if the ambient temperature or the substrate control surface temperature is too high or the relative humidity is low, the reducing agents (solvents) in the blush will evaporate too quickly. This rapid evaporation prevents the paint from curing properly, which can lead to delamination, wrinkling, bubbles, peeling, and cracking. Most paint containers indicate the ambient and substrate temperature range. Some paint manufacturers give a recommended range of relative humidity. Exposure to ultraviolet (UV) rays is the worst enemy of paint performance (Pati & Pati, 2013). Cold temperatures can cause substrates (water-based paints and solvents in solvent-based paints) to freeze or thicken and delay the hardening process.
- **Seals and Sealants**: freeze thaw cycles and exposure to ultra violet light reduces the resiliency of seals and sealants, resulting in loss of elasticity hence causing embrittlement (Crissinger, 2005).
- **Fibrous and Porous Products:** Fibrous and porous materials, including wood, fiber insulation, drywall, carpet, and masonry, are models of materials that absorb and retain moisture. To prevent distortion and damaged conclusion, these token should be kept dry and protected before, during, and after construction **(Crissinger, 2005)**.
- **Roof**: The geographic location (coastal or inland area, open or wooded area, urban or rural area, etc.) of a structure or the shape and height of the building can influence wind elevation or uplift pressure on a roof. Strong winds can create enough wind uplift to cause severe damage. (Crissinger, 2005).
- **Doors and windows**: The infiltration of air and humidity is directly proportional to the pressure generated by the speed of the wind. The expected wind speed and the height of doors and windows must be taken into account during construction and installation. In dry climates and fine soil, manure can easily swirl through inadvertent cracks in doors and

windows and leave a small groove of soil along the crack(Crissinger, 2005).

- **Building:** Building operation can be significantly improved by draining everything from the cap to the basis (from roof to foundation). Wetness or moisture are intruders that will penetrate the building shell of the best defended structure. However, once moisture breaches the building shell, drainage provisions can be used to gaining control it and direct it to the exterior(Crissinger, 2005).

3.0. Methodology

The main purpose of the study was to conduct a POE of FET building to determine the performance of the building. An operational framework consisting of diverse set of activities was developed to attain a systematic performance evaluation that concentrates on the users of the sought FET building. The developed framework entailed carrying out a walkthrough investigation, interviewing the facilities manager of the FET building and administering a questionnaire survey to the target population. Walkthrough investigation involved walking through the FET building to analyse the condition of the building and its elements (Hassanain, et al., 2009) explain that preliminary investigation pinpoints the major problematic zones or elements by recording signs of deterioration in and outside the building. The investigation should be backed up with photos. An in-depth face to face interview was held with the facility manager of FET building. The reason why the facilities manager was interviewed is because he is the one responsible for maintenance works in the building. The facility manager also handles all reports and maintenance requests made by building occupants. A Questionnaire was self- administered to 96 building occupants in order to determine users' satisfaction rate. The collected data was analysed hence giving a range of solutions for improving the FET building. The measurement scales that were used in the questionnaire measured what they intended to measure hence ensuring internal validity of the measurement instrument.

The population used for this study was 1453 occupants of FET building in the University of Botswana. This included 1174 students, 179 academic staff, 32 cleaners, 68 security guard and a Facilities Manager. In determining the sample of the study, a proportionate stratified approach was used to sample the population. A sample is a set of respondents (people) selected from a larger population for the purpose of a survey. Therefore, sampling can be said to be a technique that is employed to select an appropriate sample to try and find the parameters or characteristics of the whole population. Table 36 shows the total number of

Table 1: Staff numbers in FET

Department	Number of staff
Civil engineering	40
Faculty office	30
Mechanical engineering	31
Electrical engineering	23
Industrial engineering (IDT)	25
Architecture and Planning	30
Total	179

Source: FET Human Resource Office (2017)

Table 2 shows the number of all students in FET.

Table 2: Number of all students in FET

Program	Male	Female	Year 1	Year 2	Year 3	Year 4	Total
Bachelor of Architecture	78	34	27	23	18	15	112
Bachelor of Design and Tech	29	4	13	4	5	5	33
Bachelor of Design: Industrial	76	17	41	8	13	11	93
Bachelor of Engineering: Civil	124	42	0	162	4	0	166
Bachelor of Engineering: Beng	85	36	4	7	22	39	121
Bachelor of Engineering: Construction	31	9	0	1	5	9	40
Bachelor of Engineering: Electrical	93	18	8	3	31	20	111
Bachelor of Engineering: Industrial	45	23	2	4	17	10	68
Bachelor of Engineering: Mechanical	110	4	3	5	24	36	114
Bachelor of Engineering: Mineral	47	10	4	7	12	6	57
Bachelor of Geomatics: General	44	14	7	18	15	18	58
Bachelor of Land Management	13	18	0	9	9	13	31
Bachelor of Science: Mining	25	4	2	14	11	2	29
Bachelor of Science: Real estate	27	44	35	12	9	15	71
Bachelor of Science: URP	36	24	24	10	11	15	60
Diploma in Mining Engineering	3	0	0	0	3	0	3
Master of Arts Prof URP	2	5	1	0	0	6	7
Total							**1174**

Source: (FET Faculty Administrator, (Dingalo, 2017)

staff in all the Departments in the Faculty of Engineering.
There were 68 security guards, 39 worked during the day and 29 in the night shift. According

Staff	179
Students	1174
Cleaners	32
Security guards	68
Total	1453

Source: Field survey

The calculation is as follows;

Table 4: **Population sampling using proportionate stratified sampling technique**

Study population	Number	Formula	Sampling
Staff in FET	179	(94/1453)* 179	12
Students	1174	(94/1453)*1174	76
Security of guards	68	(94/1453)*68	5
Cleaners	32	(94/1453)*32	3
Total	1453		96

Source: Field survey

to cleaners' supervisor, there were 32 cleaners therefore the total population is equal to:
The population of the study consisted of Students, Lecturers (Staff), Facilities Manager, Cleaners and Security Guards as users or occupants of the FET building. According to Botswana Laws, a Research permit is required if one is undertaking research in Botswana as part of ethical considerations. However, this study was conducted within the University of Botswana, therefore IRB review was not necessary.

From the information provided above the sample size was determined using 90% confidence level using Taro Yamane's Formula for definite population which is sample size (n) = Population (N) divided by (1+ Population (N) multiplied by the level of significance or margin of error (e) 10% (Yamane, 1967):

4.0. Data Presentation, Analysis And Interpretation

In this section, the findings from the data collected from the self-administered questionnaire and interview were thoroughly discussed. An interview guide was used to collect data and was analysed using thematic analysis. A presentation of the statistical data followed through the use of tables.

4.1 Findings from the questionnaire

The questionnaire sought to determine the level of satisfied with FET building by occupants. The respondents were required to rate their level of satisfied with the building as well as with

the various components in the building. They were also required to give their opinion on whether climate affects the building. The results are discussed below.

4.1.1 *Question 1: Are you satisfied with the FET building?*

The first question asked the respondents to note their level of satisfaction with the FET building. The findings from the students revealed that;

- 100% of first years are satisfied with the overall services provided by the building.
- 81.82% of the second year students are satisfied with the overall services offered in the building (9/11 * 100).
- 50% of the third years are satisfied (18/26 * 100)
- 58.62% of the fourth years are satisfied (17/29 * 100)
- 71.43% of fifth years are satisfied (5/7 * 100)

Academic staff were generally satisfied with the building. This was shown by 75% (9/12 * 100) for lecturers indicating that they are satisfied with the building whilst 25% were unsatisfied.
In terms of the cleaners and security staff, the results reveal that 83.33% (5/6 * 100) of respondents are satisfied with FET building whilst the remaining 16.77% are not satisfied with the building.

From the above, one can note that the occupants of the FET building are satisfied and these results are in agreement with what other previous studies had (Shah, 2007; Krawczyk, 2015) noted.

The researcher had kindly asked the cleaners to list down all the problems they see within the building elements while cleaning and here are what they gave:

- *"Most of the air conditioners are not functioning well and need serious attention, they drip water into offices wetting carpets and leaving unpleasant smell.*
- *Water is always on the floor, which is a draw back to them if the air conditioners are left un-attended because they would spend the whole day just mopping the floors.*
- *Toilets are leaking and even if they are reported they take too long to be fixed.*
- *Door locks are breaking down making door operations very difficult.*
- *They encounter the problem of colour of walls because they easily catch dirt mostly due to the fact that students put their shoes on the walls all the time, so there are always black stains on the walls"*.

From the above narratives, one can say that though occupants are satisfied with the building there a number of issues that still need to be attended to in order to improve the performance

of the FET building.

4.2.2 *Question 2: Please rate the satisfaction level of the following facilities in the building on a Likert interval scale of 1-5.*

In order to address this question, the respondents were asked to rate their level of satisfaction using an interval five point Likert scale of strongly satisfied (SS) 5, Satisfied (S) 4, Moderately Satisfied (MS) 3, Dissatisfied (D) 2 and Strongly Dissatisfied (SD) 1. After collecting the results, the mean or average score for the factors were determined.

The scoring criteria used was that a mean score of less than 1.49 indicates that respondents on this factor are strongly dissatisfied with building components; for a mean score between 1.5 and 2.49 indicates that they are dissatisfied; an average score between 2.5 and 3.49 shows that there is Moderately satisfied with the building elements; for an average score between 3.5 and 4.49 means they are satisfied and for an average score greater than 4.5 indicates that the respondents are strongly satisfied with the elements in the building. Tables 5, 6 and 7

Table 5: Student responses

No	Performance criteria	Mean score	Remark
1	Elevators	2.55	Moderately satisfied
2	Projectors	3.00	Moderately satisfied
3	Air conditioners	3.07	Moderately satisfied
4	Ramps for the disabled	3.18	Moderately satisfied
5	Door conditions	3.18	Moderately satisfied
6	Speakers	3.24	Moderately satisfied
7	Safety	3.33	Moderately satisfied
8	Internet facilities	3.45	Moderately satisfied
9	Air ventilation	3.47	Moderately satisfied
10	Building communications	3.50	Satisfied
11	Lecture rooms	3.55	Satisfied
12	Good open spaces	3.57	Satisfied
13	Overall environment of FET	3.59	Satisfied
14	Natural lighting	3.63	Satisfied
15	Floor finishes	3.64	Satisfied
16	Office conditions	3.64	Satisfied
17	Toilets	3.66	Satisfied
18	Tables and chairs	3.67	Satisfied
19	Level of cleanliness	3.67	Satisfied
20	Ceilings	3.75	Satisfied
	Average	**3.42**	Moderately satisfied

Source: Field survey

shows a summary of the results from students, lectures, cleaning and security guards.
It is evident from table 5 that students are satisfied with half of the building components in FET building. This shown by mean score within the range of 2.5-3.49. The respondents have moderate satisfied with other components such as air conditioners, elevators, projectors, speakers, door conditions, air ventilation and internet facilities. The students opine that projectors and speakers at times do not work thus frustrating learning process. They also add that air conditioners and elevators breakdown thus causing an inconvenience to them. However, they state that even though these components sometimes breakdown,

Table 6: Lecturer responses

No	Performance criteria	Mean score	Remark
1	Elevators	2.08	Dissatisfied
2	Projectors	2.25	Dissatisfied
3	Air conditioners	2.33	Dissatisfied
4	Speakers	2.92	Moderately satisfied
5	Air ventilation	2.92	Moderately satisfied
6	Door conditions	3.00	Moderately satisfied
7	Ramps for the disabled	3.08	Moderately satisfied
8	Tables and chairs	3.17	Moderately satisfied
9	Building communications	3.30	Moderately satisfied
10	Toilets	3.42	Moderately satisfied
11	Good open spaces	3.50	Satisfied
12	Safety	3.50	Satisfied
13	Lecture rooms	3.58	Satisfied
14	Natural lighting	3.58	Satisfied
15	Floor finishes	3.58	Satisfied
16	Office conditions	3.58	Satisfied
17	Overall environment of FET	3.75	Satisfied
18	Ceilings	3.83	Satisfied
19	Internet facilities	3.83	Satisfied
20	Level of cleanliness	4.00	Satisfied
	Average	**3.26**	Moderately satisfied

Source: Field survey

maintenance personnel always work timeously to fix them.
According to lecturers, building components such as air conditioners, elevators and projectors are the main building elements that they are not satisfied with as depicted in Table 6. They mention that faulty air conditioners affect learning. When classrooms get too hot it prevents students from learning as they tend to lose concentration and sleep in class. They also mention that they are frustrated with poor working projectors in FET building. The respondents mention that they often require assistance from technicians to fix the projectors

when class commences. This results in delay in teaching, hence resulting in dissatisfied. On the other hand, the respondents are satisfied with the lecture rooms, ceilings, natural lighting, office conditions, safety and internet facilities in the building. They mention that the

Table 7: Guards and Cleaners responses

No	Performance criteria	Mean score	Remark
1	Door conditions	2.17	Dissatisfied
2	Elevators	2.60	Moderately satisfied
3	Toilets	2.67	Moderately satisfied
4	Air ventilation	2.67	Moderately satisfied
5	First aid kit	2.83	Moderately satisfied
6	Desk and chair	3.17	Moderately satisfied
7	Open spaces	3.17	Moderately satisfied
8	Overall environment of FET	3.17	Moderately satisfied
9	Level of cleanliness	3.30	Moderately satisfied
10	Building safety	3.33	Moderately satisfied
11	Ramps for the disabled	3.50	Satisfied
12	Floor finishes	3.50	Satisfied
13	Telecommunications	3.50	Satisfied
14	Lecture rooms Natural lighting	3.67	Satisfied
15	Ceilings	4.00	Satisfied
16	Office conditions	4.00	Satisfied
	Average	**3.20**	Moderately satisfied

Source: Field survey

sizes of the lecture room are adequate enough to accommodate a large number of students.
The results from Table 7 indicate that security guards and cleaners are generally satisfied with a few components in FET building. These components are natural lighting in classrooms, floor finishes, telecommunications and rams for the disabled but dissatisfied about door conditions.

It is also noted that all the respondents were moderately satisfied with the performance of the FET building and this corroborates well with what was noted in the interview with the Facilities Manager that "*the building performs well as intended even though some people may never really be satisfied with what the building has to offer*." These results are similar to a study that was conducted by Adewunmi, et al., (2011) on postgraduate hostel facilities in the University of Lagos in Nigeria but contrary to what Gabr & Al-Sallal (2003) had found in their study.

ANOVA was used in Table 9 below in order to establish if there was a statistical significant difference in how the three groups (students, Lecturers, Cleaners/Guards) had rated the

variables that were used to evaluate the FET building. It was established that since the computed F value of 1.07 was less than the critical value of 3.17 at degrees of freedom (DF) (2,53), we believe that there was no significant statistical difference in their perception and views about the performance of the FET building between the three groups and within each group as well. Therefore, the null hypothesis is accepted and the alternative hypothesis is

Table 8: ANOVA single factor

Anova: Single Factor						
SUMMARY						
Groups	*Count*	*Sum*	*Average*	*Variance*		
Students	20.00	68.34	3.42	0.09		
Lecturer	20.00	65.20	3.26	0.30		
Cleaners/Guards	16.00	51.25	3.20	0.26		
ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0.46	2.00	0.23	1.07	0.35	3.17
Within Groups	11.25	53.00	0.21			
Total	11.70	55.00				

rejected. They all agreed that they were moderately satisfied with the FET building.***4.2.3 Question 3: Do you think colour of the walls affect your work performance?***

The survey revealed that majority of the students, 89% believe that the colour of the walls has an effect on their performance. Only 11% believed that the colour of the walls does not impact on the productivity performance.

4.2.4 Question 4: Does climate affect the performance of The FET building that you occupy? Would you say it somehow temper with the building materials?

Responses from the questionnaire and interview with the Facilities Manager revealed that "*Climate affects the performance of the building. Botswana's weather is semi-arid although it is hot and dry for most of the year there is a rainy season, which runs through the summer months (November, December, and January)*". Below are some of their reasons to support their answer:

The respondents indicated that "*FET building is cold during winter and hot in summer. It should be the other way round. The respondent went on to say that the building should have been designed to accommodate the weather condition variation. One respondent said that the sun heats the roofing which brings in natural light, the material that was used to design it is not as durable as iron sheets therefore it gets damaged leading to roof leakages which will eventually damage the ceiling. If air-conditioners are working the building cannot cool itself during summer and vice versa. Another respondent said offices get extremely cold during winter or extremely hot during summer. And during the rainy season, there are leakages through the ceilings into offices and lecture rooms*". The researcher's observations also found that, many students gather on the ground floor benches of Block 248 in FET to use the internet and to study during the day. The disabled people are well catered for by the building because there are ramps designed for them to use to move around.

The results revealed that the weather affect the performance of the FET building on visible building elements such as windows, roofing, walls, plaster and painting. This is in line with what other studies (Brick Industry Association, 2006; Crissinger, 2005; Camilleri, et al., 2010) had also noted.

4.3 Findings from interview with the facilities manager

The Facilities Manager was interviewed to get information that the respondents could not provide.

The facilities manager stated that "*the building has been in operation since 2013. The type of maintenance that they use to maintain FET building is Day-to-Day maintenance where every building element is inspected and attended to if there are any defects. He added on that the budget is never exceeded because there is usually enough money reserved for any repairs that may be costly*".

The Manager said that "*the building performs as intended even though some people may never really be satisfied with what the building has to offer. He also added that the finishes of the building suit the learning environment. He mentioned that the only mistake that he could recall was that there was a projector which was put in the woodworks lab that was not supposed to be there because the building is always going to be dusty and the projector cannot function under such conditions. Another mistake that was made was with the plaster of walls in one room in Block 250. The plaster was about 30 – 35mm which was very thick and started cracking but the plaster was eventually removed. A POE has never been carried out*

about the building. The facilities manager said that the building cannot handle change and growth because many facilities are not designed to carry so many weights of students and other occupants therefore the lifts would break down. This means that a lot of things will need to be changed in order for them to accommodate change hence more expenses".

From this study, it is noted that a higher number of students was used to assess the performance of the FET building even though they do not spend most of their time in the building than that of lecturers who spend most of their time in the building. This is a limitation to the study though there is agreement on most of the variables that were used to assess the performance of the FET building.

5.0. Summary, Conclusion And Recommendations

The previous section presented, analyzed and discussed the data that was received from the questionnaires' handed to building occupants (lecturers and students) and interview with facility manager. The purpose of this section is to give a brief summary of findings, conclusion and recommendations that could be done to improve satisfied and building performance of FET building. In addition, a suggestion of further areas of study that could be embarked on by other academicians is outlined.

5.1 Summary of key findings of the study

The purpose of this study was to use POE method to evaluate the FET building's performance and determine users' satisfied with the building. There were two objectives that were posed at the beginning of this study. The results of each objective are summarized below.

5.1.1 *To determine the satisfaction level of the building occupants in terms of building elements, services and the environment.*

The conclusion that is drawn from this study is that occupants of the FET building are moderately satisfied with the overall performance of the building although they raised a few complaints on the performance of elevators (mean 2.55 students, 2.08 for lecturers and 2.6 for security guards and cleaners), projectors (2.25 mean score of lecturers) and speakers (2.92 mean score of lecturers). The research shows that the design of the building to let in natural lighting is on point because students are happy with the fact that there is ample lighting in the building during the day.

5.1.2 To establish the effect of climate on the performance of the FET building

Climate affects the performance of the FET building. FET building is cold during winter and hot in summer. In normal conditions, a building should provide warmth when it is cold and eliminate heat when it is too hot. Buildings should be designed to accommodate changes in weather conditions. Building material should be selected properly looking at the climate and weather conditions. The roofing material used in FET building is not durable as compared to iron sheets. Therefore during rainy seasons there tends to be leakages in offices and classrooms as the roof has been damaged. This also damages the ceilings.

5.2 Conclusions and recommendations of the study

The study has thoroughly addressed the objectives that were posed at the beginning of this study. Secondly, the research has contributed to new knowledge as no study has specifically investigated building performance of University buildings in Botswana. The survey results provide a strong foundation for future research studies POE in tertiary institutions. The study concludes that the performance of the FET building is moderately satisfactory based on the aggregate score of the responses from the study sample. However, there are some areas that they showed dissatisfaction about such as door conditions for cleaners and Guards, air conditioners, elevators and projectors in the lecture rooms for lecturers. The implication of these findings to the institution is that if they are not attended to, the level of satisfaction for these users will be highly affected which might end up compromising their productivity as well as academic performance for students.

5.3 Recommendations

The study therefore recommends that:

- The University should ensure that building materials used in construction of learning facilities are durable and can withstand the continuously changing climate and weather conditions and that all defects that were identified as a cause of dissatisfaction should be attended to.
- There should be constant training and development of staff on building performance evaluation to keep up with latest technology should be encouraged by the institutions; and
- A performance evaluation database for buildings in educational institutions should be developed in Botswana. This would provide information on performance standards and cost of performance evaluation activities thereby helping to improve the

effectiveness of design and evaluation process.

5.4 Further Areas of the study

The research recommends on the areas to be further studied;

i. A study on the various building performance evaluation measures and techniques.
ii. Investigate on building performance evaluation indicators for buildings in higher learning education institutions.
iii. The relationship between building performance measures and academic performance of students in higher learning institutions.
iv. Conduct further research into the performance of educational buildings in other parts of Botswana. Analysing the gaps between the results of such research efforts and those presented in this study could provide an important feedback to educational building facilities managers in higher learning institutions and other building service providers.

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