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POST OCCUPANCY EVALUATION OF THE SCHOOL OF ENVIRONMENTAL TECHNOLOGY BUILDING COMPLEX, FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA, NIGER STATE, NIGERIA

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ABSTRACT

Buildings of all types are basically enclosures which house human activities and interests. Building ought to be designed, operated and be fit for the people that use it, fit for its purpose, and fit for the planet. Post Occupancy Evaluation (POE) is the logical last step in a cyclical design process, whereby lessons learned from the performance of a building can be used to improve the performance of future designs. Post occupancy evaluation (POE) of the School of Environmental Technology building complex, Federal University of Technology, Minna, Niger State, Nigeria was carried out. In order to achieve the aim of this paper, Investigative POE methodology approach was adopted to collect data.One hundred and twenty questionnaires were distributed to staff and students who are the actual users of the building complex. A total of ninety-five completely filled questionnaires were retrieved and used for the analysis to ascertain the level of satisfaction of the occupants. The questionnaires were validated for reliability through pilot survey. Of those respondents surveyed, 55% were students and 45% staff. 19% were women aged under 30, 24% over 30. 32% were men aged less than 30 and 25% over 30.The findings were compared with Building Use Studies 'BUS' database of educational buildings. Users' perception is worst in the area of general cleanliness and maintenance of the facility. The report generated from the users' perception of their working/ learning environment could be used to aid building performance.

KEY WORDS: *Building performance, design professionals, occupant's satisfaction, post occupancy evaluation.*

INTRODUCTION

The process of constructing buildings is a complex activity, which has a variety of impacts on our environment, society and economy. Buildings provide shelter, encourage productivity, embody our culture and can create a great legacy for the future while at the same time establishing links with the past (Egan, 2002). But they also consume a huge share of our land, energy, water and material resources. They affect our health and have an impact on the social interaction and economy of their area. It is therefore important to ensure that resources invested in buildings are used wisely to maximise usefulness, performance, longevity and occupant's satisfaction with minimal negative impacts on the environment, all of which are key issues that is strive for a more sustainable society.

Kirk and Stirrett (2011) described POE of a building as a formal study that tests whether a building has met goals and objectives set forth

in the original programme. Learning how our buildings work is essential for better design. Without information feedback loops, every building becomes to a large extent a prototype and the knowledge that could be learnt from each is lost. Yet building designers in Nigeria rarely evaluate their buildings once they are in use; the next project beckons and the users are left to struggle with the problems of the completed buildings. Projects with recurring design elements can provide a rare opportunity for Architects and Built-Environment engineers to apply the lessons learnt from older buildings to those constructed later. Feedback is a crucial part of a construction process, a vital mechanism by which clients, designers and contractors can learn from experience. It is crucial to conduct a POE because it indicates how well the building is performing in order to satisfy the occupants' needs and achieve organisational goals (Chandrasekhar, 2011).

It also leads to increased awareness of energy conservation in the design of buildings and encourage architects to produce high quality designs that really fit many end uses. Sadly, the adversarial nature of the construction industry militates against this, which more often affect building occupants, the client or most of the time both. Furthermore, designers like to think of their buildings as finished products, which have been perfected, and should remain unchanged. Buildings are rarely designed to accommodate significant change and development over their life, and there is little guidance about how to design to allow buildings to evolve over time. Yet, just like human beings, buildings need to be allowed to develop over time, to mature, grow and evolve. Brand, (1994) proposed the concept of "blue jeans buildings" – buildings that age honestly and elegantly with time. This requires acceptance of a building as an evolving entity where the design and construction phase is just the start of a long process over the life of the building.

Despite the Royal Institute of British Architects – RIBA's (1962) published report – The Architect and his office, and the interest in the 1960s and 1970s in experimental psychology, the study of buildings in use failed to establish itself in UK schools of architecture or in the industry. The early editions of the RIBA plan of work (in the 1960s) included a Stage M, feedback, which was intended to encourage architects and their clients to inspect and review finished buildings two or three years after practical completion. Stage M was later removed probably for the pragmatic reason that it was not related to any fee payment stage of the architects' agreement, and subsequently most related initiatives in schools of architecture were abandoned (Guide RIBA Publishing, 2016). Although there are now proposals to bring back a Stage M, this has not yet occurred and has had little influence on the curricula of professionals in the construction professions (Cooper, 2001).

Increasingly, some enlightened designers of green or sustainable buildings are finding that they want to know how effective have been their strategies to reduce environmental impact while creating comfortable spaces, and some are using the various forms of feedback loops as an aid to learning (Hydes, *et al.*, 2004). Feedback can be in a variety of forms including mere discussions with the client representatives about issue of satisfaction and functionality, short user surveys about functionality and operations, comprehensive surveys about building performance, or full measurement of environmental conditions and appraisal of energy and water use. The Chartered Institution of Building Services Engineers (CIBSE, 1999) has led the way in this regard through the Post Occupancy Review of Building Engineering (PROBE) studies. Examples of alternative approaches that have been used include: the office Productivity Network Survey developed by Building Research Establishment (BRE, 1995) and Sick Building Syndrome (SBS) which focuses on the Operation of a workspace for satisfaction and productivity (Oseland, 2004), the Overall Liking Score (OLS) (Levermore, 1994) used by the American Bureau of Shipping (ABS) consulting which focuses on occupants perception of the working environment to aid Facilities Management and

consider occupant feedback as a "key performance indicator" of building (Ure& Hampton, 2004), the Probe surveys developed by Building Use Studies which address a wide range of issues relating to efficient operation of buildings (Bordass *et al.*, 1999) and the web based Occupant satisfaction Survey developed by the Centre for the Built Environment (CBE) of University of California at Berkeley. In addition the Agents of Change Programme in North America aims to increase awareness of methods of measurement of environmental performance among faculty and students in schools of architecture (Kwok *et al.*, 2004).

LITERATURE REVIEW

The potential benefits of POE to the design, construction and operation of buildings include developing an understanding of the short and long term effects of design and construction decisions (in terms of costs, occupant satisfaction and building performance aspects such as energy management) and improving the knowledge and practices of clients, designers, builders, facility managers and other built environment professionals (ibid.). In the UK context, POE has yet to become embedded as routine practice in the building delivery process (Bordass & Leaman, 2005). Typical barriers to more widespread adoption of POE cited by practitioners include cost considerations, time constraints, perceived challenge to professional judgement (including risk of litigation) and the availability of researchers and practitioners possessing the broad range of skills required for undertaking a successful POE study (Vischer, 2002; Stevenson, 2009). The emergence of POE as a distinctive discipline traces its origins to studies of public and student housing in the UK, France, Canada and the United States in the 1960s and 1970s (Zimring*et al.*, 2010). These early studies gathered information about the responses of occupants to buildings through questionnaires, interviews, site visits and observation, sometimes linked to physical assessment of the building, with the objective of understanding the performance of design elements, identifying best practice approaches and also what should not be repeated in future (Federal Facilities Council, 2002).

This mixed-methods approach and investigative ethos principally focussed on user experience remains central to most contemporary approaches to POE. Recent developments are characterised by two trends; the creation of standardised POE methodologies for specific building types (for example, offices, healthcare and educational facilities) and the extension of the scope of POE activities to incorporate evaluation and feedback at repeated intervals during the building delivery lifecycle (Stevenson, 2009). In recognition of this diversity of objectives and application, Vischer (2002) offers a loose definition of POE as "any and all activities that originate out of an interest in learning how a building performs once it is built, including if and how well it has met expectations and how satisfied building users are with the environment that has been created".

The frameworks below show where POE fits in the context of an overall building performance evaluation (Figure 1), and three levels within a POE framework.

Most of the literature reviewed tends to analyse and arrange this proliferation of methodologies on a thematic basis. Preiser (1995) for example, identifies three approaches that summarise the range of POE that can be applied to the full spectrum of projects, from the minutiae of a specific building, to the overall procurement programme of a whole project. These three approaches are summarised as: Indicative, Investigative and Diagnostic POE (Preiser, 1995, Preiser*et al.*, 1988):

i). Indicative POE, it is suggested, are cursory analyses that may include "quick walkthrough evaluations involving structured interviews with key personnel, group meetings with end users as well as inspections" (Preiser, 1995).

ii). Investigative POE is considered to be more in-depth analyses, utilizing interviews and questionnaires, usually across a number of buildings of the same or similar type.

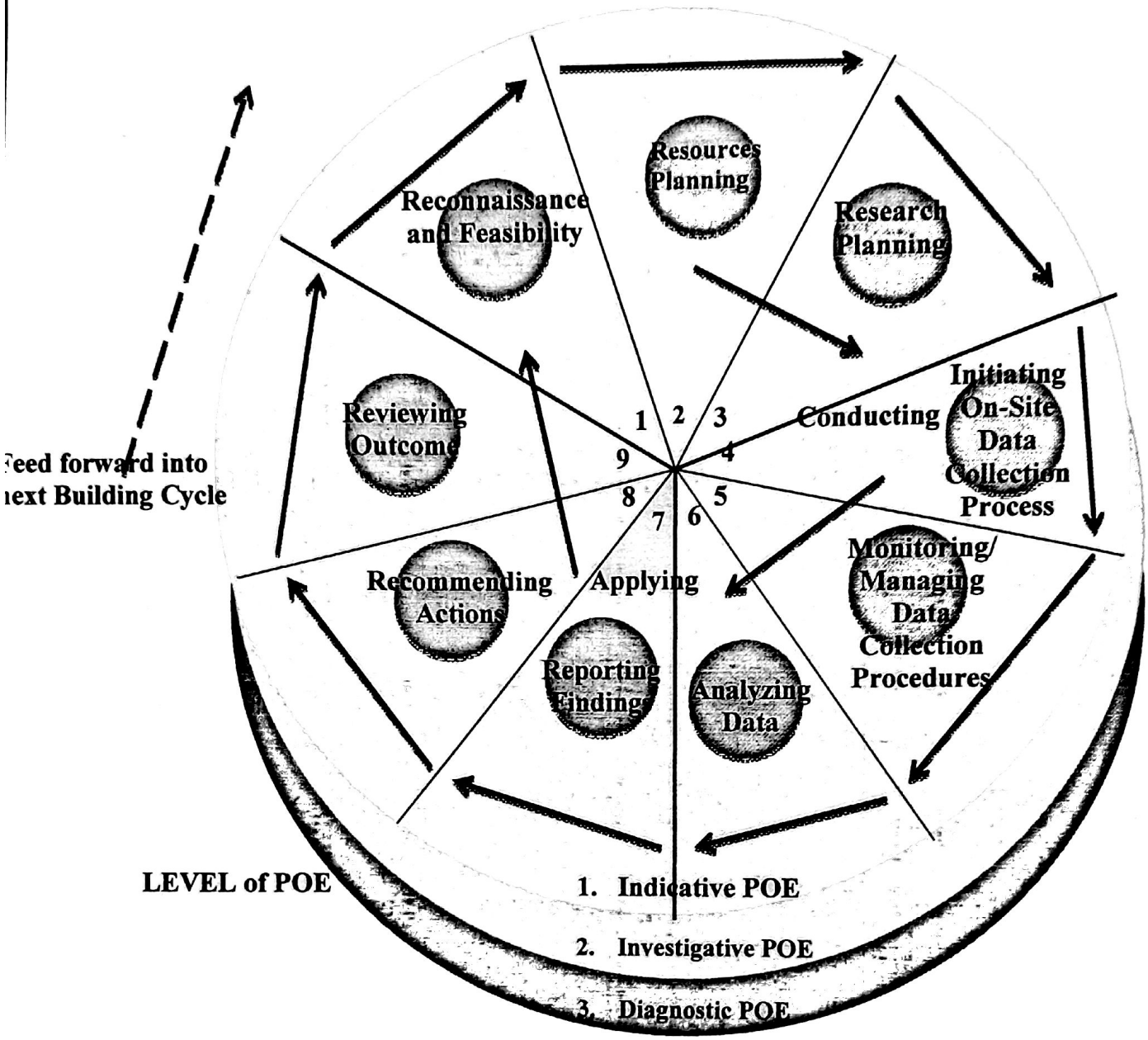

Fig. 1: Post-occupancy Evaluation Framework
Source: Preiser*et al.* (2002)

iii). Diagnostic POE is regarded as being the most sophisticated of the methodologies. They tend to have a broad, system wide focus on a number of comparable facility types, focusing on a broad range of technological and anthropological areas of research. Preiser suggests that this type of in-depth POE produces "high validity and generalisability of data collected (Preiser, 1995).

Objectives of POE

One of the primary objectives of POE is to feed forward 'lessons learned' from the review of completed capital projects into a process that would ensure that best practices are applied in future projects. More specifically POE tests generic and specific aspects of the planning and detailed design of facility buildings. It also tests their impact on building users with respect to several parameters such as, health and safety, security, indoor environment quality and functions. According to Zimmerman and Martin (2001), "the over-arching benefit from conducting POE is the provision of valuable information to support the goal of continuous improvement". POEs

have been used to evaluate the degree to which buildings enable users to fulfill their intended goals. A comprehensive POE method, one that includes assessments of occupant well-being and productivity, along with the evaluation of the building functions and operations, completes the feedback loop that is essential for the successful future development and improvement of building design and practices (Huizenga, *et al.* 2006).

Importance of POE to Facility Owners

POE is a powerful tool to enable owners to determine the true value of a facility in terms of economic, environmental, human and community outcomes. Through evaluation, researchers and professionals have found the occupant satisfaction survey to be useful as it provides valuable information and results in the context of the Indoor Environment Quality (IEQ) performance of a built space. This helps to evaluate the effectiveness of design and operation of facilities, provide information for the formulation of design and construction guidelines and, benchmark facility performance. An evaluation renders the identification of environmental factors that need improvement, diagnosis of causes for occupant dissatisfaction and supervision of occupant perception of building, and contractors' performance (Huizenga *et al.*, 2006).

The LEED rating system has been widely adopted in the US by federal agencies, state and local governments, and private companies as the standard for sustainable building. While it has brought green design and construction practices into the mainstream, systematic assessments of how these buildings affect occupants are rarely done (Cathy, 2006). Hence, POE studies of green buildings have focused on more easily quantifiable criteria such as energy use and physical measurements of environmental conditions, which at best give an indirect assessment of how the building is affecting its occupants (Huizenga, *et al.*, 2006). In accordance with the ASHRAE 55 standard, it is now imperative for POE to be conducted by an owner in order to check if the constructed facility meets minimum IEQ performance requirements. POE may be conducted for various categories that will result in individual outcomes. For example, POE may be conducted in behaviour research, feedback to the pre-design program, strategic space planning and capital asset management (Preiser and Schramm, 2002). "POE expertise and data gathering methods can be applied to various situations which would benefit facility performance in the continuous quest for quality improvement. Thus POE techniques have become important asset in the "toolkit" facility managers can use for TQM (Total Quality Management)" (Preiser, 1995).

Ways to Enriching the Sustainability Issues in the Design of Buildings

It is a well-known premise in education that one learns far more by doing or experiencing something than by being told about it. The scriptures also stated in John 13: 17 that a man's knowledge becomes a blessing (-useful, applicable) only when it is translated to a doing. Only through actually implementing a design and studying it in use does a designer begin to appreciate and understand in detail the full characteristics of a building and that users, clients and designers may evaluate buildings differently. However, building design students are generally far removed from the feedback loops about real building performance. They rarely if ever implement their designs, and are generally separated from many practical concerns of the occupants and users, relying only on limited feedback from instructors; they are starved of real world understanding and knowledge. Students rarely analyze and evaluate real building performance. Sources of design inspiration are often journal articles usually written just after the building has been completed and before it is properly put to use. There is a lack of critical information about how well the featured buildings actually function and how satisfied occupants are with the environmental qualities. Medical students are expected to study actual human bodies and not merely learn through textbooks, yet in effect this is what we expect of Building design students - from architecture to engineering students.

Furthermore, education processes in construction reflect the split between professions with little integration and cross curricula activity, and little teaching of collaborative processes in which clients or users have a stake. Yet it is increasingly accepted that a holistic or integrated design process (IDP) is important to sustainable building (Pearl, 2004).

Post Occupancy Evaluation (POE) Benefit for Professionals

Fieldwork, and experience of assessing real building performance, from both a technical and social perspective, is one way of raising the profile of issues such as functional fit and clients/user satisfaction that may lay dormant in universities but which are important to occupants and users, and should be considered by designers. Improving understanding of how existing buildings affect occupants and meet, or fail to meet, user expectations can reduce future problems and capitalise on successful design features. Assessment of building in use offers the opportunity to bring some real world experience and knowledge to professionals who will be involved in building design, and allows them to learn from the experiences of others in real buildings. Such experiences should help the professionals to develop a better understanding of whether a building meets the aspirations of the client and how well it responds to users needs. Such skills will inevitably also improve student's employment possibilities when they complete their studies as they will have a better understanding of the way buildings interact with users. POE can be relevant to students in the building design team courses in several ways:

a. Student POEs

Carrying out POE assessments of buildings will bring students closer to the feedback loops that are provided by experiencing buildings first-hand. It can help develop an appreciation of the importance of the users and of considering the on-going lifecycle of a building. Students can focus on a range of issues such as occupant satisfaction of spaces or amenities and satisfaction of the building design by carrying out user surveys, and/or they can use measurement tools to assess the quality of the thermal, acoustic and lighting environment. The Agents of change program in North America is leading the way by training teams of architecture faculty and teaching assistants in building performance evaluation methods and expanding the knowledge base of field-based case studies (Kwok, *et al.* 2004). Such studies can be integrated into existing building science courses, or individual modules can be introduced which focus on a comprehensive POE of a building by a group of students. The Canadian Mortgage and Housing Corporation (CMHC) run a competition for students to carry out a technical appraisal of an existing building, where students are encouraged to collect extensive data about an existing building and carry out an appraisal of its performance. At present this is limited to technical issues but could be expanded to include operational and functional issues.

b. Change Over Time

Studying buildings in use should develop in the students an appreciation of how buildings change over time, and how they can design buildings that are more adaptable to future change to maximise longevity and usefulness of resources. History modules should include consideration of how buildings change and adapt over time, POE studies of established (as opposed to new) buildings can help students understand the problems of occupation of a building and how the users have to make the spaces work, or adapt them.

c. Lessons from Professional POEs

Professionally carried out POE (Such as the PROBE studies) offer many genetic lessons about how buildings are used that should not be integrated into the University curricula so that chronic problems are nor repeated in the future (Bordass*et al*, 1999). What is the point of research and innovation if the lessons are not fed back into the industry and to the students? Unfortunately, many POE studies are carried out by commercial organisations to improve their own effectiveness and are unwilling to share their results. The PROBE

(Post Occupancy Review of Building Engineering) studies in the UK stand apart in that they have provided generic lessons that architectural education should adopt for the benefit of future buildings and their occupants. In addition recent conferences such as closing the Loop in the UK, and the formation of the Usable buildings web site and trust have provided a forum for sharing generic results (Ure, and Hampton, 2004). Some of the generic lessons relevant for students include:

i. The importance of establishing ends and objectives for the design team to work to.
ii. A need for more strategic briefing and greater clarity of discussion, and assessment of options and solutions for usability, robustness and manageability.
iii. Regular review of designs against strategic objectives for the building and the needs of occupants.
iv. Keeping things simple and doing them well
v. Providing local user overrides for control systems where possible
vi. The importance of attention to detail
vii. Complex buildings may need the equivalent of "sea trials"
viii. Making sure that appropriate management systems are in place. Don't procure what you cannot manage.
ix. Addressing air leakage control.
x. Focusing on interfaces.
xi. Being wary of unnecessary complications.
xii. Improving collaboration and data sharing.
xiii. Making assessment of building performance and essential part of education (Ure, and Hampton, 2004).

d. Interdisciplinary Design

A feature of the complexity of modern buildings is that many fragmented design professions shape the environment, and it is often their concerns and priorities that are given precedence to those of the users, or of the society and community as a whole. The diversification in design, construction expertise and education has created a conventional building design and construction process with confrontational structures and barriers between areas of expertise, which is often underpinned by mistrust reducing the likelihood of effective team working. Addressing both the sustainability agenda and in particular issues of occupant satisfaction requires a more effective dialogue between all participants involved in the production of buildings, and with occupants (Pearl, 2004).

The integrated design process (IDP) is based on the well-proven observation that changes and improvements in the design process are relatively easy to make at the beginning of the process, but become increasingly difficult, expensive and even disruptive as the process unfolds. Student involvement in POEs (particularly if carried out by an interdisciplinary group) can help develop an understanding of the problems that other professions face. Contact with users and other designers can teach students the importance of communication; with clients, design team and potential users, and the need for collaborating with the design team at all stages (Pearl, 2004).

e. Briefing

One of the key findings of the PROBE studies is the need for more strategic briefing, greater clarity of discussion, and the assessment of the options for usability, robustness and manageability (Zimmerman and Martin, 2001). By increasing a professional's awareness of user needs and building functioning problems POE can develop in a professional an appreciation of the importance of the briefing stages of a project and allocation of responsibilities, so that it is clear who owns which problems, and what are the implications of design decisions. This can develop an appreciation of the importance of clear objectives which can be used to assess the design at various stages. This has been identified as a major contributing factor to later problems (Zimmerman and Martin, 2001).

f. Continuous Learning

The principle of looking back at designs to see how they are functioning instills a culture of respect for users of buildings, continuous

learning, and improvement which can be applied through a desire to learn from the buildings that professionals in the built environment work on once in practice, and to establish feedback loops that will inform their future designs. Professionals can learn from POEs that they need to be ready to learn from each project they undertake, from other professionals, and from users. In this way their buildings will benefit from the feedback loops available to them (Zimmerman and Martin, 2001 and Kwok, *et al.* 2004).

g. Building Management Strategies

Sustainable operation of buildings requires appropriate building management strategies based on an understanding of how the building is functioning, that will prepare the organisation to reduce environmental impact as opportunities arise. POEs can provide that understanding, and professional contact with such POEs can help them appreciate the importance of considering and discussing building management strategies during the design process (Egan, 2002).

Figure 2 illustrates the building life cycle as proposed by Ure and Hampton (2004). At each decision point there is an opportunity to reduce environmental impact, which usually reduces operating cost, and can often enhance value. A rigorous strategy will enable a continuous improvement process to be adopted that takes account of minor as well as major refurbishment and replacement.

METHODOLOGY

This study used an investigative methodology approach was adopted to collect data. Considering the set objectives as comfort, convenience and safety expected within the

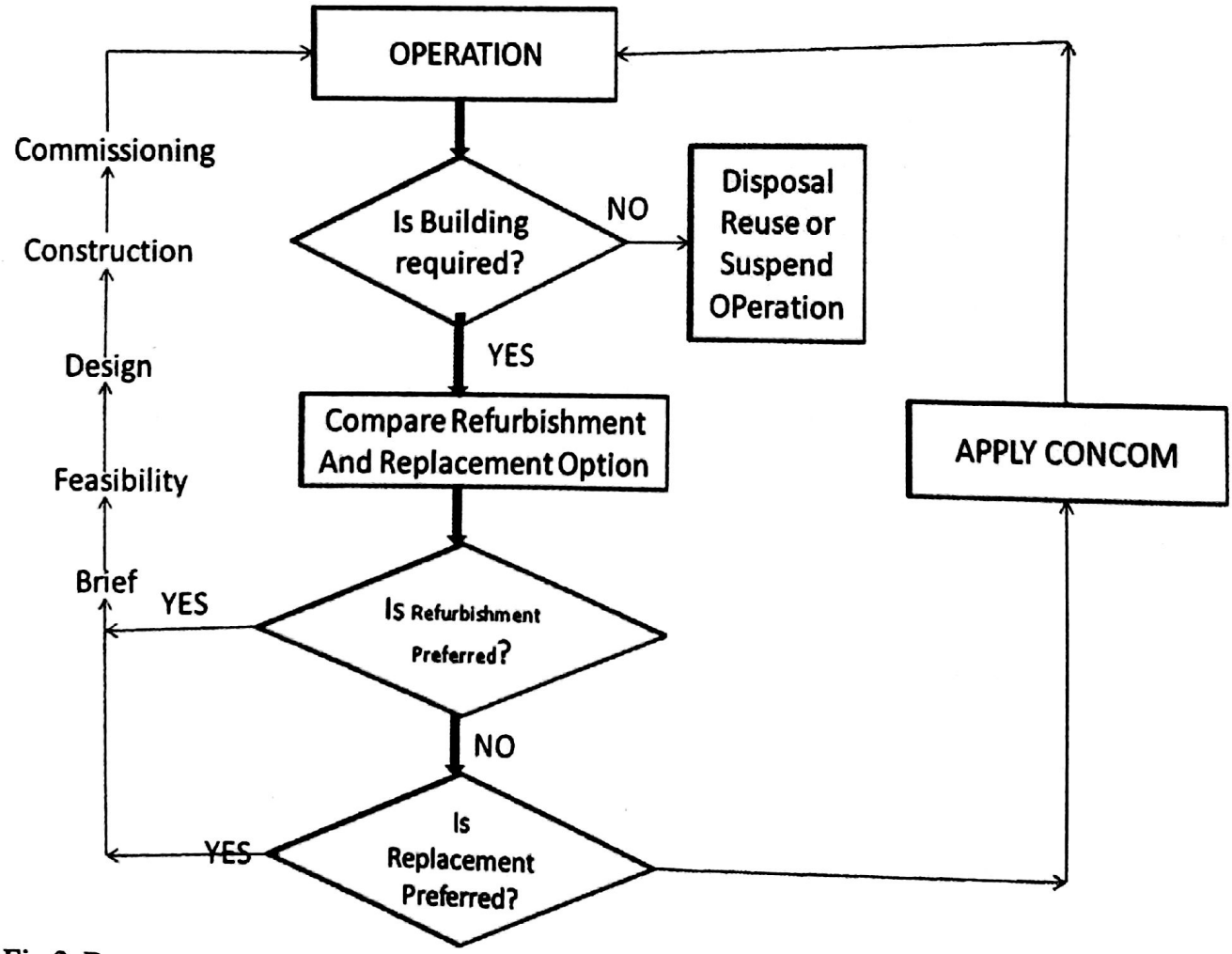

Fig.2: Proposed Building Lifecycle
Source: Ure and Hampton (2004)

School of Environmental Technology Building, measurements of the building services engineering provisions and determination of the comfort criteria under the processes of POE were conducted using portable handheld environmental sensing measuring devices, such as Lux for light intensity, sound meter for sound level and psychrometer for thermal comfort. Questionnaires were distributed to users of School of Environmental Technology Building to obtain data to ascertain the level of satisfaction of the occupants. The questionnaires were validated for reliability through pilot survey. One hundred and twenty questionnaires were distributed to staff and students who are the actual users of the building complex. A total of ninety-five completely filled questionnaires were retrieved and used for the analysis. The respondents were requested to indicate their opinions through a relative satisfactory rating for the listed facilities provided in the building. A five-point Likert scale (i.e. 5 = Very Satisfied to 1 = Very dissatisfied) was used.

RESULTS AND DISCUSSION

Respondents in the building were students and staff (academic and non-academic). Most of them interact with the building for five or six days per week, with eight-hour a day as the norm. Of those respondents surveyed, 55% were students and 45% staff. 19% were women aged under 30, 24% over 30. 32% were men aged less than 30 and 25% over 30. The findings were compared with BUS database of educational buildings. Users' perception is worst in the area of general cleanliness and maintenance of the facility. Cobwebs were noticed in classrooms and offices. Some luminaries have not been dusted for years and students have the attitude of littering the complex with paper and nylon bags. The washrooms were the second most dissatisfied facility. Students have no access to any of them within the complex; even the staff have no direct access as the keys are kept in a pool. The other problem of the washrooms is availability of water, especially at the upper floors. Fig. 3 shows that air quality was rated with highest satisfaction while the thermal comfort is in the dissatisfaction zone. This is so because most of the spaces are ventilated using windows. Maintenance requests are always not quickly attended to by the works department as a result of inadequate finances. The procedures of making maintenance requests are cumbersome. Maintenance requests can be eased via internet. This leads to decreased perceived productivity at work. The complex is not able to provide the quality of space and flexible working environment that standard lecturing and students' life requires.

CONCLUSION

Conducting a POE in an organisation like a university is beneficial by equipping it with valuable information that will help the university management or decision makers to assess the performance of the buildings. If the POE is applied correctly, the level of satisfaction for the occupants can easily be assessed. Having the POE in place will facilitate detection of the building's defects at an early stage, and remedial action can be implemented as early as possible. It is imperative to conduct the POE process, as it will enhance the development of design standards that will allow occupants to carry out their duties comfortably in their building. Benchmarking of the existing faculty or school of environmental building complex will be used as a point of departure to identify the current performance of the buildings in relation to other relevant best practices in the portfolio of higher institutional property. Having POE as part of the organisational knowledge base will assist in the development of future projects. If POE is applied strategically, it will help the organisation with regard to the building's performance and the utilisation of energy in a more productive way. If the POE is applied in a more holistic way, this will assist the directorate of works and maintenance of the university to fully analyse the organisational needs, perceptions of building users and the economic evaluation any productivity including energy audits Future projects or

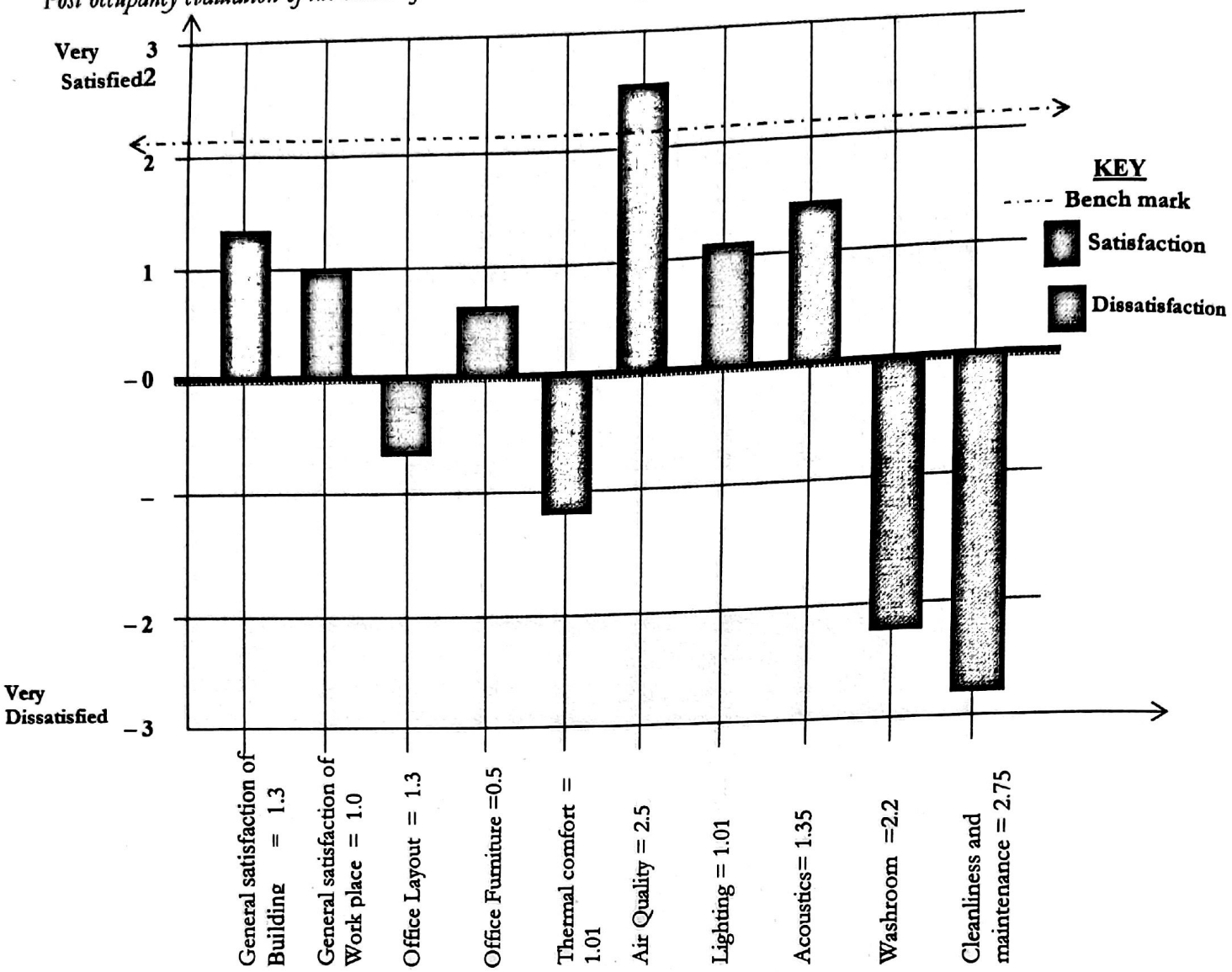

Fig 3: An Output from School of Environmental Technology Complex Building Occupant Satisfaction Survey Report

buildings will be designed to accommodate the issues of safety, comfort, cost-effectiveness and sustainability.

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