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Article · September 2017

DOI: 10.1016/j.foar.2017.06.004

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Frontiers of Architectural Research (2017) **6**, 412–429

Available online at www.sciencedirect.com

Frontiers of Architectural Research

http://www.keaipublishing.com/en/journals/frontiers-of-architectural-research/

RESEARCH ARTICLE

Performance assessment of buildings via post-occupancy evaluation: A case study of the building of the architecture and software engineering departments in Salahaddin University-Erbil, Iraq

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Received 6 December 2016; received in revised form 19 May 2017; accepted 27 June 2017

KEYWORDS
Post occupancy evaluation;
University buildings;
Building performance;
User satisfaction;
Correlation;
Erbil city

Abstract
Buildings are established to meet the needs and desires of users. The purpose of a building is defeated if its users are not satisfied by the overall building performance. This study determines whether the users of the building of the architectural and software engineering departments at Salahaddin University-Erbil are satisfied with overall performance attributes. Assessment using users as a benchmark shows that the potential for improving the performance of a building is tremendous. This paper develops a post-occupancy evaluation (POE) framework that integrates building performance attributes for university buildings and facilities in the Iraqi Kurdistan region based on users' satisfaction. The objectives were to identify the concept of POE in relation to building performance, to determine the performance level of an existing building, and to determine correlation between building performance and users' satisfaction level. Results showed that 88% of building performance attributes is highly correlated with users' satisfaction. The compelling correlational results confirmed the relevance of POE as a building performance tool. The thrust of the findings indicates that the indicators and variables used in assessing the level of building performance are significant in determining levels of users' satisfaction in university buildings and facilities.

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Peer review under responsibility of Southeast University.

http://dx.doi.org/10.1016/j.foar.2017.06.004

1. Introduction

Educational buildings, facilities, and their environment must be accorded with the highest premium for effective functioning and productivity (Olatunji, 2013). A completed and designed building should be able to perform its functions in the manner that will ensure satisfaction for its occupants, and ensure effective function at all times (Nawawi and Khalil, 2008). Architects seldom receive useful feedback about the performance of completed buildings, except from satisfied or dissatisfied clients or users. Evaluation by the actual users of a building is therefore important for improving design quality (Ilesanmi, 2010). University buildings need an evidence-based plan to fix their issues permanently in the form of revised design standards and oversight processes. Universities can learn from their past to improve their building's functionality and efficiency in the future (Tookaloo and Smith, 2015).

Specialized work and literature about performance evaluation and appraisals of university buildings in relation to their various architectural aspects are lacking. Leaman (2004) reported that the reason is because academic disciplines do not regard building performance as an area of legitimate interest. Many gaps have yet to be bridged. The provision of continuous and specific information that is derived from rigorous evaluative works and empirical evidence to architects and other professionals that are mainly concerned with the design of this type of buildings are either unreliable or non-existent. Reliable statistical data as well as documented university briefs and plans are either non-existent or inaccessible to architects. University buildings are highly dynamic institutions. Furthermore, studies that surround this subject indicated that university buildings and facilities are most prone to change as well as the most expensive to provide, enhance, renovate, and run (Krada et al., 2014).

The College of Engineering at the University of Salahaddin-Erbil (SUE), in the Iraqi Kurdistan region was established more than four decades ago. It consists of multiple scientific departments, administrative buildings, and facilities. After its occupation, it underwent problems and deficiencies related to functional and environmental aspects. This requires in-depth research and studies to diagnose such problems and defects. Among the research trends related to this issue is the post-occupancy evaluation (POE) approach for having a distinct mechanism in finding solutions to the buildings in use, in addition to offering possible alternatives that may enrich the design process feedback. These approaches are in line with the needs and desires of the occupants to avoid recurrence in subsequent designs of buildings and facilities in the future.

POE is one of the best practical ways to find and realize obstacles and errors. It is different from other evaluation methods in that it emphasizes the needs and values of building occupants (Preiser and Vischer, 2005). The potential of such an approach of studies extends beyond the benefits for improvement to a specific building under investigation. It probes outcomes and makes recommendations that open opportunities to enable transfer of knowledge in future projects (Lackney, 2001; Zimring, 2002; Aye et al., 2004; Mastor and Ibrahim, 2010). In short, the building facilities and services must fit the purpose of the users. POE is the evaluation of the performance of buildings after they have been occupied. In addition, POE provides a mechanism for understanding the mutual interaction process between buildings and users' needs and for recommending ways of improving the environment necessary to accommodate these needs (Nawawi and Khalil, 2008).

In this paper, we aim to show that POE is a tool for facility managers, architects, designers, and decision makers to identify and evaluate the behavior of a building. POE can then provide design guidance for future facilities. With the help of POE, facilities can have better space utilization and save time and money in operation and upkeep costs (Preiser, 1995). One of the purposes of POE in higher education is to determine whether the building meets the goals and visions of the university. POE is the collection and review of user satisfaction, space utilization, and resource consumption of a completed constructed facility after occupation to identify key occupant and building performance issues. POE can also be used to analyze trends over time, as well as to identify ways in which to improve on-going processes and outcomes. Implementing POE process increases accountability for facilities managers, standardizes best practices, and helps the university to understand opportunities for future project improvements (Tookaloo and Smith, 2015).

Increasing the efficiency performance, quality, and level of productivity of university buildings and facilities is a pressing need of the construction industry in the Kurdistan region, Iraq. The main purpose of the study is to evaluate the condition of an existing university building and its facilities at Salahaddin university-Erbil, Iraqi Kurdistan region, by using POE as a tool in examining the relationship between users' satisfaction and building performance to improve future development that meets users' requirements. Many previous research studies have shown significant outcomes in optimizing the performance of buildings by applying POE as a viable research tool. The present study provides a clear depiction on how certain quality and performance elements and attributes of the educational environment contribute to creating conditions that are consistent with users' satisfaction.

1.1. Problem formulation

The public buildings in the Iraqi Kurdistan region, including university buildings, occupy a special position compared to the remainder of the sectors. Despite the paramount importance of the ongoing process of management and maintenance of these buildings and facilities, no systematic and organized mechanism is present to do this. Many complaints from users of these buildings are related to defects and shortcomings after occupation, such as the performance and functional efficiency, accessibility, distribution and configuration of spaces, ventilation and day-lighting, thermal comfort, productivity, security, and safety, among others, require accurate and considered treatment. Post occupancy evaluation can be adopted as a manifold tool in solving problems of buildings and facilities management, because it provides the ability to evaluate the performance of buildings and facilities systematically. In addition, POE can also be applied as an efficient and systematic method to gather data and information on a specific building, but unfortunately, it has not yet been undertaken for governmental and public buildings in the region.

Among the benefits that can result from POE is the identification of successful design features that can be scrutinized recurrently. These include identification of problems to mitigate or reduce buildings and facilities defects, improvement of building performance and environment, identification of redundant and unnecessary building features, and empowerment of users to negotiate building issue and reduce maintenance work and cost (Leaman and Bordass, 2001 Vischer, 2002; Watson, 2003; Hewitt et al., 2005). Over the last four decades, many POEs have been conducted on a variety of building types and facilities. Some solutions included increasing the participation of the organization being studied and presenting the best results and better targeting of information to appropriate decision makers (Preiser et al., 1988; Zimring, 1988; Nawawi and Khalil, 2008; Preiser and Nasar, 2008). Preiser (1995) stated that, historically, building performance was evaluated in an informal manner, and the lessons learned were applied in the next building cycle of a similar facility type. Given the relatively slow change in the evolution of building types in the past, knowledge about their performance was passed on from generation to generation of building specialists. Therefore, building performance criteria are an expression and translation of client goals and objectives, functions and activities, and the environmental conditions that are required (Preiser, 1995; Nawawi and Khalil, 2008).

Locally, little realistic evidence is present to ascertain the key problems and the specific factors of "inadequacy" or "non-satisfaction" in existing university buildings and facilities. The result of this study will provide a database for the construction industry about buildings in use and abilities to determine how well a new concept of POE works for the government and public buildings, as well as contribute in improving buildings and building delivery processes. POE has become an important tool for the improvement of building design and operations to solve misinterpretations and fill the gaps that are often found between client and design expectations for a specific performance level (Deuble and De Dear, 2012). The process of POE is relative to the integration of people's (users) requirement and their workplace. Hence, POE is described as the best application strategy that must be adopted in evaluating the performance of government and public buildings in general and university buildings in the Kurdistan region, Iraq, that has not been applied so far.

The existing studies rarely associated users' satisfaction with the performance of university buildings in public and government projects in the Kurdistan region, Iraq. Hence, this study is an attempt to bridge this gap in research. Buildings are established to satisfy, provide, and meet users' needs and desires. The purpose of a university building is diminished if its users are not satisfied in terms of overall building performance. This study is set to determine if users of the building of the architectural and software engineering departments at Salahaddin University-Erbil (SUE) are satisfied with the overall performance that is offered by the building. In principle, this study contributes to knowledge in the field of evaluating the performance level of university buildings and facilities in terms of POE and user satisfaction.

1.2. Research aim and objectives

Based on the research problem, this research seeks to develop a Post Occupancy Evaluation framework that integrates building performance attributes for university buildings and facilities in the Iraqi Kurdistan region based on users' satisfaction. Watson (2003) defined POE as a systematic evaluation of opinions about buildings in use, from the perspective of users. Eliciting the perceptions of the users and correlating them with the performance level of the building as determined by POE is essential. In accordance with the research aim, the objectives of this study were as follows:

i. To identify the concept of Post Occupancy Evaluation in relation to the building performance;
ii. To determine the performance level of an existing university building in use;
iii. To determine the relative levels of users' satisfaction in terms of design quality, indoor environmental quality, and building support services.
iv. To determine the correlation between the level of building performance attributes and the users' satisfaction level.

2. Literature review

The terms *building appraisal*, *building evaluation, building diagnosis, POE*, and *buildings in use* describe studies that focus on completed building projects (Ilesanmi, 2010). Preiser and Schramm (1998) attempted to widen the scope in the direction of building performance evaluation, to integrate user and aesthetic factors with technical and economic factors. Watt (2007) uses the term "Building pathology" to describe that aspect of building appraisal that is concerned principally with defects and associated remedial action. Although Duffy (2008) suggests the existence of a terminological dilemma, these concepts aim to find how the completed building performs; determining possible misfits, mistakes, or omissions; and accumulating information for future programming and design efforts. However, Preiser and Vischer (2004) consider POE the most commonly used term for the activity of evaluating buildings in-use. POE is about procedures for determining whether design decisions made by the architect are delivering the performance needed by those who use the building.

By using occupants as a benchmark in evaluation, POE provides enormous potential for improving the performance of a building. POE evolved to fill the gap in the conventional building process, which consists of planning, programming, design, construction, and occupancy of a building. It represents the vital diagnostic step that is needed to feed the prescriptive tools of planning and programming (Van der Voordt and Van Wegen, 2005). POE is a systematic manner of evaluating buildings after they have been built and occupied for a duration of time (Preiser, 1995, 2002). The gap between the actual performance of buildings and explicitly stated performance criteria constitute the evaluation (Preiser et al., 1988).

One of the applications of POE is the comparison between the use that the designer intended for an environment and that to which its users put it. The merits of POE are diverse. First, it ensures the sustenance of building performance, particularly of public buildings and facilities. In this context, Vischer (2002) suggests that POE is used in determining building defects, formulating design and construction criteria, supporting performance measures for asset and facility management, lowering facility life cycle costs by identifying design errors that could lead to increased maintenance and operating costs, and clarifying design objectives. Second, POE provides a mechanism for understanding the mutual interaction between buildings and users' aspirations and for proposing ways of improving the environment necessary to accommodate these aspirations (Vischer, 2002; Ilesanmi, 2010).

Although informal and subjective evaluations of the environment have been conducted throughout history, systematic evaluations that use explicitly stated performance criteria with which performance measures of buildings are compared, is of more recent origin. POE evolved from the architectural programming techniques of the late 1950s and early 1960s. Early significant evaluative efforts were in response to severe problems faced in institutions such as mental hospitals and prisons, some of which were attributable to the built environment (Ilesanmi, 2010). The 1960s saw the growth of research that focused on the relationship between human behavior and building design, thereby leading to the creation of the new field of environmental design research. The 1970s witnessed a significant increase in the scope, number, complexity and magnitude of evaluation studies and publications. The decade was marked by developments such as the use of multiple buildings for data collection and comparative analysis; the use of multi-method approaches to building evaluation; the investigation of a comprehensive set of environmental factors, not as isolated variables, but to access their relative importance to the users of the facilities; and the addition of technical and functional factors to the scope of evaluation studies, compared with the earlier emphasis on strictly behavioral research. The final decades of the century were the era of applied evaluation in which POEs became routinely used (Preiser, 2002).

Architecturally, evaluation research falls into three environmental dimensions: the physical, the social, and the socio-physical environments. In all cases, the assumption is that users judge the adequacy of their environments based on predefined standards of quality. Some studies evaluate cognitive responses to the physical environment and focus on issues such as the perceived quality of buildings and environmental quality (Cold, 1993; Kane et al., 2000; Fornara et al., 2006; Nwankwo et al., 2014). Van der Voordt and Van Wegen (2005) described quality as the extent to which a product fulfills the requirements set for it; and "architectonic quality" as an umbrella term that covers various aspects of quality such as aesthetic, functional (building efficiency), symbolic, and cultural value. Other studies attend to the evaluation of the quality of the built environment in terms of effective responses, using user assessment of the environments (Al-Momani, 2003).

Satisfaction, attitudes, and preferences are three types of criterion that are normally used. Although these effective responses are not mutually exclusive, satisfaction as an effective criterion has been more widely investigated (Lawrence, 1987; Amaratunga and Baldry, 2000; Parker and Mathews, 2001; Varady, 2004; Hanif et al., 2010; Jiboye, 2012; Nwankwo, 2013; Olatunji, 2013; Nwankwo et al., 2014; Mohammadpour et al., 2015; Sanni-Anibire and Hassanain, 2016). Three levels of effort in typical POE work have been identified, namely: (1) indicative, (2) investigative and (3) diagnostic. "Effort" refers to the amount of time, resources, and personnel; the depth and breadth of investigation; and the implicit cost that is involved in conducting a POE. Indicative POEs provide an indication of major strengths and weaknesses of a particular building's performance. Investigative POEs are more in-depth, whereby objective evaluation criteria are explicitly stated. Diagnostic POEs require considerable effort and expense and utilize sophisticated measurement techniques (Preiser and Vischer, 2004) because POE is the process of obtaining feedback on a building's performance in use. The value of POE is being increasingly recognized, and it is becoming mandatory in many public projects. POE is valuable in all construction sectors, especially healthcare, education, offices, commercial, and housing, in which poor building performance will affect running costs, occupant well-being and business efficiency (Lawrence, 2013).

The most important benefit of POE, however, is continuous improvement of quality and performance of facilities. This is particularly beneficial in projects with reoccurring construction programs or in which a significant number of facilities are typical (Preiser, 1995), such as a university campus. This review of literature confirms the relevance of POE in university building evaluation. Thus, research and studies adopting this trend has continued and increasingly developed. Many institutions, governmental authorities, agencies, research centers, forums, and scientific conferences have been devoted to and responded to the data and outcomes of this distinctive research approach because of its direct effect and relation to the sector of construction industry and building performance. However, despite the large number of research in the context of building performance, POE as a systematic method of collecting data on buildings in use has not found wide usage for university buildings and facilities in the Iraqi Kurdistan region, hence the need for this study.

2.1. Building performance evaluation in educational institutions

Buildings are paramount to the day-to-day running of human activities. It is of importance to all organizations. In the present trends of high operating costs, increasing competition and rising user expectations, educational institutions, particularly universities, must seek to maximize their return on building investments. Building performance evaluation facilitates the realization of this objective (Amaratunga and Baldry, 2000; Olatunji, 2013). According to Douglas (1996), Amaratunga and Baldry (2000) and Sanoff (2003), buildings represent a substantial percentage of most educational institutions assets, operating costs, and user requirements. Their performance level is therefore very critical to educational effectiveness. Educational buildings are designed and built to meet specific or groups of human needs that are already determined before construction. Educational buildings constitute the structural enclosure that enables academic activities to run effectively. Mayaki (2005) states that the ability of the building to successfully accomplish the purpose for which it is designed measures its success. In this context, educational buildings are designed to facilitate learning process, i.e., knowledge transfer, promotion, and management (Okolie, 2011).

Sanoff (2003) maintains that the design of modern educational building strongly emphasizes stimulating and adaptable learning environments with spaces that support various styles of teaching and learning. Then, educational building design should be adaptive and flexible to accommodate required functional change within the building envelope and its environs. Okolie (2011) clarifies that building performance evaluation helps to ascertain if organizations are managing existing building stock responsibly. By understanding how existing buildings affect occupants, designers can minimize problems and capitalize on successful design features that improve system performance. Different researchers have suggested and developed models/methodologies that are focused on building performance of educational facilities. These studies include Preiser et al. (1988), Cash (1993), Kaplan and Norton (1996), Sanoff (2001), Kathsrine and Svein (2004), Zimring et al. (2005) and Alexander (2008). Their methodologies involved data collection tools such as questionnaires, walkthroughs, focus group discussions, interviews, and observations.

2.2. User satisfaction as a benchmark in building performance evaluation

The factor of the user and occupant is crucial in the whole evaluation process. Building performance is not limited to energy conservation, life cycle costing, and the functionality of buildings. It also needs to focus (and already does) on users' perspectives on buildings (Mamalougka, 2013). The relationship between building and user should be investigated. Problems and their sources must be identified and factors that influence the level of satisfaction should be determined. The most important factor, as a benchmark of a building's success in meeting the design objectives, is the level of user satisfaction (Wilkinson et al., 2011). Satisfaction studies cut across a wide range of disciplines in the management and social sciences as well as the built environment (Ibem et al., 2013).

In general, satisfaction is a subjective evaluation of the performance of products or services in meeting the needs and expectations of users or customers (Parker and Mathews, 2001; Ueltschy et al., 2007; Hanif et al., 2010). It compares the benefits or values that users or customers derive to that expected when a product or service is consumed. In sum, satisfaction is a measure of the difference between the actual and expected performance of products or services in meeting users' needs and expectations from the users' or consumers' perspectives during or after a consumption experience. In fact, based on the expectancy-disconfirmation theory, from which most studies on satisfaction draw, if the performance of a product or service meets users' or customers' needs and expectations, the user or customer is said to be satisfied with the product and/or service, and vice versa (Oliver, 1981; Parker and Mathews, 2001).

Buildings, like any other products, are designed and constructed following many expectations by clients, professionals, users, and the community. To clients, buildings require huge capital investment and are expected to bring returns on investment, whereas to professionals (e.g., architects, builders, and engineers) buildings are products of their creativity and imaginative thinking. On the part of users and the community, one crucial expectation is that buildings will meet their needs and aspirations by supporting their daily activities (Preiser, 1999; Davara et al., 2006) and ultimately improve the aesthetic quality of the built environment. To this end, Van der Voordt and Maarleveld (2006) noted that building performance evaluation (BPE) assesses the architectural, functional, technical, and economic value of buildings (product evaluation) or building procurement process (process evaluation).

By identifying the major weaknesses and strengths of buildings from the end user's perspective (Preiser, 1999; Khalil and Nawani, 2008), BPE contributes to improving the quality of buildings and building projects delivery process (Preiser, 1995; Kim et al., 2005). In addition, PBE also provides feedbacks on causes and effects of environmental issues that are related to buildings, thereby informing planning and management throughout the building's life cycle (Meir et al., 2009) and culminating in the production of sustainable built environment (Zimring, 1988). In short, BPE is important in understanding the actual performance of buildings in meeting the various expectations of the different stakeholders as compared to predicted performance, and the efficiency of building procurement process. Accordingly, BPE can be used in assessing different aspects of buildings and building procurement process, and the findings can serve different purposes. Evidently, BPE may be intended for the formulation and implementation of government policies, or the development of new theories or research tools or the dissemination of information on the performance of building spaces and fabrics to professionals, contractors, and material manufacturers in the building industry as well as to the public (Ibem et al., 2013).

The literature indicates that in the last few decades, much progress has been made in developing different BPE tools and approaches. The main categories of approaches to BPE, include those approaches that focus on the (i) functional suitability of buildings that is space utilization, physical condition, safety and statutory requirements; (ii) quality assessment of buildings; (iii) serviceability of buildings with respect to occupants' needs and facilities provided; (iv) environmental performance in terms of indoor environmental quality, air quality, intrusion, control, appearance and lighting; (v) energy consumption and indoor air quality; (vi) user satisfaction with the design and construction of and services in building; (vii) post occupancy evaluation (POE) of technical, functional and behavioral aspect of buildings. A wide range of tools have also been developed for each of these approaches (O'Sullivan et al., 2004; Kim et al., 2005; Khair et al., 2012).

In the last few decades, much research work has also been used for the development of building performance indicators (BPIs). Hasselaar (2003) noted that an indicator is a sign that points to a condition to be measured, to evaluate specific qualities and performances. In the context of building, Preiser (1999) held the view that BPIs should be derived from values held by individuals, groups, organizations, or the entire society who are stakeholders in the building industry, thereby indicating that the criteria for measuring the performance of buildings should be derived from how people see their buildings and the importance that they attach to them. Similarly, Fatoye and Odusami (2009) proposed that at the inception of building occupation, users hold various expectations on the performance of their building, in terms of the benefits that it will provide and the needs it should meet. The implication of the former is that a building may be perceived by the same people differently at different times, or differently by different people at same time, and that the expectations of building users and the community are diverse and vary among individuals and groups (Ibem et al., 2013).

To capture the feelings and expectations of all categories of users while evaluating the performance of buildings, Kian et al. (2001) and Kim et al. (2005) on one hand suggested the adoption of six BPIs, namely; spatial (functional) comfort, indoor air quality, visual comfort, thermal comfort, acoustic comfort, and building integrity (structural and material performance). On the other hand, Meir et al. (2009) argued that because BPE is based on the concept of building-users' experience, BPIs should be based on parameters that are related to thermal comfort such as heating, ventilation and air-conditioning; illumination and visual comfort; users' satisfaction and behavior; as well as physiological and psychological comfort of users.

In the light of the above, certain inferences can be made. First, BPE can follow different approaches and diverse tools and indicators can be used. Second, the expectations of users and the community with respect to buildings are diverse and can be measured in terms of performance indicators. Finally, the different approaches to BPE, tools and indicators used contribute to policy, practice and research when they focus on issues that are related to users' satisfaction and the sustainability of buildings and the surrounding physical and socio-economic environment (Ibem et al., 2013). Different tools for BPE are identified in the literature. Existing studies (e.g., Kian et al., 2001; Nawawi and Khalil, 2008; Ilesanmi, 2010; Jiboye, 2012) have shown that user satisfaction surveys have become a highly valuable tool in assessing the technical performance of buildings and understanding human attitudes, needs, and expectations towards buildings in use. In the same context, Zagreus et al. (2004) indicated that the views of building users are important in investigating the performance of buildings in meeting occupants' needs and expectations. Gupta and Chandiwala (2010) added that the evaluation of performance of built environment has traditionally been based either on physical monitoring or user satisfaction surveys principally because users give their views and/or feelings about buildings-in-use based on their experience and interactions with buildings (Vischer, 2008) as compared to the views of professionals who design and construct buildings and never use them (Preiser, 1995; Nawawi and Khalil, 2008; Khalil and Nawawi, 2008; Chohan et al., 2010). Nawawi and Khalil (2008) have established that occupants' satisfaction highly correlates with the performance of public buildings, thereby indicating that user' satisfaction has a direct relationship with the overall performance of buildings in meeting the needs and expectations of the users. The existing studies rarely associated users' satisfaction with the performance of university buildings and its facilities at least in the Iraq and Iraqi Kurdistan region. Hence, this study is an attempt to bridge this gap in research.

3. POE categories based on building performance elements

The focus of a POE can be considered in terms of three broad categories of performance elements. These categories include the technical performance elements, functional performance elements, and behavioral performance elements (Preiser et al., 1988; Blyth et al., 2006). These performance elements consist of performance indicators that represent signs, markers, attributes, and items that evaluate specific qualities of an element to be measured. Performance indicators change based on the evaluation purpose and the case study at hand (Kim et al., 2005; Sanni-Anibire et al., 2016).

3.1. Functional performance elements

Functional performance deals addresses the functionality and efficiency level of the features in university buildings and facilities. Functional elements include accessibility, spatial capacity for activities, and adequacy of necessary facilities. Other elements include utilities, telecommunications, responsiveness to change over time, and efficiency of communication and circulation. These elements are directly connected to the activities within a building. They are required to be in conformity to the specific needs of the occupants (Preiser et al., 1988). This direct connection between a building's functional aspects and the needs of its users is probably the reason for its receipt of noteworthy attention in POE studies (Sanni-Anibire et al., 2016).

3.2. Technical performance elements

Technical performance elements deal with survival attributes, such as structure, sanitation, fire safety, and security (security: the degree of resistance to, or protection from, harm; fire safety: fire resistance of the major structural elements of a building, fire extinguishment and containment, flame spread, smoke generation, the toxicity of burning materials, and the ease of egress in case of a fire), ventilation, and health (Preiser et al., 1988). From an environmental perspective, technical performance addresses the issues of indoor environmental quality (IEQ), which affect the comfort, health, and productivity of occupants (Choi et al., 2012). IEQ elements include thermal comfort (HVAC system and natural ventilation system), indoor air quality, visual comfort (the quantity and quality of lighting, glare, control of shadows, luminance, and adequate luminance) (Hwang and Kim 2011), and acoustical comfort (acoustic comfort relates primarily to providing conditions in a building that facilitate clear communication of speech between its occupants). Noise control can be provided through walls, floors, windows, and doors that provide adequate reduction of sound from adjacent activities (Hassanain, 2008; Sanni-Anibire and Hassanain, 2016).

3.3. Behavioral performance elements

Behavioral performance elements create a link between occupants' activities and the physical environment. Typical behavioral performance issues include the effect of area size and number of persons that share it upon a building's occupant, and the effect of functional distance between spaces upon the frequency of use. Moreover, occupants' comfort is also affected by the configuration of circulation routes on social interaction, and the features that affect the building's image and outlook (Preiser et al., 1988; Sanni-Anibire et al., 2016).

4. POE performance indicators

4.1. Design quality - DQ

This includes the quality of all architectural attributes of the building such as the design and configuration of space, building location relative to other facilities in the campus, landscape architecture, and general aesthetic appearance (Preiser et al., 1988; Sanni-Anibire and Hassanain, 2016).

4.1.1. Building layout

The layout of space, furniture, and storage and the convenient circulation and accessibility to various usable spaces within a building are of utmost importance to residential satisfaction. Spatial attributes, the sequence, location, relationships, shape, size, and detail of spaces have been shown to affect occupant behavior (Preiser et al., 1988). The interior layout of the building should be efficient in terms of the arrangement of rooms in each level in the building, the width of the corridors for circulation, and the location and number of stairs (Hassanain, 2008; Sanni-Anibire and Hassanain, 2016).

4.1.2. Interior and exterior appearance

Appearance is one of the most important aspects of building performance. It pertains to the aesthetic perception of the building by the occupants (Preiser et al., 1988). Common problems that affect exterior walls are color fading, moisture and wind infiltration, spalling, buckling, delamination, cracking, cleanability, and erosion. The quality of construction and selection of building materials should be compatible with, and complement, the existing physical environment (Hassanain, 2008; Sanni-Anibire and Hassanain, 2016).

4.1.3. Access to facilities on campus - accessibility

This refers to the building's closeness to the facilities on the campus, usually within a walkable distance to teaching, recreational, food-consuming, and car parking facilities. These facilities include sports facilities, parking lots, campus shuttle stations, worship centers, grocery stores, food courts, medical centers, libraries, and academic buildings (Hassanain, 2008). The location of a building and its proximity to places of interest are major factors in the satisfaction of its occupants (Hassanain, 2008; Fatoye and Odusami, 2009; Sanni-Anibire and Hassanain, 2016).

4.2. Indoor environmental quality (IEQ)

IEQ of a building is a primary concern at present because it influences the health, well-being, and productivity level of its occupants (Fisk, 2001). IEQ consists of thermal comfort, indoor air quality (IAQ), acoustic comfort, and visual comfort (Sanni-Anibire and Hassanain, 2016).

4.2.1. Thermal comfort

ASHRAE 55 (2004) defines thermal comfort as “the state of mind that expresses satisfaction with the surrounding thermal environment.” The major influencers of thermal comfort in an indoor space are the HVAC system and natural ventilation system through windows and other openings. Thus, comfort will be determined by the ability to control both systems (Sanni-Anibire et al., 2016; Sanni-Anibire and Hassanain, 2016).

4.2.2. Indoor air quality

IAQ is the quality of air within a facility or the built-environment. Anderson et al. (2014) define IAQ as “the comfortable range of the temperature, humidity, ventilation and chemical or biological contaminants of the air inside a building.” The major concern is indoor air pollution, which can be the cause of asthma, allergies, and irritation. Two of the most dreaded implications of poor IAQ are sick building syndrome (SBS) and building-related illnesses (BRI) (Sanni-Anibire et al., 2016; Sanni-Anibire and Hassanain, 2016).

4.2.3. Acoustic comfort

“Acoustic criteria cover the ambient level of sound, the transmission of sound between areas and rooms, reverberation, and specific areas such as machine noise and auditorium acoustics” (Preiser et al., 1988). Indoor and outdoor factors influence acoustical comfort. Although indoor factors can be controlled, outdoor factors are the primary causes of discomfort, and its control depends on the filtering level of the building envelope (Sanni-Anibire et al., 2016; Sanni-Anibire and Hassanain, 2016).

4.2.4. Visual comfort

The Illuminating Engineering Society of North America (IESNA, 2000) defines visual comfort as “an essential human need that can affect task performance, health and safety, and mood and atmosphere.” The design of buildings and facilities creates balance between artificial and daylighting, whereby sufficient natural light is allowed through transparent parts of the building envelope (Hassanain, 2008; Sanni-Anibire and Hassanain, 2016).

4.2.5. Security and fire safety

Security is defined as “the degree of resistance to, or protection from, harm. It applies to any vulnerable and valuable asset, such as a person, dwelling, community, nation, or organization” (Garcia, 2007). Fire safety is one of the earliest elements to be evaluated systematically, likely because of enormous concerns for life and property. Relevant criteria include the fire resistance of the major structural elements of a building, fire extinguishment and containment, flame spread, smoke generation, the toxicity of burning materials, and the ease of egress in case of a fire (Preiser et al., 1988). Security and fire safety are usually treated together as one technical performance element because of their role in the protection of life and the property from disastrous events (Sanni-Anibire et al., 2016).

4.3. Quality of building support services - QBSS (serviceability)

Building services and infrastructures are an integral part of the built environment and a major influence on educational satisfaction and quality of life of occupants. They include water supply, washrooms and water closets, laundry, information technology, and electrical services (Ibem, 2011; Hassanain, 2008). These facilities should be properly designed, installed, maintained, and managed. Services, such as electricity supply and warm water, must be adequate for the level of use. The availability and adequacy of these facilities coupled with the issues of the cleanliness of washroom facilities are of utmost concern (Hassanain, 2008; Sanni-Anibire and Hassanain, 2016).

5. Methodology

The following methodological steps are formulated to achieve the research objectives and solve the research problem.

5.1. Building description (the case study)

The Architecture and Software Engineering Department building at the College of Engineering, SUE is selected as a case study. This building was designed by the author within a design team. It was established in 2004. The total internal floor area of the building is approximately 2675.2 m^2. The building is two stories in height, a cruciform in shape, and contains more than 10 studios, library, cafeteria, administration rooms, staff rooms, laboratories and workshops, and lecture and seminar halls. Six washrooms and three stairwells are available on each floor. The modular dimension of the building is 7.2 m $\times$ 7.2 m. Figure 1 provides a typical floor plan of the building. Similar buildings and facilities are currently being constructed. Hence, a POE conducted on the presently occupied building and facilities provides a feedback for continuous improvement.

5.2. POE approaches

As mentioned in the literature, three levels of effort, namely, indicative, investigative and diagnostic approaches, are used in POE (Preiser et al., 1988). The selection of any of these approaches depends on the level of information required and resources available. This selection also influences the data collection techniques that will be used simultaneously (Turpin-Brooks and Viccars, 2006). The different data collection techniques include walkthroughs,

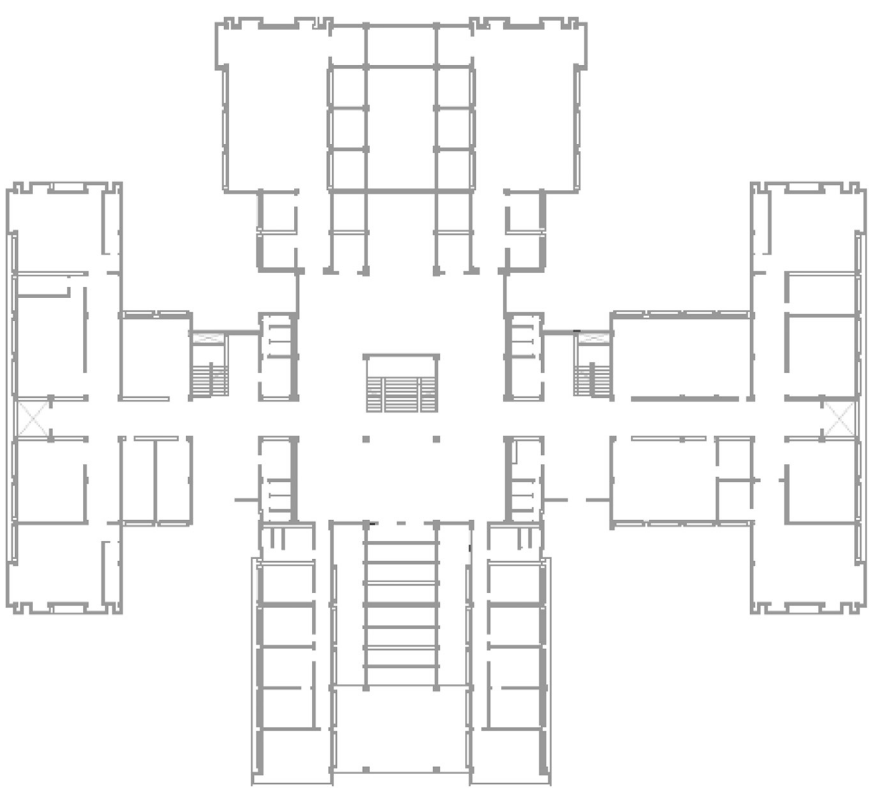

Figure 1 Typical ground floor plan of the building of the Architecture and Software Engineering Departments at SUE.

questionnaire surveys, focus group meetings, and physical measurements (Bordass and Leaman, 2005; Eley, 2001; Watson, 1996, 2003). This study uses an investigative approach through the questionnaire survey to collect data.

5.2.1. Questionnaire surveys

Questionnaire surveys are recognized as a key component of any building performance evaluation study (Nooraei et al., 2013). A survey communicates the effectiveness of building systems between the users and the management team of the facilities when used appropriately (Jiboye, 2012). Industry-available and customized questionnaires can be used (Blyth et al., 2006). In developing customized questionnaires, an array of performance indicators is developed to address various performance attributes and elements contributing to the overall performance satisfaction.

Questionnaires in POE studies are the most important part of any building evaluation study, because buildings that do not satisfy the requirements of their users cannot be judged to perform well, even if their physical measurements are found to be satisfactory (Sanni-Anibire and Hassanain, 2016). Therefore, assessing user satisfaction in building evaluations is fundamentally proactive in measuring performance and acting upon the information gathered. Owing to POE studies that emphasize the importance of feedback from the users, users' satisfaction is measured to improve the increasing issues in the said building (Eley, 2001; Watson, 1996, 2003; Husin et al., 2015).

Accordingly, the questionnaire survey was used due to the nature of the current study, which was developed based on an existing case study. Bordass and Leaman emphasized that a major technique or tool when undertaking case studies depends on using user satisfaction/occupant survey (Bordass and Leaman, 2005; Krada et al., 2014). The performance attributes and elements highlighted in the survey questionnaire were presented in the form of questions. The questions were short and simple for the users to easily understand the purpose of the survey.

A pilot survey was conducted on 10 senior students (5th year) from the Department of Architecture to ensure the clarity and inclusiveness of the questionnaire. The questionnaire was designed using a five-point Likert scale, where 5 represents strongly satisfied (SS), 4 represents satisfied (S), 3 represents moderately satisfied (MS), 2 represents dissatisfied (D) and 1 represents strongly dissatisfied (SD). The selected building accommodates approximately 500 users (academic staff, non-academic staff, and students). Sloven's formula (Kanire, 2013) was used to determine the minimum number of respondents (n) to consider the study statistically valid.

$$n=\frac{N}{1+Ne^2} \tag{1}$$

In this study, the effective population size (N) was 500. The sample error (e) was considered 0.1, indicating a 90% confidence that the sample size accurately represents the population. This process resulted in a sample size (n) of 83 respondents, representing 18.8% of the population (building occupants). A total of 120 questionnaires were distributed to the users, and 107 responses were received; a total of 94 valid responses were adopted in the study, representing nearly 78% of the distributed questionnaires that were retrieved. This number was considered adequate for the analysis based on the assertion by Moser and Kalton (1971) that the result of a survey could be considered biased and of minimal value if the return rate was lower than 30–40%. The data presentation and analysis used frequency distributions and percentages of all the respondents (Table 1).

6. Analysis and evaluation

The current study adopted an investigative POE using some defined criteria, items, and attributes, following Preiser (2002) and Van der Voordt and Van Wegen (2005). The process of evaluation involved an expert rating of 10 evaluators and a survey of users' satisfaction. The satisfaction level can be measured through metrics/indicators called attributes (Gopikrishnan and Topkar, 2014). In this study, the indicators covered the technical, functional, and behavioral aspects of the building.

The process of analysis was divided into three parts. The first part included the comparative analysis of the building performance review (building quality) to determine the building performance score in terms of whether they were evidenced in very good state (5), good state (4), medium state (3), poor state (2), and very poor state (1). The constructed building performance survey (BPS) was adapted from previous schemes and studies (Nawawi and Khalil, 2008; Che-Ani et al., 2010; Ilsanmi, 2010; Husin et al., 2015; Sanni-Anibire and Hassanain, 2016). This part was conducted through an expert rating survey on 10 evaluators who have vast experience in the field of architectural design and construction industry (including consultant architects and academicians). The second part comprised presenting results involving the analysis of the survey findings regarding the satisfaction level of the surveyed building users with 40 items in terms of DQ and performance, IEQ, and QBSS.

The mean item scores (MIS), which refers to the mean percentages of experts/respondents to each building item in both surveys (experts' rating and users' satisfaction), were adopted for measurement and comparison. The findings were derived from the questionnaires that had been distributed to the users of the building being tested. The answers obtained from the questionnaires were used to provide specific findings and recommendations for the study. The final part demonstrated the correlation analysis between the building performance scores and the users' satisfaction scores based on similar performance attributes for the selected building.

Table 1 Questionnaire respondents.
Source: Field survey 2016.

Participants	Frequency	Percent	Cumulative percent
Students	63	67	67
Academic staff	25	26.6	93.6
Non-academic staff	6	6.4	100
Total	94	100	

6.1. Building performance review based on the experts' rating

The building performance assessment based on the experts' rating was measured using a score based on the quality of various building attributes as mentioned previously. Table 2 presents the summary of the results of the building performance score based on the 40 indicators and factors of DQ, IEQ, and QBSS. The 40 items and attributes related to building performance were listed on the survey form (experts' rating survey), and the rating of each attribute in the relative performance elements refers to the scale value of the BPI.

Table 2 displays the summary of the result of the building performance level for the identified performance attributes.

Table 2 presents the result of the building performance level for the building that was selected as a case study, demonstrating the results for attributes under performance as the building performance category. The experts' rating evaluated the scale of the building performance during the building performance inspection survey. Based on the result, the ratings of experts for several items were as follows:

6.1.1. Results of DQ

1. **Building layout:**
   Three of five items related to the building layout recorded mean scores of (3.7), (3.3), and (3.1), indicating that their performance degree is higher than moderate. According to the experts' rating, the mean value of the overall quality of building layout items and attributes was (3.3). This result indicated that the quality of building layout achieved a degree of performance above the moderate.
2. **Interior appearance:**
   All items of the interior appearance quality recorded mean rating scores of (2.2) and (2.5). The overall quality and presentation of interior appearance achieved a mean value of (2.3), indicating that its level of performance was less than the moderate.
3. **Exterior appearance:**
   Similar to the interior appearance but with a slight increase, the indicator of exterior appearance and its items recorded mean scores of (2.5), (2.6), (2.9), and (2.8). The overall quality, appearance, and presentation of building exterior attained a mean value of (2.7), denoting a level of performance slightly less than the moderate.
4. **Access to facilities on campus – accessibility:**
   The results regarding this indicator and its items and attributes highlighted a fluctuation in their mean scores; three of five items recorded mean values of (2.3), (2.8), and (2.8), indicating a level of performance lower than the moderate. By contrast, two of five items achieved mean values higher than the moderate performance with (3.4) and (3.3). Therefore, this indicator maintained a mean value of (3.2), revealing that the level of performance for the selected building was higher than the moderate level in terms of accessibility to facilities on campus.

6.1.2. IEQ

1. **Thermal comfort:**
   The results obtained from the experts' rating indicated that the overall quality of the thermal comfort (natural and artificial) of the building recorded a mean value of (2). This result indicated that the thermal comfort of the building was marked as "poor" performance.
2. **Indoor air quality:**
   Two of five items related to this indicator obtained mean values of (2.4) and (1.5), showing "poor" performance. Only one item achieved the mean value of (3), representing a moderate level of performance. The experts' rating revealed that the overall indoor air quality was (2.5), which was lower than the moderate level of performance.
3. **Acoustic comfort:**
   Three of four items and attributes related to the indicator of acoustic comfort recorded mean values slightly less than the moderate level of performance with (2.81), (2.5), and (2.9). The fourth item achieved a mean value of (3.6), representing a level of performance above the moderate level. Therefore, the acoustic comfort quality of the building was marked as "moderate" performance.
4. **Visual comfort:**
   This indicator represented by two items, namely, natural and artificial lighting of the building, recorded mean values of (3.5) and (3.3), respectively, and was marked as "moderate" performance. The overall quality and adequacy of lighting in the building achieved a mean value of (3.2), which refers to a level of performance higher than the moderate.
5. **Security and fire safety:**
   The overall quality and adequacy of security and fire safety of the building according to the experts' rating recorded a mean value of (2.7), suggesting that the level of performance of this indicator was slightly lower than the moderate.

6.1.3. QBSS – serviceability

Most of the items and attributes under this indicator were marked as "poor" performance with mean values of (2.1), (2.2), (1.3), and (2.4). Only one of five items, which is the availability and quality of electrical supply, recorded a mean value of (3), denoting a "moderate" performance. The overall availability, adequacy, and QBSS achieved a mean value of (2.7), which is slightly less than the moderate level of performance.

Based on the results obtained from the experts' rating survey, Figure 2 summarizes the percentages of the overall indicators and their items and attributes related to the building performance level. A total of 10% of experts rated the building performance based on 40 indicators and their items with "Very Poor" performance, while 28.75% of these experts rated the building performance with "Poor." Then, 39% of the experts rated the level of performance of the

Table 2 Results of the building performance review based on the experts' rating.

POE performance indicators and criteria			Building performance level %					
			VP	P	M	G	VG	Mean
DQ	Building layout	Adequacy of horizontal circulation routes in the building	0	10	20	60	10	3.7
		Adequacy of vertical circulation routes within the building	0	10	50	40	0	3.3
		Spatial configuration, size/zoning/grouping of spaces, rooms, studios, and halls	0	10	70	20	0	3.1
		Proportions and dimensions and ceiling height of the rooms/halls/spaces	0	40	30	30	0	2.9
		Adequacy of opening design (doors and windows)	0	60	10	30	0	2.7
		Overall quality of building layout	0	10	50	40	0	3.3
	Interior appearance	Quality and presentation of interior finishes	20	40	40	0	0	2.2
		Quality, size, color, and distribution of furniture/instruments/tools in all spaces	10	30	60	0	0	2.5
		Overall quality, appearance, and presentation of the building's interior finishes, furniture, materials, and colors	20	30	50	0	0	2.3
	Exterior appearance	Quality and presentation of exterior finishes	20	20	50	10	0	2.5
		Quality and presentation of landscaping and pavements around the building	10	40	30	20	0	2.6
		Availability of adequate sidewalks between buildings	10	20	40	30	0	2.9
		Quality of open space design (green parks and walkways)	0	30	60	10	0	2.8
		Overall quality, appearance, and presentation of the building's exterior finishes, materials, and colors	0	40	50	10	0	2.7
	Accessibility	Proximity to sports facilities	20	40	30	10	0	2.3
		Proximity to the student cafeteria	0	30	60	10	0	2.8
		Proximity to shuttle bus stops (public transportation)	10	20	50	20	0	2.8
		Proximity to car parking facilities	0	10	40	50	0	3.4
		Proximity to places of worship	0	10	50	40	0	3.3
		Overall adequacy and quality of accessibility	0		80	20	0	3.2
IEQ	Thermal comfort	Overall quality of thermal comfort (natural and artificial) of the building	20	60	20	0	0	2.0
	Indoor air quality	Quality of air in rooms, studios, and labs (smelliness and dryness)	20	40	20	20	0	2.4
		Quality of air in washrooms and toilets	60	30	10	0	0	1.5
		Quality of air in the lobby, common spaces, and corridors	10	10	50	30	0	3.0
		Overall indoor air quality	10	30	60	0	0	2.5
	Acoustic comfort	Noise from people between rooms and spaces	0	40	40	20	0	2.81
		Noise from the air/HVAC system	10	40	40	10	0	2.5
		Noise from lighting fixtures (bulbs and lamps)	0	30	50	20	0	2.9
		Noise from outside the building	0	20	20	40	20	3.6
		Overall acoustic comfort quality	0	30	40	30	0	3.0
	Visual comfort	Adequacy and quality of natural lighting levels in all spaces	0	10	40	40	10	3.5
		Adequacy and quality of artificial lighting levels in all spaces	0	20	40	30	10	3.3
		Overall quality and adequacy of lighting in the building	0	10	60	30	0	3.2
	Security and safety	Overall quality and adequacy of security and fire safety in the building	30	10	20	40	0	2.7
Serviceability		Quality, cleanliness of washroom facilities and all spaces	10	80	0	10	0	2.1
		Quality of doors and windows, key to doors, and lockers	10	70	10	10	0	2.2
		Availability and quality of support services for disabled persons	70	30	0	0	0	1.3
		Availability and quality of water supply	30	20	30	20	0	2.4
		Availability and quality of electrical supply	0	30	40	30	0	3.0
		Overall availability and QBSS	0	40	50	10	0	2.7

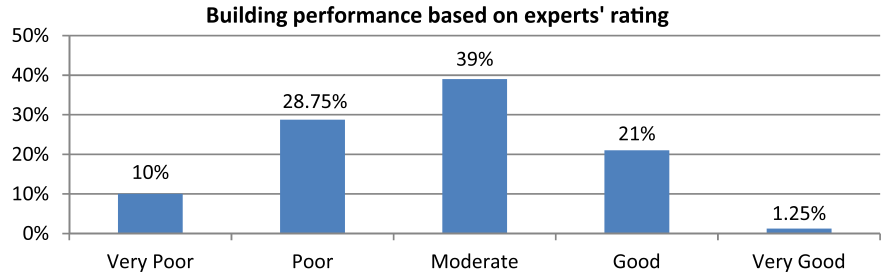

Figure 2 Building performance based on the experts' rating to the overall building attributes and items.

building with "Moderate," and 21% rated "Good." Finally, only 1.25% rated the building with "Very Good" performance. Accordingly, 77% (10%, 28.75%, and 39%) of the experts' rating on the level of performance of the building were confined between the "Poor" and the "Moderate." The next analysis presented the results of the users' satisfaction level for similar attributes as investigated in the building performance inspection survey that was evaluated by experts.

6.2. Building performance review based on the users' satisfaction survey

The second part of the results was obtained from the questionnaire survey, which was designed to determine the satisfaction level of the building performance. This part required the respondents to rate their satisfaction level based on 40 performance attributes under the DQ, IEQ, and QBSS. These items and attributes of performance were similar to the attributes outlined in the BPS. The respondents were required to rate their satisfaction level based on five-point Likert scale: "1" (very dissatisfied), "2" (dissatisfied), "3" (moderately satisfied), "4" (satisfied), and "5" (very satisfied). Table 3 illustrates the percentages of the users' satisfaction level toward the listed performance attributes.

6.2.1. Results of DQ

1. **Building layout:**
   Three of five items related to the building layout (adequacy of horizontal circulation, adequacy of vertical circulation, and proportions and dimensions of spaces) recorded mean scores of (3.56), (3.44), and (3), respectively, denoting that their satisfaction degree is higher than moderate. The rest of the items related to the building layout (spatial configuration of spaces and adequacy of opening design [doors and windows]) achieved mean values of (2.73) and (2.94), respectively, indicating that the users' satisfaction level for both of these items was lower than the moderate level. Based on users' responses, the mean value of the overall quality of building layout items and attributes was (3.3), suggesting that the quality of building layout achieved a degree of satisfaction above the moderate.
2. **Interior appearance:**
   All items under the interior appearance quality (quality and presentation of interior finishes and quality, sizes, colors, and distribution of furniture in all spaces) recorded mean values of (2.03) and (2.26), respectively. The overall quality and presentation of interior appearance achieved a mean value of (2.19), revealing that its users' satisfaction level was less than the moderate.
3. **Exterior appearance:**
   Three of four items (quality and presentation of landscaping and pavements around the building, availability of adequate sidewalks between buildings, and quality of open space designs), which constitute most items related to this indicator, recorded mean scores of (3.16), (3.06), and (3.18), respectively; this result shows a degree of satisfaction above the moderate level. Only one item (quality and presentation of exterior finishes) recorded a mean value of (2.52), indicating a level of satisfaction less than moderate. However, the overall quality, appearance, and presentation of the building exterior attained a mean value of (2.63), demonstrating that users were dissatisfied.
4. **Access to facilities on campus - accessibility:**
   All items and attributes related to this indicator recorded mean values of (1.9), (2.53), (2.33), (2.82), and (2.84), indicating a users' satisfaction level lower than the moderate. Therefore, this indicator achieved a mean value of (2.87), which revealed that the users' satisfaction level for the selected building was slightly lower than the moderate level in terms of accessibility to facilities on campus.

6.2.2. IEQ

1. **Thermal comfort:**
   The results obtained from users revealed that the overall quality of thermal comfort (natural and artificial) of the building recorded a mean value of (2.81). This result indicated that the thermal comfort of the building was marked as "dissatisfied" with a certain tendency toward a moderate level of satisfaction.
2. **Indoor air quality:**
   All items and attributes related to this indicator (quality of air in rooms [smelliness and dryness], quality of air in washrooms and toilets, and quality of air in lobby and common spaces) achieved mean values of (2.59), (1.69), and (2.71), correspondingly, denoting their dissatisfaction. The users' responses highlighted that the overall indoor air quality was (2.58), which was lower than the moderate level of satisfaction.
3. **Acoustic comfort:**
   The first half of the items and attributes (two of four items) related to this indicator (noise from people

Table 3 Results of users' satisfaction level.

POE performance indicators and criteria			Users' satisfaction level %					
			VD 1	D 2	MS 3	S 4	VS 5	Mean
DQ	Building layout	Adequacy of horizontal circulation routes within the building	1.1	13.9	41.2	36.2	7.4	3.56
		Adequacy of vertical circulation routes within the building	3.2	14.9	40.4	38.3	3.2	3.44
		Spatial configuration, size/zoning/grouping of spaces, rooms, studios, and halls	13.9	34.0	34.0	18.1	0.0	2.73
		Proportions and dimensions and ceiling height of the rooms/halls/spaces	9.6	25.5	40.4	22.4	2.1	3.00
		Adequacy of opening design (doors and windows)	11.7	33.0	25.5	26.6	3.2	2.94
		Overall quality of the building layout	11.7	37.2	38.3	12.8	0.0	2.68
	Interior appearance	Quality and presentation of interior finishes	36.2	40.4	20.2	3.2	0.0	2.03
		Quality, size, color, and distribution of furniture/instruments/tools in all spaces	23.4	46.8	23.4	6.4	0.0	2.26
		Overall quality, appearance, and presentation of the building's interior finishes, furniture, materials, and colors	28.7	41.5	25.5	4.3	0.0	2.19
	Exterior appearance	Quality and presentation of exterior finishes	17.0	41.5	28.7	12.8	0.0	2.52
		Quality and presentation of landscaping and pavements around the building	6.4	26.6	38.3	21.3	7.4	3.16
		Availability of adequate sidewalks between buildings	8.5	23.4	42.6	23.4	2.1	3.06
		Quality of open space designs (green parks and walkways)	6.4	29.8	28.7	28.7	6.4	3.18
		Overall quality, appearance, and presentation of the building's exterior finishes, materials, and colors	19.1	30.9	35.1	13.8	1.1	2.63
	Accessibility	Proximity to sports facilities	48.9	28.7	17.1	5.3	0.0	1.9
		Proximity to the student cafeteria	23.4	33.0	27.7	13.8	2.1	2.53
		Proximity to shuttle bus stops (public transportation)	33.0	31.9	21.3	10.6	3.2	2.33
		Proximity to car parking facilities	25.5	20.2	26.6	19.2	8.5	2.82
		Proximity to places of worship	14.9	29.8	33.0	18.1	4.2	2.84
		Overall adequacy and quality of accessibility	9.6	33.0	37.2	18.1	2.1	2.87
IEQ	Thermal comfort	Overall quality of thermal comfort (natural and artificial) of the building	24.5	39.3	24.5	10.6	1.1	2.81
	In. air quality	Quality of air in rooms, studios, and labs (smelliness and dryness)	18.1	35.1	33.0	12.7	1.1	2.59
		Quality of air in washrooms and toilets	60.6	24.5	10.6	4.3	0.0	1.69
		Quality of air in the lobby, common spaces, and corridors	11.7	33.0	45.7	8.5	1.1	2.71
		Overall indoor air quality	16.0	35.1	39.4	9.5	0.0	2.58
	Acoustic comfort	Noise from people between rooms and spaces	10.6	28.7	40.4	19.2	1.1	2.89
		Noise from the air/HVAC system	17.0	38.3	29.8	13.8	1.1	2.59
		Noise from lighting fixtures (bulbs and lamps)	5.3	22.3	49.0	18.1	5.3	3.15
		Noise from outside the building	6.4	22.3	38.3	24.5	8.5	3.26
		Overall acoustic comfort quality	5.3	26.6	45.8	20.2	2.1	3.06
	Visual comfort	Adequacy and quality of natural lighting levels in all indoor spaces	4.3	14.9	51.1	22.3	7.4	3.34
		Adequacy and quality of artificial lighting in all indoor spaces	4.3	29.8	37.2	27.6	1.1	3.1
		Overall quality and adequacy of lighting in the building	7.4	20.2	51.1	20.2	1.1	3.06
	Security and safety	Overall quality and adequacy of security and fire safety in the building	31.9	30.9	21.3	13.8	2.1	2.38
Serviceability		Quality cleanliness of washroom facilities and spaces	39.4	28.7	27.6	4.3	0.0	2.09
		Quality of doors and windows, key to doors, and lockers	31.9	47.9	17.0	3.2	0.0	2.04
		Availability and quality of support services to disabled persons	52.1	35.1	8.5	3.2	1.1	1.77
		Availability and quality of water supply	27.6	38.4	27.6	6.4	0.0	2.26
		Availability and quality of electrical supply	14.9	30.9	40.4	11.7	2.1	2.71
		Overall availability and QBSS	17.0	42.6	31.9	6.4	2.1	2.49

The results obtained from the users' satisfaction survey based on the building performance items and attributes could be clarified as follows:

between rooms and spaces and noise from the air/HVAC system) recorded mean values of (2.89) and (2.59), respectively, which was slightly less than the moderate level of satisfaction. The second half of the items (noise from lighting fixtures and noise from outside the building) achieved mean values of (3.15) and (3.26), respectively, achieving a users' satisfaction level higher than moderate. Overall, the acoustic comfort quality of the building recorded a mean value of (3.06), which is close to the moderate level of satisfaction.

4. **Visual comfort:**
   Both items of this indicator (natural and artificial lighting of the building) recorded mean values of (3.34) and (3.1), correspondingly, expressing that users were moderately satisfied. The overall quality and adequacy of lighting in the building achieved a mean value of (3.06), showing that users were moderately satisfied.
5. **Security and fire safety:**
   The overall quality and adequacy of security and fire safety of the building according to the users' responses recorded a mean value of (2.38), demonstrating that the level of satisfaction for this indicator was slightly above the "dissatisfied."

6.2.3. QBSS - serviceability

All items and attributes under this indicator (quality, adequacy, and cleanliness of washroom facilities and spaces, quality of doors and windows [key to doors and lockers], availability and quality of support services for disabled persons, availability and quality of water supply, and availability and quality of electrical supply) recorded mean values of (2.09), (2.04), (1.77), (2.26), and (2.71), correspondingly, indicating a degree less than the moderate level of satisfaction. According to the users' responses, overall availability, adequacy, and QBSS achieved a mean value of (2.49), which is also slightly less than the moderate level of satisfaction.

Based on the results obtained from the users' satisfaction survey, Figure 3 summarizes the percentages of overall indicators and their items and attributes related to the users' satisfaction level. A total of 19% of users were very dissatisfied, while 31% of these users were dissatisfied. Moreover, 32.4% of users were moderately satisfied, and 15.4% were satisfied. Finally, 2.2% of users were very satisfied with the building items and attributes. Accordingly, the levels of satisfaction for 82.4% of the respondents ranged from very dissatisfied to moderately satisfied. This large percentage was fully compatible with the ratio obtained from the experts' rating (77% poor to moderate), which should be remedied to overcome the drawbacks and defects of building items and attributes that may become severe if left unattended.

6.3. Correlation between the results of building performance and users' satisfaction

The final part of the analysis demonstrated the finding of the correlation between building performance scale and users' satisfaction level. The correlation analysis was performed using Kendall's tau correlation. The correlation test was conducted to investigate whether a significant relationship exists between the building performance level and the users' satisfaction level with similar performance attributes. This test provides the reliability of using POE as the benchmark of building performance assessment in university buildings. The correlation coefficient obtained was 0.811, which is higher than the empirically acceptable coefficient of 0.7 for reliabilities in basic research (Cournoyer and Klein, 2000). The correlation analysis was conducted using the statistical software program SPSS (Statistical Packages for the Social Sciences, version 22.00). The hypotheses were statistically tested with a two-tailed alpha level of 0.05. The correlation analysis was conducted to determine whether building performance correlates with the building users' satisfaction level based on the 40 items and attributes specified in both questionnaires (experts' rating and building users' satisfaction survey). The high correlation between building performance and users' satisfaction showed that the suggested method of POE is effective and applicable for use in assessing the performance of university buildings and facilities in Kurdistan region. The correlation coefficients are presented in Figure 4 with clarifications of its zones as follows:

6.3.1. Zone A - very high correlations ($\geq$ 0.8)

The correlation between building performance and users' satisfaction scores is very high for the indicators of vertical circulation, proportions of spaces, adequacy of opening design (doors and windows), quality of interior finishes, quality of pavements around the building, availability of sidewalks between buildings, overall quality of exterior appearance, overall quality of thermal comfort, quality of air in all spaces, quality of air in washrooms and toilets, overall indoor air quality, noise from people between spaces, noise from the air/HVAC system, noise from lighting fixtures, overall acoustic comfort quality, quality of natural lighting in indoor spaces, quality of artificial lighting in indoor spaces, overall quality of lighting in the building, quality of doors and windows (key to doors and lockers), availability and quality of services for disabled persons, and overall QBSS. The very high correlation coefficients show

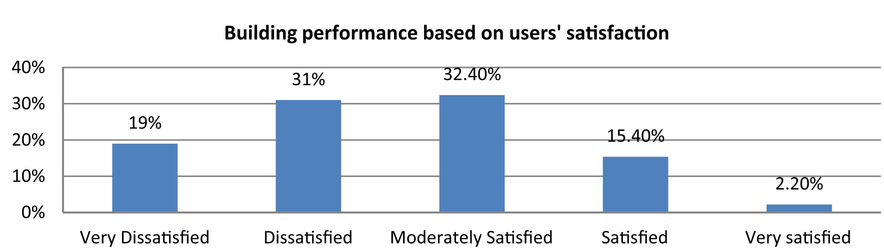

Figure 3 Users' satisfaction to overall building attributes and items.

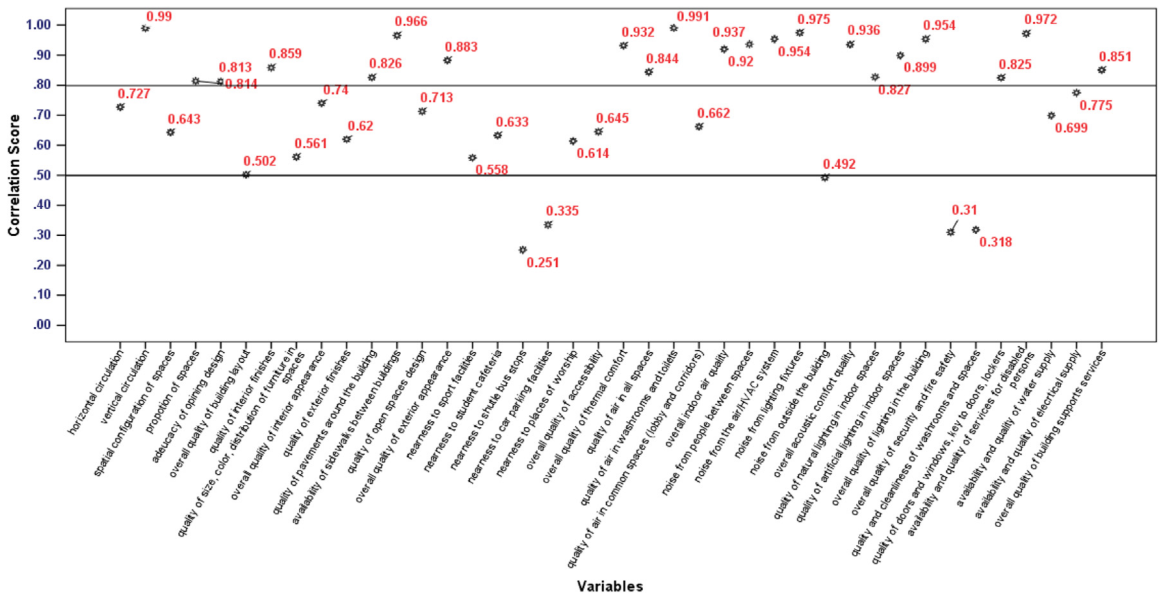

Figure 4 Zones of correlation between building performance and users' satisfaction.

that the building performance review based on the experts' rating of these indicators has a robust positive relationship with the building users' satisfaction level.

6.3.2. Zone B – high correlations ($\geq$ 0.5)

The correlation between building performance and users' satisfaction scores is positively high for the indicators of horizontal circulation, spatial configuration of spaces, overall quality of building layout, quality of size, color, and distribution of furniture in spaces, overall quality of interior appearance, quality of exterior finishes, quality of open space design, proximity to sport facilities, proximity to the student cafeteria, proximity to places of worship, overall quality of accessibility, quality of air in common spaces (lobby and corridors), availability and quality of water supply, and availability and quality of electrical supply. The high correlation coefficients reveal that performance review based on the experts' rating of these indicators has a robust positive relationship with the building users' satisfaction level.

6.3.3. Zone C – low correlations ($\leq$ 0.5)

The correlation between building performance scores and the building occupants is positively low for the indicators of proximity to shuttle bus stops, proximity to car parking facilities, noise from outside the building, overall quality of security and fire safety, and quality and cleanliness of washrooms and spaces. However, they do not constitute negative correlations despite having low correlations. These low correlations are due to the difference in perception between the building users and the assessment conducted by the experts' rating on the performance levels of these indicators and attributes. The users have different insights, perceptions, and prospects of the outlined indicators and items, which are influenced by their general knowledge and technical skills, backgrounds, and working experiences. This finding highlights the requirement for further studies on the details of the indicators and parameters involved in the questionnaires to ensure that they are consistent with the building users' satisfaction levels. These further studies may also include refining the indicator details in the questionnaire design. Based on Figure 4, the correlations show that 88% of the indicators or variables are in the zone of very high and high correlations between building performance (MIS) and users' satisfaction scores (MIS). Therefore, the developed method of POE is effective and relevant for assessing university buildings and facilities in Iraqi Kurdistan region, because most of the indicators and attributes (35 of 40) are in very high and high correlations.

This obvious and significant relationship between the two variables supports the research hypothesis that a significant relationship exists between the building performance and the users' satisfaction. Both results in the correlational analysis reveal significant relationships between building performance and users' satisfaction level. The correlational outcome only offers the value of coefficient and the strength of relationship and expectations against the reasons, and the consequences should be identified from the analysis. This study assumes that the users' satisfaction level depends on the building performance level in their university building facilities environment. This correlational outcome is a vital confirmation of the efficiency of POE as a tool in assessing the performance of buildings, especially university buildings and facilities.

7. Conclusions

This study presents the correlation analysis between building performance and users' satisfaction with their environment and facilities in a selected university building in Iraqi Kurdistan region. The most important conclusions of this study can be summarized as follows:

- POE offers a valuable methodology for analyzing the performance of buildings in general, especially the university buildings and facilities in Iraqi Kurdistan region.

The analysis of the findings confirms that the application of POE is pertinent, effective, and successful in determining the users' satisfaction level and providing recommendations for improving building performance.

- This approach has great potential for analyzing building performance, because it uses a planned approach to achieve the best quality in building services, whereby the building users' behavior, insights, and opinions are integrated.
- POE also plays a vital role in the strategic planning of building management and can be placed in the context of the public sector. POE can reduce the appearance of defective problems, because the process allows a strategic assessment of the current performance of the building.
- The design of the buildings should also consider variables, attributes, and parameters that will determine the efficient performance of the buildings consistent with high satisfaction and comfort to the users of the buildings.
- The findings of this study also outline the imperative considerations and recommendations toward improving the performance of university buildings. The findings show that most of the indicators and its attributes and items related to building performance (DQ, IEQ, and QBSS) have a high correlation with the building users' satisfaction levels. Hence, using the POE approach in improving the performance of university buildings and facilities in Iraqi Kurdistan region is recommended.

Based on the foregoing conclusions, the compelling correlational results confirm the relevance of POE as a building performance tool for this study. The scientific contribution of this study lies in adopting an integrated approach in the process of evaluation by combining numerous indicators and relevant variables (40 attributes and items) used in assessing various aspects of building performance, such as functional, behavioral, technical, and supportive services; all these aspects are molded into the methodology of POE using two sophisticated exemplary surveys (experts' rating and users' satisfaction surveys). In addition, this study adds to the empirical evidence that the users' perception of university buildings and facility environment cannot be discountenanced at the policy, planning, design, and implementation phases. The thrust of the findings denotes that the indicators and variables used in assessing the building performance level are significant in determining the levels of users' satisfaction in university buildings and facilities.

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