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### POST OCCUPANCY EVALUATION (POE) FOR ENHANCING SATISFACTION LEVEL OF COMFORTS IN MALAYSIA'S SCHOOL BUILDINGS

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#### ABSTRACT

The physical factors of building performance in a school building must be determined to meet the users' basic requirement of comfort level. The disruption of physical factors such as ventilation, lighting, or thermal may constitute to reduce the productivity and efficiency among users. Thus, Post Occupancy Evaluation (POE) is a significant tool to indicate the level of satisfaction and occupants' comfort in ensuring the current issues mainly related to physical aspects such as indoor environmental quality, space utilization, energy efficiency, and so forth. Therefore, the primary purpose of this study is to assess the satisfaction level of school building users in Malaysia, including students, teachers, and staff to improve the quality of the indoor environment in a school building as the leading learning space for the future generation. The interview was conducted with 12 participants in determining the satisfaction level of building performance assessment on school buildings. Next, the survey instrument was distributed to 224 respondents in 7 different schools, to evaluate the awareness level of POE in current practice and to analyse the physical criteria to conduct the evaluation standards on school buildings in Malaysia. This study concludes that POE is the most accurate approach to estimate the quality of building performance, especially for school buildings. Also, it should be emphasized as a continuous routine of physical environment evaluation or a periodic assessment of school buildings.

**Keywords:** Comfort level, post occupancy evaluation (POE), satisfaction, school building

## INTRODUCTION

Post Occupancy Evaluation (POE) of a building is one of the essential assessments after it has been completed and occupied. POE is generally defined as a process of systematic assessment of the extent to which the occupied buildings meet the needs of the occupant. The occupant in that building should feel comfortable and experience the highest quality performance in the building environment. POE involves building users in defining how structures function for them. It measures the effectiveness of the design, construction, communication, and design occupancy to make sure that the evaluation methods can be adapted to all types of buildings. Besides, POE is the most effective mode of assessment for indoor environment to improve the level of operation, occupant performance, and learning process in the evaluated spaces. The main issue of that statement, which is the disruption of the indoor environment, such as lack of lighting source (darkness), may reduce the occupants' efficiency and work productivity (Nielsen et al., 2016). Over the last 20 years, a range of POE methods have been developed, and their systematic application has demonstrated an enormous potential not only to reduce the financial and environmental cost but also to improve the quality of life, comfort and productivity of buildings (Middlehurst et al., 2018).

Therefore, Post Occupancy Evaluation (POE) is beneficial to improve the quality of life, comfort, and productivity of school buildings (Middlehurst et al., 2018). There are some key elements to measure the Post Occupancy Evaluation (POE) process, such as space, communication, safety, and security. The results of Post Occupancy Evaluation (POE) being applied in school buildings will enhance the teaching and learning environment to be more comprehensive (Choi & Moon, 2017). Hence, building performance is essential to optimize educational settings in school design. The relationship between the building performance and educational aspects is very significant to ensure occupants satisfaction, that may identify the criteria to be implemented for building performance evaluation in current practices. This assessment will maintain the quality of building performance and improve the building delivery process, which incorporates a flexible, efficient evaluation process into daily activities. However, the Post Occupancy Evaluation (POE) for school building is still a new practice in Malaysia. Most of the buildings here, especially school buildings, are not yet familiar with this assessment's purpose.

According to Taemthong (2019), building performance will impact the effectiveness and efficiency of occupants' productivity. Ventilation and thermal provision are primary determinants towards building users' experience; the weakness in providing these essential comfort factors will result in poor building performance. There exists a conceptual framework for Post Occupancy Evaluation (POE); however, the framework is too general for application in different types of buildings (Agyekum et al., 2016). This study aims to provide a practical framework for school buildings, to guide the management to apply Post Occupancy Evaluation (POE).

Besides, the framework will ensure better building performance of school buildings while providing the opportunity to solve various problems related to its performance. Therefore, this study focuses on the satisfaction level of the occupants on the school buildings in Malaysia, including students, teachers, and the staff to improve the quality of the indoor environment in a school building as the leading learning space for the future generations. The objectives are the following: (i) to determine the occupants' satisfaction level of building performance in school buildings, (ii) to evaluate the awareness level of Post Occupancy Evaluation (POE) in the current practice and (iii) to analyze the physical criteria to conduct Post Occupancy Evaluation (POE) on school buildings in Malaysia.

## **LITERATURE REVIEW**

POE can have a significant impact on the occupants as the building manager will improve the satisfaction of building conditions. First, an evaluation would be undertaken two months before the formal opening. Then the routine Post Occupancy Evaluation (POE) would then review the buildings from six to 12 months after its occupancy. The timing of the evaluation is to make sure the building remains in good condition after its completion. The assessment should, however, be carried out at any time as it determines the building's performance and the consistency of its functionality. However, school buildings being a learning institution, need to be evaluated at a proper period that would not disrupt the learning environment. Such evaluation is critical in assessing effective teaching, learning environment and classroom management that should be conducted in a comfortable and safe area to ensure the students can give feedback while focusing in class (American Association for the Advancement of Science, 1990). Nonetheless, some school buildings have inadequate space for allocating their students to the classroom, so the relevant school should resolve the issue, one of which is to use the multi-grade or double-shift class system (C Jain et al, 2017). Usually, double-shifts classes are a solution to overcrowding situations in the urban area because they have insufficient space for the learning and teaching session. These examples exemplify the solution for school buildings after POE assessments.

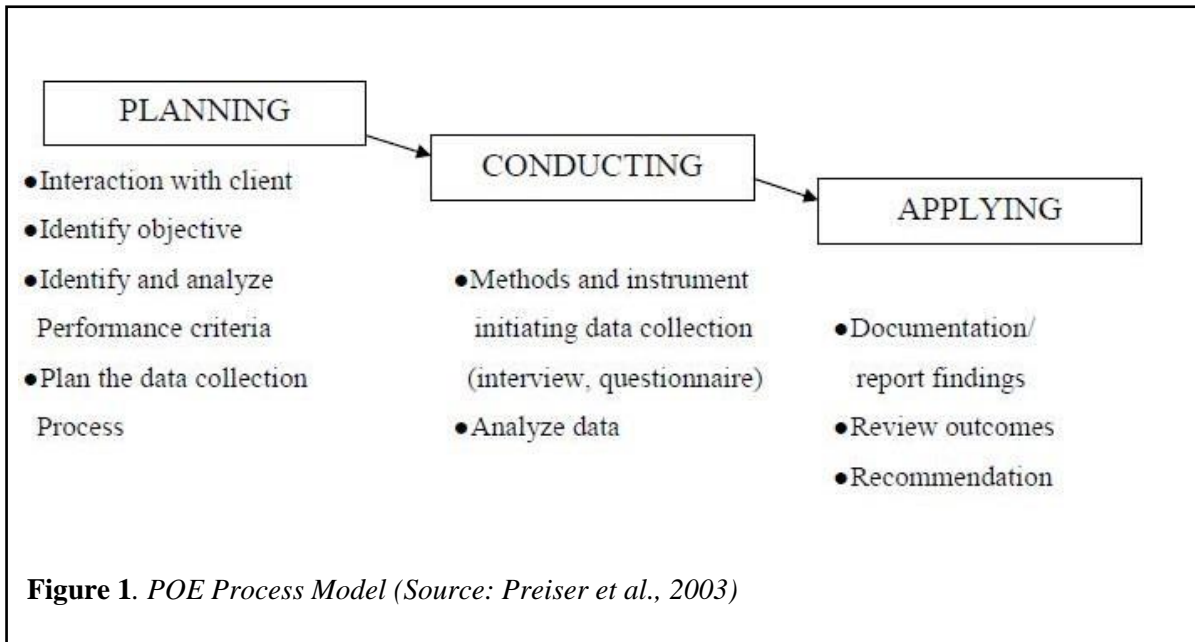
### **Post Occupancy Evaluation**

Post Occupancy Evaluation (POE) is a strategic process that assesses the sustainability of buildings after occupancy. Therefore, POE is the most common method used by many researchers and consultants to inspect different buildings' performance experienced by its occupants in a significant period after their completion. To ensure the optimum level of comfort and satisfaction, POE is an assured technique that can achieve the desired assessment of the designed environment. Some of the buildings have beautiful surroundings and design but lack comfort and safety for the occupants; this will affect the performance of the building. Specifically, the Post Occupancy Evaluation (POE) is an assessment of building performance that is based on the occupant's physical and mental capacity. There are five significant steps that POE usually follows, which are planning, programming, design, construction, and occupancy. The POE should be done if the building has been occupied for a significant period, to evaluate the level of the occupant's satisfaction. In some cases, after the POE has been carried through, guidelines on the building's maintenance and future actions in the related building need to be prepared (Kim et al., 2018).

Hence, Post Occupancy Evaluation (POE) is useful, cost-effective, timely, and beneficial for all that is involved. However, this situation depends on the result and quality of the evaluation done. POE procedure should also consider both the positive and negative aspects of the building performance; it is to have a balanced evaluation and result findings (Cleveland & Fisher 2014). Besides that, POE is to compare the actual building performance systematically with the current practice.

### **Process Of Post Occupancy Evaluation (POE)**

There are three (3) major phases involved in the POE process (Preiser et al., 2003), which extends to i) Planning ii) Conducting and iii) Applying. All of these phases include activities, resources, and justification, while the results are based on different building planning. Figure 1 shows the POE process model for each phase.



### Building Performance For Post Occupancy Evaluation (POE)

Building performance is defined as a comprehensive approach to fixing comfort and energy efficiency issues in a building structure (Keyvanfar et al., 2014). Building performance is considered successful when the constructed building saves money but maintain its effectiveness and designed-functionality. Furthermore, high building performance is not only based on energy efficiency but also durability, indoor air quality, and thermal comfort. Building Performance Institute Inc. (BPI), (2010) defines building performance as a condition where the building can sustain and maintain a degree of comfort level, health, safety, durability, and is energy-efficient. The primary practice of successful POE, therefore, is to ensure a concerted effort to minimize energy consumption but also to provide maximum comfort. Today, some technologies can be used for building performance optimization through architectural software solutions.

The POE process evaluates three (3) building performance elements considered through the regulatory codes that control building aspects such as safety and health codes for building standard occupancy (Hassanain & Iftikhar 2015). These evaluated elements are; i) technical, ii) functional, and iii) behavioural. Meanwhile, functionality refers to the capacity of occupants to carry out their activities efficiently and effectively. The functional elements are in keeping with the comfort between the building and the occupant’s activities. Simultaneously, the behavioural aspect is an essential aspect of building performance because it involves the psychological and social facets of the occupant’s satisfaction. For example, how the occupant interacts with the building facility and so forth.

### METHODOLOGY

This study contains two primary instruments for data collection: semi-structured interviews (qualitative) and questionnaires (quantitative). Both provided critical data for the analysis to be carried out. First, there are two approaches to data collection used: primary data collection carried out to determine the elements and factors of Post-Occupation Evaluation in schools while the secondary data was collected from relevant literature reviews. The 1st study’s objective was achieved through the semi-structured interviews, consisting of twelve (12) respondents. The respondents have to answer all the questions by giving appropriate examples where necessary. It was conducted for about one hour for each respondent at the school’s administrative office.

Likewise, the survey questionnaires were then used to achieve the study's objectives 2 and 3. A total of 224 sets of questionnaires were distributed at seven selected secondary schools in the Klang Valley, Malaysia and circulated to the teachers, school staff, and the students. Each school was given 30 sets of questionnaires, distributed equally to students and teachers or staff-respondents. The other 14 questionnaires were distributed at random to the public users of the school buildings. However, only 162 sets of questionnaires were collected. The value of mean was analyzed through the Statistical Package for the Social Science (SPSS) computer software. The data is then interpreted in the tables and diagrams to illustrate the result findings for the research's discussions and conclusion.

## RESULTS AND DISCUSSION

### The Level of Satisfaction on School Building Performance

Post Occupancy Evaluation (POE) is known as a method of seeking feedback on the performance of an occupied building, which is ideally the most systematic evaluation process to observe the overall quality of the building. POE is practiced in several countries, and the aim is to encourage feedback from the users to address the quality of building performance.

**Table 1**

*Summary of users' satisfaction with the different spaces in the school building environment*

Space		Satisfaction Level / Percentage (%)						
		Very dissatisfied	Dissatisfied	Slightly Dissatisfied	Neutral	Slightly Satisfied	Satisfied	Very Satisfied
Classroom	Frequency	0	2	0	1	5	3	1
	Percentage (%)	0.00	16.67	0.00	8.33	41.67	25.00	8.33
Laboratory	Frequency	0	1	2	3	0	4	2
	Percentage (%)	0.00	8.33	16.67	25.00	0.00	33.33	16.67
Office	Frequency	0	3	0	1	2	0	6
	Percentage (%)	0.00	25.00	0.00	8.33	16.67	0.00	50.00
Library	Frequency	0	0	0	2	4	5	1
	Percentage (%)	0.00	0.00	0.00	16.67	33.33	41.67	8.33
Meeting room	Frequency	0	0	1	2	0	6	3
	Percentage (%)	0.00	0.00	8.33	16.67	0.00	50.00	25.00
Canteen	Frequency	4	2	3	1	2	0	0
	Percentage (%)	33.33	16.67	25.00	8.33	16.67	0.00	0.00
Toilet	Frequency	5	7	0	0	0	0	0
	Percentage (%)	41.67	58.33	0.00	0.00	0.00	0.00	0.00
Hall	Frequency	0	3	0	3	4	2	0

Prayer room	Percentage (%)	0.00	25.00	0.00	25.00	33.33	16.67	0.00
	Frequency	0	0	2	2	5	2	1
	Percentage (%)	0.00	0.00	16.67	16.67	41.67	16.67	8.33

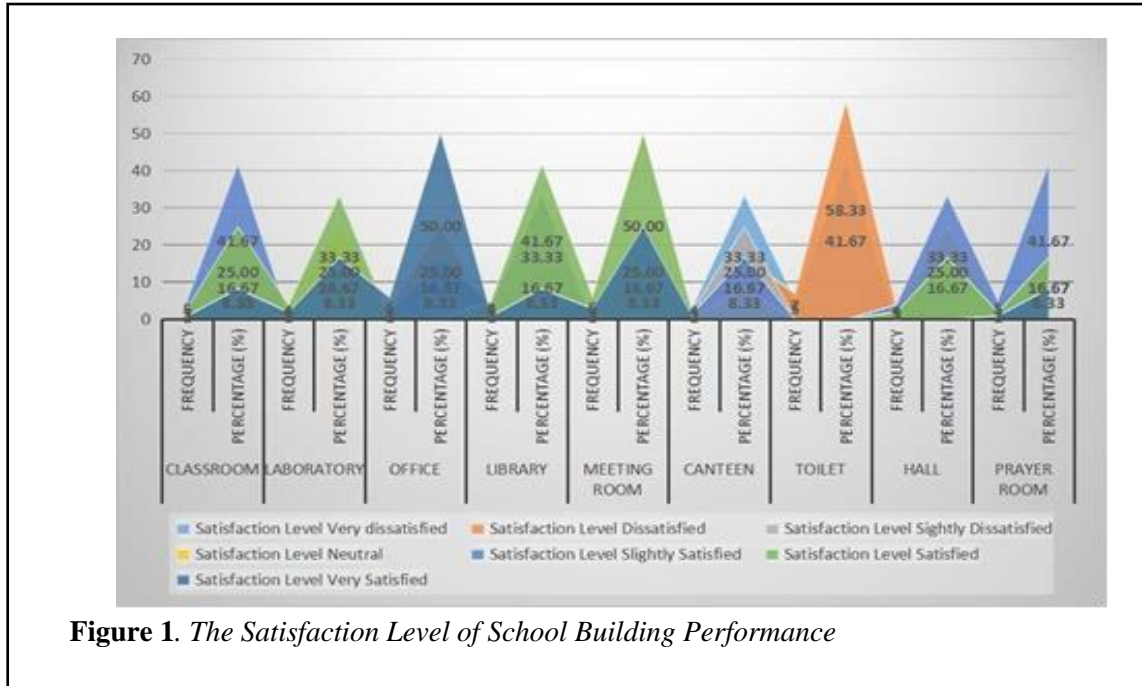


Figure 1. The Satisfaction Level of School Building Performance

Table 1 and Figure 2 illustrate the result of frequency and percentages (%) for the satisfaction level of school building performance obtained in various spaces, including the classroom, office, laboratory, library, canteen, and others. Students and teachers have used the spaces in the school buildings to a large extent; as a result, defects are usually attributed to aging factors, user behaviours, and adverse weather conditions (Talib et al. 2014; Mydin et al., 2014) that affected the level of satisfaction. Therefore, based on the statistical differences between users' satisfaction levels, the toilet recorded the highest percentage of dissatisfaction at 58.33%. The results indicate poor performance due to low maintenance work on issues such as leakage, faulty plumbing, and poor cleanliness, which eventually reduced the functionality of the space. The second highest value at 50% is recorded by the meeting room and the school office as being very satisfied and satisfied. The consistent response pattern was mostly satisfied for the library (41.67%), and the school lab (33.33%) followed by 41.67 percent, slightly satisfied with the prayer room and the classroom, respectively. This pattern could be read as thermal and ventilation satisfaction; for instance, the air-conditioned school office enjoys a higher percentage than the very dissatisfied experience in the school canteen, which is often designed in an open area that influences thermal comfort. Besides, the level of satisfaction is also attributed to school management, which always receives advice from the Public Works Department (PWD), especially when it needs to address critical issues related to building structure management (Norazman et al. 2019). Seven of the twelve interviewees informed that the school building's administration has a standard form to record damages to any of the school buildings, either to improve its quality or to ensure that it is properly maintained, thus boosting their satisfactory response.

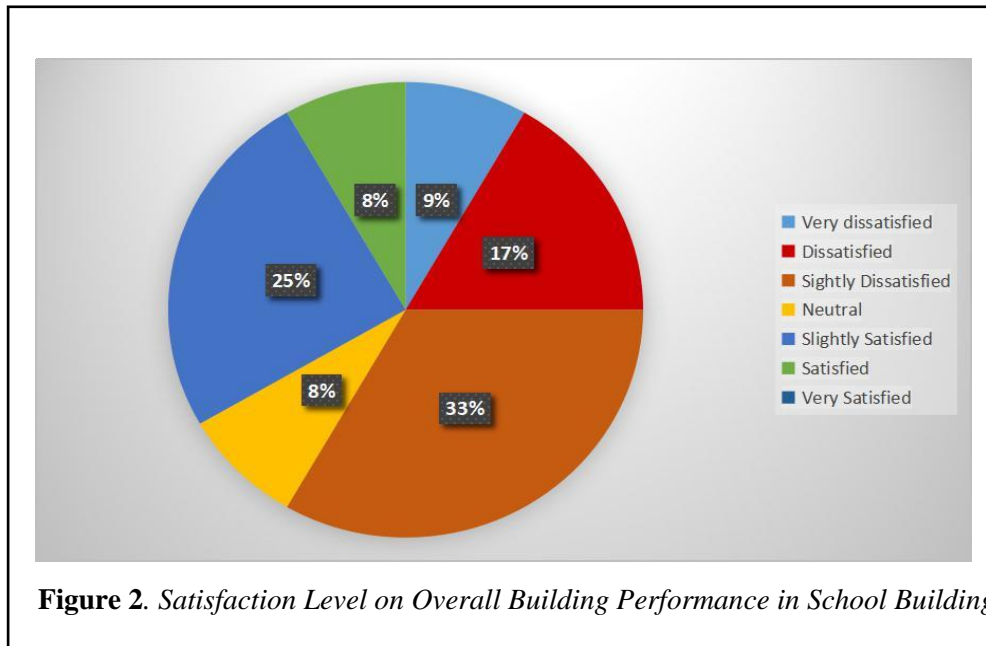


Figure 2 shows the satisfaction level of the overall school building performance achieved slightly dissatisfied at 33 percent as the highest score. Slightly lower ranking at 25 percent is satisfied-answered respondents. Accordingly, the data illustrates that the overall school building performance is evaluated at dissatisfaction value. The assessment was attributed to poor indoor environmental quality and low functionality, which contributed to users' discomfort in experiencing the spaces assessed. Moreover, a low 8 percent satisfactory level indicates that school building performance needs to be improved. At the very least, it is crucial to reduce the consistency of highly sensitive building defects and critical issues (Talib et al. 2014).

According to Nielsen et al., (2016), performance evaluation characteristics can be classified into three (3) main components: functional, technical, and indoor-environment. Maintaining all three parts ensure building longevity and sustains its value in the future. Moreover, periodic building assessment for school buildings may enhance the building comforts levels, influence a conducive learning environment, and reduce the possibility of critical defects (Norazman et al. 2018).

### **The Factors of Post Occupancy Evaluation (POE) Implementation in School Buildings into the Current Practice**

Results indicate that POE is essential for consistent assessment of building performance in school buildings, as a poor quality environment may have an impact on students' productivity and health. A sustainable school building should be particularly critical of its indoor quality, both in terms of thermal and spaces ventilation, to provide an adequate level of user comfort. In evaluating the occupant's feedback, the study provided the educational institutions to recognize the unsatisfactory level of its school settings' experience and quickly address the particular complaint. At the same time, the POE implementation enables the recognition of the root cause of critical issues to determine efficient design solutions for school buildings and its facilities by considering the satisfaction of its users. The practice potentially minimizes the annual budget for maintenance and repair work to retain building functionality.

**Table 2***Factors for POE Implementation in School Building into Current Practice*

Factors	Mean
Increase users satisfaction	4.32
Regular building inspection	2.68
Scheduled maintenance approach	3.72
Access to natural lighting	2.28
Sufficient facilities	1.31
Good accessibility	0.86
Minimize energy usage	2.02
Avoid critical defects	2.39

Table 2 illustrates the main factors this paper recommends implementing the Post Occupancy Evaluation (POE), specifically in school buildings, into current practice. Most school buildings have the initiative to ensure that the building environment's performance is at least equivalent to the expectations of users. However, the result shows that the conditions are not favourable. Hence, the most straightforward justification for introducing POE in school buildings with the highest mean value at 4.32 is the increase in user satisfaction. Since school occupants are students and teachers who spend more than 5 hours a day doing activities in the school environment, sustaining satisfaction value would be of considerable benefit to learning institutions (Norazman et al. 2018). Also, the educational settings should provide an optimum degree of comfort in terms of indoor environmental aspects, which will increase motivation among students. (Khalil et al. 2016).

The second most important factor is the scheduled maintenance approach, with a mean value of 3.72. Strategic maintenance is needed for school buildings to ensure its functional regularity instead of corrective or emergency maintenance work (Mydin et al. 2014). The lowest mean value was recorded by accessibility (0.86) followed by sufficient facilities (1.31) are not highly significant factors since the Department of Public Works (PWD) defines most corrective requirements, and also because of fewer deficiencies highlighted by the surveyed-respondents (Anselm et al

### **The Environmental Criteria to Conduct Post Occupancy Evaluation (POE) on School Buildings in Malaysia.**

Ample literature has shown that building has an impact on user experience; therefore, physical aspects are relevant to improving the overall performance of school buildings. The following are the essential physical requirements that are significantly applicable to the Post Occupancy Evaluation (POE) of the school building.



**Table 3***The Common Physical Criteria of POE in the School Building.*

Physical Criterion of POE	Mean
Indoor Air Quality	4.06
Lighting	3.09
Thermal Comfort	2.60
Ventilation	3.56
Space Utilization	1.49
Noise	1.19
Cleanliness	2.51
Safety & health	2.26

Table 3 illustrates the physical criteria for the process of POE in the school building. Most of the criteria relate to the quality of the indoor environment, thus the indoor air quality is valued at 4.06 as the highest mean score; it takes into account the attributes such as temperature and relative humidity experienced by the building users. Therefore, a healthy learning environment for students is mainly determined by the indoor air quality especially in classrooms. The value is supported by the second highest mean score - ventilation at 3.56 that may enhance the comfort level, such as sufficient air circulation in the building spaces that is divided into natural or artificial ventilation. Nevertheless, the majority of the participants interviewed agreed that electrical fans should be turned off in the classrooms when they are not in use. In particular, because most school buildings in Malaysia practice energy conservation (Ahmad et al. 2014).

For example, students often prefer natural ventilation compared to artificial ones during the rainy season with high wind velocity. Next, sufficient lighting is an essential criterion when conducting POE in the school building. It maximizes productivity and concentration levels in the classroom, which is necessary for paper and computer-based learning activities. According to Norazman et al. (2018), poor quality of lighting in classrooms can cause users to experience stress or vision problems if they spend long periods in such spaces. Notably, 8 percent of interviewees mentioned that some classes in the school building block out natural lighting, creating unnecessary wastage by relying on artificial light more than other classrooms. Meanwhile, noise recorded the lowest POE criterion at a mean score of 1.19, which indicates that the noise level is challenging to regulate in school settings due to the high student numbers. However, the nature of noise, especially its source, needs to be assessed by the school building's performance, resulting in a better user comfort level. Therefore, the Post-Occupancy Evaluation criteria discussed above, ensure better school building performance that would significantly improve the quality of its indoor environment, lowering operating costs, and achieve higher productivity levels among students and teachers. Most POE parameters listed impacts human health, motivation, and productivity generally.

## CONCLUSION AND RECOMMENDATION

In conclusion, Post Occupancy Evaluation (POE) provides optimal building comforts. It enhances user satisfaction among users in the school buildings, especially students and teachers who spend the most time there. Centred on the discussions made, improvements in the physical environment impact its performance regularity, which results in influencing users' comfort value. Thereby, a benchmark can be developed by empowering end-users through Post Occupancy Evaluation to measure the effectiveness of such a framework on the assessment of school buildings. Thus, POE provides standards for enhancing the efficiency of the indoor environment and the users' experience. The aspects of regulations apply to ventilation, lighting, thermal comfort, and noise control. Besides, effective implementation of POE in educational buildings enables organizations, communities, and researchers alike to learn about positive and negative environmental changes. Post Occupancy Evaluation (POE) should, therefore, be implemented as a benchmark towards more conducive educational building standards in Malaysia. Ideally, POE should be a continuous practice to determine the consistency of building performance regularity. However, the root cause of building failures should be identified at earlier stages to maintain building sustainability.

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