



Performance Analysis of Government and Public Buildings via Post Occupancy Evaluation

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Abstract

The government has an important obligation to ensure that the public buildings and facilities should be well managed to maintain building sustainability. Evaluation after occupancy in buildings is vitally needed to ensure that building performance is sustained. Post Occupancy Evaluation (POE) of buildings is of utmost importance in building performance evaluation as it comprises the technique that is used to evaluate whether a building meets the user's requirement. By using occupants as benchmark in evaluation, the potential of improving the performance of building is enormous. This paper discusses about a research with the broad aim of developing a general guideline for the POE practice specifically for government and public buildings in Malaysia. The entailing objectives are firstly, to review and analyze the government and public building performance, secondly, to determine the occupants' satisfaction level, and thirdly, to determine the correlation between building performance and occupants' satisfaction level. The study has revealed that 74% of the aspects of building performance are in high correlation with the occupants' satisfaction. The study concludes that the proposed guideline of POE is effective, relevant and beneficial to be used by public sector in evaluating the performance of government and public buildings in Malaysia.

Keywords: Post Occupancy Evaluation, Government and Public Buildings, Building Performance, Occupants' Satisfaction, Performance and Occupants' Correlation

1. Introduction

A completed building should be able to perform its functions in the manner that will ensure satisfaction to its occupants. Generally, regular maintenance programmes are conducted after the building has been occupied to ensure that the building is functioning well at all times. By execution of maintenance programmes, the occupants will be able to use and utilize the facilities as the provision of facilities supports the business operations by the building occupants. In short, the building facilities and services must be fit for the purpose of the users. Post Occupancy Evaluation (POE) is the evaluation of the performance of buildings after they have been occupied. In addition, POE provides a mechanism to understand the mutual interaction process between buildings and the user needs and to recommend ways of improving the environment necessary to accommodate user needs. Zimring and Reizenstein (1980) defined POE as an examination of the effectiveness of occupied design environments for human users. Vischer (2002) finds that POE is used not only to determine client's or user's satisfaction, but it is also used to fulfill other objectives. These objectives include determining building defects, supporting 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, clarify design objectives and improve building performance. POE research is undergoing a major shift (Zimring, 1988) whereby for greater effectiveness, the POE methodology must consider the entire building procurement life cycle. This approach implies a strong relationship between the development of a brief for a building project and the post occupancy evaluation stage. It serves as a tool to account for building quality which is essential when organizations are required to demonstrate that building programmes are responsibly managed (Watson, 2003).

In relation to the title, the main purpose of this study is to propose guidelines to implement POE for public buildings in Malaysia, with regards to the building performance review and satisfaction level of the building occupants. The analysis of findings is determined based on the POE undertaken, which comprises of approaches and evaluation methodologies that address the POE effectiveness and then within the broader context of the problem of building procurement fragmentation.

2. Problem Identification

The federal government is the largest owner of public buildings and facilities in Malaysia. Despite the realization of the importance of the management and maintenance of the buildings and facilities, it has not been emphasized clearly and systematically, which results in over budget costing for maintenance and remedial works (Zakaria and Hamzah, 2007). Many building defect complaints are reported in public buildings such as ceiling collapse in Parliament building in year 2006, leaking pipes in Mahkamah Jalan Duta (Offical Court Jalan Duta, Kuala Lumpur) and fungal appeareance at the Sultanah Aminah Hospital Johor in year 2007. The reported cases are described in a chronology of events starting from year 2005 to2007 (refer to Table 1).

Hence, POE can be seen as a multifaceted tool to be adopted in solving problems of building and facilities management as it evaluates the performance of buildings and facilities systematically. POE can also be seen as a systematic way in data collection and information on a particular building but unfortunately it has not yet been undertaken for government and public buildings in Malaysia (Zakaria and Hamzah, 2007). Among the benefits that can result from POE, is the identification of successful design features which can be scrutinized repeatedly (Watson, 2003), identification of problems to mitigate or reduce building and facilities defects, improvement building performance and environment, identification of redundant or unnecessary building features and empower users to negotiate building issues and reduce maintenance works and cost (Vischer, 2002 and Hewitt et. al, 2005).

According to Preiser et al (1988), hundreds of POE have been conducted on a variety of building types over the last 25 years. Some solutions included increasing involvement of the organisation being studied, better presentation of results, and better targeting of information to appropriate decision makers (Zimring, 1988). 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. Because of 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 environmental conditions that are required. In relation to evaluation of building performance using POE application, Preiser (1995) illustrates the performance concept in the building delivery process as shown in Figure 1.

The outcome of the research to be discussed in this paper provides information to the building industry about building in use and able to determine how well a new concept of POE works for government and public sector. The process of POE is relative to the integration of people's requirement and its workplace. Hence, POE is described as the best application strategy that needs to be adopted in evaluating performance of government and public buildings in Malaysia.

3. Research Objectives

The introduction and the problem statement above led to the formulation of the research aim and objectives. The broad aim of this research is to propose a POE guideline for government and public buildings in Malaysia. In accordance with the research aim, the objectives of this study are:

- a) To review and analyze the performance of government and public buildings using the proposed POE guideline
- b) To determine the satisfaction level of the building occupants in terms of building elements, services and environment
- c) To obtain the correlation between performance of government and public buildings and occupant's satisfaction level

4. Literature Review

POE as defined by Watson (2003) is a systematic evaluation of opinion about buildings in use, from the perspective of the people who use them. POE are generally intended to convey the parameters of buildings that work well and also focus on the ones that should not be repeated in future designs of buildings. POE describes rather than manipulate settings of building performance. The data collection of POE is usually done in actual settings rather than in laboratory. Based on the relevant parameters, POE can be categorized by its purpose to serve at various stages of a building life cycle.

A POE study conducted by Watson (2003) at a public building i.e. Marlborough School Technology Centre, New Zealand found that the centre successfully supports student learning, and it produced key recommendations for the future. The recommendations are mainly to identify relatively simple design modifications to overcome noise control, to change teaching culture to suit technology curriculum and need input from all building stakeholders at the planning stage. This helps to improve the building performance when similar buildings need to be developed. The result from the

POE helps to identify a measurable link between building quality and educational outcomes, which is notoriously difficult to show. Public Works Canada (1983) adopts POE study for a number of different federal office buildings in Canada to examine the performance of the building systems. The results led to the conclusions that there are major conditions that affect users' perceptions of their level of comfort in office buildings. It relates to the measures of performance of the technical building systems.

The Federal Facilities Council (2002) has compiled results from POE to various types of government and public buildings in the United States (US) into a technical report. The study was conducted by six federal agencies in the US and among the objectives of such implementation is to increase building quality and performance. The summary of the findings provides input to the ongoing performance measures programmes for the offices and public building and enhance design improvement. Based on the above review from various source of literature and precedent research, it shows that POE is relevant to be carried out as it indicates how well building's performance works to satisfy the organization's goal, as well as the needs of the individuals in the organization. At the most fundamental level, the purpose of a building should provide shelter for activities that could not be carried out as effectively in natural environment. Only building performance evaluation has the ability to accomplish this and POE provides the process of the actual evaluation of a building performance once in use by human occupants.

Despite many research that have been undertaken in the context of building performance, aspects of evaluating building performance have not been emphasized widely in Malaysia. The term of POE is still new in Malaysia, and many building practitioners are still unfamiliar with this approach in evaluating building performance. POE provides an extension to other technical evaluations like energy audit, building audit, maintenance and operation review, security inspections and other programmes developed by building and facility management in an organization (Preiser, 2002).

5. Proposed POE Guideline

The suggested guideline is derived from the analytical literature review of the study which consists of the concept, process, phases and also in-depth review of previous study conducted from previous research. The proposed guideline is illustrated in Figure 2. This guideline consists of a systematic sequence of six (6) steps involving identification of building parameters; evaluation of objectives; selection of planning approach; conducting of the POE inspection; application of findings and actions in response to feedbacks. The steps fall within three (3) phases namely, the initial phase; process phase, and recommendation phase. Each phase illustrates issues or activities that need to be addressed in the POE. This guideline provides an initial framework to facilitate the application of POE for government and public building in Malaysia.

6. Analysis and Findings

Based on the POE guideline, a POE inspection survey was conducted to eight (8) selected government and public buildings in Putrajaya, the administrative urban centre of the federal government where major government and public buildings are located. The analysis of this research is divided into three (3) sections. The first section features comparative analysis on building performance review in the pursuit of determining the score performance either under poor, medium or good performance. The second section features the presentation of result which consists of analysis on the survey findings pertaining to the satisfaction level of the surveyed building occupants in terms of building elements, services and environment. The findings were derived from 133 replied survey questionnaires out of 160 survey questionnaire sets that have been distributed and the respondents consists of the building occupants of the government and public buildings in Putrajaya. Answers obtained from the questionnaires are used to provide specific findings to the study and to provide recommendations. The final section features the correlation analysis between building performance scores and the building occupants' satisfaction score.

6.1 Section 1 – Building Performance Review Based on the POE Guideline

The building performance based on the POE guideline is measured using a score based on the quality of various building elements, services and environment. It denotes that if the building elements, services and environment in the stipulated building falls into a scale of 10 which constitutes a full score ($S=1.0$). Hence, the building performance score is poor if the scale category is below than 4 ($S \leq 0.4$), medium if scale is 5 ($S=0.5$) and good if the scale category is above 6 ($0.6 \geq S \geq 0.9$). Table 2 presents the summary of results of the building performance score based on the 19 parameters of building elements, services and environment.

The results from Table 2 show that generally the performance of the sample buildings is good (*with $S \geq 0.60$*). However, there are several buildings which attain performance score of 0.5, which is rated as medium performance. Only Building #6 has poor performance in terms of air-conditioning as the score perceived is 0.4. This evaluation is however conducted based on one time study visit and observation. The score needs to be compared with the building occupants' satisfaction score as they had sufficient time to experience the performance of the buildings, and hence able to identify any chronic problems.

6.2 Section 2 – Occupants' Satisfaction Level

The survey under Section B of the questionnaire was designed to determine the satisfaction level of the building occupants on the 19 parameters as stated earlier in Table 2 based on a likert scale from 1 to 5:

- “1” - Very Unsatisfied
- “2” - Unsatisfied
- “3” - Medium Satisfied
- “4” - Satisfied
- “5” - Very Satisfied

The calculation of the scores for occupants' satisfaction is based on the 19 parameters listed in Section B of the questionnaires.

The formula generated to calculate the satisfaction score is illustrated as follows:

$$SS = \frac{RS [N^5 + N^4 + N^3 + N^2 + N^1]}{FS [Total N^5]}$$

where,	SS	-	Satisfaction Score
	RS	-	Relative Score
	FS	-	Full Score
	N	-	No. of respondents
	N ⁵ , N ⁴ , N ³ , N ² , N ¹	-	(No. of respondents answered for Likert Scale) x (Likert Scale)

Table 3 presents the summary of the building occupants' satisfaction score for each building.

6.3 Section 3 – Correlation Coefficient of Building Performance and Occupants' Satisfaction

The final section of the analysis involves finding the correlation coefficient of the building occupants' satisfaction in relation to the building performance. The correlation analysis was undertaken using Kendall's tau correlation. The analysis of the correlation was conducted using the statistical software program SPSS (Statistical Packages for the Social Sciences, version 12.00). The hypotheses were statistically tested with a two-tailed alpha level of 0.05. The correlation analysis was undertaken to see whether building performance correlates with the level of building occupants' based on the 19 parameters stipulated in the questionnaires. High correlation between building performance and building occupants' satisfaction indicates that the proposed guideline is effective and relevant to be used to evaluate performance of government and public buildings in Malaysia. The correlation coefficients are presented in Figure 3 and are explained as follows:-

Region A – very high correlations (top):

The correlation between building performance scores and the building occupants' satisfaction scores are positively very high based on parameter window, staircase, lightings and lifts. The very high correlation coefficients show that performance review based on the POE on these parameters has very high positive relationship with the building occupants' satisfaction level.

Region B – high correlations (middle):

The correlation between building performance scores and the building occupants' satisfaction scores are positively high based on parameter floor finishes, ceiling finishes, door, quality of finishes, maintenance, air-conditioning, landscape, quality of M&E fittings, water services and noise control. The high correlation coefficients show that performance review based on the POE on these parameters has high positive relationship with the building occupants' satisfaction level.

Region C – low correlations (bottom):

The correlation between building performance scores and the building occupants are positively low based on parameter wall finishes, roof, quality of structure, safety and cleanliness. Nevertheless, despite having low correlations, they do not constitute negative correlations. The possible explanation for these low correlations is the difference in perception between the building occupants and the assessment made from the POE guideline on the performance levels of these parameters. The occupants have different perception and expectation of the outlined parameters which is influenced by

their background, working experience, body of knowledge and technical skills. The finding highlights the need for further investigations into the details of the parameters included in the POE guideline to ensure that they are in tandem with the building occupants' satisfaction levels. This may involve refining the parameter details in the POE guideline.

Based on figure 3, the correlations show that 74% of the parameters or variables are in the region of very high and high correlations between building performance scores and building occupants' satisfaction scores. Since the majority of the parameters are in very high and high correlations, it can therefore be concluded that the proposed guideline of POE is effective and relevant to be carried out for government and public buildings in Malaysia.

7. Conclusion

POE provides a valuable approach in analyzing the performance of government and public buildings in Malaysia. Analysis of the findings confirms that the application of POE is relevant, effective and able to determine occupants' satisfaction level as well as provide recommendation to improve building performance. The approach has a great potential in analyzing building performance as it uses a strategic approach to achieve the best quality in building services, whereby the assessment integrates the building occupants' behaviour, perception and opinion as the building users.

Inevitably, POE is a useful tool for building asset and facilities management; as long as the approach employed to collect feedback from users is effectively integrated towards sustainability of government and public buildings. POE also seems to have a natural place in strategic planning of building management and can be developed under public sector. The key to this application is by allocating the needs of POE in building design and planning phase. The research also noted that much ideas and solution are developed to achieve buildings' sustainability and this can create an opportunity for wider application of POE, especially to government and public buildings. POE able to mitigate emergence of defective problems as the process is comprise as strategic assessment to building current performance. More importantly, the design of the buildings should also consider parameters that will determine the good respectable performance of the buildings in line with high satisfaction and comfort to the building occupants as the users of the buildings.

The findings of the research have also outlined the important considerations and recommendations towards improving the performance of the government and public buildings. As the findings has shown, the majority of the parameters or aspects in building performance (building elements, services and environment) has high correlation with the building occupants' satisfaction levels, hence the POE guideline is recommended to be used to improve the performance of government and public buildings in Malaysia

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Table 1. Chronology of Defects Occurrence in Government and Public Buildings

DATE/YEAR	CHRONOLOGY OF DEFECTS OCCURENCE
April 2005	Collapsed ceiling at Parliament Building
*Year 2006	Fungus infection on wall at Hospital Sultanah Aminah, Johor Bharu
*Year 2007	Defects at Navy Recruit Training Centre (PULAREK), Johor
*Year 2007	NKVE-Meru highway collapse
*Year 2007	Floods from 7 th floor down to 2 nd floor at Immigration Department Putrajaya
*Year 2007	Plaster ceiling collapse at Entrepreneurial Department Putrajaya
14 May 2007	Collapsed ceiling at the new court complex in Jalan Duta, Kuala Lumpur
17 May 2007	Collapsed ceiling at Parliament Building
21 May 2007	Leaking pipes caused flooding at the new court complex in Jalan Duta, Kuala Lumpur
28 May 2007	Collapsed ceiling at Hospital Sultan Abdul Halim, Sg. Petani, Kedah
November 2007	Fungus infection on wall at Hospital Umum Sarawak (HUS), Kuching
November 2007	Fungus and spores detected on wall at Hospital Temerloh (HoSHAHS) Pahang

*Exact date not available

Table 2. Score for Building Performance Review Based on the POE Guideline

NO	BUILDING ELEMENTS, SERVICES & ENVIRONMENT	PERFORMANCE SCORE (PS)							
		<i>"Poor" if $0.10 \leq PS \leq 0.40$, "Good" if $0.60 \leq PS \leq 0.9$ </i>							
		<i>"Medium" if $PS = 0.50$, "Excellent" if $PS = 1.0$ </i>							
		BLDG #1	BLDG #2	BLDG #3	BLDG #4	BLDG #5	BLDG #6	BLDG #7	BLDG #8
1.	Floor Finishes	0.60	0.70	0.80	0.80	0.80	0.70	0.80	0.60
2.	Wall Finishes	0.60	0.70	0.80	0.80	0.8	0.90	0.80	0.80
3.	Ceiling Finishes	0.70	0.70	0.70	0.80	0.90	0.70	0.80	0.90
4.	Door	0.70	0.70	0.70	0.90	0.80	0.80	0.70	0.80
5.	Window	0.60	0.70	0.70	0.90	0.90	0.70	0.80	0.70
6.	Staircase	0.60	0.80	0.70	0.90	0.90	0.70	0.80	0.80
7.	Roof	0.70	0.60	0.80	0.70	0.80	0.60	0.80	0.70
8.	Quality of Finishes	0.60	0.60	0.80	0.80	0.80	0.70	0.70	0.70
9.	Quality of Structure	0.80	0.60	0.70	0.90	0.80	0.80	0.70	0.70
10.	Physical Maintenance	0.50	0.60	0.50	0.60	0.60	0.50	0.70	0.60
11.	Safety & Security	0.80	0.80	0.90	0.80	0.90	0.80	0.80	0.90
12.	Level of Cleanliness	0.80	0.70	0.90	0.80	0.80	0.90	0.80	0.80
13.	Quality of Lightings	0.60	0.70	0.60	0.70	0.80	0.50	0.70	0.60
14.	Air-Conditioning	0.80	0.70	0.50	0.90	0.80	0.40	0.80	0.70
15.	Landscaping	0.70	0.80	0.80	0.80	0.80	0.70	0.80	0.80
16.	Lift/Escalators	0.60	0.70	0.60	0.80	0.90	0.60	0.80	0.70
17.	Electrical & Mechanical	0.60	0.70	0.50	0.60	0.80	0.70	0.70	0.60
18.	Water & Plumbing Services	0.60	0.60	0.60	0.70	0.80	0.60	0.70	0.70
19.	Noise Pollution or Vibration	0.60	0.60	0.80	0.80	0.90	0.50	0.80	0.80

Table 3. Result of Occupants' Satisfaction Score

QUESTIONS (SECTION B OF QUESTIONNAIRE)	OCCUPANTS' SATISFACTION SCORE (SS)							
	“Discomfort” if $0.10 \leq SS \leq 0.49$				“Neutral” if $0.50 \leq SS \leq 0.59$			
	“Comfort” if $0.60 \leq SS \leq 1.0$							
	BLD #1	BLD #2	BLD #3	BLD #4	BLD #5	BLD #6	BLD #7	BLD #8
Q1- How satisfied are you with the finishes of the floor (its aesthetics, durability, suitability)?	0.58	0.65	0.73	0.77	0.73	0.66	0.62	0.60
Q2- How satisfied are you with the finishes of the wall (its aesthetics, durability, suitability)?	0.52	0.69	0.71	0.85	0.81	0.63	0.67	0.65
Q3- How satisfied are you with the finishes of the ceiling (its aesthetics, durability, suitability)?	0.57	0.64	0.61	0.77	0.81	0.66	0.65	0.71
Q4- How satisfied are you with the provision of door (its aesthetics, durability, suitability)?	0.55	0.67	0.67	0.84	0.82	0.63	0.63	0.71
Q5- How satisfied are you with the provision of window (its aesthetics, durability, suitability)?	0.40	0.64	0.55	0.87	0.83	0.58	0.71	0.70
Q6- How satisfied are you with the provision of staircase (its aesthetics, suitability)?	0.58	0.64	0.61	0.85	0.82	0.65	0.79	0.72
Q7- How satisfied are you with the finishes of the roof (its aesthetics, suitability)?	0.57	0.68	0.61	0.83	0.81	0.63	0.75	0.67
Q8- How satisfied are you with the overall quality of finishes in this building?	0.57	0.56	0.65	0.81	0.73	0.60	0.69	0.65
Q9- How satisfied are you with the overall quality of structure in this building?	0.57	0.60	0.65	0.80	0.82	0.65	0.71	0.67
Q10- How satisfied are you with the physical maintenance in this building?	0.49	0.52	0.35	0.59	0.54	0.46	0.56	0.53
Q11- How satisfied are you with the safety and security in this building?	0.62	0.71	0.78	0.68	0.78	0.58	0.74	0.65
Q12- How satisfied are you with the level of cleanliness in this building?	0.68	0.64	0.78	0.79	0.80	0.68	0.74	0.71
Q13- How satisfied are you with the quality of lightings (natural & artificial) in this building?	0.58	0.61	0.54	0.75	0.76	0.41	0.66	0.59
Q14- How satisfied are you with the cooling system (air-conditioning) in this building?	0.52	0.68	0.39	0.84	0.78	0.39	0.72	0.56
Q15- How satisfied are you with indoor and outdoor landscape in this building?	0.46	0.51	0.81	0.73	0.80	0.53	0.66	0.66
Q16- How satisfied are you with the lift/escalators system?	0.54	0.68	0.56	0.81	0.84	0.55	0.72	0.65
Q17- How satisfied are you with quality of electrical and mechanical fittings in this building?	0.46	0.61	0.38	0.53	0.84	0.53	0.52	0.59
Q18- How satisfied are you with the water and plumbing services in this building?	0.55	0.59	0.54	0.80	0.72	0.59	0.69	0.66
Q19- How satisfied are you with the noise pollution or vibration? (eg. traffic, mechanical systems)	0.57	0.51	0.68	0.80	0.81	0.54	0.75	0.68

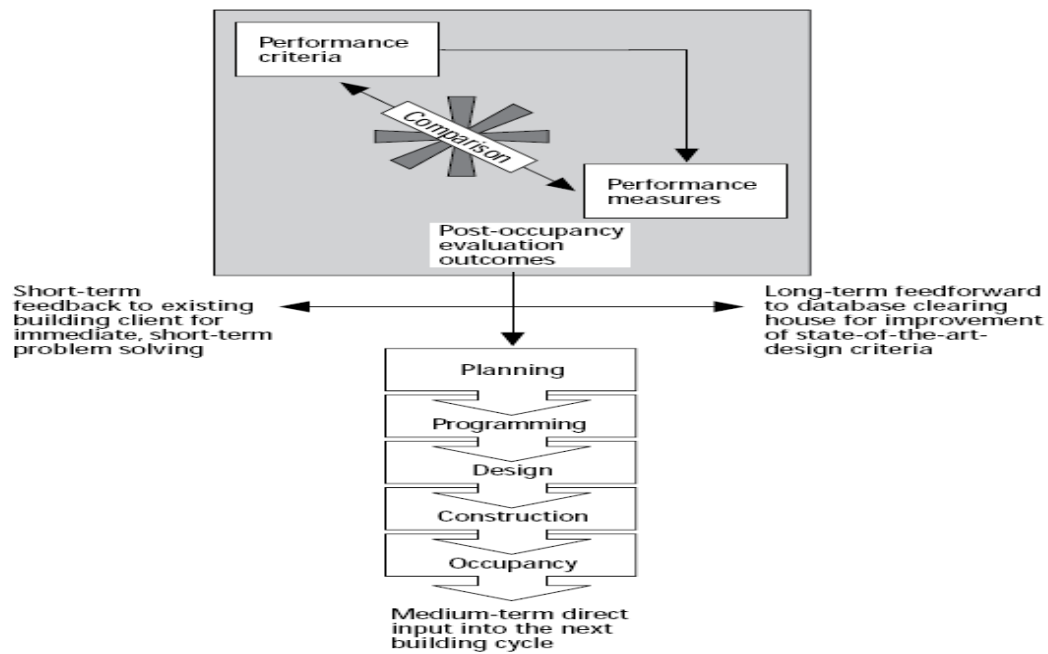


Figure 1. The performance concept in the building delivery process

(Source: Preiser, 1995)

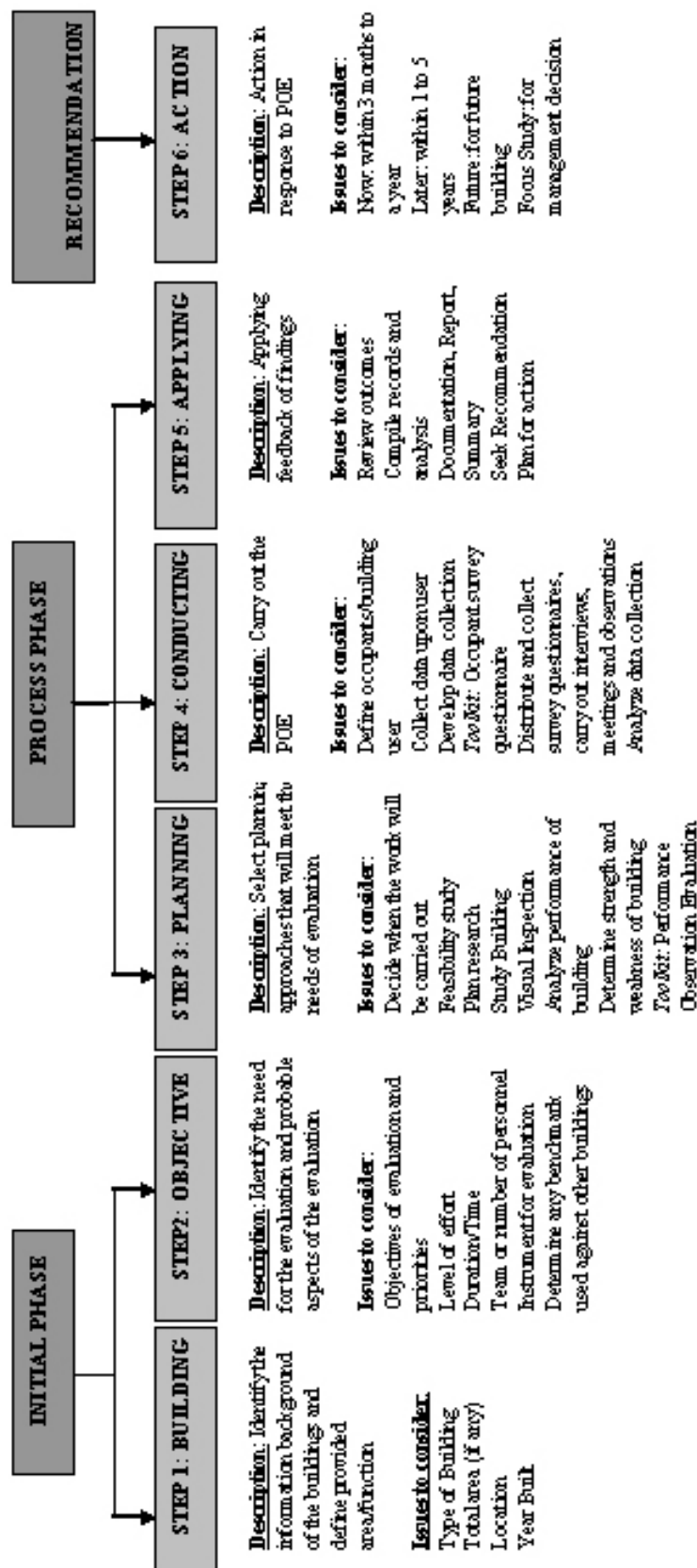


Figure 2. Proposed Guideline of POE for Government and Public Buildings in Malaysia

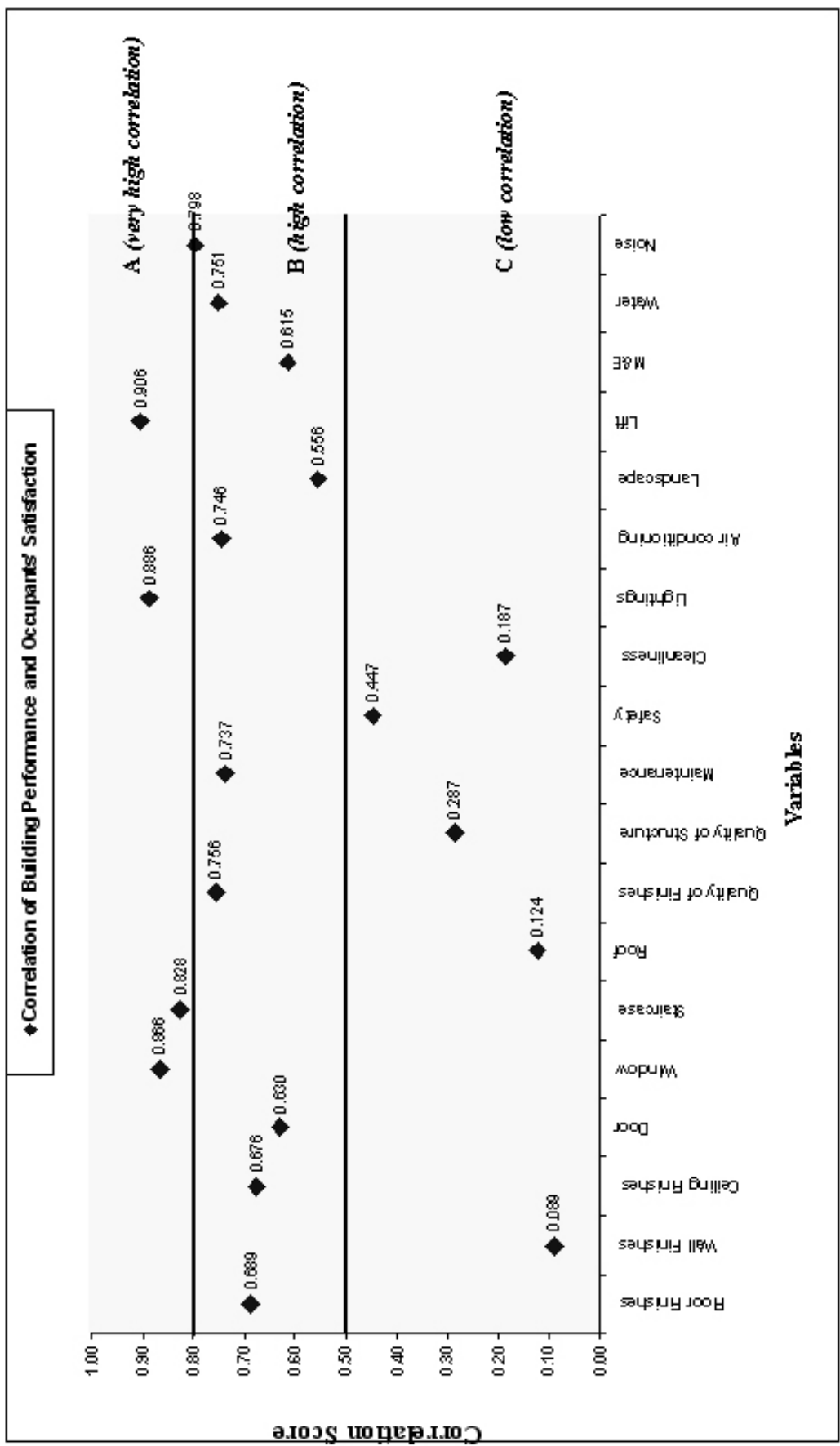


Figure 3. Correlation between building performance and occupants' satisfaction by Kendall's Tau correlation