Post Occupancy Evaluation (POE) of Indoor Environmental Quality (IEQ) in Malaysian GBI Rated Office Buildings: A Pilot Study

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Abstract— **This pilot study aims to examine the possibility of association between the non-environmental factors in Indoor Environmental Quality (IEQ) with occupants' satisfaction in an office building. The research questionnaire consists of 24 items where section A has 12 items that inquire on respondents' demographic profile while another 12 items are allocated to section B. The questionnaires were distributed to 100 occupants that are working in the rated green office building. The respondents were asked to select their preferences based on a seven-point Likert scale of agreement and satisfaction for section A and multiple answer question for section B. Results of the pilot survey indicated that there is a significant relationship between the non-environmental factors of the Indoor Environmental Quality (IEQ) with occupants' satisfaction in an office building especially on the aspect of building characteristic (façade). These results highlight the importance of the Indoor Environmental Quality (IEQ) non-environmental factors of the dimension such as office layout, furnishing, personal control, cleanliness and maintenance and building characteristic (façade) in perceiving occupants' satisfaction. Analysis of the data from the pilot study was conducted by using SEM-PLS: to examine the reliability and validity of the questionnaire which determine the significance of the independent variables and dependent variable of this study.**

Keywords—POE, IEQ, Non Environmental Factors, Office

I. INTRODUCTION

Recently, a significant change in the construction industry has increased the interest in green design and sustainable materials. Similarly, the development and introduction of sustainable building codes are taking place around the world with vast support from prominent organizations [1]. Thus, the establishment of green building certification systems worldwide is seen as one of the significant efforts among the numerous efforts in the emerging green building movement. Consequently, as an acceleration of the Malaysian sustainable construction industry and the use of green technology in Malaysia, Green Building Index (GBI) was launched by the government on 21 May 2009 [2]. The GBI is a green rating index on environmentally friendly building with the ability to save utility costs and preserve the quality of the external and internal environment.

Subsequently, some research suggests that occupants in environmentally sustainable buildings feel better psychologically even though this area of research is still in its infancy stages. Thus, the construction of green and sustainable buildings has increased due to the increasing level of awareness on the sustainability issues globally to reduce the negative environmental impact to building indoor space and increase occupants' satisfaction [3,4]. One of the most crucial aspects in GBI Malaysia assessment criteria is the Indoor Environmental Quality (IEQ). The IEQ can be defined as "the measurement of the key parameters affecting the comfort and well-being of occupants" or the "elements to provide an environment that is physically and psychologically healthy for its occupants"[5]. Preceding literature reviews that have investigated on the issue of satisfaction of building occupants in indoor environments were primarily focused on the effects of the environmental factors on the IEQ. Majority of the previous reviews was made by exploring the conditions that lead to satisfaction with the visual environment [6] or with the acoustic environment [7], the visual environment [8] or the thermal environment [9,10]. According to [11], none of the reviews have been conducted in identifying the possible influence of the non-environmental factors on the overall IEQ criteria in a building towards perceived satisfaction by its occupants. Therefore, the present pilot study was performed to examine the possibility of the association between factors unrelated to the indoor environment with occupants; satisfaction in an office building.

II. Hypothesis and Research Model

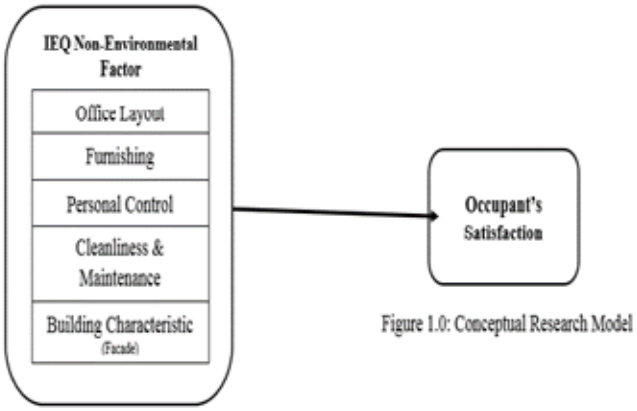

Fig. 1. Conceptual Research Model

Subsequently, this study has 5 hypotheses that are tested in this initial study which are as follows:

H1. Indoor Environmental Quality (IEQ) non-environmental factors has a positive relationship with Occupants' Satisfaction

H1a. Office Layout has a positive relationship with Occupants' Satisfaction

H1b. Furnishing has a positive relationship with Occupants' Satisfaction

H1c. Personal Control has a positive relationship with Occupants' Satisfaction

H1d. Cleanliness & Maintenance has a positive relationship with Occupants' Satisfaction

H1e. Building Characteristic (Façade) has a positive relationship with Occupants' Satisfaction

III. Methodology

This employed a cross-sectional research design that enables the integration of the literature review and the real data survey that utilizes both the subjective and objective measurement as the main procedure of data collection [12]. Therefore, the initial stage of this study is to test the reliability and validity of the instruments (subjective measurement) by conducting a hands-on survey to the building occupants. The unit analysis of this study is the occupants in the rated office building in Malaysia that include the administrative, technical person, professionals, and others that work daily at the selected building. The selected building is a government building located in the heart of Kuala Lumpur Malaysia with an occupancy rate of over 700 occupants and had been occupied and fully operated for less than 2 years. This beautiful and modern design green office building was awarded the Platinum award by the GBI Malaysia in its Provisional Stage. Thus, this study employs a non-probability purposive sampling since it is not possible to obtain the list of all the elements of the building population due to its private and confidential policy. Hence, as for this study, a total of one hundred (100) questionnaires were distributed among the occupants in the selected GBI office building by hand. A total of 81 questionnaires were received which represents an approximately 81% of response rate. The survey questionnaires used in this study consist of four sections. The first section of the questionnaire focuses on the independent variable (IV) of the study which is the Indoor Environmental Quality (IEQ) that comprises of five dimensions; (1) Office Layout, (2) Furnishing, (3) Personal Control, (4) Cleanliness & Maintenance and (5) Building Characteristic (Façade). All 21 items in the first section are adapted from the Methodology, Centre for the Built Environment (CBE) [22] and Building Occupants Survey System Australia (BOSSA) [23] post occupancy evaluation and the literature review. The second section of the survey is focused on the aspect of occupants' satisfaction as the dependent variable with three (3) items. The items in this section are taken from various sources of literature on satisfaction. The items in the both sections were measured using a 7-item scale.

IV. Analysis

SPSS and SEM-PLS was employed to assess the reliability and validity of the survey questionnaires data and conduct preliminary testing the research hypothesis. The demographic profile of the respondents is analysed using the SPSS while the measurement model of the research framework was analysed by using the SEM-PLS. Table I summarises the results of the measurement model of the conceptual framework. The model consists of 21 independent variable items that were then divided into 4 items for office layout, 4 items of furnishing, 4 items for personal control, 4 items on the aspect of cleanliness and maintenance and lastly 5 items for building characteristic (Facade). As for the dependent variable of the model which is Occupants' Satisfaction, the original number of items was 4 and was then reduced to 3 items to increase the reliability of the variable. The model was then analysed again using SEM-PLS algorithm function with a total of 6 variables that are comprised of 24 items. Results of the model are presented as illustrated in Figure 1. Subsequently, it is to test the goodness of the proposed conceptual model and further rectify its validity as an instrument for real study data collection, there are few test and figures that need to be finalised within its acceptable range of measurement. Two of the significant tests that need to be taken into consideration in determining the goodness of measure for a model are reliability and validity test. According to [13], reliability is a test of measuring the consistency of the instruments while validity is a test that indicates the wellness of the developed instrument in measuring a concept of the study. Reliability of the measurement model can be accessed using two values which are the Cronbach's alpha coefficient of above 0.6 in assessing the inter-item consistency and through composite reliability where value ranged from 0.7 or greater is considered as acceptable [14]. As for this study, Table I indicates that the composite reliability of the model measurement values ranged from 0.828-0.935 for Cronbach's Alpha value and range of 0.880-0.954 for composite reliability as portrayed in Table I. Thus, the values prove that it is acceptable to consistently measure the instruments.

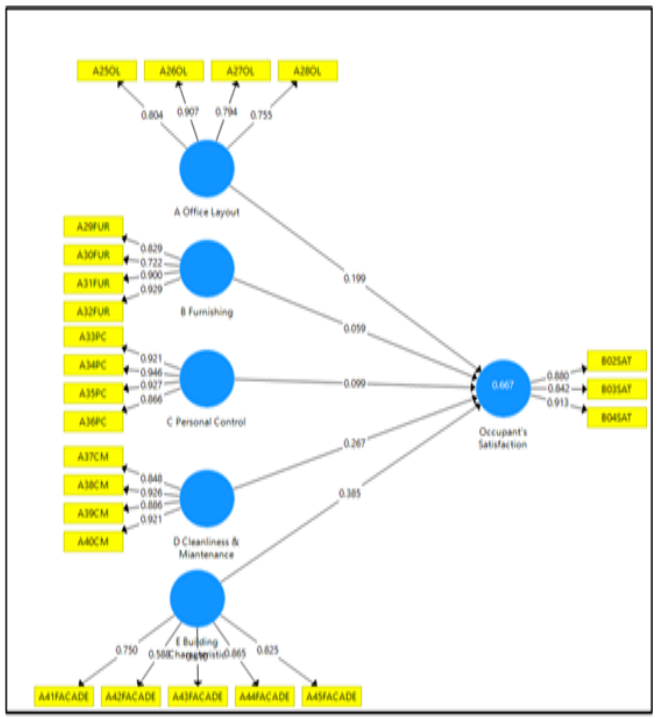

Fig. 2. SEM-PLS Algorithm Value of the Measurement Model (Indicator: A. Office Layout; B.Furnishing; C.Personal Control;D.Cleanliness and Maintenance; E. Building Characteristic (Façade) – DV : Occupabts Satisfaction)

Following table shows results of the research measurement model analysis using SEM-PLS:

TABLE I. MEASUREMENT MODEL ANALYSIS RESULT

Construct	Item	Convergent Validity		Internal Consistency Reliability		Discriminant Validity	
		Cross Loading	AVE	Cronbach Alpha	Composite Reliability	HTMT	VIF
		>0.50	*>0.50*	*0.60-0.90*	*0.60-0.90*	*>1*	*<5.00*
Office Layout	4	0.755-0.907	0.668	0.833	0.889	Yes	2.495
Furnishing	4	0.722-0.929	0.721	0.869	0.911	Yes	2.522
Personal Control	4	0.866-0.946	0.838	0.935	0.954	Yes	1.394
Cleanliness & Maintenance	4	0.848-0.926	0.802	0.918	0.942	Yes	2.031
Building Characteristic (Façade)	5	0.588-0.865	0.599	0.828	0.880	Yes	1.848
Occupant's Satisfaction	3	0.842-0.913	0.772	0.852	0.910	Yes	

The main purpose of a validity test is to measure the theories fitness of the designed test [13]. It can be divided into two tests which are convergent validity and discriminant validity. Convergent validity can be assessed by looking at the results of measurement model's factor loading, composite reliability and its average variance extracted (AVE) [15].

Table I shows that the factor loading of each item in the construct exceeded the endorsed value of 0.5 as stated by [15]. Although the cross-loading value of the second items in the fifth construct (Building Characteristic) was quite low, it still passes the minimum requirement value of 0.50. This low loading value may be due to the small sample size of the respondents in the pilot study. Subsequently, Table I also further confirms the validity of the model by indicating the value of composite reliability of the model that ranged from 0.880-0.954, which surpassed the recommended value of 0.7[16]. The model's average variance extracted (AVE) values also exceed the expected value of 0.5 [14], [15] and [17] with the range of 0.559-0.838 that reflects the overall amount of variance in the items for the latent construct. Thus, the result for convergent validity is acceptable for this model. The next test that needs to be taken into consideration is the discriminant validity test that explores the degree to which definite measure of one variable is not a reflection of another variable in the model. According to [18], discriminant validity test can be

indicated by the low correlation between items in a different construct. This test can be identified by looking at the collinearity statistic of the Varian Inflation Factor (VIF) value of the constructs. Table I rectifies that all constructs in the model obtain VIF values of less than 5. Therefore, it can be concluded that there are no collinearity issues between the constructs in the proposed conceptual model.

To further examine the status of model discriminant validity, it is best to assess the discriminant validity in SEM-PLS by looking at the HTMT criterion value to auxiliary confirm that the items across construct do measure different construct in the model. This can be identified by looking at the fact that the confident interval value of HTMT statistic must not comprise the value of 1 for an entire combination of the construct and by assessing the value of HTMT below 0.90 [16] as presented in Table I. Based on the above discussion of the model measurement findings, it can be concluded that all five constructs of the IEQ: Non-Environmental Factors which are the office layout, furnishing, personal control, cleanliness & maintenance, and building characteristic are all valid measures of their individual constructs based on their factor estimations and statistical significance. It can also be summarised that the measurement model established adequate reliability and validity standard that can be used in the main data collection stage.

V. Conclusion

This initial study tested a conceptual framework based on the literature on indoor environmental satisfaction. The instrument used in this study fulfill the acceptable requirements of the reliability and validity analyses. The outcome of the path model analysis has confirmed that Indoor Environmental Quality (IEQ) is significantly correlated with Occupants' Satisfaction. At present, the main data collection has been conducted in several GBI rated office buildings in Malaysia and currently in the analysis and writing process to further clarify the roles of the non-environmental factors of the IEQ in predicting occupant's satisfaction on a larger scale. The results from the main data collection are expected to be published in the nearest future.

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