Jurnal
Teknologi

Full Paper

# POST OCCUPANCY EVALUATION OF PHYSICAL ENVIRONMENT IN PUBLIC LOW-COST HOUSING

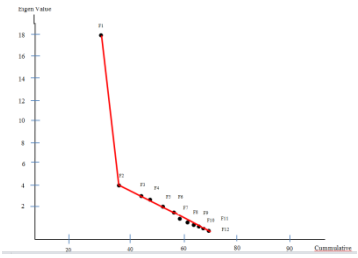
Nurhayati Khair[a,b*], Hishamuddin M. Ali[a], Ibrahim Sipan[a], Nur Hafizah Juhari[a], Siti Zaleha Daud[a]

[a]Faculty of Geoinformation and Real Estate, Universiti Teknologi Malaysia, 81310 UTM Johor Bahru, Johor, Malaysia
[b]Faculty of Accountancy and Management, Universiti Tunku Abdul Rahman, Bandar Sungai Long, 43000 Kajang, Selangor, Malaysia

**Article history**
Received
*6 April 2015*
Received in revised form
*12 August 2015*
Accepted
*23 August 2015*

*Corresponding author
hishamuddin@utm.my

## Graphical abstract



## Abstract

Malaysian government has introduce public low-cost housing during Malaysian Plan as an initiative to help the low-income household owners and squatters. However, in developing the low-cost housing, the quality and environmental aspects should be emphasized. Post Occupancy Evaluation (POE) is an approach in assessing existing building performance and future development of buildings to ascertain feedback from occupants after the building has been occupied for some time. This paper determines the physical environment based on occupants preference by using the POE tools. Physical environment elements obtained through literature review consists of facilities, spaces and services offered in each housing unit. A sum of 13 physical environment elements were measured by 868 occupants in Johor's Public Low-cost Housing. Convenience sampling technique was the method used to determine the adequacy of sample throughout data collection process, subsequently it has been analyzed using frequency and factor statistics. The study reveals that physical environment elements were playing the crucial role in every housing unit. However, dwelling unit features, housing conditions and location were mainly the highest preference amongst occupants. In fact, physical environment elements plays an entirely crucial role in developing occupant's comfort and satisfaction. Nevertheless, a few physical elements that show the least preferable amongst occupant such as external utilities and services, management, lighting and ventilation need to be given more attention in order to create a better environment in the future.

*Keywords*: Post-occupancy evaluation, physical environment elements, public low-cost housing

## Abstrak

Kerajaan Malaysia telah memperkenalkan Projek Perumahan Rakyat dalam Rancangan Malaysia sebagai satu inisiatif bagi menempatkan golongan yang berpendapatan rendah dan penduduk setinggan. Walau bagaimanapun, aspek kualiti persekitaran dan keselesaan penduduk perlulah dinilai dalam membangunkan perumahan kos rendah rakyat ini. Penilaian Selepas Menduduki ataupun *Post Occupancy Evaluation* (POE) merupakan pendekatan yang telah dibangunkan bagi menilai prestasi bangunan sedia ada dan bakal dibangunkan untuk mengenalpasti maklumbalas daripada penghuni setelah sesebuah bangunan didiami. Kertas kerja ini mengukur persekitaran fizikal yang mempengaruhi tahap kepentingan penduduk melalui pendekatan POE. Seramai 868 penghuni telah memberi maklum balas soal selidik mengenai 13 elemen persekitaran fizikal bagi unit kediaman di Projek Perumahan Rakyat di sekitar negeri Johor. Teknik persampelan *convenience* digunakan bagi menentukan sampel yang digunakan dalam proses pengumpulan data dan seterusnya, ia dianalisis menggunakan statistik frekuensi dan faktor. Hasil kajian mendapati bahawa hampir keseluruhan penduduk berpendapat persekitaran fizikal sangat penting dalam sesebuah unit kediaman. Walaubagaimanapun,

elemen-elemen persekitaran fizikal yang paling dititikberatkan pada perspektif penghuni adalah penggunaan ruang dalam bangunan kediaman, kualiti bangunan dan lokasi. Merujuk kepada keseluruhan elemen-elemen persekitaran fizikal ia merupakan aspek yang penting dalam membentuk keselesaan dan kepuasan penduduk. Namun begitu, elemen-elemen persekitaran yang kurang dititikberatkan oleh penghuni seperti perkhidmatan dan utiliti luar bangunan, pengurusan, pencahayaan dan pengudaraan perlu juga diberi perhatian dalam membentuk persekitaran yang lebih baik pada masa akan datang.

*Kata kunci*: *Post-occupancy evaluation*, elemen-elemen persekitaran fizikal, projek perumahan rakyat



## 1.0 INTRODUCTION

Housing and the environment is one of the basic requirements that affect the quality of life of residents, especially the physical, economic, social, and psychological. [53]. Theoretically, housing is seen as an entity that encompasses several aspects such as physical quality, location and services offered in a house [27]. However, according to reports Utusan Malaysia on 29th April 2008, there were several complaints from occupants of public low-cost housing. The quality of the flats provided was below par in terms of comfort. In addition, the flats did not have collateral security implications of careful monitoring being carried out after a complaint is received by the Management. Evaluation for the physical environment elements in public low-cost housing if not carried out carefully will cause issues regarding the quality of the physical environment to become worse. As a result, the frequent complaints received described failures in achieving the main objectives for developers in developing public low-cost housing. In addition, failure to achieve quality housing will create more serious problems such as social phenomena among the occupants, environmental pollution, and resident's mental health distress [53].

In fact, the general recommendations set out in *Rancangan Tempatan Daerah Johor Bahru, 2002-2020* is also focused towards the planned physical environment in Johor Bahru City. With the transformation of Johor Bahru City into an international hub, the physical aspects of the planned development and housing play an increasingly important role in meeting the needs of the occupants. Suitability requirements and demands of the occupants should be identified in the determination of the physical aspect of a housing development. Yet, there is no uniformity in evaluating aspects of the physical environment. Research studies have so far touched on certain aspects only.

Previous studies on the evaluation of housing devlopment have investigated certain elements but these elements are not sorted and listed as a guideline for the development of future housing. Therefore, the need for occupants' feedback on the service and the physical environment plays a very important role in determining the quality of housing. Thus, a study on specific elements of the physical environment should be identified to address similar complaints and issues that occur repeatedly. Therefore, the evaluation of occupants' feedback on the physical environment elements play an important role for the development of low-cost housing and should be given emphasis by the government in providing a comfortable and better quality housing, especially for the low income household.

Post Occupancy Evaluation (POE) is developed as an approach not only to reduce the environmental and financial costs, but also to improve the quality of life and provide comfort to the occupants and increase productivity inhabited building [28]. POE is an approach that provides a systematic assessment of a building. It is assessed by the occupants or users who use the building and is the tool that is used to acquire feedback on the building performance [18]. Feedbacks from occupants are used as a guide for future development [44]. This approach indirectly helps to improve the design and performance of a building. Through the POE, this study aims to present the occupants preferences regarding the physical environment of the building.

## 2.0 LITERATURE REVIEW

### 2.1 Physical Environment Elements

Physical environment refers to the external facilities and public spaces in the entity owned by a building [48]. It refers to the spaces in a building that will provide performance improvement in a building. The physical environments also affect the level of satisfaction of users through their views and perceptions and assessments of the environmental features such as building design, density and location [49]. The quality of the environment is not only focused on personal space but, it includes the development of the external environment and public space. In order to achieve quality housing, there are three important human needs that must be achieved in advance to ensure that residents' lives are safer.

The essential requirements that must be included in a housing listed by the American Public Health Association (1971) are as follows: -

i. Psychological needs
ii. Protection from diseases
iii. Protection from any accidents

Basically, each component within the housing is designed to meet the social needs related to daily life, including the occupant's psychological needs. There are some elements of the physical environment that affect the mental development population for example, noise level, social and density. Therefore, it can be concluded that good housing is fundamental to the health and lives of people [13]. The physical environment is one factor that influences the activity of the population in various ways [1]. According to Djebarni and Abed (1998) the environment is classified into two categories as follows:

1. **Interior of housing unit:** Elements that form the internal structure of a residential building and consists of elements humidity, lighting, heat, ventilation, water supply, irrigation systems, drainage and kitchens.
2. **Exterior of housing unit:** Elements of supporting external structure of a building, including the surface of walls, roofs, doors and windows, exterior paint quality building and stairs.

Quality housing development is linked to the elements of the physical environment that is planned. There are 13 main elements that have been identified that tend to improve the quality of life and a priority population to population. Elements of the physical environment are represented by indicators that contribute to the process of the building life-cycle in a long period. Table 1 shows the elements of the physical environment as well as the indicators that contribute to improving the quality of life of building occupants and building performance.

**Table 1** Physical environment elements and indicators [a]

| Physical Environment Elements | No. of Item | Sources |
|---|---|---|
| Health and Safety | 4 | Ralid, 2003; Ge, Hokao, 2005; HEFCE, 2006; Berkoz *et al*, 2009; NA Salleh, *et al*, 2011; & Ibem and Amole, 2011. |
| Lighting | 3 | Ge, Hokao, 2005; Calvert, 2009; Ilesanmi, 2010; Ibem and Amole, 2011. |
| Ventilation | 4 | Liu, 1999; Meir *et al*, 2009; Opoku, Abdul-Muhmin, 2010; NA Salleh, *et al*, 2011. |
| Temperature and Humidity | 4 | Voordt and Wegen, 2005; Leaman, 2005; HEFCE, 2006; Ghoz lane Fleury-Bahi *et al*., 2008; Meir, *et al*., 2009. |
| Noise | 3 | Pacione, 1984; Savasdisara *et al*., 1989; Ilesanmi, 2010 |
| Aesthetic | 4 | Berkoz *et al*., 2009; Lee and Chan, 2010; NA Salleh, *et al*., 2011 |
| Dwelling Unit Features | 9 | Opoku, Abdul-Muhmin, 2010; Mohit *et al*, 2010; NA Salleh, *et al*,. 2011; Ibem & Amole, 2011. |
| Location | 9 | Kellekci &Berkoz, 2009; Calvert, 2009; Berkoz *et al*., 2009; Mohit *et al*., 2010; NA Salleh, *et al*., 2011; Ibem &Amole, 2011. |
| Management | 4 | Pushpa &Rosadah, 2008; Jiboye, 2009; NA Salleh, *et al*., 2011. |
| Utilities and Services | 8 | Nurhayatii Sebli, Bujang Ahmad Ariffian, 2008; Mohit *et al*,. 2010; Kellekci & Berkoz, 2009; Mohit *et al*., 2010; Ilesanmi, 2010; NA Salleh, *et al*., 2011. |
| Housing Condition | 5 | Ukoha & Beamish, 1997; Liu, 1999; NA Salleh, *et al*., 2011. |
| Crowding/ Density | | Nurhayatii Sebli, Bujang Ahmad Ariffian, 2008; Wu, 2010. |
| Privacy | | Jauzens *et al*., 2003, Voordt &Wegen, 2005; Jiboye, 2010; Ilesanmi, 2010; NA Salleh, *et al*., 2011; Ibem &Amole, 2011. |

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## 2.2 Building Evaluation Technique

Building evaluation is the systematic assessment of building performance. This assessment process is to evaluate how buildings work better, who occupies, owns and manages it [2]. Information on the performance of the building as well as the evaluation of a building in terms of comfort and ability to enhance the occupants' daily activities is important. There are several techniques in assessing the performance of a building as shown in Table 2.

**Table 2** Justification of elements for building evaluation technique

| Building Evaluation Technique | Type of Building | Elements |
|---|---|---|
| [1] Functional Suitability Assessment<br>- approach is to evaluate functional suitability, space utilization, physical condition, safety and statutory, energy performance [14] | Lanakshire Health Board, Scotland | Functional Suitability, Space Utilization, Physical Condition, Safety and Statutory, Energy Performance. |
| [2] Building Quality Assessment<br>- approach is a tool in scoring the performance of a particular building based on actual performance according to the need of the occupants in that building [6] | School, Office Building | Presentation, Space, Access and circulation<br>Business services, Personnel ammenities, Working environment, Health and safety, Structural considerations, Manageability. |
| [3] Serviceability Tools and Methods (STM)<br>- Matching occupant requirements and facilities [9] | Office Building | Support for office work, Meetings and Group Effectiveness, Sound and Visual environment, Thermal environment and indoor air. |
| [4] Building Research Establishment's Environmental Assessment Method – BREEAM<br>- assess the environmental performance of both new and existing building [20] | Residential | Indoor environmental quality, Air quality, Intrusion, Control, Appearance, General, Lighting |
| [5] Hombsat<br>- An instrument for measuring homebuyer satisfaction. To test HOMBSAT instrument data were collected from homebuyers regarding their level of satisfaction [41] | Residential | Design dimension, House dimension, and Service dimension |
| [6] Quality Function Deployment (QFD)<br>- Aim to provide customer satisfaction and to ensure product quality throughout the production process. [48] | Public Housing | Design quality |
| [7] Post Occupancy Evaluation (POE)<br>- Process of evaluating buildings in a systematic and rigorous manner after they have been built and occupied for some time [35] | Student dormitories, Hospital, Public Housing, Office Buildings. | Technical, Functional and Behavioral |

Based on all the building evaluation techniques, only Post Occupancy Evaluation or POE takes into account feedback from the user during the building evaluation process [46]. POE is different from other techniques because it evaluates all environment aspects, rather than only focusing on one aspect [47]. POE is basically the approach in evaluating the performance of the environment after the building has been occupied, owned or used [47]. According to Masterson (1978), POE gives a description of the quality of the design environment based on occupant's perception. Thus, POE is systematically analyzes the environment, and describes whether it will facilitate or complicate the occupants' daily activities [44].

The study on POE began in 1960 and primarily focused on the environment in residential buildings, this is due to the development of housing at the time after the Second World War which increased dramatically [35]. Further research in the field has been limited to only POE of the physical environment as desired by the users of the building. POE also contributed a lot to the housing where it has created an impetus in raising housing quality while avoiding the negative impact of residential building. Therefore, the POE not only focused on physical environmental factors alone, but included the social and economic factors.

## 3.0 METHODOLOGY

Four (4) public low-cost housing schemes in Johor were involved in this study, involving a total of 868 respondents. Data obtained were analysed using Statistical Package for Social Science (SPSS) version 19. Frequency and factor analysis were carried out on the results of the questionnaire survey.

### 3.1 Instrument

The main objective for this paper is to determine the physical environment elements based on the occupants preference using the POE tools. To achieve this, questionnaires were used as the main source in collecting the data. Identification of the elements of the physical environment that influence the level of preference of the occupants is important for designing the questionnaire. Socio-demographic questions are general in nature and do not contain personal questions. Among the questions asked were those related to race, gender, age, occupation, marital status, monthly average income and the duration respondents occupy the existing flats. Sixty questions were designed to measure the residents' perceptions towards the physical environment, the question were

formulated in five point Likert-scale ranging from '1' for extremely unimportant, '2' for unimportant, '3' for neutral, '4' for important, '5' for extremely important for the particular elements. Data were analyzed using frequency analysis and factor analysis using Statistical Package for the Social Sciences version 19.0.

### 3.1 The Reliability of Instrument

The degree of measurement reliability of a research instrument, for example, a questionnaire survey is very important because it can produce a degree of constancy in every instrument measured. Cronbach's Alpha Test is an initial test to ensure that the study can be conducted to the next level. The Cronbach Alpha shows that the value of physical environment elements is 0.959, higher than the recommended index 0.8. The values obtained reflect that all the elements of the physical environment that are identified can be used as a tool in accordance with the level of preference amongst occupants in public low-cost housing.

### 3.2 Data Analysis

The collected data were analysed using factor analysis. Factor analysis was used to measure the level of preference towards the physical environment. By using this method, the elements and indicators of the physical environment will be grouped in a table below. The main purpose for this technique is to group some set of variables, namely the physical environment indicators into one set of factors or elements. Variables that have a relationship to one another will be grouped into one similar factor. Therefore, each factor that has a high correlation to a factor will be grouped into one physical environment element.

## 4.0 RESULT AND DISCUSSION

### 4.1 Respondents and Background

The public low-cost housing in Johor Bahru involved in this case study has been occupied for more than 5 years. The biggest number of respondents in terms of ethnicity is Malay 88.2%. 41.6% of the respondents are between 36 to 55 years old. The respondent's socioeconomic status is important to determine the entitlement to occupy the dwelling unit in a public low-cost housing. A majority of the respondents is self-employed, working as taxi drivers and businessmen with a reasonable monthly average household income of RM500-RM1000. Meanwhile, the highest education level among respondents is Sijil Pelajaran Malaysia. In fact, the highest number of people in a household is between 4 to 6 people making up 57.4%. The majority of the respondents have occupied the flats within 3 to 4 years (51.4% or 466 people).

### 4.2 Occupants' Preference of Physical Environment Elements

Factor analysis with Varimax rotation method was conducted to ascertain the occupants' preference to the physical environment in public low-cost housing. The Kaiser-Mayer-Olkin test is able to identify whether the listed elements are suitable for factor analysis. The KMO has a value of 0.939 which is higher than the recommended index of 0.50. There are 12 components of the factors that have eigen values greater than 1.0, all components of this factor contributed 69.442% change in the variance of the data. All the variables in the extracted factors have values greater than 0.1.

The findings (please refer to Table 3) indicate that the factors that have the highest value are the dwelling unit features. The highest eigen value is 18.016 representing the factors of Dwelling Unit Features with the variance of 30.535. Variables representing the use of space in residential buildings are size of dwelling, living room, bedroom, dining room, toilets and bathroom and kitchen, number and location of bedroom, laundry and washing area. Variables contribute to the high variance of changes made as the most important factor in the population's perspective. The factor that has the next highest correlation is the quality of the building. The value of this factor is of 4.507. The next important factor, which explained 5.369 of total variance, was the location factor consisting of nearness to town centre, school or workplace, police station, hospital, market or shops, shopping centres, religious buildings, recreational parks, and ease of access by public transport.

The next factor is related to the health and safety element which explained 4.957% of the total variance. Variables in the four factors listed by some researchers among them are [25], [12], [22] closely related to the housing needs of a major occupants' perspective. The next correlation are factors associated with the management. These factors are represented by the management and has a value of 1.168 which explained 1.979% of total variance. Lastly, the factors represented by external utilities and services have a value of 1.038 which explained 1.759% of the total variance. This factor is represented by the variables of ladder and lift, storage, drainage and telephone network. These factors which do not affect the daily lives of the occupants make it a less important factor in their perspectives. Thus, it can be concluded from the analysis that the three most important factors that affect the occupants' perspectives were dwelling unit features, housing condition, and location.

**Table 3** Factor analysis of physical environment in public low-cost housing

| Factors | Factor Loading | Eigen Value | Explained Variance | Cummulative |
|---|---|---|---|---|
| **Factor 1: Dwelling Unit Features** | | 18.016 | 30.535 | 30.535 |
| Dwelling Size | 0.718 | | | |
| Size of Living room | 0.805 | | | |
| Size of Bedroom | 0.828 | | | |
| Number of Bedroom | 0.828 | | | |
| Location of Bedroom | 0.809 | | | |
| Size of Dining room | 0.817 | | | |
| Size of toilets and bathroom | 0.782 | | | |
| Laundry and washing area | 0.745 | | | |
| Size of kitchen | 0.771 | | | |
| **Factor 2: Housing Condition** | | 4.507 | 7.639 | 38.174 |
| Quality of walls | 0.834 | | | |
| Quality of Floors | 0.840 | | | |
| Quality of windows | 0.839 | | | |
| Quality of Doors | 0.854 | | | |
| Quality of Painting | 0.791 | | | |
| Crowding/ Density | 0.473 | | | |
| Privacy | 0.470 | | | |
| **Factor 3: Location** | | 3.167 | 5.369 | 43.543 |
| Nearness to town centre | 0.598 | | | |
| Nearness to school/ workplace | 0.698 | | | |
| Nearness to police station | 0.746 | | | |
| Nearness to hospital | 0.782 | | | |
| Nearness to market/ shops | 0.723 | | | |
| Nearness to shopping centre | 0.654 | | | |
| Nearness to religious building | 0.632 | | | |
| Nearness to recreational park | 0.540 | | | |
| Ease of access by public transport | 0.537 | | | |
| **Factor 4: Health and Safety** | | 2.925 | 4.957 | 48.500 |
| Cleanliness | 0.733 | | | |
| Fire safety | 0.787 | | | |
| Safety from criminals | 0.856 | | | |
| Public Safety | 0.800 | | | |
| **Factor 5: Temperature and Humidity** | | 2.418 | 4.098 | 52.597 |
| Heating capacity | 0.738 | | | |
| Cooling capacity | 0.794 | | | |
| Humidity capacity | 0.797 | | | |
| Indoor/ outdoor temperature | 0.556 | | | |
| **Factor 6: Noise** | | 2.005 | 3.399 | 55.996 |
| Noise from neighborhood | 0.852 | | | |
| Noise from traffic | 0.901 | | | |
| Noise from outdoor | 0.892 | | | |
| **Factor 7: Aesthetic** | | 1.689 | 2.862 | 58.858 |
| Building Form | 0.746 | | | |
| External appearance | 0.774 | | | |
| Building Height | 0.703 | | | |
| Colour of Building | 0.651 | | | |
| **Factor 8: Internal Utilities and Services** | | 1.455 | 2.466 | 61.324 |
| Electricity | 0.794 | | | |
| Water Pressure | 0.807 | | | |
| Sewerage | 0.707 | | | |
| No. of Sockets | 0.405 | | | |
| **Factor 9: Ventilation** | | 1.315 | 2.229 | 63.554 |
| Fresh air availability | 0.612 | | | |
| Odour | 0.530 | | | |
| Indoor / Outdoor Air Quality | 0.707 | | | |
| Air Movement | 0.662 | | | |
| **Factor 10: Lighting** | | 1.269 | 2.150 | 65.704 |
| Natural lighting | 0.711 | | | |
| Artificial lighting | 0.796 | | | |
| Quality of lighting | 0.764 | | | |
| **Factor 11: Management** | | 1.168 | 1.979 | 67.683 |
| Garbage Collection System | 0.457 | | | |
| Amount of Rent Paid | 0.717 | | | |
| Handling of Residents' Complaints | 0.781 | | | |
| Responds to Necessary Repairs | 0.672 | | | |
| **Factor 12: External Utilities and Services** | | 1.038 | 1.759 | 69.442 |
| Ladder and Lift | 0.450 | | | |
| Storage | 0.687 | | | |
| Drainage | 0.624 | | | |
| Telephone network | 0.590 | | | |

## 5.0 CONCLUSION

In general, this paper indicates that all the physical environment elements are the main priorities in housing development. However, it will become the least or the most preferable based on the occupant's perspective. The occupant's perspective will be different within a low-cost and high-cost housing. There are some elements that should be given more emphasis in giving maximum comfort to the residents: dwelling unit features, housing condition, location and health and safety. However, it is not indicated that the

elements do not need to be addressed in improving the comfort of the residents, but the four elements tend to be more focused on the physical environment than other elements. As it is, elements such as temperature and humidity, noise, aesthetics, ventilation and lighting focused on a dwelling unit as perceived by those who occupied residential units. In addition, elements such as external services and utilities are given less attention by the occupants as a result of charges that will be imposed as in the case of maintenance of building services and utilities. In addition, this study can be useful for the developer or architect for any future housing development in order to enhance the comfort and level of satisfaction of the occupants.

## Acknowledgement

The authors appreciatively acknowledge Ministry of Higher Education (MoHE).

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