# Consumer Awareness in Energy Efficiency for Residential Houses in Peninsular Malaysia

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**Abstract.** Most energy efficiency (EE) measures implemented (or yet to be implemented) in Malaysia involve technological interventions, but it will rely on consumer behaviour including their awareness in energy consumption. This paper highlight the energy-saving awareness among consumers for residential houses which involves two main components: i) knowledge and ii) practice. The method for this study is using the questionnaires of 408 respondents from four zones in Peninsular Malaysia. Pearson Correlation analysis technique was used to examine the relationship of several variables with electricity saving awareness. The results of the analysis found that the both components, knowledge and practice have a significant relationship with consumer awareness. It shows that both components are very important to ensure the awareness of EE will be implemented by the consumer.

## 1 Introduction

Global is energy consumption has risen 30% in the last 25 years. As a developing country, Malaysia faces the same situation regarding this issue. Residential sector in Malaysia has been recorded to emit 2,347,538 tonnes of $CO_2$ and will rise up to 11,689,308 by 2020 [1]. Based on the report by Energy Commission of Malaysia, 20.6 % of electricity were from domestic users [2]. There were about 7.8 million registered as electricity consumers with the largest electricity utility in Malaysia, Tenaga Nasional Berhad (TNB). Figure 1 shows the distribution of electricity users in Peninsular Malaysia and from total 7.8 million, 82 % is domestic users (6.4 million), 17 % commercial, 0.4 % industrial and 0.6% from other types [3].

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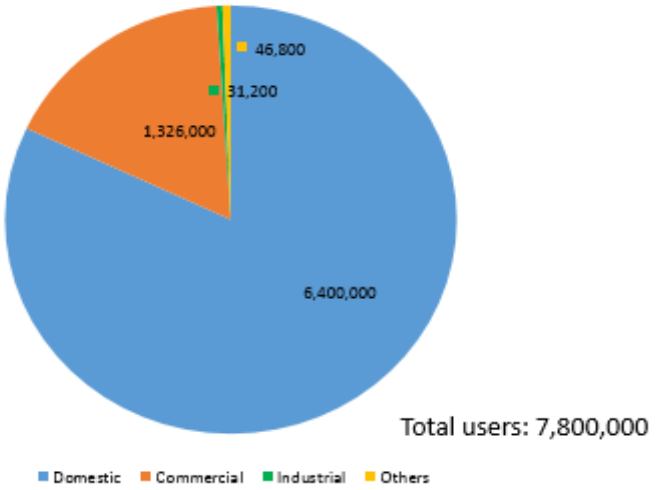


**Fig .1** Distribution of electricity users in peninsular Malaysia for 2013.

According to AWER [4], in this scenario, improvements in energy efficiency are regarded as the solution to increase the economic growth, and at the same time decrease the energy use. According to Noor Hanita [5], three major issues that are associated with energy efficiency were architectural (design) issue, appliances/services (technology) efficiency issue, and the human (behavioural) issue. Households have a direct connection between their energy efficiency behavior and the monthly or quarterly cost of energy. Furthermore, the potential for savings through behaviour change is thought to be greater in the domestic environment because there is more direct control over energy consumption [6]. Thus, this study is directed at residential buildings because more than one-third of the world's energy is used in buildings especially in residential building [7].

## 2 Literature Review

According to Fragidis [8], energy awareness is refer to the knowledge about how much energy is consumed. Consumers need to reduce their energy consumption but they do not know how to do it without the knowledge. More importantly, consumers need to know details about their energy consumption, such as how much electricity they use, when they use it, and how much it costs in time to appropriately impact their monthly electricity bill. On the other hand, the more knowledgeable they are, the more interested they are adopting energy saving practices. In the beginning, energy consumers' awareness is a first step in adopting energy saving behaviours [8]. Yet even with adequate knowledge of how to save energy and a professed desire to do so, many consumers still fail to take noticeable steps towards EE and conservation. Energy awareness towards energy saving requires an appropriate attitude and human behaviour of the house inhabitants [1]. It seems rational to assume that increasing consumers' awareness about their EE may influence their consumption behavior.

Based on the study that have been done in Nigeria, it focused on the issues to determine the factors that affect energy efficiency on pre-determined housing samples. The results of the study indicated that there is a strong correlation between attitude and behaviour to EE in the residential housess. In addition, the same researchers has done a social survey with the same issues but focused on the implication of the energy efficiency delivery specific in Bouchi town, Nigeria [9]. The result reveals a much lower level of EE practice by the

occupants due largely to lack of awareness and the requisite knowledge of EE. Moreover, a study has been conducted by Syed Hussain [10] to survey energy-saving awareness among students at Universiti Utara Malaysia (UUM), Malaysia. This research involves three main components which is knowledge, views and actions. The results found that the level of awareness about energy saving among UUM students is low and this has caused a great burden on the university management in terms to pay the cost of electricity bills. Therefore, they suggested the further concerted effort must be put in place towards improving the level electricity saving awareness among UUM students. In the same way, according to Noor Hanita [5] factors such as awareness and social status may have implication on EE awareness but not necessarily determine it. They also suggested that the needs of EE practice in the households to reduce the energy consumption. In line with that, the results from the study found that the levels of awareness and education of the individual influence the EE practice. As well as, awareness and practice also can be implemented by using the star rated electrical appliances [11]. In addition to consumer awareness, the EE awareness campaign were found to have a positive impact on decreasing levels of electricity consumption [12].

## 3 Approaches and Methods

This study focuses on the implications of human behaviour in household energy consumption. The objective is to determine the relationship of a combination of two behaviours: knowledge and practice of consumer awareness. According to Syed Hussain [10], knowledge is one of the main components that need to be considered when implementing energy saving awareness. Subsequently, Noor Hanita [5] highlight the needs of EE practice in the households to implement energy saving behaviour. Furthermore, the theoretical background has provided the dependent variable of awareness (level of efficiency practice by usage of energy star rating appliances) with the independent variables of knowledge and practice as the basic parameters of the study. A quantitative approach was adopted via questionnaire administration on the target respondent. According to Creswell [13], the appropriate sample size is determined by the level of confidence, level of precision and the type of test that will be used in data analysis. Hence, the formula by Fowler [14] for estimating the sample size and a table to determine the same were used. By using a table that specifies the required sample size that would ensure a good decision model (Table 1), the sample size was greatly reduced. This formula is based on three major scenarios: a) Percentage of sampling characteristic: The first row shows the percentage of the sample that will have the desired characteristics, ranging from 5/95 to 50/50 (an equal chance). As this research seeks to equally divide the sample as much as possible, 50/50 was selected. b) Sampling error: Sampling error is the amount of error that a study can tolerate. 4% to 6% is a common choice. In this research 6% of sampling error has been selected means the sample mean will differ from the true population mean only 6% of the time. c) Confidence level: The confidence level that has been choose is 95%.

**Table 1.** Sample size table (adapted from Fowler, [14]).

| Sample size | Percentage of Sample with Characteristic | | | | |
|---|---|---|---|---|---|
| | 5/95 | 10/90 | 20/80 | 30/70 | 50/50 |
| 35 | 7 | 10 | 14 | 15 | 17 |
| 50 | 6 | 8 | 11 | 13 | 14 |
| 75 | 5 | 7 | 9 | 11 | 12 |
| 100 | 4 | 6 | 8 | 9 | 10 |
| 200 | 3 | 4 | 6 | 6 | 7 |
| 300 | 3 | 3 | 5 | 5 | 6 |
| 500 | 2 | 3 | 4 | 4 | 4 |
| 1000 | 1 | 2 | 3 | 3 | 3 |
| 1500 | 1 | 2 | 2 | 2 | 2 |

Based on the above characteristics, the recommended sample size for this research is 300 but for this study 500 questionnaires were distributed. This to prevent not significant data due to the reject questionnaire that not fulfil the study requirement. From 500 questionnaires, only 408 questionnaires were fully answered. The questionnaires were distributed to respondents in four main zones in West Malaysia including North Malaysia (Kedah, Perlis and Penang), South Malaysia (Negeri Sembilan, Johor and Malacca), East Malaysia (Terengganu, Pahang and Kelantan) and West Malaysia (Perak, Selangor and Wilayah Persekutuan). Figure 2 shows the fragments of the study area where the highest number of respondent comes from the South Zone (191) followed by West Zone (108), East Zone (55) and North Zone (54).

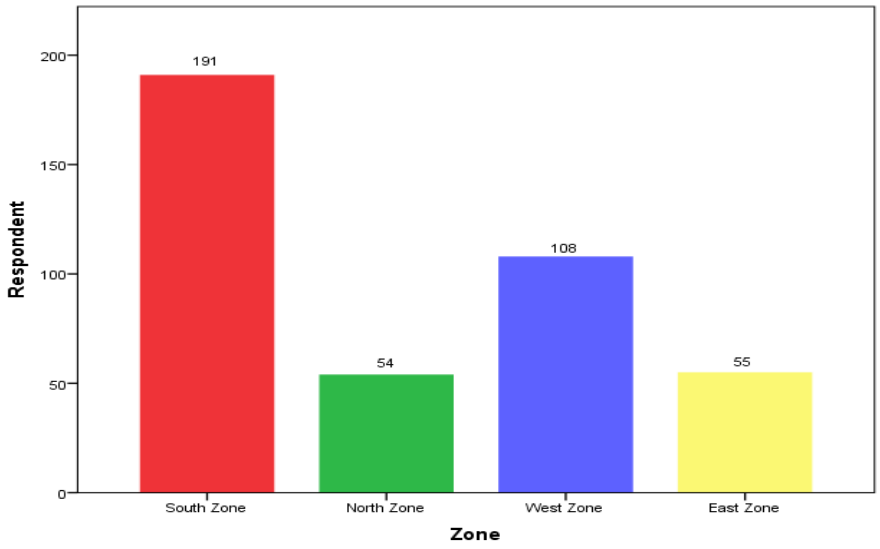


**Fig. 2.** Study area and the number of respondents for the energy survey.

The dependent variable of awareness was subjected to a five-point scale measure (one star - five star), while the independent variables of knowledge and practice were subjected to a four-point "Likert" scale (strongly disagree - disagree - agree - strongly agree). The reason to use only 4-point Likert Scale rather than 5-point Likert scale is to avoid the social desirability bias [15]. The questionnaire was developed based on two factors that influence

the consumer awareness on energy efficiency in residential houses, which is knowledge (10 items) and practice (25 items).

Correlation analysis is used to describe the strength and direction of the linear relationship between two variables [16]. The correlation coefficient is a measure of linear association between two variables. The values of the correlation coefficient are always between -1 and +1 [17]. There have two types of correlation which is Pearson Correlation and Spearman Correlation. Both are used to explore the strength of the relationship between two continuous variables, but it depend to the normality of the data distribution. The normality test for this data have been done and it found that the data is normally distributed based on the inspection of the normal probability plots (labelled Normal Q-Q Plot). In this plot, the observed value for each score is plotted against the expected value of the normal distribution. Pallant [16] suggested that a reasonably straight line consider as a normal distribution.

# 4 Result and Discussion

## 4.1 Demographic Profile

The demographic questions contained herein was developed from various sources, including the International Energy Agency (IEA), TNB, Malaysia Energy Comission (ST) and Ministry of Energy, Green Technology and Water of Malaysia (KeTTHA). This demographic profile divided into two sections which is Section A for Respondents Information and Section B for Residence Information. Section A is to gather the information about the respondent, such as the number of residents, age, type of occupation of the head of the family, and monthly household income and for Section B is for estimated size of the house, number of rooms in the house and the average energy bill of the month which may then be giving an overview of respondents and their house. Table 2 shows the distribution of the respondent base on the demographic question.

This section gathered the information about the number of people living in the house as shown in the Table 2. Four people in a house were the popular number for 78 families for this item compared to two families which have more than 11 members living in the house. Total number of people living in the house for this study is 2024. Next, this item also use of determined distribution of people according to their group of age. The highest number of people is 816 that come from age 22 to 40 years old. However the lowest is from 61 years and above which is 61 people from total 2024 peoples which come from 408 families (N = 408). Other than that, the other information is about home leader occupation. It shows 38.97% of the respondent working in the government sector from various types of occupation related and the lowest come from respondents from industrial sector which stated about 4.41%. The other respondents come from other types of occupation, such as private sector (25.25%), self-employee (16.67%), and retired (5.39%). In addition, 9.3% respondents did not assign to one of the five main categories, but ticked the option ‘others’. In this case, respondents come from other types of occupation or did not have any job for the time being. Next, respondents were asked about their monthly household income. The results show 136 respondents have income between RM4001 and above. This is because many of the respondents have more than one person that have income rather than only one from the family that have income.

**Table 2**. Distribution of the respondent base on the demographic questions.

| Demographic variables | | Description | Freq | % | Demographic variables | | Description | Freq | % |
|---|---|---|---|---|---|---|---|---|---|
| **A** | Respondents Information | | | | **B** | Residence Information | | | |
| **1** | Number of People Living in the House | 1 people | 7 | 1.7 | 1 | House Estimation Size | below 700sqf | 12 | 2.9 |
| | | 2 peoples | 47 | 11.5 | | | 700sqf - 749sqf | 52 | 12.7 |
| | | 3 peoples | 55 | 13.5 | | | 750sqf - 799sqf | 110 | 27.0 |
| | | 4 peoples | 78 | 19.1 | | | 800sqf - 1000sqf | 145 | 35.5 |
| | | 5 peoples | 69 | 16.9 | | | 1001sqf and above | 89 | 21.8 |
| | | 6 peoples | 63 | 15.4 | | | Total | 408 | 100 |
| | | 7 peoples | 31 | 7.6 | 2 | Number of rooms | 1 room | 10 | 2.5 |
| | | 8 peoples | 29 | 7.1 | | | 2 rooms | 34 | 8.3 |
| | | 9 peoples | 18 | 4.4 | | | 3 rooms | 173 | 42.4 |
| | | 10 peoples | 9 | 2.2 | | | 4 rooms | 139 | 34.1 |
| | | More than 10 peoples | 2 | .5 | | | 5 rooms | 44 | 10.8 |
| | | Total | 408 | 100 | | | Others | 8 | 2.0 |
| **2** | Age Group of the Family | Toddler under 3yrs | 128 | 6.3 | | | Total | 408 | 100.0 |
| | | 4 to 12yrs | 268 | 13.2 | 3 | Average electricity bill | Below RM20 | 9 | 2.2 |
| | | 13 to 21yrs | 375 | 18.5 | | | RM20 - RM50 | 82 | 20.1 |
| | | 22 to 40yrs | 816 | 40.3 | | | RM51 - RM100 | 134 | 32.8 |
| | | 41 to 60yrs | 376 | 18.6 | | | RM101 - RM150 | 89 | 21.8 |
| | | 61 yrs and above | 61 | 3.0 | | | RM151 - RM200 | 47 | 11.5 |
| | | Total | 2024 | 100 | | | RM201 and above | 47 | 11.5 |
| **3** | Home Leader's Occupation | Government Sector | 159 | 39.0 | | | Total | 408 | 100.0 |
| | | Private Sector | 103 | 25.2 | C | Level of awareness | 1 star | | |
| | | Industry | 18 | 4.4 | | | 2 star | | |
| | | Self-Employee | 68 | 16.7 | | | 3 star | | |
| | | Retired | 22 | 5.4 | | | 4 star | | |
| | | Others | 38 | 9.3 | | | 5 star | | |
| **4** | Monthly Household Income. | 0 (no income) | 1 | 0.2 | D | Energy efficiency knowledge and practice rating (Likert Scale) | Strongly disagree | | |
| | | Below RM1000 | 46 | 11.3 | | | Disagree | | |
| | | RM1001 - RM2000 | 61 | 15.0 | | | Agree | | |
| | | RM2001 - RM3000 | 76 | 18.6 | | | Strongly Disagree | | |
| | | RM3001 - RM4000 | 88 | 21.6 | | | | | |
| | | RM4001 and above | 136 | 33.3 | | | | | |
| | | Total | 408 | 100 | | | | | |

Moreover, for Residence Information section, there were 88 respondents have MYR3001- MYR4000 monthly household income and followed by MYR2001- MYR3000 (N=76), MYR1001- MYR2000 (N=61), and below MYR1000 (N=46). However, from all the respondents, there was one respondent that has no income at all. This has been identified that the respondents were very old and live lonely in the house and the daily expenses comes from his children every month. Meanwhile, the estimation size for housing for this item divided into five categories, which is 800sqf to 100sqf have a higher value (35.5%) followed by 750sqf to 799sqf (27.0%), 1001sqf and above (21.8%), 700sqf to 749sqf (12.7%) and below 700sqf is the lowest (12.7%).

Next category examined was the distribution of number of rooms in the house. The category has been broken down into six categories from one room to five rooms and followed by others (more than five rooms). The highest percentage was for respondents that have three rooms in their house (42.4%) and followed by four rooms (34.1%), five rooms (18.8%), two rooms (8.3%), one room (2.5%) and others (2.0%). Finally, the average electricity bill for respondents were examined. This category was divided into six categories which is below MYR20 (0-92kWh), MYR20 to MYR50 (93-220kWh), MYR51 to MYR100 (221-361kWh) MYR101 to MYR150 (362-462kWh), RM151 to MYR200 (463-563kWh) and the last categories is the respondent that has an average bill from RM201 and above (>563kWh). The highest average bill is comes from MYR51 to MYR100 category (N=134) and the lowest is for below RM20 category (N=9). It is more easier to collect the information about the electricity usage in Malaysian Ringgit (MYR) rather than usage by (kiloWatt/hour) kWh due to the background of the respondent that come from various background and some of them may not familiar with the technical term. The current electricity tariff in Malaysia as shown in Table 3 [18] and the price rate is not included of 6% of Goods and Service Tax (GST). GST only implement to those who have more than 300kWh of electricity usage.

**Table 3.** Electricity tariff in Malaysia.

| Tariff Category | Unit | Current Rate (MYR) (effective 1st Jan 2014) |
|---|---|---|
| Tariff A – Domestic Tariff | | |
| For the first 200 kWh (1 - 200 kWh) per month | cent/kWh | 21.80 |
| For the next 100 kWh (201 - 300 kWh) per month | cent/kWh | 33.40 |
| For the next 300 kWh (301 - 600 kWh) per month | cent/kWh | 51.60 |
| For the next 300 kWh (601 - 900 kWh) per month | cent/kWh | 54.60 |
| For the next kWh (901 kWh onwards) per month | cent/kWh | 57.10 |

**The minimum monthly charge is MYR3.00*

## 5 Variables Measurement

The results of the measurements that have been made against both variables of awareness which is knowledge and practice of EE. Through this descriptive data, it found that the mean, standard deviation and variance of each factor affecting the consumer awareness on EE. Table 1 shows data mean, variance and standard deviation of each factors.

Table 4 shows the mean value of the knowledge is 3.41 and 2.75 for practice. Robinson [19] suggested for four point Likert scale that means score 1 for very low priority, 2 for low priority, 3 for high priority, and 4 for very high priority. This means that the majority of respondents said that the knowledge and practice can caused them to implement energy efficiency although for the factor practice have low priority. The mean score for knowledge is high priority (3.41) that indicates the knowledge on EE among consumer is high.

However, consumers' awareness towards practice the EE in residential houses is low based on the mean score (2.75). It means, they know and have the knowledge about EE but they do not or less practice in their daily life. Meanwhile, these factors has 0.39 standard deviation and 0.16 variance for knowledge and 0.42 standard deviation and 0.17 variance for practice.

**Table 4.** Mean, variance and standard deviation.

| | N | Mean | Std. Deviation | Variance |
|---|---|---|---|---|
| Knowledge | 408 | 3.4105 | 0.39332 | 0.155 |
| Practice | 408 | 2.7527 | 0.41693 | 0.174 |
| Valid N | 408 | | | |

## 5.1 Correlation between Knowledge and Practice

A Pearson product-moment correlation or Pearson's r was run to determine the relationship between knowledge and practice to implement energy efficiency approach in their daily life. The data showed no violation of normality and linearity. There was a positive correlation between knowledge and practice, which was statistically significant ($r = 0.348$, $n = 408$, $p < 0.05$) as shown in Table 5. This correlation means an increase in knowledge was increasing the practice & application and both variables were important for consumer to implement the energy efficiency of electrical appliances in residential houses.

**Table 5.** Correlation of knowledge and practice.

| | | Knowledge | Practice |
|---|---|---|---|
| **Knowledge** | Pearson Correlation | 1 | 0.348** |
| | Sig. (2-tailed) | | 0.000 |
| | N | 408 | 408 |
| **Practice** | Pearson Correlation | 0.348** | 1 |
| | Sig. (2-tailed) | 0.000 | |
| | N | 408 | 408 |

**. Correlation is significant at the 0.01 level (2-tailed).

## 5.2 Correlation of Awareness and Knowledge

The same analysis, Pearson's r was computed to assess the relationship between knowledge of energy efficiency and awareness that can determine from the usage of star rated appliances. From the analysis, it found that there has positive correlation between the two variables, *are* = 0.120, $n = 408$, $p = 0.015$ as shown in Table 6.

**Table 6.** Correlation of awareness and knowledge.

| | | Awareness | Knowledge |
|---|---|---|---|
| **Awareness** | Pearson Correlation | 1 | 0.120* |
| | Sig. (2-tailed) | | 0.015 |
| | N | 408 | 408 |
| **Knowledge** | Pearson Correlation | 0.120* | 1 |
| | Sig. (2-tailed) | 0.015 | |
| | N | 408 | 408 |

*. Correlation is significant at the 0.05 level (2-tailed).

### 5.3 Correlation of Awareness and Practice.

Another relationship that has been determined from the analysis is the relationship between awareness and consumers' practice taken from the usage of star rating appliances as shown in Table 7. The data show that there was a positive correlation between consumer's practice & application and the usage of star rating appliances, $r = 0.81$, $n = 408$, $p = 0.00$. Cohen [20] suggests that the correlation have a strong relationship if the value of Pearson's $r$ is from 0.50 to 1.00. This result means increased in practice of energy efficiency can reduce the electricity bill for the month.

**Table 7.** Correlation of Star Rating appliances and practice.

| | | Awareness | Practice |
|---|---|---|---|
| **Awareness** | Pearson Correlation | 1 | 0.814** |
| | Sig. (2-tailed) | | 0.000 |
| | N | 408 | 408 |
| **Practice** | Pearson Correlation | 0.814** | 1 |
| | Sig. (2-tailed) | 0.000 | |
| | N | 408 | 408 |

**. Correlation is significant at the 0.01 level (2-tailed).

## 6 Conclusion

This study has revealed that knowledge and practice is a main component of awareness to implement the EE approach for residential houses. Both components must be implemented together to enhanced the awareness of energy saving among consumers. However, the mean score of the study found that the level of practice in implementing EE among consumers is low and this has caused the wastage of energy in residential. Meanwhile, the results revealed that the level of knowledge is good. It means consumers have good knowledge about EE and if they implemented both main components, it will enhance the awareness among consumers. Awareness is the challenge of implementing the EE which is majority consumers have the knowledge about EE but they do not practice the knowledge. Therefore, addressing the issue of energy efficiency practice could play a valuable role in guiding the consumer to reduce energy consumption. Other than that, the government should further initiate regular information and awareness programms for the general public on energy efficiency to boost the awareness level and subsequently energy efficiency practice.

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