Analysis of Energy Conservation Intention of Residential Consumer in Malaysia

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Abstract. The residential sector displays complicated energy consumption patterns owing to the household's human and physical features. Using the theory of planned behavior (TPB) framework, this suggested study focuses on researching the intention of residential consumers in Malaysia to conserve household energy but adding expertise measured by the highest level of academic qualification. The objective of this study is to analyze the correlation between attitude, subjective norm, belief and awareness towards consumers’ intention on performing energy conservation behavior. This research shows that Multiple Linear Regression (MLR) was an appropriate technique for defining energy-related behavior drivers. The result of this study shows that there is a favorable connection between attitude, subjective norm belief and awareness and intention of consumers towards conservation of household energy. The research also discovered that only attitude and subjective norm contribute more to the intention of consumers to conduct the conservation of household energy.

1. Introduction
Malaysia’s energy consumption has increased by an average of 5% from 2015-2017 [1] in line with its economy growth. Currently, the bulk of the country’s energy production comes from natural gas and imported coal which are depleting and subject to foreign exchange fluctuations [2]. The residential sector in Malaysia has become the single largest energy sector accounting for 21% of the entire energy usage of the country with the number of residential consumers is 82% of the total consumers in Malaysia [3]. Therefore, this industry is a significant element of the energy economy and the way in which this industry reacts to energy efficiency initiative is essential to understand.

Over the previous 10 years, the Malaysian government has conducted several energy efficiency strategies in the residential industry, including the Tiered Electricity Tariffs Structure, Electricity Bills Rebate and Sustainability Achieved Via Energy Efficiency (SAVE) Rebate Programme [4]. There is no clear proof, however, that through these policies, the total residential energy consumption has been significantly reduced [5].

Residential industry displays complicated energy consumption patterns owing to the household’s human and physical features. Most consumer still need to be aware of how to make efficient use of energy in their daily lives [6] Electrical devices such as water heater, freezers, lighting, televisions, and washing machines are among electricity’s largest consumers. These devices are used depending
on the demand of the consumer, which varies based on their operations. Thus, the behaviour of the occupants is the main factor in the household’s energy consumption. These behaviours also affect the operation of electronic devices [7]. Energy efficiency cannot be accomplished through technological change, but also through the manner in which it is used, which is linked to energy behaviours [8]. Research findings in the 21st century have often found that individuals tend to be worried about climate change, but have not linked their daily energy related conduct to enhanced emissions and consequently climate change. The key question of why energy consumption in the residential sector keeps rising has been highlighted in the energy behaviour research time and time again. Therefore, the objective of this study is to analyse the correlation between attitude, subjective norm, belief and awareness towards consumers’ intention on performing energy conservation behavior to overcome this issue.

2. Literature study
Previous studies on residential consumers’ energy related behavior indicate that energy consumption in residential buildings is dependent on building characteristics and occupants’ behavior. It is believed that the relationship between the occupant and the building (i.e. control of heating and ventilation systems) has a powerful impact on energy consumption [9-13]. The energy consumption in the household can be further determined by cognitive factors such as attitudes and motivation towards energy saving and environmental concerns [14-15]. Lifestyle, preferences, and attitudes, perceptions of convenience, personal background and household characteristics can determine the living patterns of residents [14]. The findings also show perception, gender and ownership influence the conduct of ventilation and heating behavior. Thus, altering energy behaviours to more effective patterns, increasing energy efficiency involves targeting which particular behaviours to adjust and a thorough knowledge of the variables leading to their activation.

Contemporary research used modelling as one of the tools when dealing with complicated problems such as energy related behaviours, as it allows information to be structured and apparently concealed relationship to be discovered. Literatures show that energy related behaviours, depending on goals and disciplines have been modelled using a variety of different techniques. For example, modelling is used by the social sciences to clarify, interpret and predict behaviours while engineering use quantitative models to determine energy consumption [15]. One of the important frameworks used in psychological studies is the Theory of Planned Behavior (TPB), as shown in Figure 1. According to the theory, the three factors which are attitude, subjective norm and perceive behavioural control influenced the intention to perform the actual behaviour [16]. For instance, the more favorable the attitude and subjective norm, and the greater perceived behavioural control, the stronger the person’s intention to perform the actual behavior should be. A field survey was performed in this research involving residential consumers in Malaysia. Using TPB framework, the result gathered from the survey were analysed using Statistical Package for Social Science (SPSS) software to identify the drivers of energy related behavior. This study proposed knowledge as a new element into the framework. The knowledge element was included into the questionnaire to identify whether knowledge on certain issues will influence the human behavior. In this study, knowledge will be measured by the highest level of academic qualification. Thus, Multiple Linear Regression (MLR) method was used to determine the most influential independent variable towards dependent variable.
3. Method and data collection

The target population in this study was domestic users who resided in Kuala Lumpur, Selangor and Putrajaya. These areas were chosen because they have the highest residential population in Malaysia. The survey was conducted using two approaches which are online method and paper based method. The link to the questionnaire study was sent to prospective participants for internet method while the questionnaire was distributed to participants for paper-based method. There are approximately 2.8 million residential customers in Kuala Lumpur, Selangor and Putrajaya, according to Tenaga Nasional Berhad which is the main utility company in Malaysia. Based on this population with a confidence level of 95% and confidence interval of 5, the minimum sample needed is 384 responses as per the Sample Size Calculator [16]. This sample size calculator system can be used to determine how many individuals needed for interview to get the accurate outcomes as needed. 403 of 1000 participants presented surveys for a 40% usable response rate. Figure 2 shows that 60% of the respondents were female and 40% were male while Table 1 depicted the cross tabulation between gender and highest level of academic qualification from the respondents. For both genders, majority of them have a bachelor degree followed by Master and PhD degrees. The lowest academic qualifications for both categories have at least attended secondary school.
Table 1. Gender and highest level of academic qualification cross tabulation

| Gender * Highest level of Academic Qualification Cross tabulation | Secondary School | Certificate / Diploma | Bachelor Degree | Master Degree | Professional Degree | PhD Degree | Total |
|---|---|---|---|---|---|---|---|
| Gender | Female | 1 | 1 | 103 | 85 | 3 | 40 | 233 |
| | Male | 1 | 15 | 66 | 54 | 6 | 14 | 156 |
| Total | 2 | 16 | 169 | 139 | 9 | 54 | 389 |

3.1. Procedure and measure

The developed question survey was divided into four classifications based on the literature, namely knowledge and belief, household electricity consumption, feedback on consumption, and household individual detail. Knowledge and Beliefs designed to measure the knowledge and beliefs of consumers about issues related to energy and environment. While household electricity consumption intended to evaluate multiple elements of consumer use of household electricity. For feedback on consumption, it is intended to obtain opinion on the type of feedback and intention of consumers to reduce electricity consumption. Lastly, the survey included house-hold individual details for demographic purposes. The survey consists of 34 questions which include dichotomous question, multiple choice, rank order, rating scale and demographic. The result for reliability test in this study is shown in Table 2. The minimum Cronbach’s Alpha of 0.45 considered to be acceptable [17]. Since the values of the three variables which are Behavioral Belief (Energy Sources Action), Knowledge and Belief (Energy and Environment Citizen) and Awareness (Energy and Environment Government) are less than minimum requirement, the variables are not significant in this study. The internal consistency shows that two independent variables which are Subjective norm and Attitude are acceptable and one independent variable is good which is Knowledge and Belief (Energy Sources Information) in this study and one dependent variable consistency which is intention is good.

Table 2. Result of reliability test

| Variables | Number of Items | Cronbach’s Alpha | Internal Consistency |
|---|---|---|---|
| Knowledge and Belief - Energy Sources (Information) | 2 | 0.871 | Good |
| Behavioral Belief - Energy Sources (Action) | 3 | 0.132 | Unacceptable |
| Knowledge and Belief: Energy and Environment (Citizen) | 4 | 0.365 | Unacceptable |
| Awareness: Energy and Environment (Government) | 2 | 0.365 | Unacceptable |
| Subjective Norm: Normative Belief | 15 | 0.752 | Acceptable |
| Attitude | 17 | 0.777 | Acceptable |
| Intention | 17 | 0.886 | Good |
4. Results and discussion

All results of the evaluation using SPSS will be provided in this chapter. After the test of reliability, an analysis using Pearson correlation and MLR has been carried out to acquire the relationship between variables related to energy consumption behavior.

4.1. Pearson correlation (r)

The Bivariate Product-moment correlation was conducted to identify the relationship between belief and awareness, attitude and subjective norms towards intention to perform energy consumption behavior. All variables are significant at 0.01 and 0.05 both at 1-tailed test. Pearson Correlation (r) can be positive, negative or zero value and the range of r is between -1 to 1.

The correlation results between all independent variables toward dependent variable are given in Table 3. As can be seen in Table 3, there are positive relationship between all independent variables and dependent variable. All independent variables which are Belief, Awareness and Subjective Norms have weak positive relationship towards Intention in performing energy conservation behavior which is 0.136, 0.098 and 0.355 respectively while Attitude has moderate positive relationship towards Intention with correlation of 0.650. Other than that, all independent variables are significant at alpha 0.01 and 0.05 levels. To sum up, the most influential variables by far is Attitude variable followed by Subjective Norm variable. Similar findings have been observed in other studies.

|                      | Attitude Knowledge: Energy Sources (Information) | Behavioral Knowledge: Awareness: Energy and Environment (Citizen) | Subjective Norm: Energy and Environment (Government) | Intention (Y) |
|----------------------|------------------------------------------------|-----------------------------------------------------------------|--------------------------------------------------|--------------|
| Attitude Knowledge   | r                                              | 1                                                               | .748**                                           | .243**       | .164**       | .136**       |
| and belief: Sig.     | and Belief: Sig.                               | .000                                                            | .218                                             | .000         | .001         | **.004**     |
| Energy Sources       |                                                | 389                                                             | 389                                              | 389          | 389          | 389          |
| (Information)        |                                                |                                                                  |                                                  |              |              |              |
|                      | r                                              | 1                                                               | .005                                             | .179**       | .197**       | .109*        | .088*        |
| Belief: Energy Sources | Sig.                                           | .463                                                            | .000                                             | .000         | .016         | **.041**     |
| (Action)             |                                                |                                                                  |                                                  |              |              |              |
|                      |                                                | 389                                                             | 389                                              | 389          | 389          | 389          |
|                      | r                                              | 1                                                               | .020                                             | .126**       | .108*        | .196**       |
| Knowledge and Belief | and Sig.                                       | .349                                                            | .006                                             | .016         | .000         | **.000**     |
| Energy and Environment (Citizen) | N |                                                                  |                                                  |              |              |              |
|                      |                                                | 389                                                             | 389                                              | 389          | 389          | 389          |
|                      | r                                              | 1                                                               | .272**                                           | .164**       | .098*        |
| Awareness: Energy Environment | Sig. |                                                                  |                                                  | .000         | .001         | **.027**     |
4.2. Multiple linear regression

The Multiple Linear Regression (MLR) analysis was conducted to find the most influence independent variable toward dependent variable. From MLR analysis, drivers of energy related behavior was identified. Table 4 shows the result of MLR analysis carried out on independent and dependent variables. It can be seen that three out of six independent variables which are attitude, subjective norm and belief are significant to explain dependent variables. Variable Attitude (X6) is most influence factors to Intention (Y) with R-squared value equals to 0.4225. Approximately 42.25% of variance in Intention is explained by variance of self-concept (X6). The p-value is 0.000 which is less than alpha value 0.05 and indicates that Attitude (X6) is significantly influence Intention (Y). While the regression coefficient (beta) for Attitude (X6) toward Intention (Y) is 0.592 which proved that knowledge element influence the attitude of consumer thus, affect their intention on performing energy conservation behaviour.

Other than that, variable Subjective Norm (X5) is the second most influence factors to Intention (Y) with R-squared value equals to 0.1260. Approximately 12.60% of variance in Intention is explained by variance of Subjective Norm (X5). The p-value is 0.000 which is less than alpha value 0.05 and indicates that variable Subjective Norm (X5) is significantly influence Intention (Y). While the regression coefficient (beta) for Attitude (X5) toward Intention (Y) is 0.176. Clearly, as expected, subjective norm is one of important variable that can influence the intention of consumer behavior in performing energy conservation.

Finally, variable Belief: Energy and Environment Citizen (X3) is the third most influence factors to intention (Y) with R-squared value equal to 0.0384. As can be seen, the presence of variable belief: Energy and Environment Citizen (X3) led to approximately 3.84% of variance in intention. The p-value is 0.004 which is less than alpha value 0.05 and indicates that variable knowledge and belief: Energy and Environment Citizen (X3) is significantly influence intention (Y). While the regression coefficient (beta) for knowledge and belief: Energy and Environment Citizen (X3) toward intention
(Y) is 0.110. This indicates that human belief affects their intention to perform the energy conservation behaviour. This is in agreement with the results reported by other researchers. Therefore, it reveals that energy consumption in the household can be conserved by cognitive factors such as attitude, subjective norm and belief.

Table 4. Multiple linear regression analysis

| Factors                                      | B    | Std. Error | Beta | Sig. | r   | R²  |
|----------------------------------------------|------|------------|------|------|-----|-----|
| (Constant)                                   | 0.453| 0.282      | 0.109| 1    | 1   | 1   |
| Attitude: Knowledge and Belief: Energy Sources (Information) | 0.010| 0.064      | 0.009| 0.876| 0.136| 0.0185 |
| Attitude: Knowledge and Belief: Energy Sources (Action) | -0.010| 0.059      | -0.009| 0.868| 0.088| 0.0077 |
| Awareness: Energy and Environment (Citizen)   | 0.137| 0.047      | 0.110| 0.004| 0.196| 0.0384 |
| Awareness: Energy and Environment (Government)| -0.040| 0.032      | -0.049| 0.212| 0.098| 0.0096 |
| Subjective Norm                              | 0.273| 0.064      | 0.176| 0.000| 0.355| 0.1260 |
| Attitude                                     | 0.659| 0.044      | 0.592| 0.000| 0.650| 0.4225 |

5. Conclusion
In this study, the results showed that Multiple Linear Regression was a suitable method to identify the drivers of energy related behavior. Based on the Multiple Linear Regression analysis, it can be concluded that the strongest factors that influence the domestic energy consumption behavior is consumer attitude. The results above prove that there is positive and strong relationship between attitude and consumers’ intention to perform domestic energy conservation behavior.

Other than that, there is also a positive and moderate relationship between subjective norm and consumer intention to perform domestic energy conservation behavior. Subjective norm has direct influence and one of the most important determinants on behavioral intention that helps to predict the behavioral of energy user.

Moreover, results show that there is positive but weak relationship between belief and awareness towards consumer intention. In other words, this study suggests that knowledge and awareness appear to be the least important determinant that influences consumer intention to perform the domestic energy conservation behavior.
References

[1] Global Databases, Economic Indicators and Forecasts 2018 Retrieved from: https://www.ceicdata.com/en/malaysia/electricity-generation-and-consumption/electricity-consumption

[2] Energy Malaysia, Suruhanjaya Tenaga 2014 Retrieved from: https://meih.st.gov.my/documents/10620/9a9314a1-cf11-4640-a9de-3b31f336a416

[3] Malaysia Energy Statistics Handbook, Suruhanjaya Tenaga 2017. Retrieved from: https://www.st.gov.my/contents/files/download/116/Malaysia_Energy_Statistics_Handbook_2_017.pdf

[4] Performance and Statistical Information on Electricity Supply Industry in Malaysia, Suruhanjaya Tenaga 2016. Retrieved from: https://meih.st.gov.my/documents/10620/88cc637b-3d79-4597-8458-a3ac380eeac2

[5] Saidur R, Masjuki HH and Jamaluddin MY 2007 An Application of Energy and Exergy Analysis in Residential Sector Energy Policy 35 pp 1050-1063

[6] Gregory DM and Mikko S 2013 Using the theory of interpersonal behavior to explain non-work related personal use of internet at work Inf. Process. Manag. 50 pp 322-335

[7] Hitchcock G 1993 An integrated framework for energy use and behaviour in the domestic sector Energy Build. 20 pp 151-157

[8] Lopes MAR, Antunes CH and Martins N 2013 Energy Behaviours as Promoters of Energy Efficiency: A 21st Century Review Renew Sust. Energ Rev. 16 pp 4095-104.

[9] De Dear R 2004 Thermal comfort in practice Indoor Air 14 pp 32–39

[10] Karjalalainen S 2007 Gender Differences in Thermal Comfort and Use of Thermostats in Everyday Thermal Environments Build Environ. 42 chapter 4 pp 1594-1603

[11] Lan L, Lian Z, Liu W and Liu Y 2008 Investigation of Gender Difference in Thermal Comfort for Chinese People, European Eur. J. Appl. Phys. 102 chapter 4 pp 471-80

[12] Lenzuni P, Freda D and Del GM 2009 Classification of Thermal Environments for Comfort Assessment J. Occup. Environ. Hyg. 53 chapter 4 pp 325-332

[13] Schweiker M and Shukuya M 2009 Comparison of Theoretical and Statistical Models of Air Conditioning Unit Usage Build Environ. 44 chapter 10 pp 2137-2149

[14] Lopes MAR, Antunes CH and Martins N 2015 Towards More Effective Behavioural Energy Policy: An Integrative Modelling Approach to Residential Energy Consumption in Europe Energy Res. Soc. Sci. 7 pp 84-98

[15] Alias R, Hashim Z, Farzana N and Mariam S 2015 Energy Conservation Behavior among University Students Global Int. J. Bus. Manag. Soc. Res. Review 1 chapter 1 pp 271-279

[16] Sekaran U 2003 Research Methods for Business, A Skill-Building Approach 4thEd (New York: John Wiley and Son Inc)

[17] Keith ST 2016 The Use of Cronbach’s Alpha When Developing and Reporting Research Instruments in Science Education (Res Sci Educ). doi:10.1007/s11165-016-9602-2

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