An Exploratory Analysis for Household Energy Consumption and Conservation

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Abstract

Uninterrupted power supply is delivered to the most densely populated and economically important "on-grid" islands by two major electrical grids (IRENA, 2017b). As an archipelago of more than 7,000 islands, the Philippines is a rapidly expanding nation (Boquet, 2017). The remaining non-electrified lands ('missionary areas') are a significant number of remote islands without a power source or informal electricity supply. This research is intended to determine which among the predictor variables have effects on the energy consumption cost of Filipino households. A survey design with random sampling was conducted in NCR and Region IV-A to assess the quantifiable metrics and behavioral attributes of the dwellers. By offering two subsets, circumscribed and influenced, involving two variables each, the analysis can assess the sample more systematically as the estimated monthly electric bill was labeled as the dependent factor in the study. Using Pearson Correlation and Stepwise Multiple Regression, the significant factors that influence and disturb the energy consumption cost of Filipino households were determined. Moreover, the relationship among the predictor variables which plays a role on the study were also tested. This study, applies to household activities conventional electricity and does not involve other renewable energy sources such as solar, hydraulic, and wind.

Keywords
Energy Consumption; Energy Conservation; Filipino Household; Philippine Electricity; Behavioral Attribute

1. Introduction

Electricity is always as critical and essential today as it was yesterday. The Philippines plays various energy sources through the generation, transmission, and distribution of energy across the country. But even with the numerous points of power supply, the population is also in a high rise.

As of August 2020, the Philippines is burgeoning with roughly 109 million natives according to the United Nations’ Department of Economic and Social Affairs. The metropolitan Manila alone has 2.97 million occupied housing units tagging with Region IV-A with 3.30 million as of 2015 (Philippine Statistics Authority, 2018). The two urban-suburban regions are of the reigning stature in having the highest number of populated household units in the entirety of the country. Narrowing down to the Filipino household which, according to (Bauer, 2018), comprises an average of 4.4 dwellers per house. According to Wholesale Electricity Spot Market (WESM): a real-time energy market where the actual rate is identified on an hourly basis, there are number of ancestry that primely contributes to the country’s high electricity rate and pricing error ("Study of Mitigating Measures for the Philippine Electricity Market", 2014). This study is to assess if behavioral elements of a particular Filipino house dweller towards their energy-related practices are to be one of the distinctive influences aforementioned that supplement the surge of energy consumption cost. Communities use energy for several varying reasons, as to where the amount of energy they run varies significantly from household activities. Innumerable attributes have an impact on household energy efficiency. Primarily, people need to be informed that household energy is needed and that there are potential ways to reduce it and that, conversely, they need inspiration to conserve energy. Likewise, the associated behaviors should also be acceptable for them (Steg, 2008).
Several studies have been conducted regarding energy conservation and how to understand its depth through exploratory models. A Canadian research (Ritchie et al, 1981) was conducted to address the complexities of in-home energy consumption in Quebec and the Atlantic through an exploratory regression model – one of which is stepwise regression. According to NCSS Statistical Software, stepwise regression is a combination of forward and reverse selection processes. This regression model is a shift in the forward selection to decide if the significance of the candidate variables is below the defined tolerance level for each step in which a variable was inserted. When an insignificant variable is detected, the model is deleted. To further understand the depths and association of varying factors of in-home energy consumption and conservation of Filipino households, this regression model shall be used on the later chapters.

The Philippines, with a total land mass of 115,124 square miles, as of the current statistics (“Worldometers.info”, 2020), comprises 1.41% of the total world population. Resulting to the population density of the country with roughly 368 people per km² (952 mi²). The busy domain of metropolitan Manila, however, with a concentration of people of 20,785 per km² was the most densely populated administrative region of the country. This number is more than 60 times the national population density of 337 people per km². Following the lead is Region IV-A: CALABARZON, with approximately 758 persons per km². Not denying the fact that the region is as bustling for its total number of population (Philippine Statistics Authority, 2016). As an archipelago of more than 7,000 islands, the Philippines is a rapidly expanding nation (Boquet, 2017). Uninterruptible power supply is provided to the most heavily populated and economically relevant “on-grid” islands through two main electrical grids (IRENA, 2017b). There are large numbers of remote islands with informal electricity or without power supply in the remainder of the non-electrified lands (missionary areas). The Government of the Philippines aims to establish access to safe and consistent energy supplies to all parts of the country in order to further improve living conditions. Consequently, the Philippine Energy Plan (PEP) (DOE, 2015) established the target of 100% electrification of all households by 2022. However, just 89.6% in 2016 was the share of electrified households, reflecting 2.36 million without electrical supply, along with many others only having small and minimal sources (IRENA, 2017a). Inaugurated in 2008 (RA9513, 2008), the Philippine Renewable Energy Act (RE Act) is a technical policy instrument to support RE technology deployment in the country (Roxas and Santiago, 2016).

1.1 Objectives
The fundamental objective of this research is to adapt stepwise regression on assessing and putting into perspective the energy consumption and conservation of households in NCR and Region IV-A through identifying the impact of circumscribed and influenced variables to the variation of electricity consumption. This research aims to have a significant take on evaluating the current situation of the Filipino household energy consumption and conservation under the National Capital Region (NCR) and Region IV-A (CALABARZON). Through the aid of stepwise regression, Filipino households would have a clear vision and broader perspective towards the factors that play a massive role in the surge of their in-home energy consumption cost, may it be circumscribed or influenced.

Specifically, the following are the objectives of the researcher:
1. To establish the significant relationship between the predictor variables and the average monthly electric bill.
2. To identify the significant factors that influence the energy consumption cost of households.
3. To determine the percent of effect of the significant factor to the energy consumption cost of households.

2. Literature Review
2.1 Philippine Population Density
The Philippine population density rises between 255 and 337 people per square kilometer, according to the Philippine Statistical Authority (2016). As of August 1, 2015, the Philippines’ population was 100.98 million pesos based on the 2015 population census (POPCEN, 2015). NCR is the heavily populated area, meanwhile, the slightest inhabited is CAR. The NCR, with a population density of 19,988 people per square kilometer was one of the 18 administration regions of the country. This number is approximately 60 times the population density at the national level of 337 people per square kilometer. This represents an additional 1,586 individuals per km² (8.6%) of the 18,402 individuals per square kilometer in 2010. The density of the population of the NCR was 15,417 people per square kilometer in 2000.

2.2 Electricity in the Philippines
National Power Corporation (NPC) used to dominate the Philippine power industry in the generation market. NPC operated all generating plants; Independent Power Producers (IPPs) are prohibited from connecting directly to the
electrical distribution system. The 1993 Electric Power Crisis Act (R.A. 7648) and the 1994 Expanded BOT Financing Law (R.A. 7718) allowed IPPs to deal directly with transmission utilities and circumvent the NPC network, making generation a competitive industry segment. Under the 2001 Electric Power Industry Reform Act (EPIRA) (R.A. 9136), part of NPC would be maintained as the National Transmission Corporation (TRANSCO), structured as a government-owned transmission monopoly. The government, however, plans to offer strategic shareholders with expertise in the electricity transmission industry a minority share of TRANSCO, provided that Congress approves the franchise of TRANSCO. In the distribution market, private investor-owned utilities (e.g., Manila Electric Company, Visayan Electric Company, etc.) dominate the electricity supply industry in major urban centers, while electrical cooperatives (e.g., Albay Electric Cooperative, Sulu Electric Cooperative) offer electrical service to grid-connected rural areas.

2.3 Energy Conservation in the Philippines
While extensive studies have been made in developing countries on the use of and consumption of resources, very few studies have been carried out in Philippines examining such subjects in the sense of gender, and the weather variability. For lighting, cooking and heating purposes, households use various sources of energy. It helps to undertake constructive practices such as health and hygiene studies. The climate is an aspect of our lives and is definitely critical in terms of energy use. Electricity consumption is lower when it rains because there is no need for cooling. Because of the rainy season supply constraints fuelwood, charcoal, and biomass consumption can be lower. LPG use can be affected due to damaged infrastructure caused by landslides and heavy rainfall. Weather shocks and climate change, on the other hand, are understood that it affects men and women differently, and the various effects are likely to be the result of gender roles in society. In terms of energy use, (Charmes, 2006) provides evidence refuting the claim that mostly women and girls gather firewood, but supports the widely held belief that most women and girls are active in food preparations.

2.4 Behaviors Related to Household Energy Conservation
Household energy saving practices can be classified into two categories: efficiency and reduction (Gardner and Stern, 2002). Performance habits are one-shot activities that require the purchasing of energy efficient devices, such as insulation. Curtail activity requires repeated attempts to minimize energy usage, such as lowering thermostat settings. Studies reviewed in the study (Abrahamse et. al., 2005), were targeted at both performance and/or constraint behaviors, the latter appearing to be somewhat over-represented. This is surprising because the energy-saving potential of efficiency behaviors is known to be greater than that of reduction behaviors (Gardner and Stern, 2002).

For example, households can save more energy by appropriately insulating their homes than by reducing thermostat settings. It should be remembered, however, that energy-efficient appliances do not necessarily result in a reduction in total energy consumption when people use these appliances more often, the so-called rebound effect (Berkhout et al., 2000). The significance of the relationship between macro-level (e.g. technological innovations) and micro-level influences (e.g. awareness of the productive use of technological innovations) is evident. It is critical that interventions identify and alter potential obstacles to behavioral change (Gardner and Stern, 2002).

3. Methods
Through the use of Statistical Package for the Social Sciences (SPSS) software, the researcher shall be able to implement PSO algorithms for descriptive and bivariate statistics, statistical performance projections and group recognition forecasts. The platform also offers data collection, visualization and direct marketing functionality. In this case, to assess the cross-section predictor variables of in-home energy consumption and conservation of Filipino households.

To establish the significant relationship between the predictor variables and the average monthly electric bill, the researcher shall use Pearson Correlation. Through correlating all variables using Pearson Correlation to gauge and identify the degree of the linear relationship among each factor, every variable (ρ-value) with a significant value (2-tailed) less than (<) 0.05 in correlation with the dependent factor — the monthly cost of electricity consumption per household — is considered to be a significant factor. Moreover, to identify the significant factors that influence the energy consumption cost of households the researcher shall use stepwise regression. Numerous results shall appear after the regression was run, depending on the demand input. The outputs will then display the “variables entered” as to indicate what element(s) from your set of independent variables are both solely constant and significant. Those labeled as significant are variables that could explain the variation in the cost of electricity consumption. Lastly, in order to determine the percent of effect of the significant factor to the energy consumption cost of households, stepwise
regression shall be executed. The result of the regression shall assert the constant variables. Acquired significant variable(s) from the regression shall then reap R-Squared which shall display the percent effect of the relevant factors to the electricity consumption cost. The adjusted R-Squared, also the same as R-Squared yet statistically corrected, penalizes models with a wide number of parameters. Hence, the concluding result of the adjusted R-Squared shall be considered the absolute percent-effect of the significant variables per subset obtained in the regression. The R-Squared Change identifies the individual percent-effect of a variable.

### 4. Data Collection

The study is quantitative as it quantifies the demographics, description of a certain matter, attitudes, expectations, behaviors, and other defined variables with the goal of promoting or refuting theories about a specific phenomenon. In this case, the in-home energy consumption & conservation of Filipino households.

The design of data collection is survey. Usually, the survey questionnaire would revolve around the fundamental factors and data needed by the researcher to finish the study. Data points to be collected from random sampling with 400 targeted respondents from NCR and Region IV-A will be the data to be filtered and used on the analytical tools and techniques of this study. The Slovin’s formula was used to calculate the sample size (the number of respondents needed for the survey). Given with the margin of error of 5% (95% confidence level) and a housing population size in NCR as of 2015 with 2.97 million, plus Region IV-A with 3.3 million, the total number of respondents needed is 400.

\[
Margin \text{ of error: } 0.05
\]

\[
n = \frac{N}{1 + N \cdot e^2}
\]

where:

\[
N = \text{population of NCR + Region IV A}
\]

\[
e = 0.05
\]

therefore:

\[
n = \frac{(2,970,000 + 3,300,000)}{(1 + 2,970,000 + 3,300,000) \cdot 0.05^2}
\]

\[
n = \frac{6,270,000}{1 + 6,270,000 \cdot 0.05^2}
\]

\[
n = 399.9
\]

\[
n \cong 400
\]

The survey is divided into four (4) subsets based on functions as predictor variables: two (2) circumscribed and two (2) influenced in order to assess the correlation easily and appropriately. Through this partition, the researcher would be able to compare and weigh the relevance of the factors per category and behavior.

Under the circumscribed predictor elements is subset A or demographic variables. This section aims to identify the circumscribed factors that significantly impact the daily consumption cost of every household under scope: (a) age of family head; (b) gender since birth of family head; (c) Marital status of family head; (d) education of family head; (e) employment status of family head; (f) family size; (g) estimated monthly family income; and (h) location of present home address. Also, under the circumscribed variables is subset B or description of dwelling. This section aims to identify the specification of the house of the respondent as part of the circumscribed variables that could influence the daily consumption cost of every household under the area of research: (a) age of house; (b) house type; (c) estimated floor area; and (d) average monthly electric bill.

Under influenced predictor elements is subset C or monthly household energy consumption. This section aims to evaluate the number of units and frequency of usage of appliances of Filipino households under scope. This subset is classified into three classes of appliances: (a) small appliances – are portable or semi-portable machines, generally used on table-tops, counter-tops, or other platforms, to accomplish a household task. Listed in the survey design as a small appliance are the following: (1) blender; (2) blow dryer; (3) clock; (4) coffee maker; (5) flat iron; (6) food processor; (7) hair iron; (8) humidifier; (9) lights; (10) microwave oven; (11) oven toaster; (12) sewing machine; (13) vacuum cleaner; and (14) water heater; (b) major appliances or white goods – is a large machine in home appliance
used for routine housekeeping tasks such as cooking, washing laundry, or food preservation. Listed in the survey design as a major appliance are the following: (1) air conditioner; (2) baking oven; (3) dishwasher; (4) dryer; (5) electric fan; (6) electric stove; (7) freezer; (8) grill; (9) refrigerator; and (10) washing machine; and (c) consumer electronics or brown goods – are electronic (analog or digital) equipment intended for everyday use, typically in private homes. Listed in the survey design as a consumer electronic are the following: (1) CD/DVD player; (2) cell phone; (3) computer; (4) electric instrument; (5) printer/scanner; (6) radio; (7) record player; (8) speaker/stereo; (9) telephone; (10) television; and (11) video game console. Also, under the influenced variables is subset D or attitudinal variables. This section aims to assess the attitude and knowledge of dwellers towards in-home energy consumption and conservation through rating their own awareness and behavior: (a) significance of energy conservation; (b) further knowledge about energy conservation; (c) individual efforts of every person living inside the house in order to attain lower electricity consumption cost; (d) the business/government being at fault for the surge of electricity consumption cost; (e) acceptance of restrictions to avoid rise of electricity consumption cost; (f) pro-environmental ethics and concern for energy; (g) self-efficacy to attain the most desirable electricity consumption cost; (h) budget-saving electricity sources; (i) the government allocating more budget to develop alternative sources of power (e.g. wind and solar); (j) easy to get and understand information about energy conservation from electricity supplier; and (k) social media networks promoting energy conservation.

The 30 items used to measure quantifiable metrics, attitude, and knowledge behaviors were based from a study that had been used in prior studies (Ritchie, McDougall, & Claxton. 1981). Provided below are the actual sheets sent out to the population in target.

5. Results and Discussion

Reliability Test

In order to evaluate the internal consistency of the test items in the survey, Cronbach Alpha test shall be used. Most commonly, the Cronbach’s Alpha is used when the survey design has multiple Likert questions that generate a scale. The reliability test shall assess if the data gathered by the researcher is strongly relevant and/or acceptable. The generated output for the subset C with 35 items was 0.838 which is $0.9 > \alpha \geq 0.8$. To interpret, the subset has a good internal consistency according to the reliability test. For subset D, the result from Cronbach’s Alpha is 0.830 which is $0.9 > \alpha \geq 0.8$, or to interpret, the items in subset D has a good internal consistency.

5.1 Relationship between Predictor Variables and Dependent Factor Through Pearson Correlation

The Pearson Correlation and the variables with significant relationship towards each other (the dependent and a predictor variable) were explained in Table 1. Every element with a p-value $< 0.05$ (2-tailed) is considered to have a significant relationship with the dependent factor. The numbers in parentheses refers to the p-value when ran in Pearson correlation. The numbers both in parentheses and asterisk are the variables that are ran in regression and still considered a significant variable for both Pearson and partial correlation. The partial correlation values only appear if a factor is significant in regression.

The results in Table 1 showed, under subset A, estimated monthly income (DE7) with 0.000, family size (DE6) with 0.000*, and education of the family head (DE4) with 0.011* all have a significant relationship with DV for all their p-values are $< than 0.05$. Subsequently, the two factors – estimated monthly income; and family size, aside from being a significant variable in Pearson correlation, also is significant as per partial correlation for the regression equation. Under subset B, floor area (DW3) with 0.000* and age of house (DW1) with 0.047, both have significant relationship with the dependent variable as per Pearson correlation. The floor area alone is also significant as per partial correlation for the regression equation. In subset C, all the predictor variables – no. of small appliances (EC1) with 0.000*, frequency of usage of small appliances (EC2) with 0.000, no. of major appliances (EC3) with 0.000*, frequency of usage of major appliances (EC4) with 0.000, no. of consumer electronics (EC5) with 0.000*, frequency of usage of consumer electronics (EC6) with 0.000, are significant in Pearson, those with asterisk are the only predictors significant in the study as per partial correlation. Lastly, in subset D, only two predictor variables – further knowledge on energy conservation (AV2) with 0.047 and individual efforts of every dweller living inside the house in order to attain lower electricity consumption cost (AV3) with 0.000* have a significant relationship with the dependent factor. However, not both variables are significant as per partial correlation for the regression equation.
Table 1. Pearson Correlation between Predictor Variables and Dependent Factor

<table>
<thead>
<tr>
<th>Dependent Variable</th>
<th>Variables with significant relationship at p-value &lt; 0.05 (2-tailed)</th>
<th>Variables without significant relationship at p-value &lt; 0.05 (2-tailed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SUBSET A: Demographic variables</td>
<td>DE7 (0.000)*</td>
<td>DE1 (0.100)</td>
</tr>
<tr>
<td></td>
<td>DE6 (0.000)*</td>
<td>DE5 (0.058)</td>
</tr>
<tr>
<td></td>
<td>DE4 (0.011)</td>
<td>DE2 (0.690)*</td>
</tr>
<tr>
<td></td>
<td>DE3 (0.062)</td>
<td></td>
</tr>
<tr>
<td>SUBSET B: Description of dwelling</td>
<td>DW8 (0.000)*</td>
<td>DWE (0.119)</td>
</tr>
<tr>
<td>SUBSET C: Monthly household electricity consumption</td>
<td>EC7 (0.000)*</td>
<td></td>
</tr>
<tr>
<td></td>
<td>EC6 (0.000)*</td>
<td></td>
</tr>
<tr>
<td></td>
<td>EC5 (0.000)*</td>
<td></td>
</tr>
<tr>
<td></td>
<td>AV7 (0.058)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>AV6 (0.584)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>AV5 (0.533)</td>
<td></td>
</tr>
<tr>
<td>SUBSET D: Attitudinal variables</td>
<td>AV3 (0.002)*</td>
<td></td>
</tr>
<tr>
<td></td>
<td>AV2 (0.047)</td>
<td></td>
</tr>
</tbody>
</table>

Numbers in parentheses which are also the partial correlations for the regression equation containing all variables significant to DV.

5.2 Significant Predictor Variables Through Stepwise Regression Analysis

The results shall showcase the significant predictor variables per subset with relation to the dependent variable. The results shown on Table 2 present the following data that are labeled as relevant to the study.

For subset A:

*Estimated monthly income:* To support the claim, as per National Statistics Office and Department of Energy which conducted the Household Energy Consumption Survey (2011), there are a total of 18,282 households in all income class in the Philippines, in which 99.9% of households use electricity for lighting and 88.8% for recreation (consumer electronics). With this data, it was also stated that the supreme average monthly income of family in the Philippines is less than Php 10,000 yet still uses 99.9% of electricity for lighting and 83% for recreation.

*Family size:* It is considered as a significant player in the shift of energy consumption cost in Filipino households. To support the claim, a study by Yalcintas and Kaya (2017), household size (HHS) is an important factor in the estimation of residential electricity use. This is because HHS is positively linked to the energy it absorbs. Residences with high HHS consume more electricity; however, they can be more energy efficient (Lanjouw and Ravallion, 1995). HHS is calculated by dividing the de facto population by the number of residential clients. Then, the average HHS is plotted with average household electricity usage.

*Gender since birth of family head:* To support this claim, is an available data which shows that women and men have different habits of consumption (Raty and Carlsson-Kanyama, 2010). Disparities in gendered behaviors contribute to various levels of energy use. In nearly every country in the world, women spend more time doing unpaid work in the household than men do (OECD, 2014). The forms of domestic work that women prefer to engage in are energy intensive (e.g. washing and cooking). However, research in Europe and North America shows that, generally, men consume more energy than women. Men have more disposable income, spend more time on leisure activities and own/use more electronic equipment than women do.

For subset B:

*Floor area:* To support this claim, Article 2.20 Section 2.3 of the Philippine Electrical Code Part 1 (2017) states that, the minimum lighting load shall be the unit load not less than that specified for dwelling units which is 33 volt-amperes/m². The floor area within each floor shall be determined from the outside measurements of the house, housing unit or other area concerned. For housing units, the measured floor area shall not include open balconies, garages or unused or uncompleted spaces that are not appropriate for potential use.

For subset C:

To support the claims under this subset, Household Energy Consumption Survey (2011), led by National Statistics Office and Department of Energy, displayed the results of percentage of households using electricity during the six
months prior to survey, by end-use and type of appliances used in the Philippines. The total number of households in the Philippines as of 2011 is 18,282. The table as shown above presents the particulars of the type of appliance-total households’ relationship.

No. of small appliances owned: As per HECS (2011), small appliances such as lighting (84.9%), ironing (45.5%), cooking/food preparation (20.1%), and water heating (4.4%) are part of the total percentage of the appliances that the total number of households in the Philippines use. This accounts to the significance of the number of small appliances as a significant variable.

No. of major appliances owned: According to HECS (2011), major appliances listed such as air conditioning (9.3%), electric fan (65.2%), refrigeration (40.5%), freezer (0.9%), and laundry (29.4%) are of the total electricity use of total number of households in the Philippines. This accounts to the significance of the number of major appliances as a significant variable.

No. of consumer electronics: As of HECS (2011), the following consumer electronics contribute to the total electricity use of total number of households in the country: Radio/tape recorder/stereo (34.5%), TV (74.7%), VCR (25.6%), video games (0.3%), computer (15.2%), and printer (2%). This accounts to the significance of the number of consumer electronics as a significant variable.

For subset D:
To support the claims on to why attitudinal variables, individual efforts of every dwellers and significance of energy conservation, has a significant role in the shift of cost in electric consumption, a study by Sapi and Considine (2014) shows that however, appealing to environmental problems is not the only way to inspire people to save resources, attitudes towards these environmental issues have a clear, observable and statistically relevant effect on the behavior of energy consumption. In short, as the level of compliance with environmental issues rises, households are taking concrete action to conserve electricity. The key finding is that the households concerned with the climate are usually more involved conservative use of energy.

Table 2. Significant Factors that Influence the Monthly Electric Bill

<table>
<thead>
<tr>
<th>Dependent Variable: DW4</th>
<th>Variables significant as per stepwise regression</th>
</tr>
</thead>
<tbody>
<tr>
<td>SUBSET A: Demographic variables</td>
<td>DE7 (17.6%), DE6 (7.8%), DE2 (0.9%)</td>
</tr>
<tr>
<td>SUBSET B: Description of dwelling</td>
<td>DW8 (3.9%)</td>
</tr>
<tr>
<td>SUBSET C: Monthly household electricity consumption</td>
<td>EC1 (24.7%), EC3 (2.6%), EC5 (1.2%)</td>
</tr>
<tr>
<td>SUBSET D: Attitudinal variables</td>
<td>AV3 (2.4%), AV1 (1.3%)</td>
</tr>
</tbody>
</table>

5.3 Analysis and Interpretation of Regression
Evident in Table 3 is the relationship seen between the significant variables and the dependent variable. The table shall display the R-Squared in the model summary acquired from stepwise regression.

R is the linear association between the observed and the model values of the dependent variable. The larger the value, the stronger the relationship. For subset A, the cumulated R for all three variables is 0.512 which interprets to a high positive relationship; subset B with an R of 0.198 which equates to a low positive correlation; subset C with a cumulated R of 0.534 which equals to a high positive relationship; and subset D with a cumulated R of 0.192 which is interpreted as a low positive correlation. R-Squared proves how much of the overall variance of the dependent
variable can be explained by the independent variable. The concluded R-Squared per subset shall be the percent effect of the variables to the energy consumption cost per household. For subset A, the concluded R-Squared is 0.263 which illustrates that 26.3% of the variation in electricity consumption cost is explained by the significant predictor variables in demographics; for subset B, the concluded R-Squared is 0.039 which displays that 3.9% of the variation in electricity consumption cost is explained by the significant variable in description of dwelling; for subset C, the concluded R-Squared is 0.285 which shows that 28.5% of the variation in electricity consumption cost is explained by the significant variable in average monthly energy consumption; and for subset D, the concluded R-Squared is 0.039 which displays that 3.9% of the variation in electricity consumption cost is explained by the significant variable in behavioral attributes.

Adjusted R-Squared, also the same as R-Squared yet statistically corrected, constrains models with a wide number of parameters. In this case, the researcher shall use the results of adjusted R-Squared as a basis. For subset A, the concluded adjusted R-Squared is 0.257 which illustrates that 25.7% of the adjusted variation in electricity consumption cost is explained by the significant predictor variables in demographics; for subset B, the concluded adjusted R-Squared is 0.037 which displays that 3.7% of the adjusted variation in electricity consumption cost is explained by the significant variable in description of dwelling; for subset C, the concluded adjusted R-Squared is 0.280 which shows that 28% of the adjusted variation in electricity consumption cost is explained by the significant variable in average monthly energy consumption; and for subset D, the concluded adjusted R-Squared is 0.032 which displays that 3.2% of the adjusted variation in electricity consumption cost is explained by the significant variable in behavioral attributes.

R-Squared Change is the difference among the predecessors of variables per subset in R-Squared. For subset A, the R-squared change is arranged in descending order as estimated family income with 0.176; family size with 0.078; and gender since birth of family head with 0.009. For subset B, floor area with 0.039. For subset C, no. of small appliances owned with 0.247; no. of major appliances owned with 0.026; and no. of consumer electronics with 0.012. For subset D, individual efforts of every dweller with 0.024; and significance of energy conservation with 0.013.

Table 3. Model Summary of Stepwise Regression of Significant Predictor Variables and Monthly Electric Bill

<table>
<thead>
<tr>
<th>Subset A</th>
<th>Sub-set B</th>
<th>Sub-set C</th>
<th>Sub-set D</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>a</td>
<td>a</td>
<td>a</td>
</tr>
<tr>
<td>Estimated monthly income</td>
<td>Floor area</td>
<td>No. of small appliances owned</td>
<td>Individual efforts of every person living inside the house in order to attain lower electricity consumption cost</td>
</tr>
<tr>
<td>0.419a</td>
<td>0.198a</td>
<td>0.497a</td>
<td>0.154a</td>
</tr>
<tr>
<td>0.176</td>
<td>0.039</td>
<td>0.247</td>
<td>0.024</td>
</tr>
<tr>
<td>0.174</td>
<td>0.273</td>
<td>0.245</td>
<td>0.021</td>
</tr>
<tr>
<td>0.176</td>
<td>0.270</td>
<td>0.078</td>
<td>0.024</td>
</tr>
<tr>
<td>0.039</td>
<td>0.012</td>
<td>0.032</td>
<td>0.013</td>
</tr>
</tbody>
</table>

5.4 Model Summary

It is a principal goal of this research to identify which factors significantly affect the electricity consumption cost of Filipino households. With this, the percent effect of every tested predictor variable individually and per subset were determined.
For subset A, 17.6% of the variation in electricity consumption cost in terms of demographics is explained by estimated monthly income; 7.8% of the variation in electricity consumption cost in terms of demographics is explained by family size; and 0.9% of the variation in electricity consumption cost in terms of demographics is explained by gender since birth of family head. To conclude, 26.3% of the variation in electricity consumption cost is explained by demographics. However, the researcher shall consider the results of the adjusted R-Squared instead hence, 25.7% of the adjusted variation in electricity consumption cost is explained by the demographics.

For subset B, to conclude, 3.9% of the variation in electricity consumption cost is explained by the type of dwelling. However, the researcher shall consider the results of the adjusted R-Squared instead hence, 3.7% of the adjusted variation in electricity consumption cost is explained by the type of dwelling.

For subset C, 24.7% of the variation in electricity consumption cost in terms of usage of appliances is explained by number of small appliances owned; 2.6% of the variation in electricity consumption cost in terms of usage of appliances is explained by number of major appliances owned; and 1.2% of the variation in electricity consumption cost in terms of usage of appliances is explained by number of consumer electronics owned. To conclude, 28.5% of the variation in electricity consumption cost is explained by the average monthly energy consumption. However, the researcher shall consider the results of the adjusted R-Squared instead hence, 28% of the adjusted variation in electricity consumption cost is explained by the average monthly energy consumption.

For subset D, 2.4% of the variation in electricity consumption cost in terms of behavioral attributes is explained by the thinking of the dwellers that the individual efforts of every person living inside the house in order to attain lower electricity consumption is important; and 1.3% of the variation in electricity consumption cost in terms of behavioral attributes is explained by the perception of the dwellers that significance of energy conservation is important. To conclude, 3.7% of the variation in electricity consumption cost is explained by the behavioral attributes of the dwellers. However, the researcher shall consider the results of the adjusted R-Squared instead hence, 3.2% of the adjusted variation in electricity consumption cost is explained by the behavioral attributes of the dwellers.

![Figure 1. Stepwise Regression Adjusted R-Squared Results](image.png)

**5.5 Proposed Improvements**

The researcher believes that this study could have a wider potential once each predictor variables are to be assessed individually possibly with different regression models may it be exploratory or not. Focusing on a single factor or a smaller scale of variables might help assess the significance and influence on the variations of the electric consumption cost more specifically. Another probable field of research is changing one of the predictor variables into a dependent factor. For example, to test what explains the attitudinal practices of dwellers when it comes to energy consumption and conservation. The same technique and regression model could apply even with a whole diverse picture and concept of the study. Also, the population sample could be modified through expanding the scope of the area of research. Through this, the range of the study shall be multiplied, not only on NCR and Region IV-A, implying a larger number of respondents from a bigger vicinity of area. Most noteworthy is focusing solely on attitudinal variables or behavior.
attributes of the dwellers to be able to identify the percent effect of every lifestyle or practices that every member in the household have. It is also with a belief that this study would be of a help to future researchers who would evaluate with alternative energy resources from a different point of view. This research has the potential to be acknowledged as an outset for future researchers who would integrate not only electricity but also fuel energy in order to wholly grasp the concept of in-home energy consumption.

6. Conclusion
The study is to assess statistically which among the circumscribed and influenced variables have an effect on the energy consumption cost of Filipino households. A random survey was conducted in order to take note of the statistical measurements and behavioral attributes of household dwellers in NCR and Region IV-A. Through providing two subsets for each circumscribed and influenced variables, the research shall evaluate the study more accurately and precisely. The subsets for circumscribed are named (Subset A) demographics, and (Subset B) description of dwelling. For influenced, (Subset C) average monthly energy consumption, and (Subset D) attitudinal variables. The estimated monthly electric bill was labeled as the dependent factor in the study.

Through executing Pearson Correlation and Stepwise Multiple Regression, the significant factors that influence and disturb the energy consumption cost of Filipino households were determined. Moreover, the relationship among the predictor variables which plays a role on the study were also tested.

As a result of this study, the following factors have a significant relationship with the dependent variable (estimated electricity consumption cost) as their p-value are < 0.05: Subset A: estimated monthly income, family size, and education of family head; Subset B: floor area, and age of house; Subset C: no. of small appliances owned, frequency of usage of small appliances, no. of major appliances owned, frequency of usage of major appliances, no. of consumer electronics owned, and frequency of usage of consumer electronics; and Subset D: further knowledge on energy conservation, and individual efforts of every dweller.

In conclusion, it is found that estimated monthly income, family size, and gender since birth of family head under Subset A; floor area under Subset B; no. of small appliances owned, no. of major appliances owned, and no. of consumer electronics owned under Subset C; and importance of individual efforts of every person living inside the house in order to attain lower electricity, and significance of energy conservation under Subset D have an effect on the fluctuation and changes in the cost of the energy consumption of households in the area of research. This clearly means that all of the listed factors below are responsible and could explain the changes in the energy consumption cost in Filipino household.

It is one of the primary goals of this study to determine the percent of effect of the significant factor to the energy consumption cost of households. Overall, 25.7% of the adjusted variation in electricity consumption cost is explained by the demographics; 3.7% of the adjusted variation in electricity consumption cost is explained by the type of dwelling; 28% of the adjusted variation in electricity consumption cost is explained by the usage of appliances of the dweller; and 3.2% of the adjusted variation in electricity consumption cost is explained by the behavioral attributes of the dwellers.

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