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Preliminary Study of Perception and Consumer Behaviour Towards Energy Saving for Household Appliances: A Case of Makassar

Yusri Syam Akil¹, Saiful Mangngene², Sri Mawar¹, Kifayah Amar³

¹Department of Electrical Engineering, Hasanuddin University, Gowa, Indonesia

²Department of Industrial Engineering, Hasanuddin University, Gowa, Indonesia

³Department of Industrial Engineering, UIN Sunan Kalijaga, Yogyakarta, Indonesia

E-mail: yusakil@unhas.ac.id

Abstract. Electricity load has tendency to increase over the time. Therefore, efforts to maintain a balance between electricity supply and demand such as increasing energy saving related to the use of home electricity appliances are urgently needed. In general, one of the household appliances which consumes relatively high electricity energy is refrigerator. The purpose of this study is to analyze residential consumers perceptions and their behaviours about electricity energy saving in relation to the usage of household appliances in Makassar, Indonesia particularly for refrigerator. Moreover, typical relationship between perceptions and consumers behaviours is also analyzed by composed two regression models, namely model for usage behaviour (UREF_m model) and model for habitual behaviour (HREF_m model) by using general perception, specific perception, and external factors as explanation variables. To collect data, a questionnaire was designed for survey which involved 40 respondents as a preliminary study and then statistical tests including regression analysis were applied to analyze usable data. The target of respondent was an owner of a house in Makassar with installed power capacity at least 900 VA. Reliability test shown that all items in the developed questionnaire can be used for main survey as obtained Cronbach's alpha values were above 0.6. Evaluation for consumers perceptions on energy saving in relation to demographic aspect using mean and Standard Deviation values indicated some significant differences. Other results regarding regression analysis shown that both composed models were well validated and had quite good fitness degree with adjusted R-squared values around 49.31% for UREF_m model and 80.90% for HREF_m model. Among considered variables, specific perception, and external factors were found have significant influence to the usage and habitual behaviours of consumers as confirmed by their p-values in each model below 0.05. Findings of this research can be used as a reference in developing programs for residential consumers such as electricity energy conservation program.

1. Introduction

As in other countries, residential area is one of the major electricity load sectors in Makassar, Indonesia which contributes significantly to total electricity load demand. Considering electricity load has tendency to increase over the time, and depleting fossil fuel to produce electricity energy including environmental issue and fuel price make penetration of more renewable energy sources into power system and or other efforts to maintain balancing between electricity production and load demand in



any level in power systems are needed. They are important to overcome energy crisis and continuing usage of electricity energy for a long time. At consumer level, increasing usage of energy saving electricity devices or managing the using of appliances at home is a possible option. In general, although energy saving in one home is relatively small, but in accumulation for large residential area can give significance reduction to the total electricity load at certain place such as in Makassar. Regarding condition of residential electricity demand in Makassar, number of residential consumers for each group in terms of installed power capacity (900 VA; 1,300 VA; 2,200 VA; 3,500 VA – 5,500 VA; and 6000 VA above) has been increased by time and same tendency occurred for electricity consumption (sold electricity energy in kWh). Based on the data from State Electricity Company in Makassar (PT. PLN (Persero)), among the groups, majority of consumers has installed power capacity 900 VA in their homes which proportional to the level of needed electricity consumption. Number of consumers particularly for group 900 VA in Year 2012 is 251,370 and increased 319,330 in Year 2016. Meanwhile electricity consumption for the group is 383,863,181 kWh in Year 2012 and become 562,927,231 kWh in Year 2016.

In residential area, electricity load derives from utilization of many household appliances such as refrigerator, air-conditioner, washing machine, rice cooker, and lighting. However, refrigerator is known as one of appliances which consumes relatively big electricity energy. As refrigerator is a main electricity device at home which operate continuously and used by majority of the houses, therefore, it is meaningful to analyze and manage the use of refrigerator as an effort to reduce monthly electricity consumption. Basically, increasing of electricity usage efficiency is not only help to keep balancing between electricity supply and demand in one place, but also to mitigate climate change in the fastest, cheapest, and safest way [1]. Some previous studies regarding household refrigerator can be found in [2-5]. In this research, we have interesting to analyze consumers perceptions and their behaviours related to efficiency of electricity usage for household appliances in Makassar, Indonesia. To address the research objective, a questionnaire is employed to gather data from respondents through a pilot survey. Next, statistical approach is applied to analyze usable data. As consumers behaviours in residential sector can affect pattern and big of electricity consumption, therefore, findings of this study are expected to provide a contribution for better energy usage pattern at consumers side. Further, it also can be used as a basis to developing suitable programs for residential consumers in Makassar such as program for electricity energy conservation. Previous studies on electricity demand analysis in Makassar can be found in [6,7].

2. Materials and Methods

2.1. Questionnaire Design and Dataset Collection

As an initial step, a questionnaire was designed to collect data from respondent who has energy saving refrigerator at home. Information from previous studies on refrigerator or other related studies were used as a basis to develop the questionnaire [4,8]. Specifically, the questionnaire was designed to measure perceptions of consumers including their typical behaviours towards energy saving through the usage of refrigerator at their homes. Study area was Makassar city and target of respondent was house owner with installed power capacity at least 900 VA. Purposive sampling technique was used to collect sample data for 40 respondents, and then usable data were analyzed using statistical approach included such as Cronbach's alpha value test, mean value, Standard Deviation, and regression analysis as described further in each related section. The period of the data collection was in August 2017.

In the questionnaire, systematic questions were composed to gather required information which consists of four main parts. Part 1 regarding general information, Part 2 regarding general perception towards energy saving and external factors, Part 3 regarding specific perception on attribute of energy saving refrigerator, and Part 4 regarding usage and habitual behaviours of the consumers.

For example in Part 1, questions included age of respondent, house size, household income per-month, etcetera. For general perception (Part 2), composed questions such as "Implementation energy saving lifestyle reduces monthly electricity bill at home", meanwhile the questions for external factors

(social factor, media, and weather factor) such as “The usage of electrical devices is influenced by social factor like neighbors, relatives, and friends”. For questions regarding specific perceptions on attribute of energy saving refrigerator (in terms of technology, aesthetics, and cost attribute) include “Energy saving refrigerator relatively produce low noise and the compressor is more durable”. To asses items in the questionnaire, we used a seven point Likert scale which range from 1 to 7. Here, 1 shown “strongly disagree” and 7 for “strongly agree”. Next to identify typical relationship between perceptions and consumers behaviours (usage and habit) regarding refrigerator, two regression models were composed as in [8]. Both of the models can be formulated as follows:

$$UREF_m = \alpha_0 + \alpha_1 GP + \alpha_2 SP + \alpha_3 EF + u_t \quad (1)$$

$$HREF_m = \beta_0 + \beta_1 GP + \beta_2 SP + \beta_3 EF + u_t \quad (2)$$

In the Equations (1) and (2), $UREF_m$ and $HREF_m$ are usage and habitual behaviour about energy saving refrigerator, respectively. As explanation variables in the models, GP is general perception, SP is specific perception, and EF is external factors. α_0 and β_0 are intercept values, and other α and β values are regression coefficients. u_t is residual term of models.

2.2. Reliability and Validity Tests

For reliability testing, Cronbach’s alpha was used to measure internal consistency between items under the same dimensions and the Cronbach’s alpha value of this pilot survey can be seen in table 1. All dimensions shown the Cronbach’s alpha values are above 0.6. It means that all the questionnaire items can be used for main survey. For validity, we used expert validity as the questionnaire items were designed mainly based on the prior study on energy-efficient lighting [8] and it was modified to fulfill Indonesian lifestyles of household appliances usage in particular for refrigerator. All the items were reviewed and appropriate improvement were made by experts to validate them.

Table 1. Reliability test results.

No	Dimension	Cronbach’s alpha value
1	General perception	0.891
2	Specific perception	0.909
3	External factors	0.890
4	Usage behaviour	0.910
5	Habitual behaviour	0.919

3. Results

3.1. Demographic Aspect of Respondents

Demographic of 40 respondents in this study is shown in table 2. The information includes gender, education, age, house size, household income per-month, installed power capacity at home, and lenght of using energy saving refrigerator. It can be seen from the table 2 that majority of respondents were female. Of the fourty respondents, 55% were hold bachelor degree, 25% were graduated from high school, 17.5% were hold other degree, and 2.5% were hold master and doctoral degree. Majority of respondents have house with size was 60 m² and power installed capacity at home was 1,300 VA. About 48% of respondents were using energy saving refrigerator for 1 – 3 years.

Table 2. Demographic of respondents.

No		Demographic aspect	Percentage	Total
1	Gender	Female	52.5 %	100 %
		Male	47.5 %	
2	Education	High School	25.0 %	100 %
		Bachelor Degree	55.0 %	
		Master and Doctoral Degree	2.5 %	
		Others	17.5 %	
3	Age	20 – 30 Years	20.0 %	100 %
		31 – 40 Years	42.5 %	
		41 – 50 Years	30.0 %	
		50 Years above	7.5 %	
4	House size	45 m ²	22.5%	100 %
		60 m ²	50.0 %	
		120 m ²	27.5 %	
		Others	0.0 %	
5	Household income	< 2,500,000 IDR	27.5 %	100 %
		> 2,500,000 – 5,000,000 IDR	55.0 %	
		> 5,000,000 – 7,500,000 IDR	12.5 %	
		> 7,500,000 IDR	5.0 %	
6	Power installed capacity at home	900 VA	32.5 %	100 %
		1,300 VA	47.5 %	
		2,200 VA	17.5 %	
		3,500 VA – 5,500 VA	2.5 %	
7	Length of using energy saving refrigerator	6,000 VA above	0.0 %	100 %
		< 1 Year	37.5 %	
		1 – 3 Years	47.5 %	
		> 3 Years	15.0 %	

3.2. Perception of Residential Consumers on Energy Saving Refrigerator

Consumers perceptions with regards to general perception, specific perception, and external factors particularly on energy saving refrigerator were analyzed. As results, gender and length of using energy saving refrigerator have significant difference on external factors as indicated by obtained p-values which were less than 0.05, namely 0.036 and 0.018, respectively. It is found that male respondents more perceived external factors as a variable which determine the usage of energy saving refrigerator at home (as shown by Mean value is 5.745 and Standard Deviation (SD) is 1.069) than female respondents (Mean value = 5.139 and SD = 1.113). Beside that, respondents which used refrigerator less than 1 year more positively perceive the influence of external factors on the usage of energy saving refrigerator than two other categories with Mean value is 5.977 and SD is 0.963.

3.3. Factors Influence on Usage and Habitual Behaviours of Energy Saving Refrigerator

Table 3 and table 4 show regression results for UREF_m and HREF_m models which well validated. From results, typical relationship between consumers perceptions and usage or habitual behaviours about energy saving refrigerator can be identified. The fitness degree of composed models were relatively good as adjusted R-squared (adj. R²) around 49.31% for usage behaviour model and 80.90%

for habitual behaviour model. Next, at least one of involved variables in related models affect usage and habitual behaviours as indicated by their Prob. F-Statistic values are 0. The autocorrelation was not existed in the models. It is shown by Durbin-Watson test (D-W) around 2 for each composed model.

Table 3. Regression results for UREF_m model.

Variable	UREF _m model (Model for usage)			
	Coefficient	Prob. (p-value)	Standar error	t-statistic
α_0	2.2072	0.0007	0.5973	3.6953
GP	-0.4229	0.1081 ^a	0.2566	-1.6479
SP	0.8176	0.0112	0.3057	2.6744
EF	0.2114	0.0369	0.0975	2.1667
R ²			0.5321	
Adj. R ²			0.4931	
S.E Reg.			0.5620	
Prob. (F-Statistic)			0.0000	
D-W			2.0709	

^a is not significant.

S.E. Reg. is standard error regression.

Table 4. Regression results for HREF_m model.

Variable	HREF _m model (Model for habit)			
	Coefficient	Prob. (p-value)	Standar error	t-statistic
β_0	0.5345	0.0766 ^{a,b}	0.2931	1.8233
GP	-0.1712	0.2560 ^a	0.1483	-1.1543
SP	0.8564	0.0000	0.1656	5.1703
EF	0.2097	0.0014	0.0607	3.4512
R ²			0.8237	
Adj. R ²			0.8090	
S.E Reg.			0.3522	
Prob. (F-Statistic)			0.0000	
D-W			1.8038	

^a is not significant.

^bsignificance at 10% significance level.

By using 5% significance level, SP and EF variabls have significance, meanwhile GP variable is not significant as p-value for each model is above 0.05. This means specific perception (SP) and external factors (EF) are two important variables or factors which affect significantly usage and habitual behaviours of consumers regarding energy saving refrigerator in Makassar. Among the significance variables, specific perception has higher influence than external factors as indicated by regression coefficient value of SP variable for each model is bigger than regression coefficient of EF variable. Elimination of non-significance explanation variabel (GP variable) in both models gives almost the same regression results. Next, compared between the two models, adj. R² value for HREF_m model (80.90%) is higher than UREF_m model (49.31%). The difference of the values shown if considered variables affect usage and habitual behaviours differently. The variables can explain habitual behaviour better than usage behaviour of consumers.

4. Conclusion

This paper studies perceptions and consumers behaviours about electricity energy saving in relation to the usage of refrigerator at home in Makassar. It can be concluded that developed questionnaire to collect data in this study were reliable and can be used for main survey and further analysis. Both composed regression models (usage and habit models) to investigate relationship between consumers perceptions including external factors and their behaviours were well validated and had quite good fitness degree. Considered variables (general perception, specific perception, and external factors) affected the two models differently. They can explain habitual behaviour better than usage behaviour of consumers, and only specific perception and external factors had significance. Therefore, specific perception on attribute of refrigerator and external factors (social factor, media, and weather factor) were two important variables which affect highly usage and habitual behaviours of consumers in Makassar regarding the use of refrigerator towards energy saving. As consumers behaviours can affect pattern and level of electricity consumption, it is hoped findings of this research contribute to a better pattern of energy use from the consumer side. The information gained can be used as a basis in developing suitable programs for residential consumers such as electrical energy conservation programs. Future research will involve more respondents and analyze other household appliances to get more information with regards to typical behaviours of consumers and potential of energy saving at household level in Makassar.

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