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Consumer Preference for Energy Label in the Purchase Decision of Refrigerator: A Discrete Choice Experiment Approach in the East Coast, Malaysia

Muhammad Azrin Shah Razali, Mahirah Kamaludin*, A. A. Azlina

Universiti Malaysia Terengganu, Malaysia. *Email: mahirah.k@umt.edu.my

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ABSTRACT

Energy label is a widely used policy instrument to increase consumer awareness of energy-efficient home appliances. It helps consumers make better informed purchasing decision intending to save on the electricity bill. The increase in energy efficiency for a household can generate significant energy savings and emissions reduction which can reduce environmental impact. The energy label targets to fight climate change, protect the environment and is significant to support Sustainable Development Goals (SDGs). This study presents the results of a discrete choice experiment (DCE) on the East Coast, Malaysia to investigate the consumer preferences for energy label in the purchasing decision of a refrigerator. Multinomial logit (MNL) and mixed logit (ML) models are specified to measure the attributes that consumers assess when choosing refrigerators. This study focuses on four attributes, namely energy star, energy consumption, energy saving and refrigerator price. Findings show that consumers have responded positively to the labels, in which about 88.11% of respondents are willing to pay to get better quality appliances that promote a safe environment while 11.89% of respondents are not willing to pay. The findings are useful in improving the effectiveness of existing energy efficiency and labelling programs to accelerate the adoption of energy-efficient technology in Malaysia. Hence, the implementation of energy label promotes energy-efficient appliances, which is in line with SDG Goal 7: Ensuring access to affordable, reliable, sustainable, and modern energy for all.

Keywords: Energy Efficient, Energy Label, Discrete Choice Experiment, Refrigerator, Sustainable Development Goals, Malaysia
JEL Classifications: Q0, Q40, Q49

1. INTRODUCTION

Developing low-carbon technologies is crucial to achieving international climate mitigation goals (Van et al., 2018). The differences in the responses to categories of energy efficiency (EE) on labels studied so far is likely to be biased due to inter-attribute correlation in the experiment design (Sammer and Wüstenhagen, 2006; Jeong and Kim, 2015). Renewable energy and energy-efficient technologies are among those critical aspects in addressing several energy-related challenges, mostly in emerging economies. After the oil crisis in the 1970s, countries with developed economies responded by implementing several policies to promote energy-efficient technologies (Saidel and Alves, 2003). Establishing energy performance standards and labels push the market by eliminating the least efficient appliances. The EE standards and labels are being established internationally, as a simple and effective strategy for guiding consumers in their purchases of household appliances.

The minimum energy performance standards (MEPS) prohibit manufacturers from selling products with lower efficiency, below a specified level. These appliance labels inform consumers about the energy consumption or energy efficiency of appliances. The MEPS program aims to ban the production and sales of low-efficiency products to phase-out low-efficiency products from the market. It means that, to sell their products in the market, manufacturers must meet the minimum efficiency level set by the standards. Furthermore, according to Mahlia et al. (2003) energy-efficient appliances can reduce energy consumption and consumers' utility bills, as well as helping the country from becoming a dumping site for inefficient electrical appliances. Besides, the implementation of EE label may indirectly combat CO_2 emission and mitigate global warming. By establishing energy efficiency and CO_2 emissions reductions at every stage of production and process, those appliances offer a more effective solution with a lower carbon footprint, assisting the consumers in meeting their sustainability objectives. Hence, the societies' commitments and actions are in line to attain goals in Sustainable Development Goals (SDG).

Arrow et al. (1996) stated that in the prior stage of economic growth, people in poorer countries tend to emphasise material well-being over environmental amenities and assume increased pollution as a side effect of economic growth. When per capita income in a nation or a region attains a certain point, people start demonstrating more interest in environmental protection. Therefore, that was when the environmental conservation policies began in developed countries. The rise in average income and quality of people's lives has led to greater demand for household appliances, resulting in higher consumption of electricity among households and an increased carbon dioxide (CO_2) emissions from the production and consumption processes. Developed countries that have higher income levels proportionate more to CO_2 emission. Table 1 illustrates the gross domestic product (GDP) and CO_2 emission by current income status for the selected Asia Pacific and ASEAN countries in 2018. Developed nations with higher incomes like Singapore, Japan and South Korea have greater demand for energy consumption, causing higher carbon emissions when compared to other developing countries.

Table 1 demonstrates that the reduce in carbon emissions is an urgent issue globally. Many previous studies have employed the decomposition method to investigate the driving factors of carbon emissions with comparative analyses between countries, such as China, USA, UK, Greece, Turkey, and South Korea (Zhao et al., 2016; Hammond and Norman, 2012; Freitas and Kaneko, 2011; Akbostancı et al., 2011; Oh et al., 2010). However, most previous studies have analysed carbon emissions at the national level only due to the limited number of reliable CO_2 emission data available. For example, Lee and Oh (2006) used a cross-sectional decomposition method to analyse the CO_2 emissions in APEC countries. Fernandez González et al. (2014b) examined changes in CO_2 emissions in the EU at the country level and identified diverse patterns in large and small economies.

According to Xu et al. (2016), the possibilities of achieving the national carbon reduction target depend on the implementation of regional carbon reductions. To achieve the CO_2 reduction targets, the national emission reduction targets are often allocated to various provinces or states. The industrial structure has an impact on air quality. The proportion of GDP is contributed by primary industries, which make direct use of natural resources, secondary industries, which produce manufactured goods, and tertiary industries, which generate services that affects air quality to a different degree. It has been indicated that primary and secondary industries, occupying a great portion of the GDP, have a significant correlation with air quality (Jiang et al., 2014). For instance, the manufacturing sector fundamentally contributes to industrialisation and development in cities and has a significant positive correlation with the average air pollution index (API) data (Zhang et al., 2011; Shi, 2014). Taghizadeh-Hesary and Taghizadeh-Hesary (2020) stated that carbon emissions are one of several contributions to air pollution. Hence, as illustrated in Table 2, it can be seen the GDP of states proportionate to quality of API in Peninsular Malaysia for the year 2016.

The states with higher GDP tend to contribute more to the increase in API. Selangor, Kuala Lumpur and Johor are the focal points of various manufacturing industries that recorded the worst air pollution with 115, 112 and 102 respectively, these index are unhealthy for sensitive groups with big concern (Air Pollutant Index of Malaysia, 2018). Thus, energy efficiency policy and legislation are necessary to avoid the overconsumption of energy resources caused by developed nations. Although not all developed countries' energy-efficiency policies can be followed by developing countries, EE label is one of the most common solutions for many countries that guide consumers to purchase an efficient appliance (Association of Water and Energy Research Malaysia, 2012). Abu Saleh et al. (2011) highlighted that implementing EE label

Table 1: GDP and CO_2 emission indicators for selected Asia Pacific and ASEAN countries in 2018

Current income Status	Country	GDP per capita (Million US$)	CO_2 emissions per capita (metric tons)
High income	Singapore	66,679.046	8.399
	Japan	39,808.169	8.742
	South Korea	33,422.944	12.225
Upper middle income	Malaysia	11,380.082	7.6
	Thailand	9,905.342	3.714
	China	7,296.880	7.352
Lower middle income	Indonesia	3,893.860	2.178
	India	1,996.915	1.8
Lower income	Cambodia	1,512.127	0.687

Source: data.worldbank.org.

Table 2: GDP and API for states in Peninsular Malaysia

Regions in peninsular Malaysia	States in peninsular Malaysia	GDP for 2016 (RM Million)	API for 2016	
			Minimum	Maximum
Central region	Kuala Lumpur	190,075	10.0	112.0
	Selangor	280,698	2.0	115.0
	Negeri Sembilan	42,389	7.0	96.0
Northern region	Penang	81,284	2.0	84.0
	Perak	67,629	2.0	95.0
	Kedah	40,596	4.0	96.0
	Perlis	5,642	1.0	76.0
East coast region	Pahang	52,452	2.0	82.0
	Terengganu	32,270	1.0	84.0
	Kelantan	23,020	1.0	74.0
Southern region	Johor	116,679	6.0	102.0
	Malacca	37,274	12.0	86.0

Source: www.apims.doe.gov.my

on cloth washers would likely urge manufacturers to produce energy-efficient products and boost competition in the local and international markets. It encourages companies to develop and invest in energy-efficient product design (Ward et al., 2011).

Table 2 also shows that the East Coast region has recorded the lowest API compared to other regions of peninsular Malaysia. The east coast region plays a very important role in preserving the environment in Peninsular Malaysia. The economic region of the east coast includes three states and one district which is very large with an area of 51% of the area of Peninsular Malaysia, namely Terengganu, Kelantan, and Pahang as well as the district of Mersing. Figure 1 shows the area of the East Coast of Peninsular Malaysia.

According to the past literature on stated preferences, fewer papers have focused on the effects of energy label based on the willingness to pay (WTP). Most past studies examined consumers' additional WTP for energy-efficient products employed stated preference techniques, such as contingent valuation (CV) and choice experiment (CE). The impacts of label on consumers' decisions have been extensively studied in the literature using questionnaire-based studies, econometric models, and discrete choice analysis. Jain et al. (2018), highlighted that in questionnaire-based studies, respondents were directly asked about their WTP for label and higher efficiency. Elicitation of consumers' WTP for labelled appliances and energy-efficient appliances using questionnaire-based surveys indicated positive responses but produced a large range of estimates (Zheng et al., 2014; Dhingra, 2016).

Figure 1: East coast region in peninsular Malaysia

Source: www.ecerdc.com.my

Discrete choice experiments (DCE) have been used in several studies to elicit consumer preference from the stated preference data (Sammer and Wüstenhagen, 2006; Shen and Saijo, 2009; Jeong and Kim, 2015; Jain et al., 2018). In the short and medium-term, technology policies would be essential in energy and climate-related policy portfolios (Meckling, 2018). Carbon pricing policies, such as a carbon tax and cap and trade regulation are mandatory in increasing the diffusion of these technologies in the long term. Several studies have reported that the EE standards and labels program was an effective policy intervention and has contributed to energy and emission reduction (Meyers et al., 2003; Lane et al., 2007; Tao and Yu, 2011). Studies using econometric and statistical models on market data gave robust results, yet they had large data requirements and were likely to suffer from unobserved factors in consumer choices (Galarraga et al., 2011; Mills and Schleich, 2010). The household choices were observed in hypothetical choice situations.

The literature studies suggest that the EE labelling has already been implemented in households' appliances in more than 50 countries globally before the voluntary and mandatory environmental or energy certification schemes were gradually introduced in the early 1990s (Wong and Kruger, 2017). Energy labelling has become more common in marketplaces all around and offered considerable promise for reducing the financial costs and environmental damages associated with energy use (Gerarden et al., 2017). Standardization procedures and EE labelling can create awareness in using energy efficiently among consumers.

A growing number of studies have used DCE to value household preferences on energy efficiency and labelling improvement. Table 3 provides an overview of the key findings of various DCE studies on energy label attributes for both developed and developing countries. These studies use consumers' WTP of energy label attributes to value preferences for energy efficiency and labelling improvement. One of the earliest studies using DCE for energy label attributes is the study by Moxnes (2004) in Norway. The DCE was used to estimate utility functions for individuals that have recently bought a refrigerator. The researcher used four attributes in the study: (1) inside volume; (2) height; (3) energy cost; and (4) price of the refrigerator. The study found that energy efficiency standards and labels could lead to an increase utility for the average customer. The study considered the attribute price as a sensitive detail of the findings. Hence, the price of the most efficient refrigerators must drop by 15% to prevent reductions in average utility.

Sammer and Wüstenhagen (2006) presented an empirical data on the influence of ecolabels on consumer behaviour for household appliances. The study reported the results of a survey involving 151 choice-based conjoint interviews conducted in Switzerland in 2004. Choice-based conjoint analysis (also known as a discrete choice) was applied to reveal the relative importance of various product attributes for consumers. The study used six attributes: (1) brand; (2) equipment version; (3) water consumption; (4) energy consumption; (5) energy efficiency rating; and (6) price. The analysis showed that brands were important. The WTP for a premium brand compared with a no-name product was about

Table 3: Review of several DCE studies on energy efficiency label attributes

Author (s)	Study site	Key findings
Moxnes (2004)	Norway	Energy efficiency standards and labels could lead to an increased utility for the average customer. Attribute price was considered as the most important element of the findings.
Sammer and Wüstenhagen (2006)	Switzerland	Consumers preferred premium brands compared to a no-name product. Relevant for manufacturers to invest in brand value or in research and development (R&D) for energy-efficient appliances.
Shen and Saijo (2009)	China	Consumers tended to pay more attention to air conditioners rather than refrigerators.
Jeong and Kim (2014)	South Korea	Consumers showed a positive preference for labelled appliances, and an intention to pay more to purchase appliances with energy efficiency.
Zhou and Bukenya (2016)	China	Price that consumers were willing to pay increased significantly when energy consumption information became comparable.
Jain et al. (2018)	India	The implicit value placed by consumers on the highest energy efficiency category was found to be within the 95% confidence level in both appliances; air conditioner and refrigerator.

Source: Authors' own research.

a 50% premium. The result was relevant to manufacturers of energy-efficient appliances since it provided them with quantitative information for comparing investments in brand value versus in research and development for energy-efficient appliances.

Shen and Saijo (2009) conducted a hypothetical choice experiment in Shanghai, China with 1200 observations. The study examined whether the China Energy Efficiency Label could influence consumers' choices of air conditioners and refrigerators. A latent class approach was applied to observe both heterogeneities among the respondents and product brands. The study used eight attributes: (1) energy consumption; (2) cooling space; (3) capacity; (4) air purifier function; (5) noise reduction; (6) energy efficiency ranks on the labels; (7) labels indicating the savings in electric bills and (8) price. The results suggested that consumers in Shanghai were aware of the China Energy Efficiency Label and tended to pay more attention to air conditioners rather than refrigerators with such labels. In addition, air conditioners and refrigerators affixed with a hypothetical label that indicated savings in the electricity bills compared with a standard model received significant preferences, which suggested that the more information manufacturers provided, the more of their products would be preferred by consumers.

Jeong and Kim (2014) used a DCE approach to investigate the effects of energy efficiency and environmental labels on households' choice of appliances. This paper found that most households showed a positive preference for labelled appliances, and an intention to pay more to purchase appliances with energy efficiency. Two appliances were selected in this study; refrigerator and laptop, because both appliances were typical electrical appliances used at homes, compared to other household appliances.

The results suggested implications for both the government and manufacturers. The South Korean government was recommended to expand the number of product types that were required to participate in the labelling program to further promote green technologies. The results showed that consumers learned the information about energy efficiency with reasonable monetary value, hence improving the energy efficiency of the products will increase the MWTP of the consumers, thus increasing the demand. In this sense, manufacturers should concentrate on improving energy-efficiency grades and acquiring environmental labels for their products.

One of the more recent studies conducted in the largest developing country is a study by Zhou and Bukenya (2016). They examined the extent to which consumers' WTP for energy-efficient room air conditioners might be altered by correcting the information inefficiency on the China Energy Label. The data were collected using the DCE approach that was distributed randomly to 1602 potential consumers in Nanjing, China and a sample of 1569 was obtained. This study used four attributes: (1) brand; (2) energy grade; (3) type of room air conditioner; and (4) price. The analysis with multinomial and mixed logit models revealed that the price premium that consumers were willing to pay increased significantly when energy consumption information became comparable and additional energy-related information was provided.

Jain et al. (2018) used the DCE method to describe consumers' choices in the hypothetical purchase of an air conditioner and a refrigerator. The data were collected from households' survey in face-to-face interviews from the suburban district in Mumbai. The valid responses from a total of 149 households for air conditioners and 153 households for refrigerators were obtained. This study used separated attributes for the air conditioner and refrigerator. For air conditioner: (1) brand; (2) star; (3) air filters; (4) noise level; and (5) price of the air conditioner. For refrigerator: (1) brand; (2) star; (3) freezer spaces; (4) deodorizer; and (5) price of the refrigerator, indicating that consumers responded positively to labels. The implicit value placed by consumers in the highest energy efficiency category was found to be within the 95% confidence level in both appliances. These findings contrasted with the results reported by Shen and Saijo (2009) who found that consumer WTP for energy efficiency ranked more in air conditioners than refrigerators.

Literature review shows that many studies have performed a conjoint survey to obtain stated preference data, and discrete choice models, especially the mixed logit model, which have been widely used to examine the preference structure for labelled appliances. Moreover, refrigerators have been chosen as a research topic in many studies for a fact that refrigerator is the most common appliance that typically owned by majority households, when compared to other household appliances. In Malaysia, 96% of households own a refrigerator in their home, and this percentage is the highest among other household appliances (Khazanah Research Institute, 2014).

1.2. Energy-efficient Label in Malaysia

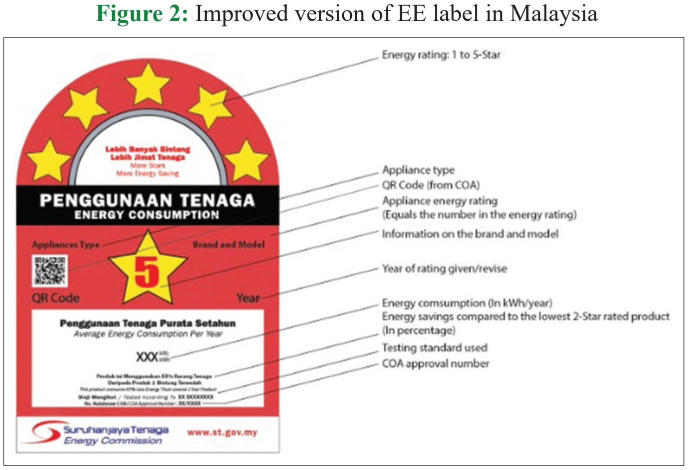
The electrification rate in Malaysia is at 100%, with the purchasing residential electricity tariff of 0.069 USD/kWh. Electricity power consumption is about 4,636 kWh per capita. The Malaysian government has an ambitious target in strengthening the energy efficiency agenda by increasing the power capacity mix from renewable energy from 5% in 2017 to 20% by 2025.

The Energy Commission Malaysia (ST) evaluates electrical appliances using the star rating that defines its fulfilment for energy efficiency under the energy labelling program. The ST has imposed Minimum Energy Performance Standards (MEPS) and Electricity Regulations, 1994 (Amendment 2012) for refrigerators, televisions, air conditioners, lamps and domestic fans on 3rd May 2014. From 2018 to 2021, ST has added several appliances under the requirements of the MEPS such as television, washing machines, microwave ovens, electric rice cookers and freezers. To meet the requirements of MEPS, the performance criteria that are tested using the relevant testing standards must be met.

All the appliances should fulfil the MEPS standards with at least a 2-star rating prior to entering the market as shown in Figure 2. The label is an improved version with three new elements added i.e., QR Code, Certificate of Approval (CoA) and year of the rating given. These improvements will make it easier for consumers to access label information. To obtain the CoA, the products (i) must pass both safety standards and energy performance standards, (ii) must have a test report assessment letter from the Standard, and (iii) Industrial Research Institute of Malaysia (SIRIM) is required for foreign products to verify that the test conducted meets the STAR rating standards.

Information presented in Figure 2 can benefit the consumers when purchasing the most energy-efficient appliances models. The Eleventh Malaysia Plan has been focusing on improving the suitable methods to ensure efficiency in the use of energy in buildings, industries and households and the MEPS for appliances would be supported (Economic Planning Unit, 2015).

Figure 2: Improved version of EE label in Malaysia



Source: www.st.gov.my

This paper assesses household preferences with respect to EE label based on consumers' willingness to pay (WTP), particularly on refrigerators. This study employed stated preference method to examine household preferences. Refrigerators were chosen as selected appliances due to its pervasiveness and as it is the most-own household item (96%) in Malaysia (Khazanah Research Institute, 2014). This study assessed how labels that implied the relative efficiency of appliances influenced preferences among households by calculating the marginal WTP for each attribute of label. The method is organized as follows i) determination of product attributes ii) specification of attribute levels, iii) experimental design, iv) Visual presentation of choice set to respondents, and v) estimation of choice model (Verma et al., 1999).

2. METHODOLOGY

2.1. Model Specification

Choice Experiment (CE) was based on random utility theory (RUT) which emphasised that a consumer's utility was based on a product's attributes (Lancaster, 1966). Respondents decided rationally and would opt for the best-case scenario which focused on the utility maximisation. Consumers were expected to create trade-offs between the attributes of energy label in this study. Hence, the utility of a household is stated as follows:

$$U_{ij} = \beta X_{ijk} + \varepsilon_{ij}$$

Where U_{ij} denotes the ith household's utility from energy label j, X_{ijk} signifies the kth attribute of the energy label j for household i, β is a vector of coefficients which is homogenous among households, and εij is a type I extreme value distributed error term. The household's utility is associated with alternative j as follows:

$$U_{ij} = V_{ij} + \varepsilon_{ij}$$

Where V_{ij} presents the utility derived from the label attributes and ε_{ij} is a stochastic component. The probability that alternative j is chosen by household i is modelled as follows:

$$P_{ij} = Prob\ (V_{ij} + \varepsilon_{ij} > V_{is} + \varepsilon_{is})$$

Then, the probability of household i selecting alternative j can be conveyed with the model specification of multinomial logit (MNL):

$$Prob_{ij} = \frac{e^{Vij}}{\sum_{j=1}^{J} e^{Vik}}$$

The MNL is specified to measure the product attributes that households search for when choosing refrigerators in this study. Previous research by Hensher et al. (2005) assumed that all respondents should have similar preferences, in which this is possible to be disobeyed. This hypothesis was based on the random parameter logit model (RPL) which conformed the respondents' preferences could be heterogeneous across all respondents.

2.2. Estimation of Marginal Willingness to Pay

The CE method is eliciting respondents' preferences via the calculation of marginal willingness to pay (MWTP) with an amount of money that the respondents are willing to pay for a specific product or service attribute. Mathematically, the MWTP is defined as marginal rate of substitution (MRS) which is estimated by dividing between attributes' coefficient value (numerator) and coefficient of price attribute (denominator). This study presents the trade-offs that the respondents are willing to choose between the energy label's attributes.

$$MWTP_j = \frac{Vj}{Vp}$$

The above equation presents *MWTPj* as the MWTP of attribute j, V_j as the coefficient value of energy label's attributes and Vp denotes the coefficient value of price attribute. A negative value of the MWTP shows that the attribute is less favoured by the respondents than the baseline.

2.3. Experimental Design

A rational number of attributes is crucial in constructing the CE method, in which too many attributes lead to exhaustion and cognitive stress on respondents while too few attributes portray unrepresentative situations in the questionnaire (Jianhua et. al, 2018). There are four non-monetary attributes involved in this study i.e., energy star, energy consumption, energy- saving, and price of a refrigerator (monetary attribute) as (Table 4). Selection of attributes is based on focus group discussions, officers, and expert opinions from the Energy Commission in the subject matter.

Efficient experimental design is vital in experimental design because the frequency of each level that appears within an attribute is likely to be the same, and each pair of levels appear equally often across all combinations of those attributes. There is a chance to reduce the confidence intervals for parameters of interest in choice models or to reduce the required number of sample sizes. Even with an equal or lesser sample size, an efficient experimental design will still be able to produce reliable parameter estimation (Louviere et al., 2000). This study generates about (4 x 4 x 4 x 3) with 192 possible combinations from three attributes (EStar, ECon, ESav) with four levels and a monetary attribute (Price) with three levels. Experts claimed the efficient experimental design fulfils high requirements of statistical efficiency. This study applies fractional factorial design with D-Efficiency experimental design using STATA econometric software.

The literature on choice sets has highlighted that a fatigue effect is possible to occur among respondents when being presented with 15-20 choice sets (Allenby and Rossi, 1998). Each choice set consists of three alternatives i.e., Option A, Option B and No-option as shown in Table 5. According to the RUT, an opt-out

Table 4: Energy label attributes and levels

Attributes	Levels	Descriptions
Energy star (EStar)	2-Star 3-Star 4-Star 5-Star	STAR rating
Energy consumption (ECon)	RM132.70 RM106.20 RM84.92 RM67.98	Average energy consumption cost per year in Ringgit Malaysia (RM)
Energy saving (ESav)	No saving Saved RM26.50 per year Saved RM47.78 per year Saved RM64.72 per year	Total energy savings per year compared to the lowest 2-star rated products.
Price	RM950 RM1400 RM2000	Price of Refrigerator in Ringgit Malaysia (RM)

Source: Authors' own research.

Table 5: An example of choice set in survey

Attributes	Option A	Option B	No-option
Energy Star	3 Star	4 Star	
Energy Consumption	RM132.70	RM106.20	
Energy Saving	Saved RM47.78 per year	Saved RM47.78 per year	
Price	RM1400	RM2000	
Please TICK your choice		√	

Source: Authors' own research.

option can always be inserted in the choice set if the condition is tallied with respondents' real-life choice (Jorien et al., 2014). The opt-out option reveals the respondents are not compulsory to make a choice that does not replicate their real preferences (Hole, 2007).

3. DATA ANALYSIS AND RESULTS

A field survey was conducted in 429 households in East Coast regions in Peninsular Malaysia, namely Kuala Terengganu, Kota Bharu and Kuantan. This study focused on the head households to assess their preferences and awareness of Malaysia's EE label. The number of selected respondents was considered acceptable as suggested by Hensher et al. (2005). They stated a total sample of 50 respondents with 16 choice sets and fully generic parameter specification for attributes with no covariate effects was tolerable. In this case, 429 respondents multiplied by 4 choice sets have offered about 1716 observations. Table 6 illustrates that the average age of respondents was 38.24 years with 43.12% of male and 56.88% of female respondents. Most of the respondents have graduated from secondary school (48.72%) and work as private- sector employees (41.03%) with an average monthly income RM2,223.

3.1. Multinomial Logit Model

Table 7 shows the estimated results for the multinomial logit model. The model includes all the energy label attributes. The coefficients for EStar2, EStar3, EStar4, ECon2, ECon3, ECon4, ESav2, ESav3 and ESav4 have generated positive preferences

Table 6: Socioeconomic characteristics of respondents (n=429)

Characteristics	Frequency	(%)	χ^2	P-value
Gender			0.8204	0.365
Male	185	43.12		
Female	244	56.88		
Age			15.1852	0.010
Less than 20 years old	5	1.17		
21–30 years old	122	28.44		
31–40 years old	140	32.63		
41–50 years old	75	17.48		
51–60 years old	68	15.85		
More than 60 years old	19	4.43		
Mean: 38.82 at 38 years old				
Education level			14.0316	0.015
No education	5	1.17		
Primary School (UPSR)	18	4.20		
Secondary School (SPM)	209	48.72		
Higher Certificate Education/Diploma	116	27.04		
Bachelor	75	17.48		
Master/Phd	6	1.40		
Occupation			0.4380	0.508
Government Employee	86	20.05		
Private Employee	176	41.03		
Business Owner	115	26.8		
Farmer/Fisherman	8	1.86		
Retiree/Housewife/ Part-Timer	44	10.26		
Household Income			24.3017	0.111
Less Than RM 2,000	274	63.87		
RM 2,001 – RM 4,000	126	29.37		
RM 4,001 – RM 6,000	12	2.8		
RM 6,001 – RM 8,000	8	1.86		
RM 8,001 – RM 10,000	8	1.86		
More Than RM 10,000	1	0.23		
Mean: RM 2223				
Total	429	100		

Source: Authors' own research

Table 7: Multinomial logit model

Variables	Coefficient	Standard error	z-value
EStar_3star	0.62657	0.09349	6.70***
EStar_4star	0.71228	0.09298	7.66***
EStar_5star	0.74395	0.08400	8.86***
ECon_106.20	0.42534	0.08919	4.77***
ECon_84.92	0.45871	0.08354	5.49***
ECon_67.98	0.16873	0.09409	1.79*
ESav_26.50	0.91724	0.09519	9.64***
ESav_47.78	1.00299	0.09467	10.59***
ESav_64.72	0.81100	0.08085	10.03***
Price	−0.00033	0.00006985	−4.67***
Summary statistics			
Number of observations			429
Log-likelihood			−1541.279
Pseudo R^2			−0.0574
Adjusted R^2			−0.0604

Significance at 1% (***), 5% (**), 10% (*). Source: Authors' own research

where the respondents chose characteristics of energy star, energy consumption and energy saving as factors in purchasing refrigerators. All variables of EStar_3star, EStar_4star, EStar_5star, ECon_106.20, ECon_84.92, ESav_26.50, ESav_47.78 and ESav_64.72 portrayed a positive preference with high significant level at 1%, except ECon_67.98 which portrayed a positive preference at 10% significant level. The negative sign of price with 1% significance level was as expected since preference or utility for a given choice would be lower when the cost of the choice increases, suggesting respondents were sensitive to price changes (Ward et al., 2011). Therefore, an increase in the price of refrigerators specified the reduction of respondents' WTP because of the decrease in the utility level. This indicated that as the price of refrigerators increased, their preferences decreased.

3.2. Mixed Logit Model

The results of the simple mixed logit (ML) model are illustrated in Table 8. The first section of the table presents the estimated values for the means of preferences for the energy labelling of refrigerator attributes, while the last section presents the summary of statistics. Four variables were found to be highly significant at 1% level with an expected sign, namely the ESav_26.50, ESav_47.78, ESav_64.72 and Price. The high positive coefficients for ESav_47.78 have implied that respondents preferred it more compared to ESav_0, ESav_26.50 and ESav_64.72. This explained that the respondents expected to have an improvement on energy savings of refrigerator from the current condition, but they did not have a high expectation for this attribute. Price was significant at 1% level with correct negative expected signage, which indicated that the respondents were less willing to pay a higher price for a refrigerator because of the decrease in the utility level.

Based on both the simple MNL and ML models, the simple ML has better goodness of fit as compared to the simple MNL model. There are notable features about the statistical results in ML model as compared to MNL model. The ML model has a higher level of model fitness with improvements in likelihood value from -1541.279 (simple MNL model) to -1393.612 (simple ML model). Furthermore, the pseudo value increased from -0.0574 (simple MNL model) to 0.2607 (simple ML model). The ML model was the best-fit model as it had higher log-likelihood values and Pseudo values as compared to Multinomial logit (MNL) model. According to Louviere et al. (2000), the Pseudo goodness-of-fit test that formed estimation between 0.2 and 0.4, implies a good model fit for cross-sectional data.

3.3. Marginal WTP Analysis

The coefficient β can be used to estimate the marginal willingness to pay (MWTP) for each attribute in the study. The MWTP or marginal rate of substitution stipulated the WTP of the respondents according to their preferences (Siebert, 2008) and could be estimated using non-monetary attribute coefficient ratio over the monetary attribute coefficient as follows:

$$\text{Marginal WTP} = \frac{\beta\, non-monetary\ attribute}{\beta\, monetary\ attribute}$$

The calculation of MWTP was produced through Wald test with econometric software NLogit 5.0 (Table 9). It should be noted that the marginal values correlated to the energy label, which was estimated in Ringgit Malaysia (RM).

Table 8: Mixed logit model

Variables	Coefficient	Standard Error	z-value
EStar_3star	0.12662	0.10828	1.17
EStar_4star	−0.01160	0.11618	−0.10
EStar_5star	0.11307	0.10706	1.06
ECon_106.20	−0.23730	0.10885	−2.18**
ECon_84.92	−0.20736	0.11491	−1.80*
ECon_67.98	−0.18368	0.12373	−1.48
ESav_26.50	0.70982	0.13384	5.30***
ESav_47.78	0.87841	0.14804	5.93***
ESav_64.72	0.37044	0.10559	3.51***
Price	−0.00069	0.00010	−6.68***
Derived standard deviations of parameter distributions			
EStar_3star	0.31205	0.40770	0.77
EStar_4star	0.60140	0.27868	2.16**
EStar_5star	0.58121	0.22003	2.64***
ECon_106.20	0.30364	0.49163	0.62
ECon_84.92	0.04917	0.27065	0.18
ECon_67.98	0.60192	0.32717	1.84*
ESav_26.50	0.46993	0.38010	1.24
ESav_47.78	0.73743	0.22426	3.29***
ESav_64.72	0.52308	0.25938	2.02**
Summary statistics			
Number of observations			429
Log-likelihood			−1393.612
Pseudo R^2			0.2607
Adjusted R^2			0.2560

Significance at 1% (***), 5% (**), 10% (*). Source: Authors' own research

Table 9: Marginal values for MNL and ML models

Variables	Marginal value (RM)	
	MNL model	ML model
EStar_3star	1922.11	183.51
EStar_4star	2185.06	−16.81
EStar_5star	2282.20	163.87
ECon_106.20	1304.83	−343.91
ECon_84.92	1407.19	−300.52
ECon_67.98	517.603	−266.20
ESav_26.50	2813.81	1028.72
ESav_47.78	3076.86	1273.06
ESav_64.72	2487.90	536.87

RM1=USD0.24. Source: Authors' own research

4. DISCUSSION

The results of MWTP values in Table 9 shows that all WTP estimated values were very different across the two models. In terms of energy star rating, the result illustrates that the highest estimated value for the simple MNL model was RM 2282.20, which was EStar_5star, while the highest estimated value for the ML model was RM 183.51, which was EStar_3star. It can be explained that the respondents valued 2-star, 3-star and 4-star energy ratings for the simple MNL model less, while 2-star, 4-star and 5-star were less valued by the respondents for the simple ML model. The respondents preferred to have a 5-star and 3-star energy ratings for the simple MNL and ML model, respectively.

In terms of energy consumption, the result illustrates that the highest estimated value for the simple MNL model was RM 1407.19, which was ECon_84.92, while the highest estimated value for the ML model was -RM 266.20, which was ECon_67.98. It can be explained that the respondents valued ECon_132.70, ECon_106.20 and ECon_67.98 less for the simple MNL model, while the respondents for the simple ML model valued ECon_132.70, ECon_106.20 and ECon_84.92 less. The respondents preferred to have RM84.92 and RM67.98 as energy consumption per year in terms of Ringgit Malaysia (RM) for the simple MNL and ML model, respectively.

In terms of energy savings, the result illustrates that the highest estimated value for the simple MNL model was RM 3076.86, with ESav_47.78, while the highest estimated value for the ML model was RM 1273.06, with_47.78 of ESav as well. It can be explained that the respondents valued ESav_0, ESav_26.50 and ESav_64.72 less for the simple MNL and the simple ML model. The respondents preferred to have RM47.78 as energy savings per year in terms of Ringgit Malaysia (RM) for the simple MNL and ML model.

Although the respondents preferred the highest value of RM 3349.69 for a simple MNL model and RM 1475.31 for a simple ML model on energy-saving attribute ESav3_47.78 (RM47.78 per year), they still favoured refrigerator with energy-saving features mostly due to the advantage of saving their monthly utility bills. According to the findings, the CE method has helped specified which attribute played a significant determinant of the values in the respondents' choices. 'Energy saving' attribute was the major reason for the willingness to pay since it produced the highest marginal value. Therefore, these valuations used in the study can convince the government to support more investment and to fund more resources to improve the energy efficiency development in Malaysia in the future. Hence, the objective of this study to evaluate EE labelling attributes in determining the consumer's WTP towards refrigerator has been achieved. It is believed that more consumers in the East Coast region in Peninsular Malaysia are more aware of the labels and they tend to look for energy-saving attributes when buying a refrigerator.

The results of the study are in line with Goal 7: Affordable and Clean Energy in SDGs, which focuses on global effort to ensure access to affordable, reliable, sustainable, and modern energy for all. This is to ensure consumers understand that choosing an energy-efficient appliance is an important step in tackling environmental issues. The purpose is not solely because the SDG 7 target is to be achieved, though energy efficiency efforts are interconnected with all the other SDGs. For instance, the ineffective consumption of energy access can unnecessarily impact on the use of fossil fuel and can harm greenhouse gas emission, leading to a greater conflict on climate change. As such, it is contradictory that the objective of SDG 13 is to take urgent action to combat climate change and its impacts only. The main goal is to work together to accelerate action and deliver results that will transform the lives of billions through sustainable energy access that also helps combat climate change.

5. CONCLUSION

EE label has been broadly used as a policy instrument to improve energy efficiency in appliances. This research analyses household preferences relating to EE label and the effects of the label on the purchasing behaviour of households. DCE is used to obtain and analyse household preferences. This study has chosen refrigerator as a measurement tool with four attributes, namely energy star rating, annual energy consumption, annual energy saving and price of refrigerators. The CE offers to calculate marginal values according to the attributes where it shows the monetary value that consumers are willing to place for each change in attributes. This study has contributed to the empirical knowledge in assessing the economic valuation of energy efficiency labelling via consumers' WTP.

Furthermore, the initiative of using the CE method will help contribute to various methodological approaches in the economic valuation of energy efficiency labelling in Malaysia for instance in marketing and policy purposes. According to Dianshu et al. (2010), consumers need to learn about the benefits they would get when appliances become more efficient. Providing relevant information to consumers will encourage them to select energy-efficient appliances. Thus, by implementing an economic valuation study, many investments programs can be suggested to benefits the public. In this regard, the EE label can guide the efficient use of energy and at the same time reduce dependency on fossil fuel through good purchasing decisions among consumers.

On top of that, the energy efficiency agenda is consistent with Goal 7: Affordable and Clean Energy in SDGs which focuses to double the global improvement rate in energy efficiency by 2030. Hence, executing energy efficiency solutions is necessary to counter climate change, which is one of the biggest threats globally. In line with the implementation of Malaysia's energy efficiency that targets 8% of demand to be reduced by 2025, which is equivalent to a total of 52,233 GWh of electricity savings for over 10 years from 2016 to 2025, this policy was authorised by ASEAN Member State as of June 2020 and contributed by ASEAN Climate Change and Energy Project (ACCEPT).

In 2022, Malaysian Government initiatives through the Sustainable Energy Development Authority (SEDA) has recently launched a program that encourages consumers to purchase efficient appliances. The Sustainability Achieved via Energy Efficiency (SAVE) 3.0 is a program that grants up to RM400 e-Rebate to domestic households that purchase appliances like refrigerator, air conditioner, television, washing machine, microwave oven or rice cooker with 4- or 5-star energy efficiency labels from the Energy Commission (EC). The objective of this program is to increase the number of 4- or 5-star energy-efficient electrical appliances in the market. This program can increase public awareness of appliances that will save electricity consumption as well as reduce greenhouse gas emissions. The program is a continuation of a successful SAVE 2.0 and it has received a favourable response from the consumers so far. A total of 134,000 redeemed e-rebates and managed to save up to RM26.8 million (Sustainable Energy Development Authority, 2022).

Besides, there were several efforts have been initiated globally to support SDG 7 that could relate to this study. According to the International Energy Agency (2015), annual investments of $45 billion were needed to meet the SDGs. The World Bank Group (WBG) has been investing in all three of the principal target areas of SDG 7: energy access, energy efficiency, and renewable energy. For instance, in Mexico, with the help of their Climate Finance and Global Environmental Facility support, the WBG has implemented a program of replacing over 25 million inefficient light bulbs, and almost two million old refrigerators with new and highly efficient ones, all targeted to low-income households. The aim was to reduce household expenses and save energy consumption as well as to combat climate change and its impacts.

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