Establishing Valid and Reliable Measures for Residential Consumer Behaviour Towards New Technology Electricity Appliances: An Exploratory Factor Analysis

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Abstract. The government policies and initiatives to guarantee sustainable energy and clean environmental conditions contributed to the introduction of new technology electricity appliances in the market. This research intends to develop a valid and reliable survey instrument to measure consumer behaviour towards new technology electricity appliances. For that purpose, the pilot study randomly sampled 104 residential electricity consumers using an online survey with an interval scale between 1 and 10 is applied. Then, the Exploratory Factor Analysis (EFA) procedure on construct elements with the extraction method of Principal Component with Varimax Rotation is used to determine the adequacy of construct elements. The results of EFA indicate one of the elements of government policy needs to be dropped because it shows the lowest total variance explained and factor loading. Cronbach's Alpha was applied to test the reliability of the retained items. All eleven constructs have Cronbach's alpha values that exceed the threshold value of 0.7, which indicates high reliability. The development scale and validation confirmed that the instrument is consistent and stable across samples. As an implication, the field study can be conducted with the remaining and valid constructs and items.

Keywords: New technology electricity appliances (NTEA) · Consumer behaviour · Exploratory factor analysis · Residential sector

1 Introduction

Electricity has been one of the world's most important resources for human and economic activity in recent years. Its function becomes rigorous, along with economic development and modernisation [1]. Realising the importance of electricity to maintain the quality of life, the government needs to ensure an adequate supply of electricity to the Malaysian community by discovering alternative energy and increasing energy

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efficiency. Accordingly, several policies and initiatives have been implemented, starting with the National Energy Policy in 1979 [2]. The government introduced the Five-Fuel Diversification Policy in 2001 and Renewable Energy Act in 2011 to encourage the use of renewables in electricity production [3]. Other government initiatives such as Feed-in-Tariff (FiT) (2011), Net Energy Metering 1.0 (NEM 1.0) (2016), NEM 2.0 (2019), and the latest one, NEM 3.0 (2021) schemes had created awareness on solar energy and increased the new technology electricity appliances (NTEA) in Malaysia. These initiatives are quite challenging initially because Malaysians are unfamiliar with the aforementioned scheme [3, 4]. Then, with the information spreading, many Malaysians realised the benefit from FiT and NEM 1.0 and 2.0. In 2021 the government had introduced the NEM 3.0 due to overwhelming response from the PV industry and to boost the usage of Solar energy [5]. Moreover, through National Green Technology Policy in 2009 and National Energy Efficiency Action Plan (NEEAP) 2016–2025, the government had promoted energy efficiency to safeguard the productive use of energy and minimise waste from energy consumption through energy efficiency appliances. However, the Malaysia Energy Information Hub (MEIH) data show the electricity consumed by Malaysians and the electricity intensity[1] still rising in the same direction (Fig. 1). The electricity consumption and electricity intensity grew by 5.5% and 1.9%, respectively, for the 1980–2020 periods. This indicates the possibility of achieving energy saving from energy efficiency (EE) by 8% in 2025 could be impossible.

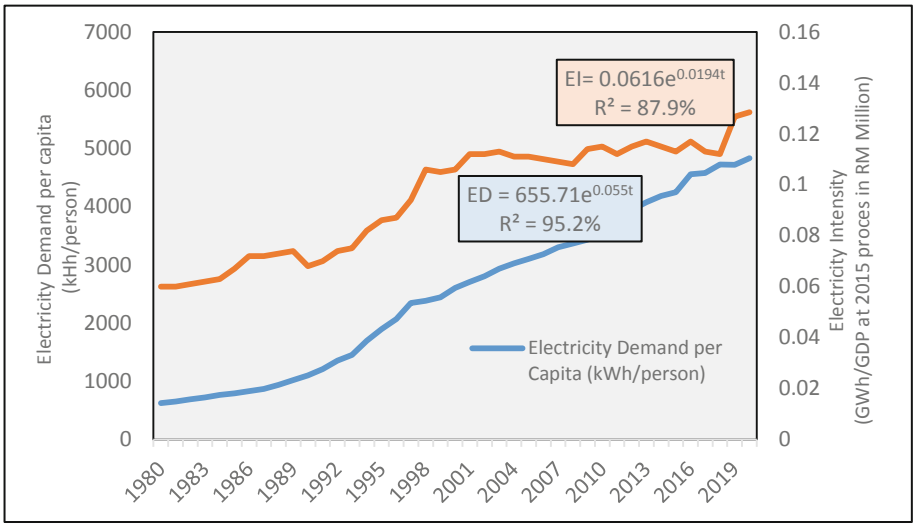

Fig. 1. Electricity demand per capita & electricity intensity in Malaysia for 1980–2020 period [6].

The adoption and success of that particular technology are beyond government control. The government and the producer (of that particular technology) need to understand

[1] Electricity intensity is the amount of electricity consumed divided with GDP. The higher the electricity intensity, the lower the level of efficiency.

the consumer behaviour intention, which also represents the gap of this research. Through it, the producer can predict market demand, the consumer willingness to pay, and benefit from the information to increase the sales of its products and gain the expected profit since it is the ultimate goal of their operation. Furthermore, household appliances have become the primary source of household energy consumption. Cultivating consumer purchasing intentions towards new electricity appliances (NTEA) and promoting energy-efficient (EE) appliances is crucial for Malaysia to achieve its sustainable development goals. Even though many empirical studies have been undertaken on behaviour intention, the past researcher focuses less on consumer behaviour intention on NTEA and therefore is relatively scant [7–11].

This research intends to develop a reliable instrument to measure consumer intention behaviour towards new technology electricity consumption. Through it, the researcher can proceed with a field study on assessing the status of Malaysian consumer behaviour intention on the aforesaid product. Instead of being beneficial to NTEA's producer, this information is also beneficial to electricity providers that enable them to plan the supply for electricity and cater to the demand of electricity mainly from the residential consumer.

The remainder of this paper is structured as follows. Section 2 is an overview of Malaysia's electricity consumption and policies. Section 3 and 4 present the literature on behaviour intention and research framework, respectively. Section 5 presents the methodology steps, and Sect. 6 presents the empirical results. Lastly, Sect. 7 concludes the findings.

2 Overview of Electricity Consumption in Malaysia

Electricity consumption in Malaysia has risen with increasing economic development. It can be shown that the annual growth rate for total Malaysian electricity consumption is 6.4% (Fig. 2). However, electricity demand in Peninsular Malaysia is likely to fall into the negative zone in 2020 due to the Movement Control Order (MCO). The anticipated sharp decline in electricity consumption is not entirely surprising, considering close to 80% of Tenaga Nasional Bhd's (TNB) sales in Peninsular Malaysia come from industrial and commercial customers [12]. The most notable decline was in the commercial sector, such as business complexes, shopping malls, and hotels, which decreased between 31 to 47% in electricity consumption [13]. Nevertheless, according to Datuk Shamsul Anuar Nasarah (Minister of Energy and Natural Resources), electricity consumption by residential users in Peninsular Malaysia soared by 23% during the MCO period compared to a decrease of 33% in the overall electricity consumption. Accordingly, the residential sector has the highest growth rate (6.9%) compared to commercial (6.7%) and industrial (5.9%) sectors (Fig. 2).

The consistent increase of electricity demand particularly comes from the residential sector, giving a negative signal to our environment with detrimental impacts on future generations. An important component of securing a sustainable future is to reduce the consumption of electricity while promoting an environmentally friendly culture.

The Malaysian government has launched the National Energy Efficiency Action Plan (NEEAP) for a ten-year implementation period from 2016 to 2025 after considering the socio-culture, policy, financial, and administration barriers. The NEEAP

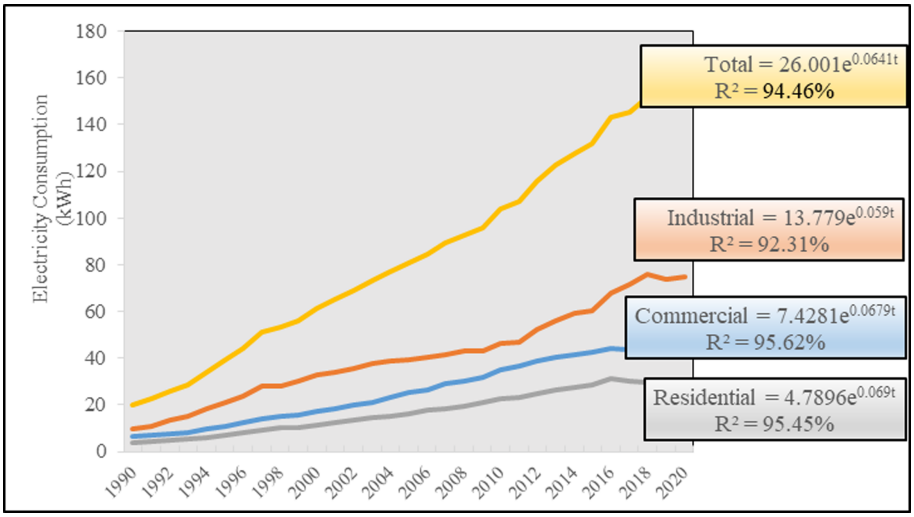

Fig. 2. Final electricity consumption in Malaysia for 1990–2020 period [6].

presents a strategy for a well-coordinated and cost-effective implementation of energy efficiency measures in the industrial, commercial and residential sectors, which will lead to reduced energy consumption and economic savings for the consumers and the nation. The plan aims to promote energy efficiency to meet the following policy direction: Promote energy efficiency to ensure productive use of energy and minimise waste to contribute to sustainable development and increased welfare and competitiveness. Accordingly, the government has initiated various initiatives for energy efficiency, especially for residential sectors, such as phasing out incandescent light bulbs, increasing energy performance labelling, and introducing Minimum Energy Performance Standards (MEPS) for selected household electric appliances. Given that, they give retailers incentives on sales of small capacity appliances and promotion of electrical appliances with Minimum Energy Performance Standards (MEPS) under the SAVE Rebate Programme. Currently, MEPS has introduced five electricity appliances: refrigerators, air-conditioners, televisions, fans, and lighting. By purchasing these appliances, the consumers will get a rebate of RM100–RM200 under the SAVE programme [14].

Furthermore, the Malaysian Electricity Supply Industry 2.0 (MESI 2.0) was reformed to liberalise the generation to distribute components of the power industry in Peninsular Malaysia and promote green energy in Malaysia. This was by establishing a hybrid generation market (honouring current Power Purchase Agreement—PPA and opening up for capacity and energy market); sourcing of own fuel (coal and gas); enabling Third Party Access (TPA) for transmission and distribution (T&D), and facilitating green energy producers and consumers. The establishment of MESI 2.0 is due to three emerging technologies disrupting the industry of electrification, digitalisation, and decentralisation. By reforming MESI 2.0, the potential outcome will be highlighted for better consumer experience, reasonable electricity supply, and generate additional economic activities [15].

In addition, having been dependent mainly on oil and gas generated power plants for half a century, Malaysia had realised the importance of adopting renewable energy as an alternative to conventional non-renewable energy resources and continuously reviewed its energy policy to ensure sustainable energy supply and security [16]. As a result, Malaysia could be self-sufficient ultimately with self-produced energy. The total production of all-electric energy-producing facilities is 148 billion kWh, which is 108% of the country's usage. Despite this, Malaysia is trading energy with foreign countries. Besides pure consumption, imports and exports play an important role [17].

3 Literature Review

Many past studies discussed household intention and behaviour with a variety of perspectives. A review of the literature found some of the previous scholarly work on behavioural intention on energy efficient (EE) usage [18], energy-saving behaviour [19], purchasing electric vehicle behaviour [20] and public intention to use solar energy [21]. Accordingly, numerous researchers applied the Theory of Planned Behaviour (TPB), Theory of Reasoned Action (TRA), and Technology Acceptance Model (TAM) as a theoretical basis for their study. However, several studies attempted to improve the explanatory power of TPB, despite the general usefulness of the theory in predicting behavioural intention, by adding additional constructs within the TPB model [22]. For example, [22] extended the TPB research by adding the items in the survey that consist of moral norms, environmental concern, and environmental knowledge to understand consumer's intention toward purchasing energy-efficient household appliances. Furthermore, the items or variables that were highlighted in their study are not much different from one study to another study, such as attitude, subjective norms, perceived behavioural control, environmental knowledge, and the intention to use renewable energy (Table 1). Thus, Table 1 shows the items/variables used in different countries, years, and contexts of the study.

This current study focuses on exploring the items towards new technology electricity appliances, namely smart meter, electricity vehicle, battery storage, solar PV, and energy efficiency appliances. Therefore, this study explores relevant items and develops an instrument for measuring residential consumer attitudes towards NTEA in Peninsular Malaysia.

Table 1. Past Studies on items/variables used

Author	Context	Country	Items/variables	Theory
Apipuchayakul & Vassanadumrongdee (2020) [18]	Household energy efficient	Thailand	Attitude, subjective norms, perceived behavioural control, intention, behavioural	Theory of Planned Behavior (TPB)

(*continued*)

Table 1. (*continued*)

Author	Context	Country	Items/variables	Theory
Akroush et al. (2019) [19]	Household energy saving	Amman, Jordan	Energy Awareness, perceived benefits, perceived price, consumers' attitudes, purchasing intention	Theory of Planned Behavior (TPB), Theory Reasoned Action (TRA), Technology Acceptance Model (TAM)
Tu & Yang (2019) [20]	Purchasing electric vehicle	China	Perceived usefulness, perceived ease of use, compatibility, personal innovativeness, interpersonal influences, external influences, self-efficacy, facilitating conditions, perceived behavioural control	Theory of Planned Behaviour (TPB), Technology Acceptance Model (TAM), Innovation Diffusion Theory (IDT)
Ali et al. (2019) [23]	Household energy efficient	Pakistan	Optimism, innovativeness, insecurity, discomfort, attitude, subjective norms, perceived behavioural control, intention to buy	Theory of Planned Behavior (TPB), Technology Readiness Index (TRI)
Alam et al. (2019) [24]	Household energy efficient	Malaysia	Purchasing intention of energy-efficient product, attitude, subjective norm, perceived control, knowledge, price	Extended Theory of Planned Behavior (TPB)
Kardooni et al. (2018) [25, 26]	Renewable energy usage	Peninsular Malaysia	Intention to use of renewable energy, knowledge, trust, cost	Conceptual Framework

(*continued*)

Table 1. (*continued*)

Author	Context	Country	Items/variables	Theory
Wang, Wang & Guo (2017) [27]	Household energy saving	China	Attitude, subjective norm, perceived behavioural control, residual effect	Theory of Planned Behavior (TPB)
Tan et al. (2017) [22]	Household energy saving	Malaysia	Attitude, subjective norm, perceived behavioural control, moral norms, environmental concern, environmental knowledge	Theory of Planned Behavior (TPB)
Park & Kwon (2017) [28]	Household energy saving	South Korea	Intention to use, perceived benefits, perceived trust, satisfaction, system quality, perceived cost, attitude	Theory of Planned Behavior (TPB)
Wallis et al. (2016) [29]	Electricity consumption in households	German	Electricity consumption, socio-demographic, economic factors, purchasing and use behaviours	–
Kim et al. (2014) [21]	Public intention to use solar energy	South Korea	Intention to use, perceived benefits, perceived trust, satisfaction, system quality, perceived cost, attitude	Theory of Reasoned Action (TRA), Technology Acceptance Model (TAM)
Wang et al. (2014) [30]	Household energy saving behavior	Beijing	Attitude, subjective norm, perceived behavioural control, information publicity, living habits, energy knowledge, demographic variable	Theory of Planned Behavior (TPB)

(*continued*)

Table 1. (*continued*)

Author	Context	Country	Items/variables	Theory
Ha & Janda (2012) [31]	Household energy saving	South Korea	Attitude, subjective norm, belief about energy efficient product, knowledge about energy efficient product, environmental awareness, confidence of consequence, eagerness of environmental engagement	Theory of Reasoned Action (TRA),

4 Consumer Behavior Framework on Residential Consumer Behavior Towards New Technology Electricity Appliances

The previous literature (Table 1) has demonstrated the majority of the studies measuring consumer behaviour are employing the theory of TPB, TRA, and TAM. Figure 3 shows the proposed research framework based on the finding in Sect. 3.

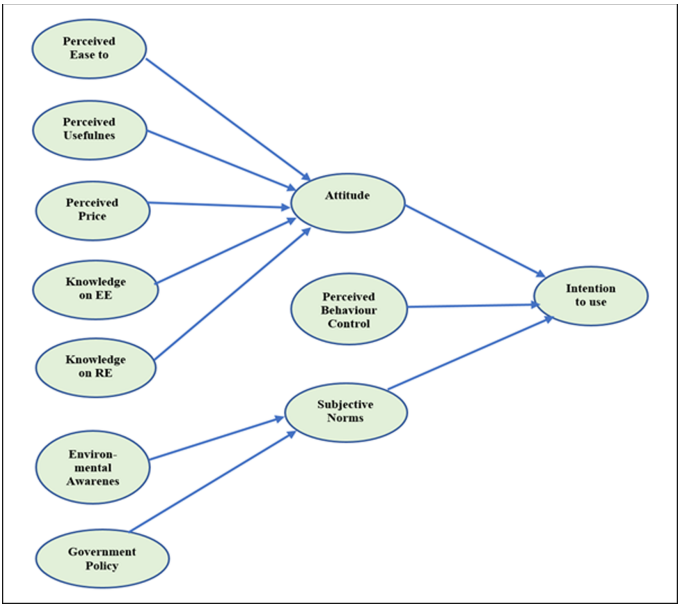

Fig. 3. Proposed research framework

The constructs employed in this study and its definition:

- Intention to use (ITU):
  The intention to use (ITU) refers to the extent to which consumers think they are willing to purchase or use such products. The TPB proposed by Ajzen stated that the behaviour of individuals is determined by their 'behavioural intention'. Therefore this study utilised TPB to determine residential consumer behaviour toward NTEA.
- Attitude (A):
  Attitude refers to consumer psychological evaluation of a certain product. According to [18], attitude is a determinant of purchase intention. The consumer with positive attitudes towards NTEA tends to have an intention to purchase the NTEA.
- Perceived behaviour control (PBC):
  According to [23] and [20] the perceived behaviour control (PBC) is an individuals' degree of control over the execution of certain behaviour. [22] defined the PBC as an individual's perceived ease or difficulty performing a specific behaviour. This study concluded the PBC as a consumer's confidence to perform a given behaviour with available resources (i.e., time, money, support, etc.) in hand.
- Subjective Norms (SN):
  The Subjective norms (SN) refer to consumers' perceived peer pressure, which dictates that they behave in a certain way to meet social expectations [18]. [23] state the SN as the influential degree of peers' opinion and perceptions while performing a specific behaviour. Based on previous literature, this study defines the SN as a consumer performance as a result of peers' opinions (friends, family, mass media, and internet information) about NTEA.
- Government policy (GP):
  The government policy (GP), in this case, refers to any related energy and environmental policies that are used to sway purchase, retail stocking, and production decisions towards NTEA. The study by [27], had classified government policy as one of the subjective norm's indicators. In the current paper, the GP purposely measures the influence of government policies and initiatives towards SN and consumer behaviour.
- Perceived ease to use (PEU):
  The perceived ease to use (PEU) refers to consumers' ability to learn the operation of NTEA and use the NTEA without much effort.
- Perceived usefulness (PU):
  The perceived usefulness (PU) is referring to consumers' perception of the efficiency of NTEA functions.
- Perceived price (PP):
  Many researchers have examined the effect of the perceived price (PP) on consumer attitude and intention to buy, and the results were found to contradict one another. The PP, in this case, is referring to consumers' perception of the price of NTEA, either affordable or unaffordable.
- Knowledge on EE (KEE) & Knowledge on RE (KRE):
  The knowledge is used to understand its influence on ITU and explain the gap between the consumers' attitudes and orientation towards energy conservation and their actual behaviour [19]. This study anticipates the better the knowledge on EE and RE, the higher ITU on NTEA.

- Environmental awareness (EA):
  Similar to KEE and KRE, environmental awareness (EA) is used to understand its influence on behavioural variables and explain the gap between the consumers' attitudes and orientation towards energy conservation and their actual behaviour [19, 32]. This study anticipates that the higher the degree of consciousness on environmental issues, the higher the ITU on NTEA.

5 The Methodology Steps

Choosing the correct methodology step is crucial in achieving the aim of any study, mainly from a psychological aspect. This is because the psychological aspect is not directly measured. It requires a few constructs to represent the indicator under investigation. Due to that, a detailed literature review was carried out to identify items measuring the consumer intention to use the NTEA construct. This study revealed the TPB and TAM as the best theory to be applied and suited to measure residential consumer behaviour towards NTEA and electricity consumption.

Next, the questionnaire with 11 constructs was measured using a 10-point interval Likert scale. As explained by [33] and [34], the 10-point interval scale presents the respondents with more response options that correspond with their specific judgment of a question. A score of 1 denotes 'strongly disagree', whereas a score of 10 denotes 'strongly agree'. The items in the instrument were adapted from past studies [3, 18, 24, 27, 32]. Accordingly, the questionnaire was structured as follows: Section A: To assess the socio-demographic aspects and the electricity consumption. Section B: To measure consumer actual electricity usage behaviour. Section C: To measure consumer attitude/behavioural intention to use the NTEA (such as solar, smart meter, battery storage, electric vehicles). And section D: To assess consumer comments and suggestions related to electricity consumption.

To ensure the quality, reliability, and validity are met, the questionnaire was reviewed and examined by an expert in the energy field and an expert in methodology (mainly the art of developing the questionnaire). Later the pilot test was conducted on 104 residential consumers in Peninsular Malaysia, covering consumers in the East Coast, Southern Region, Northern Region, and Central Region. Due to the Covid-19 pandemic, this questionnaire is distributed online via a Google Form mechanism, and convenient sampling is employed.

The Exploratory Factor Analysis (EFA) is employed to explore and assess the usefulness of items measuring the construct. In this case, the construct is used rather than variable because the construct cannot be measured directly. It requires several items/indicators to indicate or explain certain constructs (For example, attitude, perceived usefulness, and environmental awareness). The questions (items or survey instruments) are considered useful if they meet the validity and reliability criteria. Preceding EFA, the sample adequacy has to be measured, and this can be assessed by utilising Kaiser-Meyer-Olkin (KMO) and Bartlett's test of Sphericity with the following conditions. First, the value of the Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy (MSA) should be greater than 0.50. Secondly, Bartlett's test of Sphericity results should be significant at $p < 0.001$ as recommended by [35].

In EFA, the principal component analysis (PCA) was employed to determine the number of factors to be retained and dropped. In this case, the function of Varimax rotation was applied as it was the most widely used orthogonal factor rotation method as it can clarify the analysis of factors [35]. Items that attained factor loadings with an absolute value below ±0.5 were discarded, while items with factor loading values of more than ±0.55 were retained [35]. The higher factor loading indicates a higher interconnection/correlation between one item to another in that particular construct. Data analysis was performed using IBM SPSS Statistics. Once all the above criteria are met, this study can proceed with the field study and answer the objectives of the study highlighted in the earlier section. The abovementioned steps were summarised in Fig. 4.

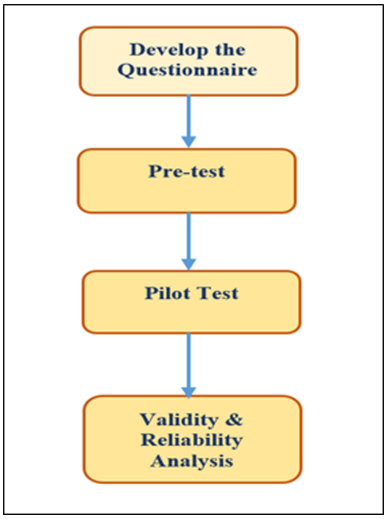

Fig. 4. Methodology steps

6 Research Finding

6.1 Exploratory Factor Analysis (EFA)

The data from the pilot study were concluded as suitable/adequate for EFA as the results from two tests which are Kaiser-Meyer-Olkin (KMO) and Bartlett's test of sphericity. These tests established that all constructs to measure attitude/behaviour and intention to use NTEA were significant. The values of KMO for all constructs exceeded 0.5, while Bartlett's test of sphericity for all constructs was significant ($p < 0.001$). Table 2 presents the results of KMO and Bartlett's test of sphericity for attitude/behaviour and intention to use technology.

Table 2. KMO and Bartlett's test of sphericity

Construct	No. of items in the construct	KMO	Bartlett's test of sphericity (<0.001)
Attitude/behaviour	7	0.917	0.000
Perceived usefulness	6	0.884	0.000
Perceived ease of use	6	0.915	0.000
Government policy	5	0.740	0.000
Intention to use	12	0.852	0.000
Perceived price	4	0.782	0.000
Environmental awareness	8	0.866	0.000
Knowledge of EE	6	0.772	0.000
Knowledge of RE	6	0.878	0.000
Perceived behaviour control	10	0.905	0.000
Subjective norms	6	0.769	0.000

Table 3 presents the retained items of the eleven constructs, namely, attitude, perceived usefulness, perceived ease of use, government policy, intention to use, perceived price, environmental awareness, knowledge of energy efficiency and renewable energy, perceived behaviour control, and subjective norms after exploratory factor analysis was conducted.

All the items in the eleventh construct obtained factor loading values of more than 0.5. The eigenvalue for the eleventh construct surpassed the recommended value 1 and above, as shown in Table 3. Instead, all the items explained at least 60% of the total variance,

Table 3. Exploratory factor analysis results

No.	Items	Factor loading	Eigenvalue	Total variance explains (%)
1	*Attitude/behaviour*			
	AT1	0.821	5.263	75.185
	AT2	0.910		
	AT3	0.928		
	AT4	0.912		
	AT5	0.682		
	AT6	0.902		
	AT7	0.890		
2	*Perceived usefulness*			
	PU1	0.894	4.840	73.397

(*continued*)

Table 3. (*continued*)

No.	Items	Factor loading	Eigenvalue	Total variance explains (%)
	PU2	0.469		
	PU3	0.933		
	PU4	0.920		
	PU5	0.948		
	PU6	0.877		
3	*Perceived ease of use*			
	PEU1	0.886	4.840	80.663
	PEU2	0.861		
	PEU3	0.903		
	PEU4	0.932		
	PEU5	0.889		
	PEU6	0.916		
4	*Government policy*			
	GP1	0.677 [0.626]	2.872 [2.565]	57.438 [64.115]
	GP2	0.640 [Dropped]		
	GP3	0.854 [0.882]		
	GP4	0.868 [0.894]		
	GP5	0.722 [0.772]		
5	*Intention to use*			
	ITU1	0.695	7.236	60.300
	ITU2	0.731		
	ITU3	0.687		
	ITU4	0.806		
	ITU5	0.849		
	ITU6	0.753		
	ITU7	0.717		
	ITU8	0.746		
	ITU9	0.826		
	ITU10	0.779		
	ITU11	0.826		
	ITU12	0.876		

(*continued*)

Table 3. (*continued*)

No.	Items	Factor loading	Eigenvalue	Total variance explains (%)
6	*Perceived price*			
	PP1	0.841	3.013	75.315
	PP2	0.824		
	PP3	0.875		
	PP4	0.928		
7	*Environmental awareness*			
	EA1	0.851	4.810	60.131
	EA2	0.880		
	EA3	0.688		
	EA4	0.203		
	EA5	0.831		
	EA6	0.836		
	EA7	0.855		
	EA8	0.823		
8	*Knowledge of EE*			
	KEE1	0.813	3.948	65.801
	KEE2	0.873		
	KEE3	0.783		
	KEE4	0.865		
	KEE5	0.829		
	KEE6	0.690		
9	*Knowledge of RE*			
	KRE1	0.845	4.698	78.300
	KRE2	0.901		
	KRE3	0.832		
	KRE4	0.951		
	KRE5	0.944		
	KRE6	0.827		
10	*Perceived behaviour control*			
	PBC1	0.716	6.593	65.929
	PBC2	0.680		
	PBC3	0.759		
	PBC4	0.825		
	PBC5	0.881		
	PBC6	0.818		

(*continued*)

Table 3. (*continued*)

No.	Items	Factor loading	Eigenvalue	Total variance explains (%)
	PBC7	0.858		
	PBC8	0.765		
	PBC9	0.879		
	PBC10	0.906		
11	*Subjective norms*			
	SN1	0.767	3.742	62.361
	SN2	0.835		
	SN3	0.747		
	SN4	0.743		
	SN5	0.786		
	SN6	0.853		

*Notes: The figure in the bracket is the new factor loading, eigenvalues, and total variance explained after taking out the GP2.

which also surpassed the recommended point as suggested by Hair et al. (2014), except for government policy with a total variance of 57.44%. Due to that, the GP2 is dropped because it has the lowest factor loading. As a result, GP1, GP3, GP4, and GP5 remained as the items to measure the government policy (Table 3).

6.2 Reliability

Next, the internal reliability of an instrument was measured to ensure that the instrument is free from random error and does not contain bias [36], Cronbach's alpha was utilised to examine the perceived usefulness, perceived ease of use, attitude, government policy, intention to use, perceived price, environmental awareness, knowledge of energy efficiency and renewable energy, perceived behaviour control, and subjective norms. This method was utilised as it is one of the most widely used methods to evaluate reliability where the value of 0.6 and above indicates acceptable internal consistency reliability [35].

Table 4 reported that all eleven constructs of perceived usefulness, perceived ease of use, attitude, government policy, intention to use, perceived price, environmental awareness, knowledge of energy efficiency and renewable energy, perceived behaviour control, and subjective norms were reliable as they surpassed the minimum reliability value of 0.6 [37]. Perceived ease of use achieved the highest reliability of 0.951, while the lowest reliability value was government policy at 0.788. Attitude/Behaviour came in second with 0.938. Table 4 also illustrates that no items were deleted among these eleven constructs as the factor loading for all items in every construct was satisfactory, as reported in Table 3. Thus, the construct reliability of these eleven constructs was established.

Table 4. Reliability results

Construct	No. of items after item deletion	Cronbach's Alpha
Attitude/behaviour	7	0.938
Perceived usefulness	6	0.894
Perceived ease of use	6	0.951
Government policy	4	0.796
Intention to use	12	0.937
Perceived price	4	0.887
Environmental awareness	8	0.854
Knowledge of EE	6	0.894
Knowledge of RE	6	0.944
Perceived behaviour control	10	0.935
Subjective norms	6	0.877

7 Conclusion

This research aims to develop a valid and reliable survey instrument to measure consumer behaviour towards new technology electricity appliances. For that particular purpose, the Exploratory Factor Analysis (EFA) was applied. Since the psychological aspect, in this case, is behaviour is not directly measured, a detailed literature review was carried out to identify items measuring the consumer intention to use the NTEA construct. This study revealed the TPB and TAM is the best theory to be applied and suited to measure residential consumer behaviour towards NTEA and electricity consumption. A set of questionnaires was developed, and it contains 11 constructs with a total of 72 items to be measured. The pilot study randomly sampled 104 residential electricity consumers using an online survey with an interval scale between 1 and 10. The EFA procedure on construct elements using IBM SPSS Statistics was performed. The Bartletts' Test of Sphericity and KMO test confirmed the adequacy of the sample size to assess a valid and reliable survey instrument to measure consumer behaviour towards NTEA. The result of EFA shows all the suggested items to measure attitude, perceived usefulness, perceived ease to use, intention to use, perceived price, environmental awareness, knowledge on EE and RE, perceived behaviour control, and subjective norms explained 60% and more of its variance changes. However, the suggested items to measure government policy explained less than 60%. One of the items (GP2) with the lowest factor loading is dropped from the construct to encounter the problem. The Cronbach Alpha indicates the constructs (with remaining items) are pretty reliable. The development scale and validation confirmed that the instrument is consistent and stable across samples. Based on the research findings, the field study can be conducted with valid constructs and items.

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